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PREFACE

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THE EFFECT OF BAFFLE SPIRAL ON THE PERFORMANCE OF HEAT EXCHANGER

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Abstract. The application of heat exchanger still causes many problems. Research on the performance improvement of the heat exchanger is also conducted by adding baffle. This research is aimed at finding out the influence of spiral baffle on the performance of heat exchanger. Research is conducted by doing experiment. The heat exchanger used is the opposite flow type. The independent variable includes round and triangular springs with gap spacing of 1, 2 and 3 cm which are installed in the heat pipe. The flow rate of the water is varied by 100, 150, 200 and 250 ml / sec. The dependent variable includes the temperature of hot water (in and out) and the temperature of cold water (in and out). Temperature measurement is done by using a K type thermocouple every minute for 5 minutes. Discharge measurement is done by using flow meter and stopwatch. The results showed that there were effects of the spiral and water discharge variation on the rate of heat transfer. The phenomenon of water discharge is inversely proportional to the rate of temperature change. Maximum heat temperature displacement occurred at a variation of 1.5 cm with a flow rate of 31.25 was 1.44°. The minimum heat transfer temperature occurred at a variation of 0.5 cm with a flow rate of 38.46 was 0.82°. The maximum cold temperature heat transfer occurred at a variation of 1.5 cm with a flow rate of 31.25 was 0.52° and the minimum occurred at variation of 0.5 cm with a flow discharge of 38.46 was 0.14°.

Keywords : heat exchanger, baffle spiral, temperature difference, performance

1. INTRODUCTION

Heat exchanger is a means of transferring heat between fluid and other fluids through a separation wall [1]. Heat exchanger is an equipment used to exchange energy in the form of heat between fluids of different temperatures. Energy exchange can occur through direct or indirect contact. Fluid that exchanges energy can be a fluid with the same phase (liquid to liquid or gas to gas) or two different fluid phases [2]. Heat exchangers are very widely used in the world of industries such as power plants, oil refineries, chemical plants and petrochemicals, natural gas industry, refrigeration, etc. [3]. Pyrolysis technology in mahogany waste treatment [4].

In the application of heat exchanger, many of the problems were still arising, for example, the heat transferred has not been maximum yet, the occurrence of pressure decrease so that the pump becomes heavy in performance [5]. One of the characteristics of the heat exchanger performance is its effectiveness [2]. The efficiency increase of energy transfer needs a change of parameters, such as the changes the parameters of the fluid flow (turbulence), the changes energy receptor area, and the temperature conditioning of the working fluid [6].

Researches on heat exchanger have been conducted for various types, they are shell and tube types [7] [8] [2] [9], plate and frame types [10], and the opposite flow type [11] [6]. Researches on the performance increase of heat exchanger are also conducted by adding delta wing fin-shaped baffle [5], static angle [12] and fins in pipe [13] [12] [14] [6].

The main function of baffle is to direct the flow of fluid to the pipe evenly to gain the efficiency of greater heat transfer. Baffle types, cut sizes, and tilt angles affect the coefficient of heat transfer from a heat exchanger [14]. This is done as an effort to engineer the flow of the working fluid through the addition of heat transfer surface area [6].

Researches on heat exchanger that study about the effect of baffle have been conducted many times. Baffle angle also affects the distribution of temperature [15]. Shinde S, Pancha MH (2012) conducted research about performance comparison of heat exchangers with partial and complete baffle along the pipe. Shinde SK, et al (2012) conducted research about the performance increase of heat exchanger with baffle helix change. Vishwakarma M, Jain KK (2013) researched the performance of heat exchanger with helix baffle. Gu X, et al (2016) researched the heat transfer and flow resistance caused by baffles spreading along the pipe. Based on the background above, it can be conducted research on the addition of flow inhibitor to increase the performance of pipe type heat exchanger. This research will be conducted with a variation of inhibitors such as spring wire mounted in the middle of pipe axis.

