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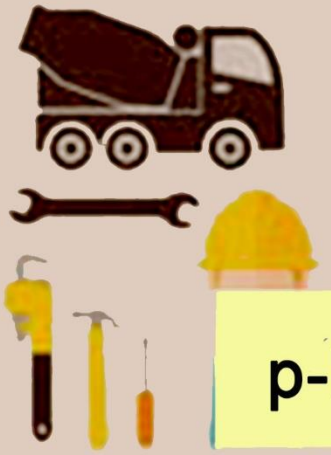

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PREFACE

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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

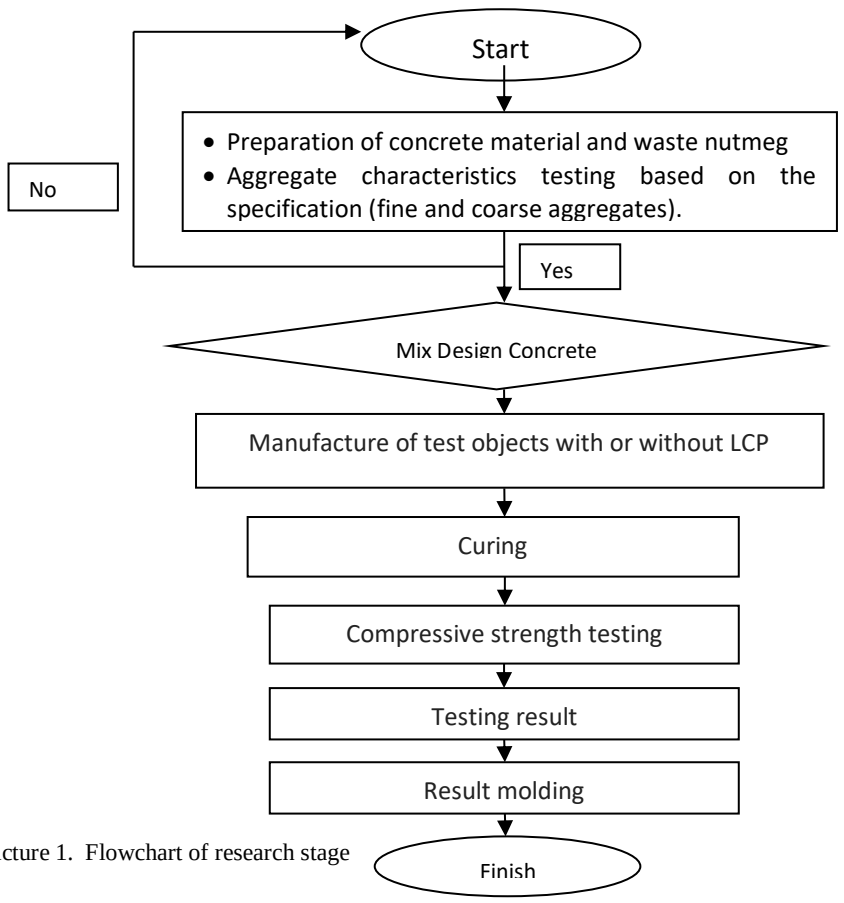
The primary data collection for this research is the result of testing of aggregate characteristics of coarse and fine aggregate. This test consists of testing the level of sludge, moisture content, volume weight, absorption, density, modulus of fineness and roughness modulus. After testing the characteristic 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)

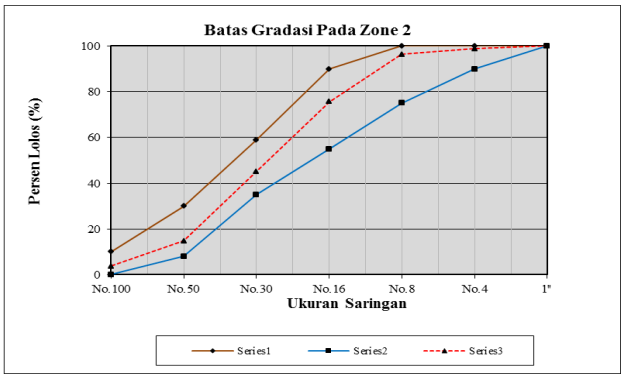
No	Aggregate Characteristics	Interval	Testing result	Description
1	Mud levels	Max 1%	1.04%	Not qualified
2	Water content	0.5-2%	1.23%	Qualified
3	Volume weight	1.4-1.9 kg/liter	1.80	Qualified
4	Absorption	0.2-2%	1.04%	Qualified
5	Specific weight			Qualified
	Dry-based S.W	1.6	1.114	Qualified
	Dry-surfaced 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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DESIGNING PLASTIC CUPES RING CUTTING MACHINE TO INCREASE PRODUCTIVITY

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Abstract. *The existence of plastic makes the society's lives easier and more practical. Recently, the various kinds of products are made from this material because the votes are more durable. Plastics also give a negative effect for the environment such as soil pollution. The purpose of designing this plastic cup ring cutting machine is to sort the kind of plastics and to accelerate the process of plastic recycling, so that the plastic processing can be done faster. The authors designed a plastic cup ring mowers with electric motor mover. The design concepts of this machine are the height of machine is: 90 mm of height with a width of 50 mm, frame in size of 50 mm x 50 mm made from angled steel. This machine uses two vertical cutting blades and one horizontal cutting blade. The activator which is used in this machine is an electric diesel 1/4 HP with the rotation speed of 1400 rpm, belt-V type A38 as a link of the diesel rotation to the spindle. It is used two pieces of cushions because the direction of the load presses is perpendicular to axis of the shaft. So it is used bearing type of UCF pillow block in the diameter of 75 mm. The cutting process is done in a standing position and the button is pressed manually by using manpower, so that the rotation can become stable. If using a machine the process of cutting a ring of plastic cup can be accelerated. Manually it can be produced approximately 5 pieces of plastic cups. But, if using a machine, it can be produced approximately14 pieces of plastic cups.*

Keywords : Machine, Cutter, Glass Ring, Plastic

1. INTRODUCTION

In everyday life, society is never separated from the use of plastics, which makes people's lives easier and more practical. The use of plastic has expanded almost to all aspects of people's lives. Various products and equipment are produced from this material, because it is considered more durable, not easily broken, flexible, and lightweight. While on the other hand, the plastic also has a negative impact on the environment. Various ways have been taken to reduce the impact of the use of plastic-based products, one of them by accumulating plastic waste, but this way will cause problems in the form of soil contamination because plastic waste is very difficult to decipher by bacteria decomposers naturally.

To reduce the amount of plastic waste, especially plastic cup waste, cutting and separation processes are required on the clear plastic cup section with colored plastic cup parts. In the Tabanan area there are many plastic cup collectors, cutting the plastic cup ring is still using the manual way that affects the safety of its workers. Cutting of plastic cup rings is mostly done by using scissors or cutter. The use of tools in the form of scissors or cutter lies in the way of cutting plastic cup rings. If using a pair of scissors, the plastic cup ring is cut from the top of the glass, then circle the cut glass beam, so that the glass ring is cut off. Meanwhile if it is used a cutter, cutting the plastic cup ring starts on the side of the glass. In the process of cutting the plastic cup rings in a manual way, it is encountered many obstacles, such as: it takes a lot of time to cut a plastic cup and the results were not maximal due to fatigue from humans.

Based on these conditions, the author wishes to facilitate and speed up the process of cutting plastic cup rings. Therefore, the author designed a plastic cup cutting machine with electric motor drive. This plastic cup cutting machine has many advantages: in the process of cutting the plastic cup rings, it can produce a flat piece on

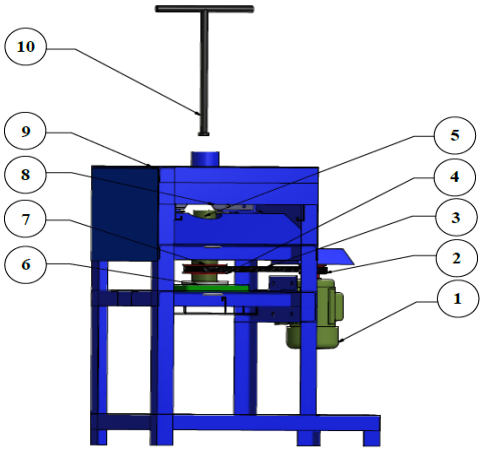
the side of the glass as it is cut vertically and horizontally or circularly according to the diameter of the glass rings. The flat cuts can add weight from plastic cups. The maintenance of this machine is very simple so that the process of replacing components and workmanship can be done independently. [1]

2. METHOD

The previous cutting process has a disadvantage that the cutting process takes quite a long time, and the cut is irregular, so it affects the weight of the plastic cup. The manual cutting process is as shown in Picture 1.

Picture 1: Manual cutting

Based on a survey conducted by the community and collectors about plastic cup waste processing, in order to make the process of cutting glass rings faster and to minimize work accidents, then it can be designed a tool that can increase the economic value of plastic cup waste. The design of plastic cup cutter is as shown in figure 2. [2]



Description:
1. Electrical motor
2. Motor pulley
3. V-belt
4. Pulley
5. Horizontal cutting blade
6. Pads
7. Pulley buffer
8. Vertical cutting blade
9. Engine frame
10. Stick

Picture 2: the Design of Plastic cup Ring Cutting Machine

The stack of glass rings will be cut in a sustainable or continuous manner using human power (stick presses). In order to cut the glass rings faster, it is made 2 pieces of cutting blades: vertical and horizontal cutting blades. The vertical cutting blade serves to split the glass rings, to allow for faster installation of 2 vertical blades. The split glass rings are meant to separate the rings with a pile of cups. Then after the split, the ring of glass will be cut by a horizontal blade in a circle. The clipped glass result will fall down, so that the results and the glass pieces will be separated. The formula required to calculate the main components of the Plastic Ring Cutting Machine is as follows: [3]

1. Selection of Electrical Motor

$$P=T.\omega = \frac{\pi . n . T}{30} \qquad \text{..... (1)}$$

In which:
T = Torque (N.m).
F = Total force (N).
r = Radius (m).
P = Electrical motor power (Watt).
n= Rotation on electrical motor shaft (rpm).
ω = Radian velocity (rad/s).

2. Power Successor with V-Belt

$$L=2C + \frac{\pi}{2}(dp+Dp)+ \frac{1}{4C}(Dp-dp)^2 \quad \text{..... (2)}$$

In which:
L = length of belt (mm).
C = Distance between axis (mm).
Dp=Diameter of the pulley driven (mm).
dp= Diameter of the mover pulley (mm).

$$N = \frac{P_d}{P_o.K_\theta} \quad \text{.....(3)}$$

In which:
N = The amount of the belts needed.
P_d=Power of the motor plan(Hp).
P_o=Capacity of the power transmitted for one belt
K_θ=Correction factor.

3. Planning of the shaft dimension

$$ds = [(5,1/\tau\alpha)\sqrt{(Km.M)^2+ (Kt.T)^2}]^{\frac{1}{3}} \quad \text{..... (4)}$$

$$\sigma_b = \frac{M_b}{W_b} \quad \text{.....(5)}$$

In which:
ds = Diameter of the shaft (mm).
$\tau\alpha$ = Shear stress (N/mm^2).
Km= For loads with light stacks
K_t= Correction factor
Mb= Bending moment
Wb = Moment of bending resistance.
σb = Bending stress.

The research method used is true experimental research. Furthermore, the test is done to get the tuna grinding process which requires the shortest time compared to the results of the survey done.
The test phase of the design is as follows:
a. Preparing the tools that have been made and other properties.
b. Observing the operation of the tool, whether to operate according to its function or not
c. Preparing plastic cupes to be cut (figure 3)
d. Starting to do the cutting process and record the time by using stopwatch.

Picture 3. a pile of plastic cupes

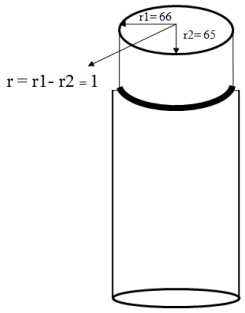
3. RESULT AND DISCUSSION

3.1 Result

Plastic cup ring cutting machine is a combination of several components required in accordance with its function to support a mechanism, so that it can become a system functioned in accordance with the expectation. The process of making the components of the machine is preceded by the calculation process. The calculation process is:

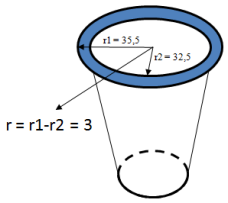
a. The electric motors required.

To determine the cutting force (F) the tensile strength of plastic until the plastic is cut off. Tensile strength (σ) of polypropylene type plastic is 40 N / mm ^ 2. [4]



Picture 4. Cutting blade.

$F = \sigma . A$
$= 40\ N/mm^2 . \pi . r^2 mm$
$= 40\ N/mm^2 x\ 3,14\ x1^2\ mm$
$= 125,6\ N\ x\ 1$
$= 125,6\ N$



Picture 5. Plastic cup

$T = F . r$
$= 125,6\ N\ x\ 0,003\ m$
$= 0,376\ N.m$

To determine the speed at the shaft, it is conducted experiments using the lathe to cut glass rings, the results obtained is assumed to be 950 Rpm. Then the calculation of electric motor power as follows:

$$P = \frac{\pi . n . T}{30}$$

$$= \frac{3,14 \times 950\ rpm \times 0,376\ N.m}{30}$$

$$= \frac{2.983 \times 0,376}{30}$$

$= 0, 050\ Hp$

To obtain a safe plan power, the nominal power must be multiplied by the correction factor (fc) 1.5, then:

$Pd = P . fc$
$= 0,050\ Hp \times 1,5$
$= 0,075\ Hp$

So the electric motor power used is 0.075 kW ~ 0.25 Hp. The specific data of the electric motor is as follows:

Type	: AC electric motor
Motor power	: 0.25 Hp
Type	: JY09A- 4
Frequency	: 50 Hz
Rotation	: 1400 rpm

b. The V-belt used

1) Determining the diameter of the drive pulley (dp)
Drive rotation (n_1)= 1400 rpm
Driven rotation (n_2)= 950 rpm
Diameter of the drive pulley (Dp) = 127 mm
$n_1/n_2 = D_p/d_p$
1400/950 = 127/dp
$1400d_p = 950 . 127$
dp = 76,2 mm

2) Length of the V-belt (L)
C = 2 . Dp
= 2 . 127
= 254 mm

$$L = 2C + \frac{\pi}{2}(dp + Dp) + \frac{1}{4C}(Dp - dp)^2$$

$$L = 2 \times 254 + \frac{3,14}{2}(76,2 + 127) + \frac{1}{4 \times 254} + (127 - 76,2)^2$$

$$= 508 \text{ mm} + \frac{3,14}{2}(203,2 \text{ mm}) + \frac{1}{1.016 \text{ mm}} + (50,8 \text{ mm})^2$$

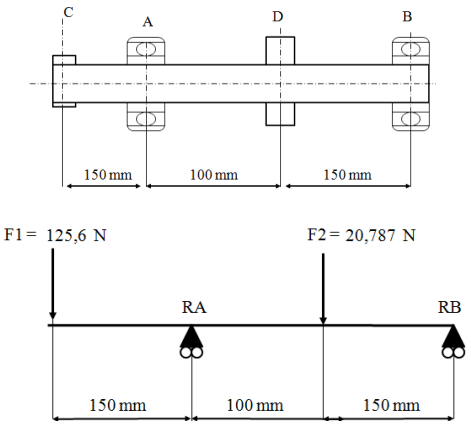
= 508 mm + 319,024 mm + 2,54 mm
= 827,024 mm + 2,54 mm
= 829,564 mm

$$= \frac{829,564 \text{ mm}}{25,4}$$

= 37,66 inch

3) The amount of belt used (N)
(Dp-dp)/C = (127 – 76,2)/254
= 0,2
Correction factor (K_θ) = 0,99
Power capacity transmitter for a single belt (Po) = 0.48 kW (with n = 1400 rpm, pulley diameter = 76,2 mm)
N = Pd/(Po . K_θ)
= (0,075/(0,48 . 0,99)
= 0,139 ~ 1 unit
So the nominal number of the V-belt, Type A, Number 3, 1 unit, L = 73 inch.

c. The shaft dimension used



Picture 6. Free Body Diagram (FBD)

In which:
$\tau_{\acute{a}}$ = material shear stress = 28,33 (N/mm^2)
M_b= biggest entress moment = 18.840(Nmm)
T = largest torque moment = 376 (N.mm)
F_S = Security factor = 3

σ_b = stretching power ST 37 = 340 (N/mm^2)

$$d_1 = [(5,1/\tau\alpha)\sqrt{(Km\ .\ M)^2 + (Kt\ .\ T)^2}]^{\frac{1}{3}}$$
$$= [(5,1/28,33)\sqrt{(1,5 \times 18.840)^2 + (3 \times 376)^2}]^{\frac{1}{3}}$$
$$= [(5,1/28,33)\sqrt{(28.260)^2 + (1.128)^2}]^{\frac{1}{3}}$$
$$= [0,180\ \sqrt{799.899.984}]^{\frac{1}{3}}$$
$$= [0,180 \times 28.282]^{\frac{1}{3}}$$
$$= 17 \text{ mm}$$

From the calculation above, it is obtained the result of the diameter of the shaft with the size of Ø17 mm. Due to the size of the cutting blade is Ø65 mm and diameter of bearings in the market is Ø75 mm, the size of the shaft used is Ø75 mm. To find the diameter of hollow shaft then it is used formula with the equation as follows:

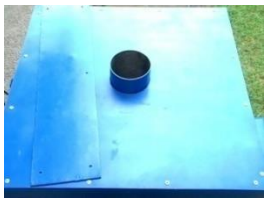
$$\sigma_b = \frac{M_b}{W_b}$$
$$\sigma_b = \frac{M_b}{\frac{1}{64}(d_1^4 - d_2^4)}$$
$$d_2 = \sqrt[4]{(d_1)^4 - \frac{64 \times Mb}{\sigma b}}$$
$$d_2 = \sqrt[4]{(75 \text{ mm})^4 - \frac{64 \times 18.840 \text{ N.mm}}{340 \text{ N/mm}}}$$
$$d_2 = \sqrt[4]{31.640.625 \text{ mm} - \frac{1.205.760 \text{ N.mm}}{340 \text{ N/mm}}}$$
$$d_2 = \sqrt[4]{31.640.625 \text{ mm} - 3.546}$$
$$d_2 = \sqrt[4]{31.637.079 \text{ mm}}$$
$$d_2 = 72,9 \text{ mm}$$

From the calculation above, it has been obtained the size of the inner diameter of the perforated hollow with the size of Ø72.9 mm. But that size is considered less secure. Therefore, the inner diameter of the hollow shaft used is Ø65 mm.