2. METHODS

Mindset of research as follow:

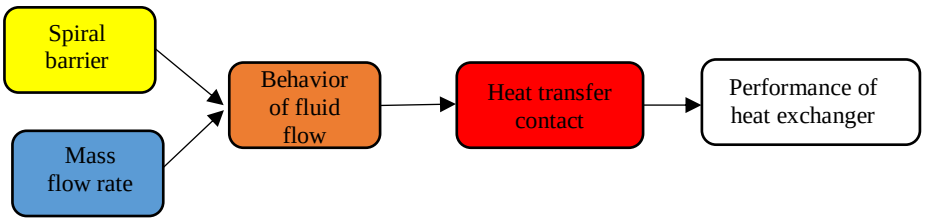

Figure 1. Mindset

Research variables

1) Independent variable:
   a. 3 variations of round spiral based on distance between the spirals (e): 1, 2, and 3 cm.
   b. 3 variations of triangle spiral based on peak distance (e): 1, 2, and 3 cm.
   c. Water discharge: 100, 150, 200, and 250 ml/sec.

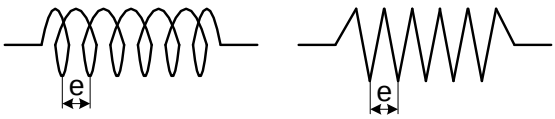

Figure 2. Spiral scheme (mounted inside hot pipes)

2) Dependent variable: in and out water temperature (flow of heat and cold)

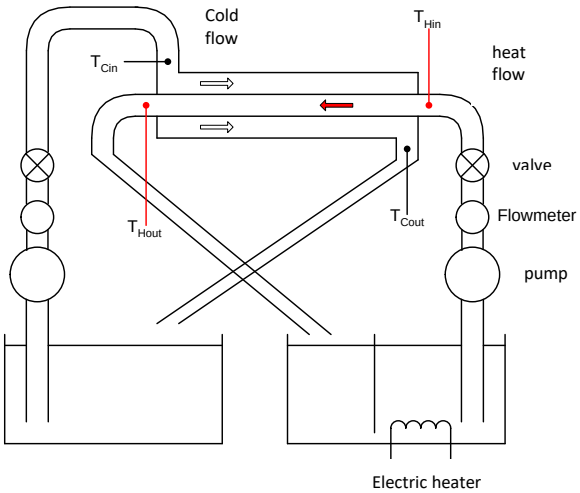

Figure 3. Device scheme

The average value of the data obtained was calculated. Temperature data was used to calculate the temperature difference occurred. Then, it was calculated the heat exchanger performance including range, the rate of heat transfer, and efficiency. The calculation results were showed in form of tables and graphics and analyzed based on the theory concerned.

3. RESULTS AND DISCUSSION

Device of reseach result as follow:

Figure 4. Device

The data obtained from the research through observation and experiment still needs to be processed. The processed data results in the average value and then it is tabulated in table.

Table 1. Temperature difference

Debit (cm3/dt)	Δt	Spiral Barrier Variations					
		0,5 cm		1 cm		1,5 cm	
		Δ H	Δ C	Δ H	Δ C	Δ H	Δ C
31.25	1	1.3	0.5	1.0	0.5	0.9	0.6
	2	0.9	0.3	1.4	0.6	1.3	0.5
	3	1.2	0.5	1.4	0.5	1.4	0.4
	4	1.2	0.5	1.5	0.5	1.7	0.5
	5	1.5	0.5	1.7	0.3	1.9	0.6
35.71	1	1.6	0.4	1.4	0.3	1.6	0.5
	2	1.1	0.2	1.2	0.4	1.0	0.2
	3	0.9	0.2	1.2	0.1	1.1	0.3
	4	0.9	0.3	1.2	0.4	1.4	0.4
	5	0.9	0.3	1.4	0.3	1.5	0.5
38.46	1	0.6	0.2	0.5	0.2	1.0	0.3
	2	0.9	0.1	0.9	0.2	0.8	0.2
	3	0.8	0.1	1.0	0.1	1.1	0.1
	4	1.0	0.1	1.0	0.2	1.0	0.3
	5	0.8	0.2	1.2	0.2	1.2	0.2