The manufacturing process includes the production process, the assembly process, and the final process (finishing). The production process is the process of making from raw material to finished product, so it involves many machines such as cutting machines, lathes, drilling machines, grinding machines, and measuring equipment. The assembly process is a process of merging the finished product / component into one unified tool or machine. Equipment used is usually welding equipment. The final process (finishing) is the final work in every tool or machine making by painting the tool or machine as desired.

Picture 7. Painting process

Here is the form of the finished plastic cup ring cutting machine which is shown in picture 8. [5]



Picture 8. The design result

This plastic cup ring cutting machine is designed with two cutting blades. Where a vertical cutting blade has a thickness of 3 mm and a vertical blade can also be removed and sharpened so that the tip of the blade remains sharp to cut the plastic. Then the second blade is mounted and welded on the iron pipe, the iron pipe will rotate clockwise and will cut horizontally. The drive of this machine uses an electric motor which is connected using a V-belt. The height of this plastic cup cutting machine 90cm, 50cm for the width and 50cm for the length to ease the process whenever the plastic cup rings are cut because the cutting process is done in a standing position and is pressed manually using human power.

The testing process is done in 2 (two) stages, the first stage is to observe directly the supporting components according to their respective functions. After all the components are observed, it works properly. The second stage is testing the performance of machines against plastic cups. Test method is done as much as 10 times with 20 cups of plastic every one minute. The testing process includes the ability of the machine to cut the plastic cup rings. From the test results it is obtained cutting results using a plastic cups ring cutting machine, as shown below:

Picture 9. The result of plastic cup rings cutting

Here is the testing result:

Table 1. Comparison of the Test Result

No	Cutting		Time
	Manually	Using machine	
1	3 cups	12 cups	1 minute
2	4 cups	14 cups	
3	5 cups	17 cups	
4	4 cups	13 cups	
5	5 cups	16 cups	
6	3 cups	14 cups	
7	4 cups	13 cups	
8	3 cups	12 cups	
9	4 cups	14 cups	
10	5 cups	15 cups	
Average	5 cups	14 ups	

3.2 Discussion

The difference of the cutting result manually or by using machine can be clearly seen, since human physical ability which cannot be used continually, requires time-lapse, and prudential factor for safety in work.

The operation of either manual or machine-used cutting lasts for 5 hours for one day. If it is linked to the average time (table 1), the amount of the plastic cups without rings is as follows:

a. Manual way
   Five plastic cups are cut for 1 minute, it means that one cup is cut for 0.2 minute, so in five hours the cups which have been cut are (5 x 60) / 0.2 = 1500 plastic cups.
b. Cutting machine
   14 plastic cups are cut for 1 minute. It means that one cup is cut for 0.07 minute, so in 5 hours the plastic cups cut are (5 x 60) /0,07 = 4285,7 ~ 4286 plastic cups.

The calculation results show an increase in the production of plastic cups that are cut with the cutting machine. Percentage increases in manual cutting compared with cutting by using machine for (4286 - 1500) / 1500 x 100% ≈186%. Thus the productivity of plastic cups has increased with the availability of plastic cups that can be recycled as much as 2786 cups.

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

Based on the test result and the discussion, it can be concluded that:

a. The machine can cut the cups faster than the manual way, so it can accelerate the recycling process of the polypropylene plastic.
b. The collectors can accelerate the process of separating these types of plastic cups and the resulting pieces that are evenly distributed.

4.2 Suggestion

a. In the process of cutting the plastic cup rings by using the machine, it is expected to still pay attention to the security.
b. To set and sharpen the cutting blade so that at the operation time, it can be gotten maximum result.
c. In pressing the plastic cup, the cup must be in perpendicular position to get a uniform cut.

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THE COST OBTAINED BY APPLYING PRECEDENCE DIAGRAM METHOD TOWARD THE TIME OPTIMIZATION ON BUILDING DEVELOPMENT PROJECTS

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Abstract. *The complexity of the project expands along with the progress of human civilization. The problems that appear will be more numerous and complicated. The role of project management is indispensable in order to address and prevent these problems, so that the cost,the quality and the time agreed upon can be realized. Cost and time relationship is not directly proportional, so it is necessary to determine the optimal time by optimum cost. Optimization is a best effort undertaken by planning various alternative methods of implementation, in order to obtain optimal timing of projects with optimum cost. Planning and scheduling are the backbone of the entire project, which is based on clear objectives. Microsoft Project as one of the scheduling software based on Precedence Diagram Method (PDM) provides many advantages, one of which scheduling can be done more quickly and thoroughly.In this research, it is created six alternative models as follows: In the first alternative ,it is acquired the project period of 256 days , at a cost of Rp2,190,234,913.43 ; In the second alternative , the was obtained the project period of 150 days , with a cost of Rp1,903,674,873.6 ; In the third alternative , it was obtained the project period of 102 days , at a cost of Rp1,873,215,897.61 ; In the alternative IV , it was obtained the project period of 99 days , at a cost of Rp1,895,159,526.12 ; In the alternative V , the project period was 96 days , at a cost of Rp2,019,623,191.13 ; In alternate VI , the project period was 89 days at a cost of Rp2,090,543,033.77. From the above calculation, then the result is interpolated in order to obtain the optimum time for the development project. The optimum time obtained is 120 calendar days, at a cost of Rp. 1,884,638,013.61.*

Keywords : Project, Project Management, Planning, Scheduling, PDM, :Optimization, Methods of Implementation, Cost and Time.

1. INTRODUCTION

1.1 Background

Nowadays construction projects have grown increasingly complex and complicated. No doubt the problems faced will be more and more difficult, so it takes the role of project management to the overall stages of the project, in order to minimize the problems posed and the three project targets that are appropriate cost, time, and quality can be met.

Planning is the overall backbone of the project, and it must be realistically structured. Realistic planning is expected to guarantee the completion time of a construction project in accordance with the plan. Because it is not guaranteed that the timing of fast project implementation requires minimal cost, and vice versa. In other words, the time and cost ratio of the project is not directly proportional. Based on this it is necessary to take into account how to get the most optimum time planning with the least cost.

Optimization is defined as a process of deciphering the duration of the project to obtain optimal completion time and reasonable cost, using various alternative methods of implementation, such as: heavy equipment use, increase in the number of workers, additional hours of work and others, tailored to the field conditions and needs.

To plan when a project should be implemented, a scheduling is required. With the scheduling, the problem of delay in completion of the project can be reduced and there will be an increase on the timeliness of completion, so the budget can be saved without any additional costs that are not really needed. There are two kinds of project scheduling techniques that are often used today. Networking is the best scheduling technique right now because it can solve the problems of the only scheduling technique (Gantt-Chart). In its development there are various kinds of networking methods such as CPM, GERT, PERT, PDM etc.

PDM (Precedence Diagram Method) is a scheduling tool that focuses on the equilibrium issue between project cost and time of completion. The PDM diagram does not require dummy / fictitious activity and additional sections to indicate overlap. Based on the above description, the authors are interested to raise the topic of Project Development Cost Building Using PDM (Precedence Diagram Method) ".

1.2 Research Problems

Based on the above description of the background, the issues to be raised in this research are as follows:

a. What is the shape of network (network) with PDM method in Building Construction project?
b. How much is the total cost of the Denpasar Building Development project with optimum duration?

1.3 Research Objectives and Benefits

The purpose of this study are as follows:

a. To determine the network on the Development project.
b. To analyze the cost estimates for a Building Development project whose completion time is accelerated.

The benefits of this research are as follows:

a. To complete the project on time so that its budget use becomes efficient and there is no waste.
b. To apply the sciences gained in lectures to solve existing problems in the project.
c. To be able to provide input to the agencies involved in construction work projects in order to produce construction products that are timely in progress, precise and cost-effective methods.

1.4 Research Scope

The limitations of the research problems are as follows:

a. The research was conducted on Building Construction project.
b. Project scheduling analysis using PDM method.
c. For alternative optimization of time on the addition of manpower, available resources are considered unlimited.
d. For alternative optimization of time on the addition of working hours (overtime), used normal labor productivity.
e. Normal working hours in one day is 8 hours ie at 08.00 until 12.00, then at 13:00 until 17:00.
f. There is no volume change in each job.

1.5 Literature Review

a. Project

The construction project is a series of activities that are only implemented once and generally takes a short period of time. In the series of activities, there is a process of processing project resources into a result of activities in the form of buildings. In addition, the construction project has 3 (three) characteristics: unique, requires resources (money, machinery, methods, and materials), and requires organization [3].

b. Project Management

H. Kerzner states that project management is planning, organizing, leading, and controlling company resources to achieve short-term goals that have been determined [10].

Project management is the implementation of systematic management functions in a project using limited resources, effectively and efficiently to achieve the project objectives more optimally.

c. Planning

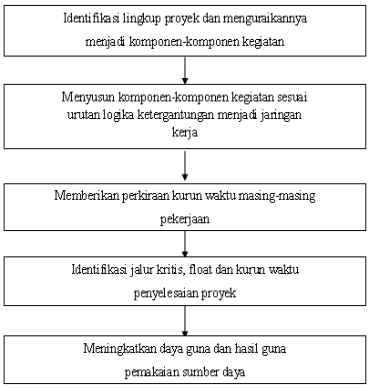
Planning is a process of trying to lay the groundwork of goals and objectives including setting up all resources to achieve them. Planning provides guidance for the implementation of resource allocation to carry out activities (Imam Suharto, 1997). Broadly speaking, planning serves to lay the foundation of project objectives, namely scheduling, budget and quality.

d. Scheduling

Scheduling is the elaboration of project planning into a sequence of steps on the implementation of work on a time scale to achieve the target. Scheduling determines when activities are initiated, deferred and resolved, so that the financing and use of resources will be timed according to predetermined needs [8]. Planning a project schedule can be done well and realistically, if in the planning process schedule is done in stages with the steps as follows:

1) Making WBS
2) Determining the implementation method
3) Determining duration
4) Determining relation between activities
5) Looking back to whether the duration and sequence of activities are reasonable and workable in the field

There are a variety of project scheduling methods to plan graphically from the construction activities, but only two methods are commonly used; they are gantt charts and networking (CPM, PERT, PDM, GERT, etc.). Here is the systematizing of scheduling on networking methods:



Picture 1 Network Scheduling Systematic

e. PDM

PDM was developed in the 1960s by the US Navy in collaboration with Professor Dr. John Fondahl of Stanford University to develop a CPM calculation method that will also solve the use of "Dummy" dependencies. Dr. Fondahl reversed the AOA diagram method to the traditional AON method known as the precedence method. The Fondahl method then became an option for the critical path method (Uher, 1996). Although the approach is substantially different between CPM and PDM, the results are the same (O'Brien and Plotnit, 1999).

The advantage of Precedence Diagram Method (PDM) compared to CPM is that PDM does not require fictitious / dummy activities so the networking becomes simpler [5]. This is because different overlapping relationships can be created without increasing the number of activities.

f. Optimization

Optimization is a process done in the best way in a job to gain profit without having to reduce the quality of work. There are several alternatives to optimize the time and cost of project completion that can be done, namely:

1) Use of Heavy Equipment.
2) Replacement or Repair of Working Methods.
3) The addition of Labor.
4) Implementation of Working Hours (Overtime).
5) Work shift

g. Implementation method

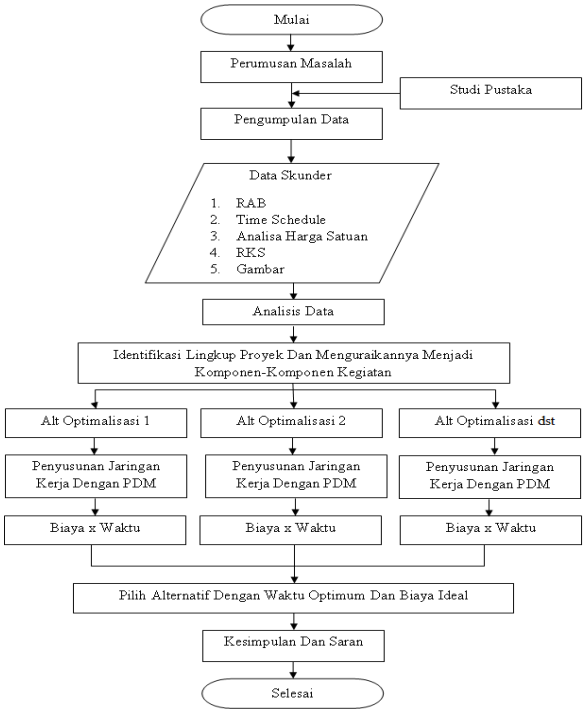
Method of work implementation represents the elaboration of procedure and technique of the implementation. The use of appropriate, practical, fast and secure methods is helpful in the completion of work on a construction project. So precise quality, exact cost / quantity and timely as determined, can be achieved. The method of implementation has an enormous impact on the direct costs of a project. The aspects that affect the method of job implementation include:

1) Implementation method is a technological innovation aspect required by the terms of the contract
2) Selected implementation methods must be tailored to the various environmental conditions of the project.
3) The method of implementation is affected by the availability of resources.

2. RESEARCH METHOD

2.1 Flow Chart

In conducting a research, obviously, a research method plan should be developed so that the research can run systematically and directed. Here is the systematic research in the form of flow chart.



Picture 1 The Flow Chart of the Research Stages

2.2 The Time of Data Collection

The research execution time is 10 weeks.

2.3 Research Location

For the location of this research, it was taken the building project.

3. RESULT AND DISCUSSION

3.1 Data Analysis

a. Identification of the Project Scope

Identification of project scope is the first step in networking. Identification of the project scope aims to know the activities that exist within a project and grouped into work groups. Arrangement of project scope is based on the sequence of job execution which is adjusted to sequence of work on Time Schedule that already exists.

b. Calculation of Project Cost

In this study, it is assumed that, costs other than the overhead cost are in the scope of the direct costs. Based on the journal Asri Nurdiana (2015) which is related to indirect cost analysis, it is mentioned that overhead cost is 5% of the budget plan, so direct cost can be formulated as follows:

Direct cost = (100% - Overhead cost) x Budget plan
= (100% - 5%) x Budget plan
= 95% x Budget plan
= 95% x Rp. 2,094,055,054
= Rp. 1.998,838,970.30

Based on the calculation of the direct cost, the indirect cost can be calculated as follows:

Indirect cost x d = Budget plan – Direct cost
= 2094055054 – 1998838970.30

Indirect cost x 150 = Rp. 95,216,083.50

Indirect cost = Rp. 95,216,083.50/150 days
= Rp. 634,773.89/day

c. Calculation of Project Resources

The calculation of the project resources in this case is labors, equipments, and materials. The calculation of the project resources applied PU unit work analysis. Here is an example of the need calculation of project resource (labors):

1 m' Analysis of Bore Pile Foundation Work (Labors)

0.03	oh	Foreman	@	Rp. 75,000	Rp. 2,250
0.18	oh	Digger	@	Rp. 60,000	Rp. 10,800
0.425	oh	Bricklayer	@	Rp. 60,000	Rp. 25,500

Produktivitas mandor = koefesien x volume pekerjaan
Produktivitas = 0.03 x 212.8
= 6.384 oh
Upah mandor = produktivitas x upah
= 6.384 x Rp. 75,000
= Rp. 478,800

Kebutuhan mandor untuk durasi 14 hari adalah sebagai berikut:

Produktivitas mandor x d = 6.384 oh
Produktivitas x 14 = 6.384
Produktivitas = 6.384 /14
Kebutuhan (14 hari) = 0.456 org
Upah mandor = produktivitas x upah
= (0.456 x 14) x Rp. 75,000
= Rp. 478,800

Produktivitas tukang gali = koefesien x volume pekerjaan
Produktivitas = 0.18 x 212.8
= 38.304 oh
Upah tukang gali = produktivitas x upah
= 38.304 x Rp. 60,000
= Rp. 2,298,240

Kebutuhan tukang gali untuk durasi 14 hari adalah sebagai berikut:

Produktivitas t. gali x d = 38.304 oh
Produktivitas x 14 = 38.304
Produktivitas = 38.304 /14

Kebutuhan (14 hari) = 2.736 org

Upah tukang gali = produktivitas x upah

= (2.736 x 14) x Rp. 60,000

= Rp. 2,298,240

Produktivitas t. batu = koefesien x volume pekerjaan

Produktivitas = 0.425 x 212.8

= 90.44 oh

Upah tukang batu = produktivitas x upah

= 90.44 x Rp. 60,000

= Rp. 5,426,400

Kebutuhan tukang batu untuk durasi 14 hari adalah sebagai berikut:

Produktivitas t. batu x d = 90.44 oh

Produktivitas x 14 = 90.44

Produktivitas = 38.304 /14

Kebutuhan (14 hari) = 2.736 org

Upah tukang batu = produktivitas x upah

= (2.736 x 14) x Rp. 60,000

= Rp. 5,426,400

Total Upah = 478800 + 2298240 + 5426400

= Rp. 8,203,440.00

d. Alternative Planning of Optimization

The alternative planning of the optimization on the building construction project consists of six alternatives. The detail of each alternative is as follows:

1) There are six alternatives consisting of one plan alternative (existing) and five new alternatives.
2) Five from three alternatives are planned by deciphering the duration and changing the dependency relationship of each alternative work item.
3) The remaining two alternatives are done by addition of working hours (overtime).

e. Deciding the Work Item Duration

In deciding the duration for each work item in each alternative, trial and error method is applied. This method is chosen because of the relation between resources and duration which use fixed work relation. Things to consider in determining duration are overhead, critical paths, dependency relationships and project densities.

f. Flatten the Resources

Resource leveling is important to determine the maximum (peak) effort required in a given period of time. In one period of course there is not only one work item but other work items being carried out in that period. Maximum requirements obtained do not reflect the needs of the unit as a whole, because between the efforts of one period to another is not the same. So the calculation of the need for the next work unit is used with the calculation of the average. This calculation will produce a straight line.

g. Calculating Overtime

In this study, overtime calculations will be planned using Microsoft Project help. The required data is the overtime wage of each labor which is calculated per unit hour. Overtime wages are determined based on Ministerial Decree No. 102/2004. In the regulation, overtime pay is calculated as follows:

3 hours of overtime = 1.5 x normal wages

4 hours overtime = 2 x normal wages

In the above calculations can be drawn conclusions for one hour of overtime requires a fee of 0.5 x normal wage.

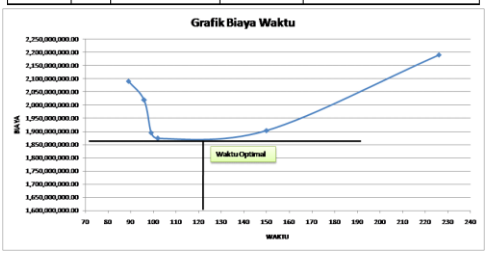
1 hour overtime = 0.5 x normal wage

h. The Calculation Results

To find out the most optimal cost and time, it is planned six alternative models. Once it is processed with Microsoft Project (see the attachment), then the results obtained are shown the following table:

Table 1 Calculation Result

	Waktu	Biaya	Jumlah Tenaga	Alternatif
Alternatif 1	226	2190234913	45	Predessesor
Alternatif 2	150	1903674874	72	Rencana
Alternatif 3	102	1873215898	101	Efisiensi Durasi
Alternatif 4	99	1895159526	101	Predessesor dan Efisiensi Durasi
Alternatif 5	96	2019623191	101	Lembur
Alternatif 6	89	2090543034	101	Lembur



Picture 3 Graphic of Cost and Time Relation

3.2 Discussion

In this research, six alternative models are created. Each alternative is described as follows:

a. In alternative I, it is obtained project time for 256 days, at a cost of Rp2,190,234,913.43;
b. In alternative II, it is obtained project time for 150 days, at a cost of Rp1,903,674,873.6;
c. In alternative III, it is obtained project time for 102 days, at a cost of Rp1,873,215,897.61;
d. In alternative IV, it is obtained time project for 99 days, at a cost of Rp1,895,159,526.12;
e. In alternative V, it is obtained time project for 96 days, at a cost of Rp2,019,623,191.13;
f. In alternative VI, it is obtained time project for 89 days, at a cost of Rp2,090,543,033.77.

From the above calculation, the graph shows that the optimal time is 120 calendar days. So in order to know how much cost incurred, interpolation is applied as follows:

Biaya = 1873215897.61 + (((120-102)/(150-102)) x (1903674873.61-

= 1873215897.61)

= Rp. 1,884,638,013.61

Based on the above interpolation result, it can be concluded that the optimal time in Building Project is 120 calendar days with optimum cost of Rp. 1,884,638,013.61. The percentage of cost efficiency and project time of the plan are as follows:

Efficiency of Project Time

E = Waktu Rencana – Waktu Optimalisasi

= 150 – 120

= 30 hari kalender, atau

E = Waktu Rencana - Waktu Optimalisasi / Waktu Rencana x 100%

= ((150 – 120) / 150) x 100%

= 20%

From the above calculation results, it is known from the time of optimization that there is efficiency / time savings of 30% of the time plan or 30 calendar days.

Efficiency of Project Cost

E = Biaya Rencana – Biaya Optimalisasi

= Rp. 1,903,674,873.61 – Rp. 1,884,638,013.61

= Rp. 19.036,860.00, atau

E = Waktu Rencana - Waktu Optimalisasi / Waktu Rencana x 100%

= ((1903674873.61– 1884638013.61) / 1903674873.61) x 100%

= 1%

From the above calculation, it can be seen from the cost of optimization that there is an efficiency / cost savings of 1% of the cost plan or Rp.19.036,860.00

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

Based on the previous calculation, conclusion can be drawn as follows:

a. The network form on the PDM (precedence diagram method) can be described as an activity on a node or AON (Arrow Activity Node). In this method, the activity is written in a node that is generally rectangular, while the arrow is the indicator of the relationship between the activities concerned. Thus, dummy which is an important sign to indicate a dependency relationship, in PDM is not required.
b. The total cost of implementation of Building Construction Project with optimum duration of 120 calendar days is Rp.1,884,638,013.61.

4.2 Suggestion

a. In choosing various alternative methods of implementation, the risks also need to be considered.
b. The important thing to consider in scheduling planning with PDM (Precedence Diagram Method) method is the logic of work dependence. In scheduling, it should be noted also about the critical path; the more work items through which the critical path is, the higher the risk will be. Good scheduling is scheduling with a project that has a total float lot and has 1 or 2 critical paths starting from the beginning to the end of the project.
c. PDM scheduling is very effective on large-scale projects.
d. In the calculation, it is assumed that the decrease in productivity in all the activities ejected is the same and fixed. In fact, it is very difficult to maintain good work productivity due to many obstacles during the implementation of the activity and because of the different volumes of each job, so good and proper planning is essential in project implementation.
e. In realizing an optimal project, it is required a strict supervision.

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AGE AND COMPRESSIVE STRENGTH OF CONCRETE FROM VARIOUS BRANDS OF PORTLAND COMPOSITE CEMENT (PCC)

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Abstract. *Recently it is provided in the construction market several types of cement such as OPC (Ordinary Portland Cement), White Cement and most recently is PCC (Portland Composite Cement). The composition of PCC cement ' s raw materials is Clinker, gypsum and additive materials. Additive materials used are limestone, fly ash and Trass. Unlike OPC type which does not use Fly Ash and Trass additives, in PCC it is used additives like Fly Ash and Trass where there is SiO2 compound that can increase the compressive strength. The research was carried out at the Laboratory of Civil Engineering Department of the Bali State Polytechnic using a cylindrical test object with size 15x30 cm of 20 pieces for each concrete age with a compressive strength of 25 MPa plan, tested at the age of 3, 7, 14, 21, 28, 56, and 90 days following PBI'71. The concrete strength of the concrete characteristics of the plan was achieved at the age of 56 days, with the value of the compressive characteristic of the plan reached at age 56 days with consecutive values of 25.82, 27.67, 26.80, 31.20 MPa and 28.81 MPa for Tonasa, Holcim, Bosowa, Merah Putih, and Tiga Roda cements. This value is greater than the value of compressive strength targeted based on the calculation of job mix design, in which it is 25 MPa. Conversion of Age and Compressive Strength Characteristics for the 5 (five) brands of PCC cement.*

Keywords : Concrete, PCC Cement, Age of concrete, Compressive strength of concrete

1. INTRODUCTION

1.1 Background

In public market, it is very difficult to get Portland type I (OPC) cement. The currently outstanding types are PPC (portland pozollan cement) and PCC (portland composite cement). This type of cement is currently used as an adhesive in a mixture of concrete. In the ready mix business there is also a tight competition, so in order to be able to exist they substitute cement with fly ash to get more competitive price.

Problems arised at the time of the testing of cube and cylinder test objects; that is the testing of concrete samples in various ages. The test data are often obtained at the ages 3, 7, 14 that the compressive strength of the concrete in accordance with the planned compressive strength is even greater. However, the 28-day sample test often results in a smaller value than the quality of the plan. To determine the value of compressive strength in the test at age less than 28 days converted with the coefficient of age and compressive strength quoted from PBI 71. Cube test object used in PBI 71 comes from cement of type I. Because of the controversy, the author wants to find out why such problems can happen.

1.2 Problems of the Study

The problems of this research are as follows:

a. At what age is the planned compressive strength of the concrete achieved?
b. What is the conversion rate of the compressive strength characteristic achievement in the variation of age for the concrete of the adhesives from several PCC cement brands?

1.3. Specific Aims of the Research

The expected objective of this research is to get an answer about the achievement of concrete compressive strength value in the age variation for some PCC cement brands. The value is to become a new reference in the construction industry which still uses the age conversion and concrete compressive strength value of type I cement adhesive.

2. METHOD

2.1 Materials

This research uses mixed concrete materials consisting of water, adhesives and fine aggregates. The provisions of each of these materials are described as follows.

The water used for mixing the concrete is taken from the existing water channel of the water supply company in the Materials Laboratory of the Civil Engineering Department of the Bali State Polytechnic. For hydraulic adhesive, a mixture of 5 PCC cement brands, among others: *Tonasa, Holcim, Bosowa, Merah Putih, and Tiga Roda.*

For fine aggregates, it is used natural sand derived from Karangasem in which the grain arrangement is designed to meet the gradations of zone 2 according to SNI 03-2834-2000. Coarse aggregate in the form of crushed stone with the provisions of the grain arrangement is designed to meet the gradation for the maximum grain size of 20 mm in accordance with SNI 03-2834-2000.

It was made 14 kinds of concrete with ratio in weight unit between adhesive material: fine aggregate: coarse aggregate equal to 1.00: 1,93: 2,67, with adhesive water factor = 0,52. The comparison of this mixture was obtained from the calculation of concrete mix design with f'c = 25 MPa. Types of concrete treatment are given in Table 1.

Table 1. Types of Concrete Treatment

Age	**The Code of the Test Object**
	TONASA
3	TNS 3
7	TNS 7
14	TNS 14
21	TNS 21
28	TNS 28
56	TNS 56
90	TNS 90
	HOLCIM
3	HLC 3
7	HLC 7
14	HLC 14
21	HLC 21
28	HLC 28
56	HLC 56
90	HLC 90
	BOSOWA
3	BSW 3
7	BSW 7
14	BSW 14
21	BSW 21
28	BSW 28
56	BSW 56
90	BSW 90
	MERAH PUTIH
3	MRP 3
7	MRP 7
14	MRP 14
21	MRP 21
28	MRP 28
56	MRP 56
90	MRP 90
	TIGA RODA

Age	The Code of the Test Object
3	TGR 3
7	TGR 7
14	TGR 14
21	TGR 21
28	TGR 28
56	TGR 56
90	TGR 90

2.1 Research Method

The implementation of the research is divided into several stages: preparation, manufacture of test specimens, specimen treatments, data collection and data analysis.

Preparatory steps include the preparation of tools, inspection of materials including the making of the implementation schedule. Equipment used such as mixer, cylinder mold 30 mm x 150 mm, vibrating machine, place of care and press test equipment. The feasibility of carrying out the research condition is checked.

Examination of the material concerning the examination of the characteristics of the basic materials used in the study such as specific gravity, unit weight, the design of fine aggregate gradation and coarse aggregate which will be used in any mixture and others.

Mixing of materials is done by using mixing machine 'Mixer' by following the standard procedure. In this study, un-mixed aggregates were prepared under SSD conditions. The number of specimens prepared according to the age of the test and the number of specimens per test.

Power measurements were performed at ages of 3, 7, 14, 21, 28, 56 and 90 days using each 20 (twenty) cylinders 30 mm x 150 mm for each type of cement and test life. Thus the required test piece for each treatment is 140 (one hundred and forty) pieces, so the total of 30 mm x 150 mm total cylinders made entirely is 280 (two hundred and eighty) pieces. The specimens were left in the mold for 24 hours and then opened from the mold for further maintenance. Treatment is carried out by placing test specimens in a room protected from direct sunlight up to the time specified for testing: 3, 7, 14, 21, 28, 56 and 90 days.

The test is done at the material laboratory of Civil Engineering Department of Bali State Polytechnic. The data collected are crushed loads for compressive strength. All of it is obtained from the test results of the cylindrical test object in accordance with the specified test age. Before testing the specimens were weighed and measured on the sides. From the information of compressive strength values, produced for each group of specimens and each subsequent age of testing, it is done an analysis to obtain the age and strength relationship of concrete made with mixed adhesive of PCC and PPC and concrete with Cement Type I adhesive.

For the purposes of drawing conclusions, the discussion involving the tested parameters and related theories in the literature is carried out. To facilitate an understanding of the discussion, the test results will be displayed in the form of tables and curves.

3. RESULTS AND DISCUSSION

3.1 Examination of Concrete Materials

The results of inspection of materials obtained from laboratory experiments shall be in accordance with the requirements of the concrete-forming material specified in the applicable concrete guidelines. This data will then be used in calculating the concrete mix design.

a. Fine aggregates

From the results of sand examination in the laboratory, sand data obtained as follows: (more data can be seen in appendix A-1)

1) Density of sand in state of SSD = 2.56 water absorption = 4.69% and volume weight 1,578 gr / cc
2) Gradation of fine aggregate designed according to SNI 03-2834-2000 goes into the gradation of zone 2 (Figure 4.1) with the fineness modulus (Fm) = 2.79.
3) Sandblood content = 1.44%, which means that sand is eligible for concrete mixtures according to SNI 03-4142-1996 that fine aggregates for concrete mixtures should not contain more than 5% sludge against dry weight.

b. Coarse aggregates

From the examination of crushed stone in the laboratory, it is obtained data as follows: (more data can be seen in Appendix A-2)

1) Weight of the crushed stone is in state of SSD = 2.32 water absorption = 3.93% and weight of volume 1.210 gr / cc

2) Gradation of coarse aggregate is designed according to SNI 03-2834-2000 with grain diameter of 20 mm (Figure 4.2), from this gradation it is obtained the fineness modulus = 6.55.
3) The level of crushed stone slurry obtained from the examination results is 0.3%. This value indicates that the crushed stone is eligible for the concrete mixture. In accordance with SNI 03-4142-1996, the crushed stone shall not contain more than 1% sludge.
4) The wear resistance is 35.56% which means that in accordance with the requirements of SNI 03-2417-1991, coarse aggregates shall not lose weight more than 50% when using a Los Angeles worn machine.

c. Cement

PCC cement is used in this study. The examination of the cement includes the volume, and from the examination it was found that the average cement volume was 1,235 g / cm3.