Table 2. Temperature average

Debit (cm3/dt)	Spiral Barrier Variations					
	0,5 cm		1 cm		1,5 cm	
	Δ H	Δ C	Δ H	Δ C	Δ H	Δ C
31.25	1.22	0.46	1.40	0.48	1.44	0.52
35.71	1.08	0.28	1.28	0.30	1.32	0.38
38.46	0.82	0.14	0.92	0.18	1.02	0.22

Table 3. Heat transfer

Debit (cm3/dt)	Spiral Barrier			Heat transfer, q (watt)		
	0,5 cm	1 cm	1,5 cm	0,5 cm	1 cm	1,5 cm
31.25	0.78	0.86	0.90	24.35	26.86	28.23
35.71	0.59	0.68	0.75	21.17	24.12	26.96
38.46	0.38	0.45	0.52	14.01	17.45	20.06

The Graphic of the Research Result

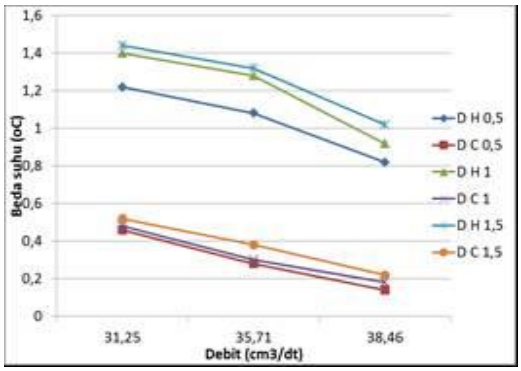

Figure 5. Graphic of temperature difference

The graphic above shows that the temperature differences tend to decrease with the increasing discharge variation. This is caused by the heat transfer that occurred when the fluids flowed through the spiral groove; the longer the spiral groove distance, the greater the heat transfer. If the transfer is greater, the effectiveness of the transfer will be greater. The maximum temperature difference occurred in a variation of hot temperature difference in discharge of 31,25 cm^3/sec and variation of spiral baffle of 1,5 cm was $1,44^0$C, meanwhile the minimum temperature difference occurred in cold temperature difference, discharge variation of 38,46 cm^3/sec, variation of spiral baffle 0,5 cm was $0,14^0$C

Graphic of heat transfer

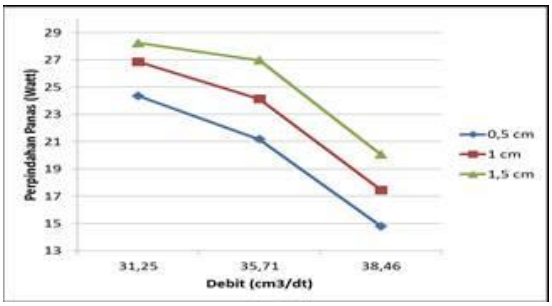

Figure 6. Graphic of heat transfer

The graphic above shows that the temperature difference tends to decrease if the discharge becomes greater. It also shows that the heat transfer of 1,5 cm spiral variation tends to be greater than the 1 and 0,5 cm spiral variations. This is because in 1,5 cm spiral, the flow of the fluid through the pipe tend to consume longer time and becomes longer, which means that the heat transfer through spiral becomes better. The minimum transfer occurred in 0,5 cm variation with the heat transfer of 14,01 watt, this is because in 0,5 cm spiral, it is the fluid touch time with the short spiral so the heat transfer tends to decrease compared to 1,5 and 1 cm variations. Hot temperature difference is 1,9 degree with the discharge of 31,25 and spiral baffle variant of 1,5 cm. Minimum temperature difference occurred in the cold temperature difference of 0,1 degree, with discharge of 38,46 and spiral baffle variant of 0,5 cm.

Temperature difference

The graphics of the result show that the temperature difference tends to decrease if the discharge is greater. This is because when the discharge is greater, the water flow will be greater as well, which means that the hat transfer from hot to cold fluid and vice versa will be shorter, thus the temperature difference becomes small. The graphics show that the temperature difference tends to increase if the discharge gets weaker, this is because in the discharge with low flow, the water flow becomes weak and it means that the fluid movement becomes laminate so the fluid touch time with the spiral might become longer, the heat transfer becomes greater, and the temperature difference becomes higher as well.