3.2 Results of Concrete Examination

a. Value of slump

The slump value test is intended to determine the degree of viscosity of the concrete mix which can further illustrate the workability of the concrete mixture. The slump test results obtained can be seen in the following table 3.1 below.

Table 3.1 The value of concrete mixture slump

Age	**The Code of the Test Object**	**VALUE SLUMP CM**
	TONASA	
3	TNS 3	4,00
7	TNS 7	3,00
14	TNS 14	3,00
21	TNS 21	5,00
28	TNS 28	3,00
56	TNS 56	3,00
90	TNS 90	3,00
	HOLCIM	
3	HLC 3	5,00
7	HLC 7	3,00
14	HLC 14	3,00
21	HLC 21	4,00
28	HLC 28	3,00
56	HLC 56	4,00
90	HLC 90	5,00
	BOSOWA	
3	BSW 3	4,00
7	BSW 7	3,00
14	BSW 14	3,00
21	BSW 21	3,00
28	BSW 28	6,00
56	BSW 56	5,00
90	BSW 90	4,00
	MERAH PUTIH	
3	MRP 3	3,00
7	MRP 7	4,00
14	MRP 14	4,00
21	MRP 21	4,00
28	MRP 28	3,00
56	MRP 56	3,00
90	MRP 90	3,00
	TIGA RODA	
3	TGR 3	3,00
7	TGR 7	3,00
14	TGR 14	3,00

Age	The Code of the Test Object	VALUE SLUMP CM
21	TGR 21	6,00
28	TGR 28	3,00
56	TGR 56	5,00
90	TGR 90	3,00

From table 3.1 it can be seen that the slump value occurring is still within the required interval of 30 mm - 60 mm, so mixing and molding of concrete can be continued.

b. Characteristic of Concrete Compressive Strength

The calculation of the compressive strength applies equations 2.1 and 2.2. The average compressive strength (Rm) is the amount of the compressive strength of the test objects divided by the amount of the test objects/ specimens (20 objects). The characteristic compressive strength of concrete (f'c) is calculated using the equation 2.3 described in chapter II. The calculation use simple statistic analysis in accordance to formula in PBI'71 article 4.5 (1) (2) pages 39 and 40.

The compressive strength value of the concrete characteristics for each treatment of the adhesive for each test age is shown in Table 3.2

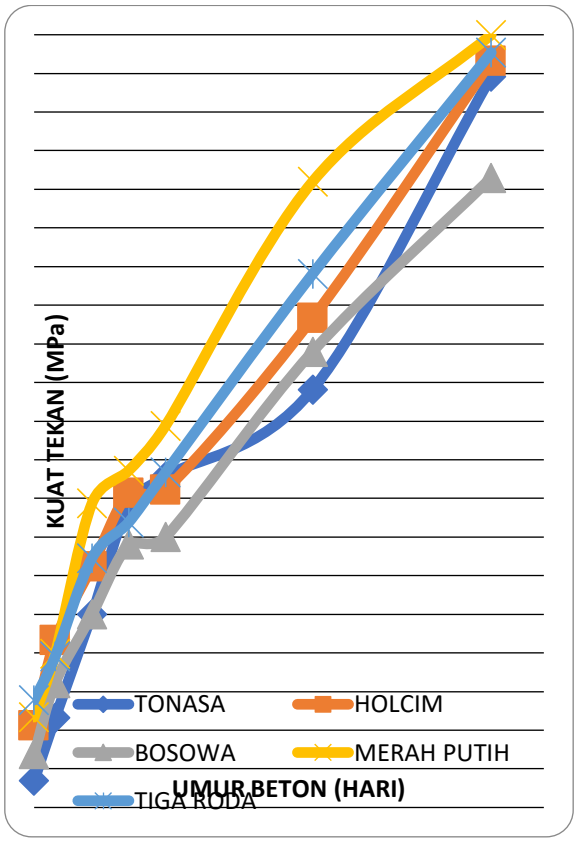
c. Conversion Rate of Age and Concrete Compressive Strength

After obtaining the result of value of concrete characteristic compressive strength for each cement, then the results are inserted into the table of concrete compressive strength recapitulation in the variation of age (3, 7, 21, 28, 56, and 90 days), then it is calculated the age conversion rate to concrete compressive strength age 56 days, shown in table 3.2 and figure 3.1.

Table 3.2 Conversion Rate of Age and Concrete Compressive Strength

Age	The Code of the Test Object	Compressive Strength MPa	Age Conversion Rate
	TONASA		
3	TNS 3	15,69	0,61
7	TNS 7	17,32	0,67
14	TNS 14	20,00	0,77
21	TNS 21	22,81	0,88
28	TNS 28	23,57	0,91
56	TNS 56	25,82	1,00
90	TNS 90	33,92	1,31
	HOLCIM		
3	HLC 3	17,12	0,62
7	HLC 7	19,32	0,70
14	HLC 14	21,23	0,77
21	HLC 21	23,14	0,84
28	HLC 28	23,22	0,84
56	HLC 56	27,67	1,00
90	HLC 90	34,32	1,24
	BOSOWA		
3	BSW 3	16,38	0,61
7	BSW 7	18,22	0,68
14	BSW 14	20,00	0,75
21	BSW 21	21,81	0,81
28	BSW 28	22,00	0,82
56	BSW 56	26,80	1,00
90	BSW 90	31,30	1,17
	MERAH PUTIH		
3	MRP 3	17,34	0,56
7	MRP 7	18,98	0,61

Age	The Code of the Test Object	Compressive Strength MPa	Age Conversion Rate
14	MRP 14	22,87	0,73
21	MRP 21	23,72	0,76
28	MRP 28	24,88	0,80
56	MRP 56	31,20	1,00
90	MRP 90	35,00	1,12
	TIGA RODA		
3	TGR 3	17,78	0,62
7	TGR 7	18,91	0,66
14	TGR 14	21,45	0,74
21	TGR 21	22,38	0,78
28	TGR 28	23,67	0,82
56	TGR 56	28,81	1,00
90	TGR 90	34,54	1,20



Picture 3.1 Age and Compressive Strength of Concrete

From Table 3.2 and Figure 3.1, it can be seen some behaviors of Concrete with PCC Adhesive as follows:

1) At the age of 3, 7, 14, 21, 28, and 56 days the value of characteristic compressive strength achieved by concrete from 5 brands of cement tends to increase.
2) The planned characteristics compressive strength were achieved at age 56 days with values of 25.82, 27.67, 26.80, 31.20 MPa and 28.81 MPa for cements of *Tonasa, Holcim, Bosowa, Merah Putih, and Tiga Roda*. This value is greater than the value of compressive strength of the targeted plan of the calculation of job mix design (25 MPa).

3) At the age of 90 days, the compressive strength value of all concrete characteristics increased by about 20% of the compressive strength at the age of 56 days.
4) The sequence of the compressive strength from the highest to the lowest: *Merah putih, tiga roda, holcim, tonasa, bosowa.*
5) From Table 3.2, it can be seen that when using the age conversion of compressive strength of PC1 concrete characteristics, then at age 3 and 7 days it will be produced higher compressive strength of PCC concrete characteristics than the planned compressive strength of concrete (25 MPa). But at the ages of 14, 21, and 28 days, it is produced lower compressive strength characteristic than the planned compressive strength. This is the answer to the field practitioner's question as to why at the early age of the test, the specimens they tested produced a compressive strength higher than the compressive strength required in the RKS.

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

From the above data can be concluded several things as follows:

a. The material of sand and gravel concrete formers meets the applicable requirements; sand enter zone 2 mud content below 5%, gradation gravel max 20 mm, mud content is below 12%.
b. The slump value of a concrete mixture is obtained in a range that meets the requirements of 30 mm-60 mm
c. The targeted characteristics compressive strength is achieved at age 56 days, all brands of cement
d. Conversion Rate of Age and Characteristics Compressive Strength for adhesives from 5 (five) PCC cement brands are as listed in table 3.2.

4.2 Suggestion

Suggestions which may be given in connection with this research are as follows:

a. To reduce the confounding variables, it is necessary to make a gradation of coarse and fine aggregate.
b. The slump value occurring is set to almost the same for each concrete slab.
c. It is needed to do research on the percentage value of pozolan content in PCC or PPC cement
d. It is needed to be researched after 90 days of age, e.g. 120 days and 180 days, seeing a tendency to increase the compressive strength of concrete is quite high at the age of 90 days.

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ANALYSIS OF ROASTING TEMPERATURE AND TIME EFFECTS TO THE QUALITY OF THE ROASTED SEEDS OF SIBETANESE SNAKE SKIN FRUIT

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Abstract. *: Sibetan is one of the villages in Karangasem Regency. Snake skin fruit in this area has a peculiarity with the name of sugar snake skin fruit. Snake skin fruit plants are one of the seasonal plants, however the fruits also can be harvested in particular months. Dealing with the post-harvest handling for Sibetan Village area, it has been done a lot of product innovations such as making chips, pasta and raw materials of canned fruit sent to the outside of the island. The price for each kilogram of this snake skin fruit species is relatively expensive; it is up to Rp.15.000,00 when it is not in its harvest season, but during harvest season when there is abundant amount of this fruit, the price will be drastically reduced to Rp.500, 00 even unsold. This spurred the creativity of the community to process the snake skin fruit to be materials that have higher selling value. The existence of third parties who are interested to buy the flesh of the fruit as raw material to produce canned food makes the price of the fruit more stable; Rp.2.000,00 for each kilogram. However, this raises the amount of waste from snake skin fruit that has not been utilized, such as the seeds. One of the efforts done in many areas is to make them as raw materials for beverage. The test result obtained from roasting the seeds of snake skin fruit shows that temperature and time affect the quality of the roasted seeds, it can be seen from the colour and aroma compared to the roasted coffee beans. At 80 ° with a time of 40-50 minutes, the cinnamon category was obtained, the light category at 100 ° with 40-50 minutes of roasting, and the Frecnh category at 120 ° with 40-50 minutes of roasting.*

Keywords : Roasting, Seeds, Snake skin fruit, Sibetan

1. Introduction

1.1 Background

In the development of agriculture, there are two main pillars integrating with each other. According to Baroh [1], one of them is secondary agriculture (down-stream agriculture/ agribusiness) as an activity to increase the additional value of agricultural products. One way to increase the additional value of an agricultural commodity is to relate agriculture to the industry/processing or services in agricultural field. In Indonesia, there are many kinds of agricultural commodities which later on can be processed to be qualified and high-valued products, one of them is the snake skin fruit. Snake skin fruit is one of the favorite fruitful plants and has a good prospect to be cultivated. Snake skin fruit (*Salacca edulis l*) is a tropical fruit originally from Indonesia which has been spread throughout the archipelago.

In the previous research, it had been designed a tool or machine to facilitate the process of production or processing the snake skin fruit seeds to be raw material for beverages. This processing activity has been done since long time ago by Sibetan villagers to tackle the overproduction of snake skin fruit during its harvest season which can lower the selling price. The machine designed and given to the villagers has facilitated them in the production process of the snake skin fruit seed powder which had been always produced by applying traditional method. There are several things needed to be studied and researched again in order to improve the quality of the snake skin seed

powder produced and to overcome the excessive post-harvest production to increase the income of Sibetan villagers.

In a research conducted by I Made Anom Adiaksa in 2015, it had been made a processing machine of snake skin fruit seeds to facilitate the processes of breaking and roasting the seeds to produce raw materials for beverage as a substitution for coffee. In that research, it had not been done yet the analysis of the roasting machine designed to get the quality of the roasting result. In a research in 2016, based on the planned roadmap, it would be done the analysis of the roasting machine. The quality of the roasted snake skin fruit seeds is almost as good as the expectation, in which the taste, aroma, and colour are almost the same as the roasted coffee beans. A research is needed to be conducted again in order to be able to produce the qualified roasted seeds as expected.

1.2 Research Problems

Based on the result of the previous researches about the designing of a machine that processes the snake skin fruit seeds to be a raw material for beverages, it is needed to be done a test for the roasting result, therefore the problems of this research can be formulated as follows:

a. Are there any effects of roasting temperature to the quality of the roasted snake skin fruit seeds?
b. Are there any effects of roasting time to the quality of the roasted snake skin fruit seeds?

1.3 Research Objectives

Looking at the result of the seeds roasting before, this research is expected to be able:

a. To obtain the temperature needed;
b. To obtain the time needed;
c. To obtain the colour of the roasting result to decide the types.

1.4 Literature Review

Coffee roasting method really determines the taste and aroma of coffee. Roasting coffee in a proper way is indicated by skilled roasters will produce high-qualified coffee powder marked with tasteful flavor and enjoyable aroma. Roasting process is usually done at atmospheric pressure, using hot air or combustion gasses as heating media. Heat is also obtained by making contact between rice coffee and hot metal surface after the preliminary treatment to remove the water content [2].

The perfection of coffee roasting is affected by two main factors, they are heat and time. The range of roasting temperature for the light level of roasting/ light brown colour is from 190 to 195^{o}C and from 200 until 205 ^{o}C for the medium level/ dark brown colour. The duration of roasting varies from 7 until 30 minutes depending on the type of tool and the quality of coffee. Roasting process can be done openly or closed. Closed roasting is applied by many factories or industries of coffee powder production to make the roasting process faster. Closed roasting will make the coffee powder taste a little bit sour because water and some kinds of volatile acids are retained. However, the aroma will be stronger since the coffee-scented chemical compounds do not evaporate much. Besides, the coffee will be spared from odor pollution from outside such as odor of fuel or gas resulted from incomplete combustion process. The roasting temperature affects the characteristic of flavor from the coffee extract. The degree of roasting is seen qualitatively from the colour of the roasted coffee. For example, the light roast, medium roast, and dark roast. The colour of the roasted coffee also affects the loss percentage of the elements inside the coffee, for light roast it is approximately 3-5 % loss, for the medium roast it is approximately 5-8 % loss, and for the dark roast it is approximately 8-14% loss (including the content of water in rice coffee) [3].

Picture 1: The coffee roasting quality seen from the colour

This clearly shows that the composition of chemical substances in coffee, whether it is volatile or non volatile, is affected by the degree of roasting. The chemical compounds of coffee which is damaged during the roasting process are chlorogenic and trigonelin acids. The level of the damage is proportional to the degree of roasting. The roasting temperature in general is as follows [4]:

1. Light Roast (sufficiently roasting, from190'C-195'C)
2. Medium Roast (medium roasting, from 200'C-205'C)
3. Dark Roast (black roasting, higher than 200'C)

The duration of the roasting varies from 7 up to 30 minutes depending on the type of tool and the quality of the coffee powder. Roasting is finished when the aroma and the taste expected. This is indicated from the changing of the colour of the seeds from greenish to dark brown, brownish black and pure black. The roasting degree is seen through the changing of the roasted coffee beans colour. The samples are taken periodically from a roasting cylinder through sampling hole. The roasting process is stopped when the roasting degree of the coffee beans has been met through the comparison of the colour to the colour of standard sample. Brightness value is a measurement reflected back by an object when it is given irradiation with a certain length of wave. The colour of rice coffee beans is green before the roasting process [5].

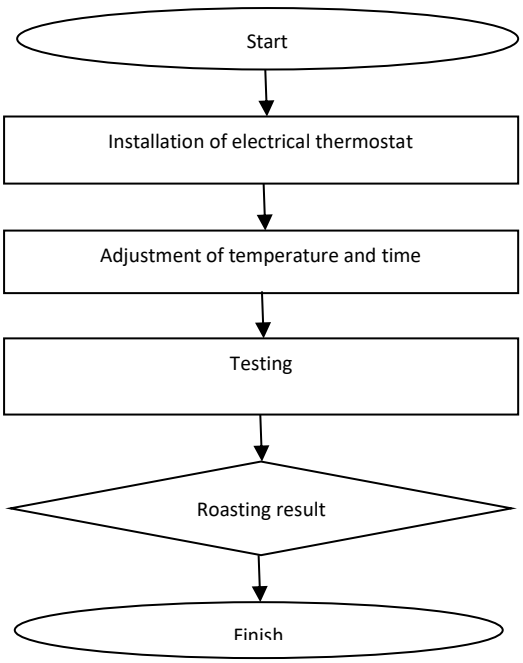
The roasting degree is usually done under atmosphere pressure. As the heating media, it is used hot air or combustion gasses. Heat is also obtained from contact between rice coffee and hot metal surface. After the preliminary treatment to remove the water, roasting process is usually started at a temperature of 200'C. The proper duration to roast coffee is approximately 30 minutes. It will be got the unexpected flavor if the roasting duration is longer than that. The physical change of the coffee beans during the roasting process is technically important as well. The expansion of the coffee beans is caused by the decrease of density as the function of the degree and speed of the roasting process [6].

Technically, the roasting machine has to be able to control the temperature needed, heat leveling for all materials, and can be heat resistant. In this coffee industry, machines are usually in big size to meet the production capacity. The capacity of the roasting machine is between 1 until 100 kilograms with the process done.

2. RESEARCH METHOD

2.1 Method of Implementation

Based on the scheme of snake skin fruit seed in picture 3.1, it is needed to conduct a research on the roasting temperature and time (duration) of dried snake skin fruit seeds to obtain the quality expected. The implementation method in this research is as follows:



Picture 2: Method of Implementation

2.2 Method of Testing

The test is carried out by changing the variable of roasting temperature and time. The amount of roasted snake skin fruit seeds is a fixed variable. The condition of the dried seeds is considered the same, given the same treatment as well. The roasting result will be observed and compared to the roasting result of coffee as shown in picture 2.4. The planning of the temperature applied is 60^0, 80^0 100^0, 120^0 with the roasting duration of 20 minutes, 30 minutes, 40 minutes, 50 minutes based on the medium of roasting (sufficient roasting with the maximum temperature of 195^0) and the good duration for the process is 30 minutes.

3. Result and Discussion

The test is carried out in a mechanical laboratory to facilitate the implementation of reparation in case of damage to the test equipment. The test is repeated three times for each sample with the weight of 2 kg because of the limitation of the raw material of the test; that is the seeds of Sibetanese snake skin fruit. The seeds are chopped/ crushed first with a machine designed in the previous research. The destroyed seeds then are dried by drying them using sun light for 4 hours, 3 times. The dried seeds are considered to be the same in case of the drought level and then stored in the shade.

Before entering the snake skin fruit seeds into a roasting machine, it is preheated the cylinder by starting the engine and setting the temperature according to the test plan. After the temperature of the cylinder space is reached, it is inserted the shredded seeds into the roasting cylinder. The engine is switched off and the shredded seeds are removed after the completion time.

Table 1. Test result in the temperature of 60^{o}C

No	Sample	Time	Result
1	A	20	The entire shredded seeds are not yet cooked
2	A	20	
3	A	20	
4	A	30	The entire shredded seeds are not yet cooked
5	A	30	
6	A	30	
7	A	40	The entire shredded seeds are not yet cooked
8	A	40	
9	A	40	
10	A	50	The entire shredded seeds are not yet cooked
11	A	50	
12	A	50	

Picture 3: The test result in the temperature of 60^{0} C and the duration of 20, 30, 40, and 50 minutes

Based on the first picture, the result is not similar to the roasted coffee beans as comparison.

Table 2. Test result in the temperature of 80^{o}C

No	Sample	Time	Result
1	B	20	The entire shredded seeds are not yet cooked
2	B	20	
3	B	20	
4	B	30	The entire shredded seeds are lightly cooked, have brownish colour and coffee scent
5	B	30	
6	B	30	
7	B	40	The entire shredded seeds are cooked, have brown colour and coffee scent
8	B	40	
9	B	40	
10	B	50	The entire shredded seeds are cooked, have brown colour and coffee scent
11	B	50	
12	B	50	

Picture 4: The test result in the temperature of 80^0 C and the duration of 40 and 50 minutes

Based on picture 1, it is obtained the test result in such temperature that there are some results similar to the roasted coffee beans as comparison; in this case that is the cinnamon type, based on the colour of the roasted shredded snake skin seeds.

Table 3. Test result in the temperature of 100° C

No	Sample	Time	Result
1	C	20	The entire shredded seeds are not yet cooked
2	C	20	
3	C	20	
4	C	30	The entire shredded seeds are lightly cooked, have brownish colour and coffee-scented
5	C	30	
6	C	30	
7	C	40	The entire shredded seeds are cooked, have brown colour and coffee-scented
8	C	40	
9	C	40	
10	C	50	The entire shredded seeds are cooked, have brown colour and coffee-scented
11	C	50	
12	C	50	

Picture 5: The test result in the temperature of 100^0 C and the duration of 40 and 50 minutes

Based on picture 1, it is obtained the result which has similar characteristics with the roasted coffee beans as comparison; in this case that is the light type (seen from the colour of the roasting result of the snake fruit shredded seeds).

Table 4. Test result in the temperature of 100° C

No	Sample	Time	Result
1	D	20	The shredded seeds are lightly cooked, have brownish black colour and coffee-scented
2	D	20	
3	D	20	
4	D	30	The shredded seeds are lightly cooked, have brownish black colour and coffee-scented
5	D	30	
6	D	30	
7	D	40	The shredded seeds are lightly cooked, have blackish colour and charcoal-scented
8	D	40	
9	D	40	
10	D	50	The shredded seeds are lightly cooked, have blackish colour and charcoal-scented
11	D	50	
12	D	50	

Picture 6: The test result in the temperature of 120^0 C and the duration of 40 and 50 minutes

By looking at picture 1, the condition of the results obtained is nearly the same as the roasted coffee beans as comparison; in this case it is the French type based on the colour of the roasting result of shredded snake fruit seeds.

4. CONCLUSION

Based on the research, it can be concluded that:

a. Roasting temperature and time (duration) affect the quality of the roasted snake skin fruit seeds based on the colour and the aroma compared to the roasted coffee beans.
b. The test result obtained in the temperature of 80° and roasted for 40-50 minutes belongs to cinnamon category, the result obtained in the temperature of 100° and roasted for 40-50 minutes belongs to light category, and the result obtained in the temperature of 120° and roasted for 40-50 minutes is appropriate to french category.

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TOPOGRAPHY & CROSS SECTION MEASUREMENT FOR CALCULATING THE COASTAL BORDER

(CASE STUDY OF BERAWA-CANGGU BEACH, BADUNG)

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Abstract. *: The coastal border is a land along of the shoreline, in which its wide is proportional to the shape and physical condition of the beach, at least 100 meters from the high water level towards the land. This research is based on the results of topography and cross section measurement work at Berawa Canggu Beach, Badung Bali, followed by calculation, drawing and reporting. The required data is the existing base data in the planned area in full to find the position of High Water Level in the field which will be used for the reference of the boundary limit for the coastal planning. The results obtained from this research are: the coastal border position is measured from BM W.3 along 55.1712 meters into the land of ownership and the coastal border position is measured from BM W.4 along 50.6926 meters into the land of ownership.*

Keywords : measurement of topography, cross section, high water level

1. INTRODUCTION

1.1 Background

The coastal border is a land along the shoreline, which is proportional to the shape and physical condition of the beach, at least 100 meters from the highest tide point towards the land. The boundary of the coastal border is a coastal border space defined by a particular method. [1]

This boundary line is part of the coastal safeguards that are intended to protect the community from high tidal hazards, abrasion, ensuring public facilities around the coast, protecting the beach from pollution, and silting the river mouth.

Before building the building and applying for IMB, the land owner must know the various border lines in the land owned. Generally, however, landowners neglect by reason of not realizing or forgetting the existence of the boundary after some time, and want to modify the building. This should be avoided because every time you make a change to the building, IMB (Building Permit) must be reorganized, so that again get notice about the applicable line border.

This report was prepared based on the results of field measurement work at Berawa Beach, Canggu, Badung Bali Regency, followed by calculation, drawing and reporting.

In this report, it is described in detail about the process of fieldwork implementation, data processing until the process of topographic map depiction.

1.2 Aim and objective of the research

To obtain the existing base data in the fully planned area of the High Water Level position in the field, to meet the technical requirements of the coastal border for building planning purposes.

1.3 Scope of the research

The scope of the survey work is the topography mapping teristris and cross section includes the activities:

a. Preparation / initial survey
b. Production and installation of benchmarks

c. Polygon measurements
d. Detailed measurements of soil topography with radial system
e. Measurement of existing situation such as beaches, roads, rivers, canals, power lines and telephone and utilities and other topographic features
f. Measurement coastal situation around the area
g. Measurement of cross section
h. Processing data
i. Photo topography map
j. Final report

2. METHOD

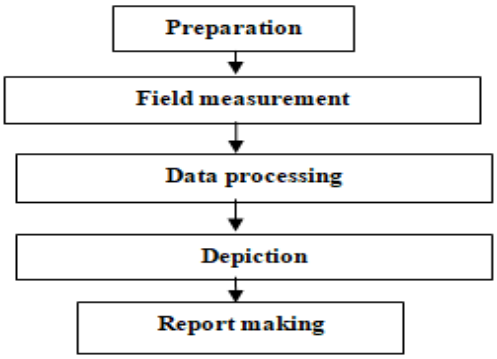
2.1 Research Location

The research and measurement were conducted in Berawa beach area, Canggu, Badung regency, Bali, in which the area is about 2 hectares, conducted for 1 week.

Picture 1. Research location

2.2 Flowchart of the Research

The process of carrying out the field measurement work to the process of drawing and reporting, which between the activities of one with the other are interrelated and is a unity. To expedite the course of work, it is needed an organization implementing the work, and the implementation steps as follows:



Picture 2. Work implementation diagram

2.3 Preparatory works

Preparatory works that have been implemented include:

a. Planning / searching of data of BM / reference point to be used as bonding measurement point.
b. Preparation of equipment to be used for the purposes of the work.
c. Preparation of personnel to be assigned to the field.
d. Setup of data recording media, such as flash or external hard drive, etc.
e. Checking tool.

In the preparatory stage, in order to obtain accurate survey results and meet the required measurement standards, all equipment is firstly checked and calibrated. Checking and calibration of the tool include: accuracy

of angle reading (horizontal and vertical), optical centing, proximity to prism constant, temperature adjustment and high difference checking. [3]

2.4 Determination of reference points

a. Coordinate reference

The reference point used as the basis for reference of the horizontal control framework (coordinates) is determined from the Government 10 BM located in the Canggu Fishermen Village, BM W3 and BM W4 in Berawa Canggu Coast, is set with the initial coordinates as follows:

Table 1. The reference point used as the basis for reference of the horizontal control framework

No	BM Code	Coordinate		Description
		X	Y	
1	BM. 10 Government Owned in Canggu Fishermen Village	294579.060	9042045.800	**UTM Coordinate**
2	BM.W3	296343.600	9040212.631	
3	BM.W4	296377.823	9040152.931	

b. Elevation reference

The elevation reference point uses the elevation reference from the existing Global Positioning System (GPS) and BM markers, i.e. from Government's BM.10 in Canggu Fishermen Village, with initial elevation at BM.10 = 6,219 meters.

2.5 Installation of Benchmark (BM)

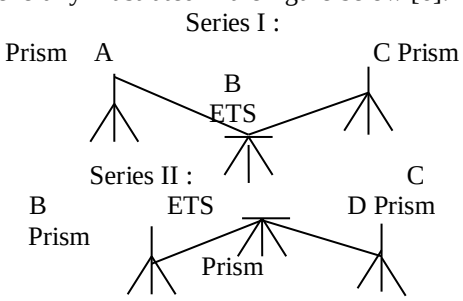
The purpose of benchmarking (BM) is to determine the reference point of topography and reference measurement for the construction phase activity at the measurement location in the future. [2] At this location 2 (two) point benchmarks are installed, and are numbered BM.W3 and BM.W4. Benchmarks are made of concrete on which are bolted to the centering point. BM is installed in a relatively safe, stable and easily visible.

2.6 Measurement of Polygon

For the purposes of the horizontal binding point as a reference for the calculation of coordinates, a polygon measurement shall be carried out which encompasses all measurement areas [3] by the following measurement methods: Polygon measurements were performed with a closed polygon system starting from BM.W3, through all the BMs and assisted points mounted.

a. Angle measurement
   1) Polygon measurements were performed with Totalcon station total electronic measuring device 111
   2) Measurement of polygons through all the benchmarks and HP points (help points) installed in the field form a closed network, covering all measurement sites
   3) The polygon angle reading system by statip to statip, the magnitude of the direct corner cover error is calculated in the field to determine the level of accuracy.
   4) For angle measurement to target use the prism attached in statip.
   5) Each corner of the polygon is measured in a series, which is extraordinary, with a remarkable reading correction of a maximum of 3 ".
   6) Incorrectly cover the maximum polygon angle of $10\sqrt{n}$, where n is the number of polygon points.

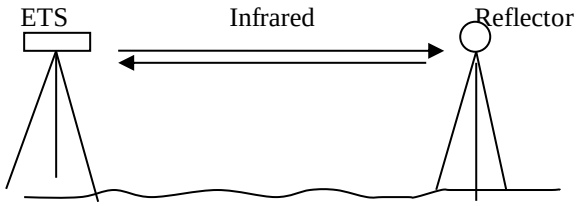
The polygon angle measurement is generally illustrated in the figure below [6]:



Picture 3. Angle measurement

b. Distance measurement
   1) In addition to being used for precise angular measurement, Electronic Total Station (ETS) has an automatic distance measurement facility (EDM) via an infrared LED wave reflected in Refectif Prism.
   2) An accurately obtained electronic distance (accuracy of 0.5 cm) is automatically corrected against the air pressure and temperature set at each measurement.
   3) Correct distance correction shows the same result at the position of the distance behind it and the distance of the face, this is because the plane and the prism are exchanged.

The distance obtained directly is the horizontal distance.
The distance measurements are illustrated as shown below [6]:



Picture 4. Distance measurement

The provisions in polygon measurement are as follows:
1) Prior to the measurement, the measuring instrument has been checked when there is an error, calibration and it is recorded in the meter.
2) Each side distance of the polygon is measured twice from the position of the different device being read three times the display and averaged so close to the actual distance.
3) The number of polygon points between two azimuth controls is adjusted to the field conditions.

2.7 Detailed Topography Measurements

The measurement of the topographic detail points is tied from the basic mapping framework or the main polygon points, if necessary for binding of the detail points that cannot be attached to the main polygon, an auxiliary polygon is made. [5] The collection of detailed points is evenly distributed throughout the survey site, all the visible features of either the natural or man-made elements are measured as a detail point and if the element is in long shape, then the detail point taking will follow the form of the element. [4].

2.8. Area Boundary Measurement

1) To know the total area of project plan area, the boundary measurement is done by the following method:
2) Boundary measurement is done by the same method as measuring detail topography by using digital distance and angle measuring device (Total station).
3) In order to avoid shortage or over-area extent, prior to measurement, the boundaries of the area have been agreed and agreed upon by the assignor or represented.
4) Each corner of the area boundary is determined by its coordinates so that it can be calculated the actual area.

2 RESULT AND DISCUSSION

The process of data calculation is divided into several parts as follows:
a. Calculation of polygon data
b. Calculation of situational data
c. Calculation of cross section

a. Calculation of Polygon Data

The calculation of polygon data is done by the adjustment method on each point and the polygon measurement line at that location there is 1 (one) loop. [2]
1) Calculation starts from polygon point BM.W3 and BM.W4 which have coordinate value. From each of these two polygon points there is an initial azimuth value.
2) Starting from the initial azimuth of BM.W3 and BM.W4, calculations of subsequent polygon points with angles and spacing of each polygon point obtained from polygon measurements in the field.

b. **Calculation of Situation Data (Spot Height)**

The calculation of detailed situation data includes coordinate count, height difference and elevation of measuring points to reference point (where tool stand) is done by trigonometry / thachimetry and spot height count including high difference count and elevation of measuring points to reference point the establishment of the tool) by way of leveling. [3]

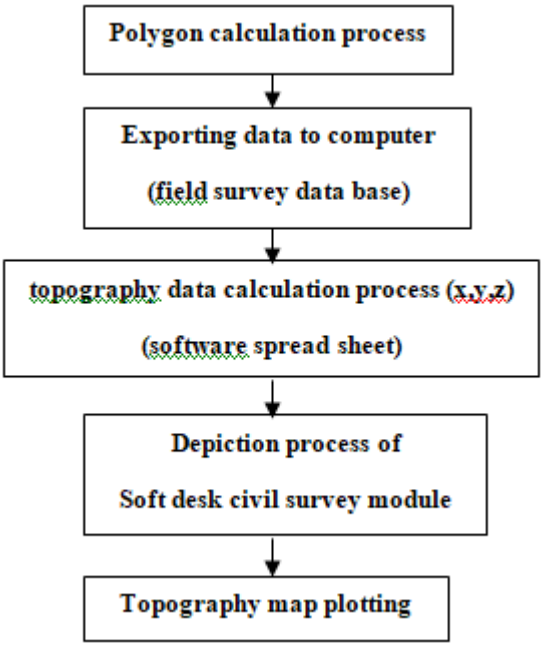
The process of calculating detailed situation / spot height data to be coordinate and elevation data (x, y, z) is done by using Microsoft excel software with polar computation system.

c. Depiction

From the result of calculation of situation data / spot height which is coordinate and elevation data (x, y, z) from the measuring point then do the drawing process by method:

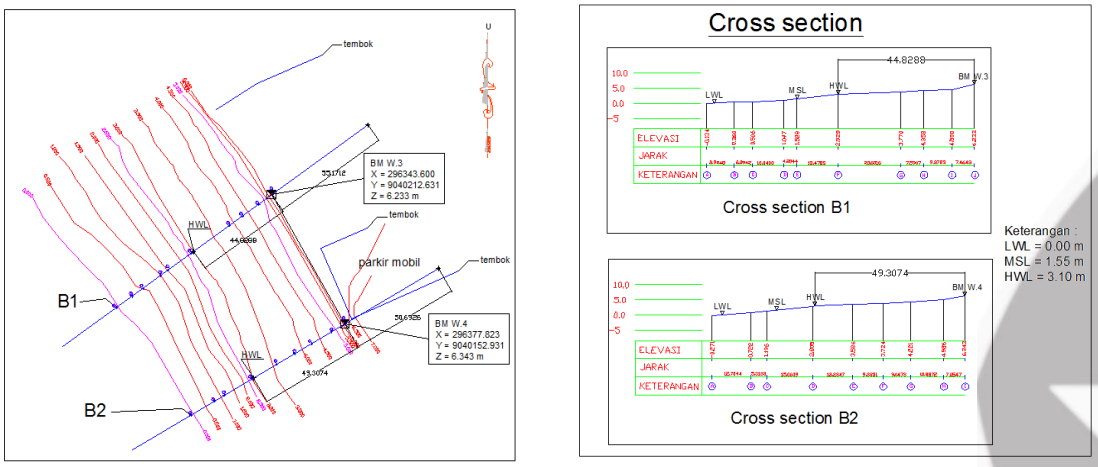
1) Before all coordinate and elevation data (x, y, z) the detail points of the situation are downloaded into he soft survey civil survey program, all data are given numeration and description first.
2) Numbering and explanation is made, in order that if there is an error in the calculation of spot height data, there is no difficulty to make corrections and corrections based on the number and description in each data.
3) After all detail situation data is calculated in the form of coordinate and elevation data (x, y, z), then downloaded by program soft survey civil survey / survey module to become picture topography (digital mapping).

Processing data diagram is as follows:



Picture 5. Processing data diagram

The depiction result is as follows:



Picture 6. Map of topography and cross section

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

The conclusions obtained after making this coastal boundary measurement are:

a. The distance from High Water Level (HWL) to BM W.3 is = 44,8288 m. Beach border 100 m from BM.W3 toward land ownership = 100 m minus HWL distance to BM.W3 = 100 m - 44,8288 m = 55,1712 m. So the position of coastal border began measured from BM W.3 along 55.1712 meters into the land area of ownership.

b. The distance from High Water Level (HWL) to BM W.4 is = 49.3074 m. Beach border 100 m from BM.W4 toward land ownership = 100 m minus L to BM.W4 = 100 m - 49,3074 m = 50,6926 m. So the position of the coastal border began measured from BM W.4 along 50.6926 meters into the land area of ownership.

4.2 Suggestion

To obtain a careful High Water Level data, a tidal observation measurement should be made for a month.

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STEEL TWIST (St. 42) STRENGTH CHANGES ANALYSIS WITH QUICK HEATING AND COOLING USING PLAIN WATER AT 800"C TEMPERATURE

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Abstract. *: Steel twist is often happened on machine component that is the axis that its main function to continue power and circle. So, the choosing of axis substance that will be used is very important to know the strength of its twist, so it is safe to be used. This research is the research continuation that is has ever done before. Steel as technical material is often used as machine components, the strength to the external load is very needed to be known before it is used. The external load that is often happened to the machine component is twist load, pull load, bend load, and pound load. This research analyze the standard steel twist St.42 after it is heated at 800'C temperature with quick cooling, using plain water that is done in material test laboratory, majors in Machine Technical, Bali State Polytechnic. The research is aimed to get how big is the St.42 steel strength changes and its twist angle changes after being heated until 800'C and being quick cooled by using plain water, infact it becomes more tough and becomes more twist endure compared to standard St.42 steel. Its strength changes shows there is twist strength improvement until 38, 549%, that is from 503,7021855 (N/mm2) becomes 697,8735409(N/mm2), thus the steel angle arises, even the specific twist angle arises from 0,959385993 ('/mm) becomes 9.403372244('/mm)..*

Keywords : St.42 Steel, heat treating, twist strength.

1. INTRODUCTION

1.1 Background

Mechanical Engineering Department, Bali State Polytechnic is a vocation education institution that educate its alumnus to be a ready working manpower. Until the last project subject, which is the main subject and come close to the end of education, its subject matter sub part makes machine building stake or efficient technology tool. Efficient technology machine is hoped to be able to support the need of tourism sector which is Bali's excellence, [1]. The main component of efficient technology is axis. The axis is generally made of steel, a technical material. The axis material steel that is found in the market, based on its pull strength, there are some kinds such as St.42, St.60 and others. Steel, in other to be used as a machine component to continue its power and twist strength circle is very important to be known. Therefore, research to know steel twist strength is very important to be done, and this research is using twist test machine.[2].

Steel twist strength can be changed by doing heating or *heat treatment* to the steel suitable as the standard. The heat treatment can be done by heating the steel in the heater furnace with a certain temperature and it is quick cooled or it is hardened as the clear procedure operational standard. The twist test machine and the heater furnace is available in testing laboratory in machine technical in Bali State Polytechnic. That is why, this research is done with the practical work students at material testing laboratory and metrology majors in machine technical in Bali State Polytechnic. To do the previous practical work twist testing has got the subject about material technology knowledge and well trained. At the testing time the researcher must pay attention and obey the rules at metrology and material test laboratory beside safety and salvation factors which is conditioned on each testing tool, in this case using Twist Testing Machine testing tool and some others equipment. Steel or material twist strength is the ability of a material or steel to put up with a twist burden on its surface wide. Material twist strength include the

hardness from a material or steel which is most of them are influenced by its fusion elements. Carbon in the iron or in steel definitely influence the quality of steel pull strength or steel hardness.[1].

Experiment result data is input into table format which is used as twist testing primary data. Furthermore testing result primary data is processed by using or input relevant formulas suitable as this research needs. Steel twist strength is a mechanical nature from the most of steels, is influenced by carbon elements and its fusion. Steel mechanical nature is very important to be known in other that at the time of using, is able to put up with the burden and is safe to be used, so that the steel purposes effectively. Carbon element in steel definitely influences steel quality and strength which is needed and can be reached is by heat treatment, [3].

This testing is done to determine the twist strength of a material/steel, of course through testing or twist experiment suitable as mutual procedure operational standard. Steel strength testing in mechanical technique Bali State Polytechnic laboratory can give information about maximum specific twist angle, twist moment, and maximum steel twist tension, [4].

1.2 Problem Formula

Based on the background of problem above, then, the problem formula in this research are;

a. Does the twist testing that is done produce twist strength change on steel St.42 suitable as heat treatment theory?
b. How much is the twist strength changes and the specific twist angle happened on St.42 which is got heat treatment?

1.3 Aim and Objective

The aim of the research such as;

a. To know the twist strength changes that is happened on steel St.42 which is got heat treatment at 800'C temperature and it is cooled by fresh water quickly.
b. To know definitely the changes of St,42 steel twist angle with heat treatment at 800'C.
c. To know definitely the changes of St,42 steel specific twist angle strength with heat treatment at 800'C temperature.

This research result is hoped to give benefit to;

a. For researcher himself, this research is very useful to develop and deepen knowledge in material technology field, and also adds skill in application and operating the material testing equipment.
b. For Bali State Polytechnic Institution, this research is useful to introduce to the parties in order to be used as resource in choosing an appropriate material especially steel St.42.
c. For the society especially who are wrestling with designing and choosing the steel material, this research result can be used as a catalog in choosing technical material or especially steel St,42.

2. METHOD

2.1 Research Location and Process

Research data, is taken from research which is done by researcher and corporate with the students in fourth semester who is doing material testing practical work in Metrology and Material Testing Laboratory, Machine Technical Department, Bali State Polytechnic. This research process is done through two phase, they are: the first phase, dimension forming that is diameter and the length of homogeneous testing material, includes heating toward testing thing on heater furnace until reach 800'C temperature, and then it is cooled quickly by using fresh water, while the second phase is data taking on twist testing machine. This research is testing by damaging the testing thing through twisting or testing the testing thing directly toward standard testing thing and which is hardened, [5]. Testing thing consist of ten sticks of each to be processed on twist testing machine. Twist testing is done by using twist testing machine Model N-50 (*Torsion Measuring Testing Machine Model N-50*), [1].

Testing process starts from measuring and recording testing thing dimension that is the length and diameter, furthermore it is paired or set on twist testing machine by handling on each of both ends on *gearbox unit* and *digital torque meter*. Load input together with twisting angle is given through *hand wheel* on gearbox unit. That loading is continued by testing thing twist to *digital torque meter* which can give twist moment data that is happened at every twist degree that is done. Thus, the testing process is done toward every testing thing carefully until finished if testing thing is cut until its twist moment signal back to zero, [6].

This research process is done through two phases, they are: the first phase of the testing thing preparation include heat treating toward testing thing and the second phase, that is data taking on hardness testing machine. The preparation work is aimed to get the smooth and flat of the testing thing surface. While heat treatment toward testing thing at heater furnace is aimed to harden and or mellow the material thing compared to standard testing thing, [7].

Research location; This research is done corporate with the students who do material testing practical work program in the fourth semester at Metrology and Material Testing Laboratory, Machine Technical Department, Bali State Polytechnic. The students divided into six groups and each group consists of four to five students. Every group is given three kinds of testing thing that is testing thing standard, hardening and mellowing, one for each. Testing result data of each group is smoothed down suitable as testing thing that its data taken as data that is put into this research.

2.2 The Observed Parameter

The Testing is using *Torsion Measuring Testing Machine Model N-50,* gets the primary data in the form of the level of twist moment and angle reading which is happened as research needs. Another data that is needed is counted by using the relevant formulas such as the previous research (below), [6]

a. Twist tension (tp) is counted with the formulas :

$$\tau p = \frac{Mp}{Wp} \left(\frac{N}{mm}\right) \text{ ..... (1)}$$

In which:

Mp = The occuring torque (N.mm)

Wp = The occuring twist resistance (mm^3) ,for solid and round cross section: $Wp = \frac{\pi d^3}{16}$ ....(2)

b. If the twist angle is divided with the length of working thing (1), so it is got the specific twist angle.

$$\theta = \frac{\phi}{l} \left(°/mm\right) \text{ ……..(3)}$$

In which:

The Testing is using *Torsion Measuring Testing Machine Model N-50* gets the primary data in the form of the level of twist moment and angle reading which is happened as research needs. Another data that is needed is counted by using the relevant formulas such as the previous research (below), [6]

c. Shearing stress (τp) is calculated by using formula:

$$\tau p = \frac{Mp}{Wp} \left(\frac{N}{mm}\right) \text{ ..... (1)}$$

In which:

Mp= The occurring torque (N.mm)

Wp= The occurring torsion (mm^3)

For solid and round cross section: $Wp = \frac{\pi d^3}{16}$ ....(2)

Thus,

d. If the torsion angle is divided by the length of the work piece (1), then it is obtained a specific angle:

$$\theta = \frac{\phi}{l} \left(°/mm\right) \text{ ……..(3)}$$

Further, the torque - twist angle and shearing stress - specific twist angle diagrams can be drawn according to data obtained directly from the torque test machine and data calculated on the basis of formulas, [10].

Furthermore, shearing stress-specific angle of the twist diagram can be described as data that is got directly from torsion testing machine as well as data that is counted based on formulas, [10].

e. At the same situation, the moment of polar inertia can be calculated or worked through the formula of shear stiffness modulus. By giving the torque, it is obtained the modulus of shear stiffness (G) or shear modulus. Within the proportional limit, the following formula can be used:

$$\phi = \frac{Mp.l}{G.lp} \left(radian\right) \text{ …….. (4)}$$

$$= \frac{Mp.l}{Gp.Ip} \frac{360^{\circ}}{2\pi} \left(°\right) \text{ …….. (5)}$$

In which :

ϕ = twist angle (°)

Mp = the occurring torque (N.mm)

l = length of the work piece (mm)

Ip = moment of polar inertia (mm^4)

G = stiffness/ shear modulus (N/mm^2)

For solid and round cross section :

$$Ip = \frac{\pi \ r^2}{2} \text{ or } \frac{\pi \ d^4}{32} \ldots\ldots (6)$$

Further, the torque – twist angle and torque-specific angle of the twist diagrams can be illustrated if necessary, in accordance with the data obtained directly from the torque test machine and data calculated on the basis of formulas , [8].

3. RESULT AND DISCUSSION

3.1 Test Result

This research data is obtained from the cooperation with the testing done by the students in the fourth semester of mechanical engineering study program, mechanical engineering department in the laboratory of materials test and metrology of Bali State Polytechnic. Testing is done thoroughly and systematically starting from standard St.42 test object. Furthermore, the test is carried out with the same stages to the test specimens of St.42 that have been heated. The test results performed on each type of specimen as many as ten times, recorded and processed with the appropriate formula, then put in the tables as below.

Test object I (round-shaped) : St.42(Standard)
Length of the test object : 43,4 mm
Diameter of the test object : 9 mm

Tabel 1. Data of St.42 Standard Steel Twist Test

Twist Angle (°)	Torque (N.m)	Shearing stress (N/mm²)	Specific Twist Angle (°/mm)
10	1.6	32.76111775	0.319795331
20	22.4	458.6556486	0.639590662
30	**24,6**	**503.7021855**	**0.959385993**
40	22.7	464.7983581	1.279181324
50	18.7	382.8955638	1.598976655
60	8.3	169.9482983	1.918771986
70	5.3	108.5212026	2.238567317
80	1.3	26.61840818	2.558362648
90	0.6	12.28541916	2.878157979
100	0.8	16.38055888	3.197953310
110	0.5	10.23784930	3.517748641
120	0.5	10.23784930	3.837543972
130	0.4	8.190279439	4.157339303
140	0.4	8.190279439	4.477134634
150	0.2	4.095139719	4.796929965
160	0.3	6.142709579	5.116725296
170	0	0	5.436520627

Here is the result of the St. 42 steel which is immediately cooled after the heating.

Test object II (round-shaped) : St.42 (Hardening)
Length of the test object : 43,4 mm
Diameter of the test object : 9 mm

Table 2. Test Data of St.42 (Hardening) Steel Twist

Twist Angle (°)	Torque (N.m)	Shearing Stress (N/mm²)	Specific Twist Angle (°/mm)
10	0,6	11.82836510	0.324254215
20	12.3	242.4814845	0.648508431
30	20,0	394.2788367	0.972762646
40	22.5	443.5636912	1.297016861
50	24.4	481.0201807	1.621271077
60	25.5	502.7055167	1.945525292
70	26.9	530.3050353	2.269779507
80	28,0	551.9903713	2.594033722
90	28.6	563.8187364	2.918287938
100	29.3	577.6184957	3.242542153
110	30.1	593.3896492	3.566796368
120	30.6	603.2466201	3.891050584
130	31.2	615.0749852	4.215304799
140	31.9	628.8747445	4.539559014
150	32.1	632.8175328	4.863813230
160	32.5	640.7031096	5.188067445
170	33,0	650.5600805	5.512321660
180	33.2	654.5028688	5.836575875
190	33.3	656.4742630	6.160830091
200	33.5	660.4170514	6.485084306
210	33.7	664.3598398	6.809338521
220	34.1	672.2454165	7.133592737
230	34.3	676.1882049	7.457846952
240	34.7	684.0737816	7.782101167
250	34.8	686.0451758	8.106355383
260	35.1	691.9593583	8.430609598
270	35.1	691.9593583	8.754863813
280	35.3	695.9021467	9.079118029
290	**35.4**	**697.8735409**	**9.403372244**
300	20,0	394.2788367	9.727626459
310	1.2	23.6567302	10.05188067
320	1.9	37.45648948	10.37613489
330	0.6	11.8283651	10.70038911
340	0.4	7.885576733	11.02464332
350	0.4	7.885576733	11.34889754
360	0.4	7.885576733	11.67315175
370	0.5	9.856970916	11.99740597
380	0.5	9.856970916	12.32166018
390	0.5	9.856970916	12.64591440
400	0.6	11.82836510	12.97016861
410	0.6	11.82836510	13.29442283
420	0.5	9.856970916	13.61867704
430	0.4	7.885576733	13.94293126
440	0.5	9.856970916	14.26718547
450	0.4	7.885576733	14.59143969
460	0.4	7.885576733	14.91569390
470	0.5	9.856970916	15.23994812
480	0.5	9.856970916	15.56420233
490	0.5	9.856970916	15.88845655
500	0.4	7.885576733	16.21271077
510	0.1	1.971394183	16.53696498
520	0.1	1.971394183	16.86121920
530	0.1	1.971394183	17.18547341
540	0	0	17.50972763

3.2 Discussion

From the data in the table of the two types of St.42 steel test object above, it can be read of the twisted forces shown at the maximum shearing stress of each test object. Table 2.1 shows that: standard St.42 steel is capable of twisting up to 170^0, maximum torque moment 24.6 N.m, specific angle of 5.436520627^0 and most importantly, in this study, the maximum twist strength is 503.7021855 N / mm2. Meanwhile, the test result of the hardened St.42, shown in Figure 2.2 shows that: St.42 (hardening) steel is capable of twisting to 540^0, its maximum torque moment is 35.4 N.m, the specific angle is $17,509,727,63^0$ and most importantly in this study the maximum torque is 697.8735409N / mm^2.

Thus, this study shows that the twist strength of St.42 Standard = 503,7021855 / mm^2, the twisting power of the St.42 (Hardening) is 697,8735409N / mm^2, meaning that there is an increase in torque strength of steel with 800^0C heat treatment with rapid cooling using freshwater by 194, 1713554 N / mm^2. In fact, the twist angle and the specific twist angle rose significantly, each at 370^0 and 12.0732^0.

Furthermore, it can be seen from the test results that the St.42 steel at 800^0C becomes more resilient to twisting, compared to St.42 Standard steel. In fact, there is a slight increase in the angle of twist and a significantly higher increase in specific angle strength in St.42 steel which gets heat treatment and then rapid cooling using fresh water.

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

Based on the research result and data analysis, it can be concluded that:

a. St.42 Hardening steel which is hardened through heating process at 800°C and quick cooling using fresh water has stronger twist than the standard St.42 steel. It is proved from the maximum torque of St.42 Hardening which is 697,8735409N / mm^2, while the maximum torque of St.42 Standard is 503,7921855N / mm2, or up 38.524% of the St.42 standard steel twist strength.

b. The twist angle of the St.42 Hardening Steel which is hardened through heating process at 800°C and is quickly cooled down using fresh water becomes larger than the twist angle of the standard St.42 steel. It is proved from the maximum twist angle of the St.42 Hardening (540^0), while the maximum twist angle of the standard St. .42 is 170^0, or there is a significant increase of 217.647%.

c. The specific twist strength of the St.42 hardening steel which is hardened through heating process at 800°C and is quickly cooled down using fresh water turns out to be larger or stronger than the standard St.42 steel. It is proved by the maximum specific angle of power of St.42 Hardening which is 17, 50972763^0 / mm, while the maximum twist strength of the St.42 standard steel is 5.436520627^0 / mm or increased up to 222.076%.

1.4 Suggestion

a. Further research is needed by conducting research on steel specimens of a kind but different types, on the type of resistance testing against hardness, tensile strength and other strengths.

b. It is necessary to test the same specimen with different heating temperatures and other studies.

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EVALUATION OF PROJECT IMPLEMENTATION PERFORMANCE WITH EARNED VALUE METHODS

CASE STUDY: THE DEVELOPMENT OF SHIMAMOTO RYOSAKU VILLA, SEMINYAK, BADUNG, BALI

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Abstract. *Planning and controlling the execution of a project is part of the overall construction project management. In addition to assessment in terms of quality, achievement of a project can be assessed in terms of cost and time. Earned value method is the integrated cost control and project schedule. This method provides project performance status information in terms of cost and time in the project reporting period. In evaluating the performance of the development project of Villa Shimamoto Ryosaku, the performance of the cost aspect shows the savings from the plan, This is shown from the value Cost Performance Index (CPI) > 1 On monthly reporting3 = 1.39, the monthly 6 = 1.97, and the monthly 11 = 1.73 While the performance of the schedule aspect shows the delay of the plan, this is shown from the value Schedule Performance Index (SPI) < 1 on monthly reporting 3= 0.79,the monthly 6 = 0.93, and the monthly 11 = 0.94. Estimate Temporary Cost (ETC) is Rp 480,175,422.16, and Estimation At Completion (EAS) is Rp2,026,445,457.16, while Budgeted At Completion (BAC) is Rp3,502,000,000.00 so get Variance at Compeltioan (VAC) is Rp1,409,621,615.49 and Estimation Temporary Schedule (ETS) is 3.2 month, and Estimation At Schedul (EAS) is 14.2 Month while the time specified in the contract during 14 month, So the project is delayed during 0.2 month (1 week).*

Keywords : Cost, Time, Performance, Earned Value

1. INTRODUCTION

1.1 Background

Economic growth in Indonesia today is very exciting for the people, so the need for construction projects is increasing. Implementation of project construction needs good management to achieve maximum results. The development of construction projects cannot be separated from the development of construction management. While the development of construction services industry is closely related to the implementation of development that is currently being actively conducted.

Construction management is planning, scheduling and controlling costs and time to achieve maximum project goals. Good management of a project requires a good cost control system on every job execution. The achievement of a project can be valued in terms of cost and time, in addition to quality. Deviations from the cost and time spent in completing a job should be evaluated to avoid any deviation from the plan. Control is needed in the implementation of a project due to limited resources, cost, and time in completion of a project. [1]

Project control is carried out so that the project can still be implemented in accordance with the time and costs set out in the plan in line with project implementation. There is a difference between planning and control, that is, Planners are processes that try to lay the groundwork of goals and goals including preparing all resources to achieve them. While controlling is a systematic effort to determine standards in accordance with the objectives of planning, designing information systems, comparing the implementation with standards, analyze the possibility of deviations between implementation and standards, then take the necessary corrective actions for resources used effectively and efficiently in achieving the target.

In general, control is done so that work can be carried out efficiently. So we need an analysis that has a system of time and cost control so that the implementation of a project is really efficient. [2] In the execution of a project very rarely found projects that run in accordance with yang planned. Generally the implementation of a project is delayed from the planned schedule, but there is also the implementation of projects that have accelerated from the schedule of the plan. To avoid losses and to know performance project implementation of cost and time completion of the project with the Method of Results Value, so that in the completion of the project can be faced with efforts to further streamline and mengefesiensikan implementation of a project. For that researchers want to know the performance of project implementation by taking the title Evaluation of Project Implementation Performance With Value Method Results with the case study of the Development of Shimamoto Ryosaku Villa, Seminyak, Badung, Bali.

With the result value method, it is expected that the performance of the project implementation, the deviations occurring in terms of time and cost, and the amount of cost and time at the end of the project implementation can be found out.

1.2 Research Problems

a. How is the performance of development of Villa Shimamoto Ryosaku Seminyak with method of result value when it is reported?
b. What is the remaining cost and time required to complete the Villa Shimamoto Ryosaku Seminyak project?

1.3 Research Objectives

a. It can be known implementation performance of the project from facet of time and cost.
b. It can be known the cost and time required to complete the project.

1.4 Literature Review

a. Project Management

Project Management is a process of planning, arrangement, leadership, and control of a project by utilizing resources optimally to achieve the specified goals. By the existence of a good project management, it will be achieved the project in which the cost is appropriate to the plan. [1].

b. Cost Management

Project cost management is ensured in accordance with the planned and approved cost budget in the management of project implementation involving all required processes. There are several things to consider in project cost management, i.e. resources that require a cost to complete the project, among others: [3]

c. The Definition of Earned Value

The "Eaned Value" method is a control methods used to control the cost and schedule of projects in an integrated way. This method provides project performance status information over a reporting period and provides the required cost prediction information and the time for completion of all jobs based on performance indicators when reporting.

2. METHODS

Research methods are the methods of research a problem or a case with a scientific way to get a rational answer. The research method is based on the research objectives and becomes something to get a settlement in order to achieve successful research.

The method used in this research is qualitative descriptive, research that describes the condition of the project by analyzing existing data. Analysis is processing existing data so as to produce a conclusion. Descriptive is the explanation of the existing problems. To examine the trend of variant of schedule and variant of cost in a period of time during the project implemented used the concept of Results Value.

2.1 Determination of Data Sources

a. Primary Data

Primary data used is Actual Cost in the form of raw data which is the actual cost of the work that has been implemented. This cost is derived from the accounting and financial data of the project at the time of reporting or the amount of expenditure and funds used to carry out the work for a certain period of time. Expenditures used as an Actual Cost consists of reports of wages for Workers, Employee Salaries, Materials and Tools which are still in the form of expenditure reports in accordance with the date of payment.

b. Secondary Data

Secondary data is the source of research data obtained through intermediate media or indirectly in the form of books, records, existing evidence, or archives whether published or unpublished in general. In order to perform the analysis required data related to the project. The data I use include:

1) Budget Plan
2) Time Schedule
3) Monthly Report

c. Stages of Data Analysis

Stages in data analysis is a sequence of steps that are implemented systematically according to the basic theory of the problem to obtain an accurate analysis to achieve the purpose of the author. Stages in this study are as follows:

1) Stage I

   At this stage a literature study is conducted to deepen the science related to the topic of research and making the formulation of the problem about which will be the topic of research.

2) Stage II

   This is the stage where the data is taken as reference data for the next calculation.

3) Stage III

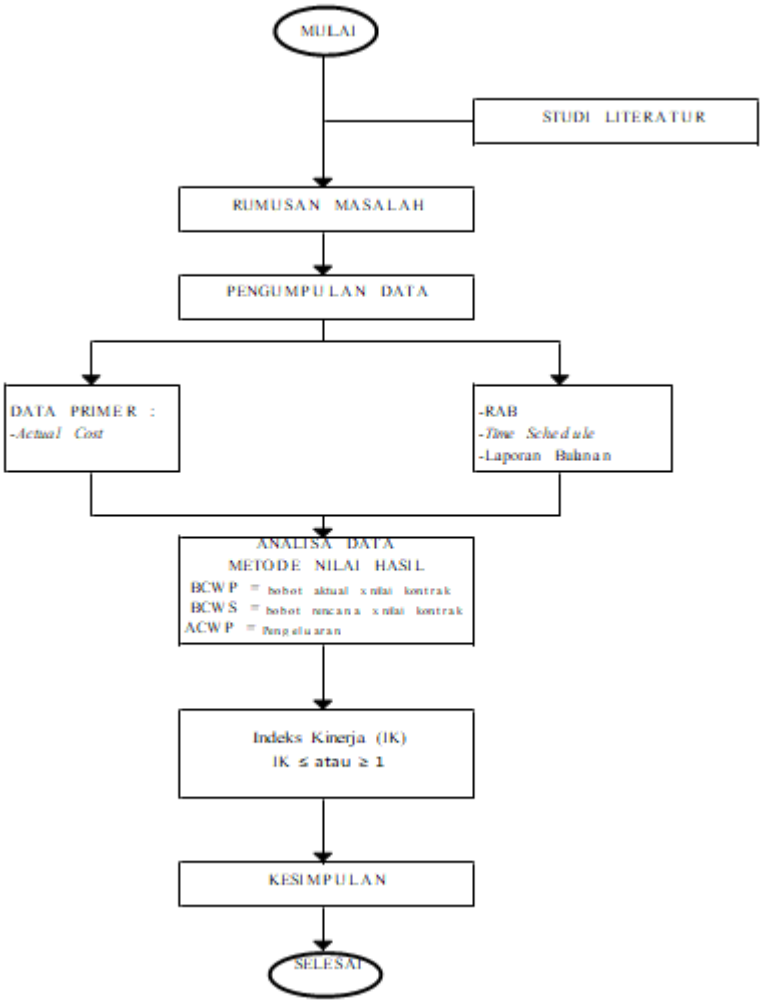
   Stage of data analysis, following stages of data analysis:

   1. Calculate BCWP with actual weight to contract value, Calculate BCWS with plan weight to cost budget plan. Calculations BCWS cumulative, Calculation BCWP cumulative.
   2. Calculating Cost Variance (CV) = BCWP – ACWP
   3. Calculating Schedule Variance (SV) = BCWP - BCWS
   4. Calculating Cost Performance Index (CPI) = BCWP / ACWP
   5. Calculating Schedule Performance Index (SPI) = BCWP / BCWS
   6. Estimated Costs for Remaining Jobs (ETC) = (BAC - BCWP) / CPI
   7. Predicted Final Settlement Costs Project / Estimate at Completion (EAC) = ACWP + ETC
   8. Estimated time of completion of all work ETS = (time remaining) / SPI EAS = End time + ETS
   9. Calculating Variance at Completion (VAC) = BAC – EAC

4) Stage IV

   Conclusion is also called decision making. At this stage, the data that has been analyzed is made a conclusion related to the research objectives.

   Flow chart can be seen in figure 1 below:



Picture 1. Flowchart of Research Stages

3. RESULT AND DISCUSSION

3.1 Indicator of the Earned Value Method

a. Analysis of BCWP (Budgeted Cost of Work Performed)

The value of the result or Budgeted Cost Of Work Performed (BCWP) is the value of a job that has been completed against the budget provided for carrying out a job. BCWP is calculated based on progress (actual weight) of completed work in the field then multiplied by the cost budget used to complete the project, so that the BCWP value is known. To be able to compare the BCWP value with BCWS and ACWP then look for the cumulative value of BCWP. Here's the formula to be able to find the BCWP value: BCWP = Actual Weight (%) x Budget Plan For BCWP value per month is displayed in table 1 below:

Tabel 1 Nilai *Budgeted Cost Of Work Performed* (BCWP) setiap Bulan

Bulan Ke	Bobot Aktual (%)	Nilai Kontrak (Rp)	BCWP (Rp)	BCWP Komulatif (Rp)
1	0.43	3,502,000,000.00	15,000,000.00	15,000,000.00
2	1.56	3,502,000,000.00	54,531,466.67	69,531,466.67
3	4.31	3,502,000,000.00	150,861,010.00	220,392,476.67
4	6.00	3,502,000,000.00	210,165,310.00	430,557,786.67
5	7.50	3,502,000,000.00	262,493,663.33	693,051,450.00
6	13.49	3,502,000,000.00	472,328,619.33	1,165,380,069.33
7	13.54	3,502,000,000.00	474,217,201.67	1,639,597,271.00
8	5.47	3,502,000,000.00	191,670,473.33	1,831,267,744.33
9	7.74	3,502,000,000.00	270,956,350.00	2,102,224,094.33
10	8.18	3,502,000,000.00	286,314,503.33	2,388,538,597.67
11	8.10	3,502,000,000.00	283,646,653.33	2,672,185,251.00
12		3,502,000,000.00	-	
13		3,502,000,000.00	-	
14		3,502,000,000.00	-	

Sumber : Hasil Analisis

b. BCWS (Budgeted Cost Of Work Schedule) Analysis

Budgeted Cost Of Work Schedule (BCWS) is a budget for a work package that is compiled and associated with the implementation schedule. BCWS is calculated based on the planned implementation of the work to be achieved as planned in the time schedule multiplied by the cost budget used to complete the project. So in can budget against schedule plans of implementation of the project according to time schedule. To compare BCWS value with BCWP and ACWP then look for the cumulative value of BCWS. Here's the formula to be able to calculate the BCWS value: BCWS = Plan Weight (%) x Budget Plan

For BCWS value every month is displayed in table 2 below:

Tabel 2 Nilai *Bugeted Cost Of Work Schedule* (BCWS) setiap Bulan

Bulan	Bobot Rencana (%)	Nilai Kontrak (Rp)	BCWS (Rp)	BCWS Komulatif (Rp)
1	0.87	3,502,000,000.00	30,450,000.00	30,450,000.00
2	1.56	3,502,000,000.00	54,619,400.00	85,069,400.00
3	5.59	3,502,000,000.00	195,673,780.00	280,743,180.00
4	7.88	3,502,000,000.00	275,798,400.00	556,541,580.00
5	7.10	3,502,000,000.00	248,507,850.00	805,049,430.00
6	12.66	3,502,000,000.00	443,454,000.00	1,248,503,430.00
7	11.66	3,502,000,000.00	408,225,625.00	1,656,729,055.00
8	8.56	3,502,000,000.00	299,642,325.00	1,956,371,380.00
9	7.54	3,502,000,000.00	264,058,252.86	2,220,429,632.86
10	9.75	3,502,000,000.00	341,286,300.00	2,561,715,932.86
11	7.78	3,502,000,000.00	272,289,400.00	2,834,005,332.86
12	7.50	3,502,000,000.00	262,634,000.00	3,096,639,332.86
13	8.02	3,502,000,000.00	281,026,220.00	3,377,665,552.86
14	3.55	3,502,000,000.00	124,334,447.14	3,502,000,000.00

Sumber : Hasil Analisis

c. ACWP Analysis (Actual Cost Of Work Performed)

In the calculation of project costs construction is divided into two major groups, namely: Direct cost (direct cost) which is the cost associated with the physical project. Indirect cost (inderect cost) is a cost that is not directly related to the project but must exist and can not be separated from the project [4].

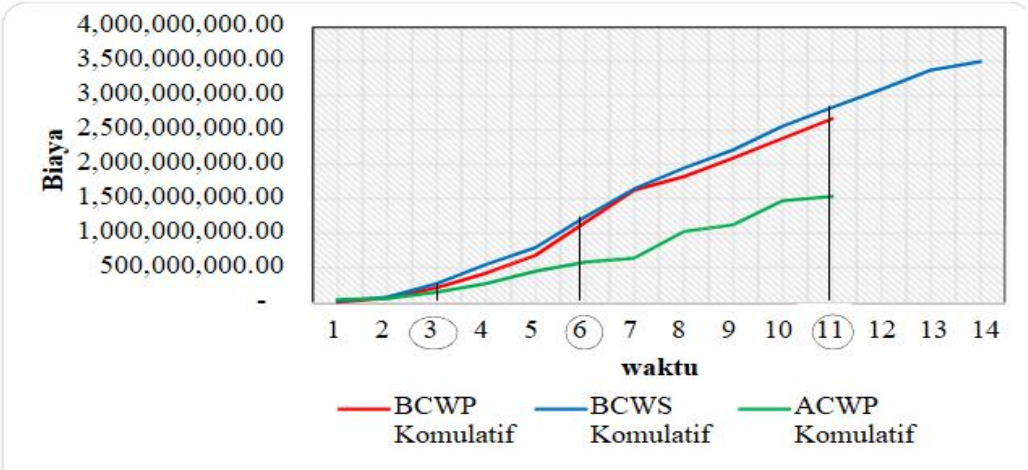
The actual cost of the work that has been performed for a certain reporting period is the actual cost of Actual Cost Of Work Performed (ACWP). The ACWP value is derived from the direct and indirect costs of expenditure

records in the form of wage expenditures, materials and tools used to carry out the work at any given time. From the expenditure of wages, materials and tools each month is added then the value of ACWP per month.

Tabel 3 Nilai *Actual Cost Of Work Performed* (ACWP) pada setiap bulan

Bulan Ke	Pengeluaran		ACWP (Rp)	ACWP Komulatif (Rp)
	Bahan dan Alat (Rp)	**Upah Kerja (Rp)**		
1	33,000,000.00	18,200,000.00	51,200,000.00	51,200,000.00
2	1,770,000.00	12,000,000.00	13,770,000.00	64,970,000.00
3	27,704,100.00	65,500,000.00	93,204,100.00	158,174,100.00
4	72,829,750.00	48,500,000.00	121,329,750.00	279,503,850.00
5	122,882,850.00	56,500,000.00	179,382,850.00	458,886,700.00
6	57,443,950.00	76,000,000.00	133,443,950.00	592,330,650.00
7	360,000.00	60,000,000.00	60,360,000.00	652,690,650.00
8	339,353,175.00	43,000,000.00	382,353,175.00	1,035,043,825.00
9	60,768,905.00	41,000,000.00	101,768,905.00	1,136,812,730.00
10	263,693,014.00	80,000,000.00	343,693,014.00	1,480,505,744.00
11	38,764,291.00	27,000,000.00	65,764,291.00	1,546,270,035.00
12	-	-	-	-
13	-	-	-	-
14	-	-	-	-

Sumber : Hasil Analisis



Picture 2 Monthly indicator graphic of earned value method

In Figure 2 we can see the results of a composite graph of the indicators used for the evaluation of project implementation performance with the earned value method are Budgeted Cost Of Work Performed (BCWP), Actual Cost Of Work Performed (ACWP), and Budgeted Cost Of Work Schedule (BCWS). These indicators are the basic concepts of value of results that can be used to evaluate project implementation performance in order to achieve the project objectives. [5]

3.2 Variations of Integrated Cost and Schedule

a. Cost Variance (CV)

Difference between values earned after completing the work item (BCWP) with the actuary cost incurred during the project implementation (ACWP) is cost variance. Here's the formula to calculate the cost variance (CV).

CV = BCWP – ACWP
The value of cost variance (CV) is determined based on the following:
Positive (+) = implementation cost is lower than the budget
Zero (0) = implementation cost is appropriate to the budget
Negative (-) implementation cost is higher than the budget.

1) Calculation of *cost variance* (CV) in the third month, is as follows:
Cumulative value of *Budgeted Cost Of Work Performed* (BCWP)
=Rp 220,392,476.67
Cumulative value of *Actual Cost Of Work Performed* (ACWP)
=Rp 158,174,100.00
Thus the value of *cost variance* (CV) in the third month can be calculated as:
CV = Rp 220,392,476.67 – Rp 158,174,100.00
= Rp 62,218,376.67
2) Calculation of *cost variance* (CV) in the sixth month, is as follows:
Cumulative value of *Budgeted Cost Of Work Performed* (BCWP)
= Rp 1,165,380,069.33
Cumulative value of *Actual Cost Of Work Performed* (ACWP)
= Rp 592,330,650.00
Thus the value of *cost variance* (CV) in the sixth month can be calculated as:
CV = Rp 991,461,325.00 - Rp 592,330,650.00
= Rp 573,049,419.33
3) Calculation of *cost variance* (CV) in the eleventh month, is as follows:
Cumulative value of *Budgeted Cost Of Work Performed* (BCWP)
= Rp 1,165,380,069.33
Cumulative value of *Actual Cost Of Work Performed* (ACWP)
= Rp 1,546,270,035.00
Thus the value of *cost variance* (CV) in the sixth month can be calculated as:
CV = Rp 2,672,185,251.00 - Rp 1,546,270,035.00
= Rp 1,125,915,216.00

b. Schedule Variance (SV)

Schedule Variance (SV) is used to calculate the deviation between BCWS and BCWP. Here's the formula for calculating Schedule Variance (SV).
SV = BCWP - BCWS
The Value of Schedule Variance (SV) is determined based on the following:
Positive (+)= implementation time is faster than the plan
Zero (0)= implementation time is appropriate to the plan
Negative (-)= implementation time is slower than the plan

1) Calculation of Schedule Variance (SV) in the third month is as follows:
Cumulative value of *Budgeted Cost of Work Performed*=
Rp 220,392,476.67
Cumulative value of *Budgeted Cost of Work Schedule* (BCWS)=
Rp 280,743,180.00
Thus, value of *Schedule Variance* (SV) in the third month is:
SV = Rp 220,392,476.67 - Rp 280,743,180.00
= Rp - 60,350,703.33

2) Calculation of Schedule Variance (SV) in the sixth month, is as follows:
Cumulative value of *Budgeted Cost of Work Performed*=
Rp 1,165,380,069.33
Cumulative value of *Budgeted Cost of Work Schedule* (BCWS)=
Rp 1,248,503,430.00
Thus, value of *Schedule Variance* (SV) in the third month is:
SV = Rp 1,165,380,069.33 - Rp 1,248,503,430.00
= Rp - 83,123,360.67

3) Calculation of Schedule Variance (SV) in the eleventh month, is as follows:
Cumulative value of *Budgeted Cost of Work Performed*=
Rp 2,672,185,251.00
Cumulative value of *Budgeted Cost of Work Schedule* (BCWS)=
Rp 2,834,005,332.86
Thus, value of *Schedule Variance* (SV) in the eleventh month is:
SV = Rp 2,672,185,251.00 - Rp 2,834,005,332.86
= Rp - 161,820,081.86

3.3 Index of Productivity and Performance

Project managers often want to know the use of power sources, which can be expressed as a productivity index or performance index. By knowing that use of resources so that project management becomes better. This performance index consists of performance index Cost Performance Index (CPI) and performance index Schedule Performance Index (SPI).

Performance index values can be translated by index criteria, as follows:

a. The performance index <1, means the spending greater than the budget or execution time is longer than the planned schedule.
b. Performance index > 1, means the expenditure is less than planned budget or schedule is faster than what had been planned.
c. The
d. more different the performance index is from number 1, the greater the deviation from the basic planning or budget is. If the number is too high, it means that the achievement of the work is very good, it needs to be carried out a deeper assessment; whether the planning or budget may be unrealistic.

a. Cost Performance Index (CPI)

Cost efficiency factors can be identified by comparing the value of the physically completed work (BCWP) at the cost of the same period (ACWP). The following formula calculates the Cost Performance Index (CPI).

$$CPI = \frac{BCWP}{ACWP}$$

1) Calculation of CPI in the third month, is as follows:
Cumulative Value of Budgeted Cost of Work Performed (BCWP)
= Rp 220,392,476.67
Cumulative Value of Actual Cost of Work Performed (ACWP)
= Rp 158,174,100.00

So the Cost Performance Index in the third month can be calculated as:

$$CPI = \frac{Rp\ 220,392,476.67}{Rp\ 158,174,100.00} = 1.39 > 1$$

Thus, in the third month, the expense was lower than the budgeted cost.

2) Calculation of CPI in the sixth month, is as follows:
Cumulative Value of Budgeted Cost of Work Performed (BCWP)
= Rp 1,165,380,069.33
Cumulative Value of Actual Cost of Work Performed
= RP 592,330,650
Thus the Cost Performance Index in the sixth month can be calculated as:

$$CPI = \frac{Rp\ 1,165,380,069.33}{Rp\ 592,330,650.00} = 1.97 > 1$$

So in the sixth month, the expense was lower than the budgeted cost.

3) The calculation of CPI in the eleventh month is as follows:
Cumulative Value of Budgeted Cost of Work Performed (BCWP)
= Rp 2,672,185,251.00
Cumulative Value of Actual Cost of Work Performed (ACWP)
= Rp 1,546,270,035.00

So the Cost Performance Index (CPI) in the eleventh month can be calculated as:

$$CPI = \frac{Rp\ 2,672,185,251.00}{Rp\ 1,546,270,035.00} = 1.73 > 1$$

Thus, in the eleventh month, the expense was lower than the budgeted cost.

b. Scheduled Performance Index (SPI)

The factor of time performance efficiency can be found out by comparing the Budgeted Cost of Work Performed (BCWP) to the Budgeted Cost of Work Schedule (BCWS). Here is a formula to count the Schedule Performance Index (SPI):

$$SPI = \frac{BCWP}{BCWS}$$

1) The calculation of SPI in the third month is as follows:
Cumulative Value of the Budgeted Cost of Work Performed (BCWP)
= Rp 220,392,476.67
Cumulative Value of the Budgeted Cost of Work Schedule (BCWS)
= Rp 280,743,180.00

So the Schedule Performance Index (SPI) in the third month can be calculated as:

$$SPI = \frac{Rp\ 220,392,476.67}{Rp\ 280,743,180.00} = 0.79 < 1$$

Thus, in the third month, the implementation schedule is longer than the planned schedule.

2) The calculation of SPI in the sixth month is as follows:
Cumulative Value of the Budgeted Cost of Work Performed (BCWP)
= Rp 1,165,380,069.33
Cumulative Value of the Budgeted Cost of Work Schedule (BCWS)
= Rp 1,248,503,430.00

So the Schedule Performance Index (SPI) in the sixth month can be calculated as:

$$SPI = \frac{Rp\ 1,165,380,069.33}{Rp\ 1,248,503,430.00} = 0.93 < 1$$

Thus, in the sixth month, the implementation schedule was longer than the planned schedule.

3) The calculation of SPI in the eleventh month is as follows:
Cumulative Value of the Budgeted Cost of Work Performed (BCWP)
= Rp 2,672,185,251.00
Cumulative Value of the Budgeted Cost of Work Schedule (BCWS)
= Rp 2,834,005,332.86

So the Schedule Performance Index (SPI) in the eleventh month can be calculated as:

$$SPI = \frac{Rp\ 2,672,185,251.00}{Rp\ 2,834,005,332.86} = 0.94 < 1$$

Thus, in the eleventh month, the implementation schedule was longer than the planned schedule.

Table 4 Recapitulation of the Project Implementation Performance Status

	Earned Value Method	Calculation	Calculation Result	Description
I. Cost Parameter				
1	*Cost Varians* (CV)	= BCWP - ACWP = Rp 2,672,185,251.00 - 1,546,270,035.00	= Rp	Positive (+), The cost is lower than the budget
2	*Cost Performance Index* (CPI)	= BCWP / Rp 2,672,185,251.00 = Rp 1,546,270,035.00	= 1.73	CPI > 1, The cost is lower than the budget
II. Time Parameter				
1	*Schedule Varians* (SV)	= BCWP - BCWS = Rp 2,672,185,251.00 - Rp 2,834,005,332.86	= Rp - 161,820,081.86	Negative (-), the implementation time is slower than the planned time
2	Schedule Performance Index (SPI)	= BCWP / Rp 2,672,185,251.00 =	= 0.94	SPI < 1, The implementation time is longer than the planned time

Table 5 Recapitulation of the Estimation on Project Completion Cost and Time

	Earned Value Method	Calculatio	Calculation	Description
I. Cost Estimation				
1	*Estimate Temporary Cost* (ETC) / Estimation for the cost of the remaining work	= (BAC − BCWP) / CPI (RP 3,502,000,000.00 − Rp 2,672,185,251.00)	= Rp 480,175,422.00	Thus, the cost to finish the remaining work = Rp 480,175,422.16
2	*Estimate At Completion* (EAC) / The cost on the end of the project	= ACWP + ETC = Rp 1,546,270,035.00 + Rp 480,175,422.00	= Rp 2,026,445,457.16	So, the cost in the end of the project = Rp 2,026,445,457.16
3	*Varia nce At Completion* (VAC) / The difference between the budgeted cost and the final cost in accordance with the accomplished work	= BAC - EAC = Rp 3,502,000,000.00 - Rp 2,026,445,457.16	=Rp 1,475,554,542.84	So, the difference between the budgeted cost and the final cost= Rp
II. Time Estimation				
1	*Estimate Temporary Schedule* (ETS) / Time estimation for the remaining work	= (the remaining time) SPI (3 months) =	= 3.2 months	So, the time spent to finish the remaining work =
2	*Estimate At Schedule* (EAS) / Time estimation for the completion of whole project	= completion time + ETS = 11 months + 3.2 months	= 14.2 months	So, the total of the time spent for the whole project= 14.2

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

The analysis results of the implementation performance of the development project of Shimamoto Ryosaku Villa, Seminyak, Bali, by applying Earned Value Method are:

a. Project implementation performance dealing with cost and time matter:

1) Performance in terms of cost shows savings from the budgeted cost, this is shown from the value of Cost Performance Index (CPI) > 1 in the report of the third month = 1.39, sixth month= 1.97, and in eleventh month= 1.73 in accordance with the positive Cost Variance (CV) value in the report of the third month =

Rp 62,218,376.67, in the report of the sixth month= Rp 573,049,419.33, and in the report of the eleventh month= Rp 1,125,915,216.00.

2) Performance in terms of schedule shows delay of the plan, this is shown by the value of Schedule Performance Index (SPI) < 1 in the third month report= 0.79, in the sixth month report= 0.93, and in the eleventh month report = 0.94, Based on the value of the negative Schedule Variance (SV) in the third month report = Rp - 60,350,703.33; in the sixth month report= Rp - 83,123,360.67; and in the eleventh month report = Rp - 161,820,081.86.

b. The remaining cost and time needed to finish the project:

1) In terms of cost, the estimation of cost to finish the remaining job (ETC) is Rp 480,175,422.16, and the cost calculated in the end of the project is Rp 2,026,445,457.16, meanwhile the contract value (BAC) is Rp 3,502,000,000.00. So the estimation of difference obtained between the contract value and the cost of project completion in accordance with the achieved work performance (VAC) is Rp 1,409,621,615.49.

2) In terms of time, the estimation of time to finish the remaining jobs (ETS) is 3.2 months, and the estimation of total time of project completion is 14.2 months. The time specified in the contract is 14 months, so the project is delayed for 0.2 month (1 week).

4.2 Suggestion

a. This research can be developed further by using Microsoft Project program in the data analysis.

b. To overcome delays, it can be done workers addition and technological innovation, so the best and the fastest working methods can be chosen.

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