The biggest comparison of hot temperature difference in spiral variants is 1,5 cm. This is because the fluid touch time between hot and cold fluid is longer. The temperature comparison based on spiral variants shows that the longer the spiral distance, the greater the heat transfer rate. It means that then temperature difference becomes higher, this is because the touch time between fluid and spiral is longer.

Heat transfer

The graphics of the result show that the heat transfer tends to decrease if the discharge is greater. This is because water discharge with the large flow is very fast so the heat transfer becomes smaller. Meanwhile the graphics also show that the heat transfer for the 1,5 cm spiral variant tends to be bigger than the 1 and 0,5 cm variants. This is because for the variants of 0,5 cm and 1 cm, the distance between the spirals is too tight so the resistance becomes small, so the flow of the fluid is not really affected by those two variants. Unlike the 1,5 cm spiral, for these variants, the fluid has big resistance so relatively large heat transfer occurs in case of these variants.

4. CONCLUSION

Based on the description of the results and discussion above, it can be concluded that the variation of the 1.5 cm spiral barrier affects the heat transfer performance of the heat exchanger, the spiral length and the amount of discharge also influence the heat transfer rate. Heat transfer is said to be good when the temperature difference resulting from the displacement is high.

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ERGO-PHYSIOLOGY DECREASES WORK POSTUR RISK AND LBP COMPLAINTS IN RED LAND WORKERS IN BOSEN VILLAGE, NORTH MOLLO SUB-DISTRICT, SOUTH CENTRAL TIMOR DISTRICT

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Abstract. The work of digging red earth is one of the physical activities of lifting and carrying. The field conditions of work, the slope level of the land wall and work aids used are one of the reasons why workers work with a bent and twisted posture. Such an posture increases the risk of Low Back Pain (LBP). LBP can reduce work capacity and productivity and in the long time reduce the quality of health and life of workers. For this reason, ergo-physiological intervention is carried out with the aim of reducing the level of risk of work posture and LBP. This research is an experimental study using the same subject design involving 30 red earth digg workers in Bosen Village as the subject of the research. Ergo-physiological interventions are given in the form of improving work posture and physiotherapy training. Improvement of work posture is focused on activities, digging move, and carrying excavated material and lifting excavated material onto transport trucks. Physiotherapy training uses a modified William flexion exercise method. Measuring the level of risk of the work posture using the REBA method and the LBP level using the modified LBP Oswestry questionnaire, carried out before and after the intervention. Differences in data before and after the intervention were tested using different tests of paired t test for normal distributed data and Wilcoxon Sign Rank test for data that were not normally distributed, each using a significance level of 5%. The results showed a decrease in the risk level of work posture and LBP of red earth digger workers is of 3.37 (34.56%) and 1.24 (32.29%) respectively. It was concluded that ergo-physiological interventions effectively reduce the risk of work posture and the level of LBP of red earth digger workers
.

Keywords : physiotherapy, low back pain, work posture

1. INTRODUCTION

Bosen Village is one of the villages in the Mollo North sub-district of Timor Tengah Selatan District -NTT which has a variety of natural potential. One of the natural potentials of the village is red earth excavation. The land contour in the location of the excavated material is in the form of hilly expanses with elevations reaching 50-100 m. This excavated land has class A soil types with characteristics that have cohesive properties, good compressive level, and are relatively stable. Testimonials from buyers / consumers of red land said that the excavated land is of good quality as a building material [1].

Red earth excavation has been carried out since 40 years ago and until now is still done manually. Manual work requires great effort. To obtain excavated land, workers must dig / or tear down the hill walls little by little using simple equipment such as crowbars, shovels and hammer. The problem is that the work equipment has a

short handle so that when working, the worker performs with a bent posture [2]. In addition, the slope level of the excavation field reaches 20-90º, causing workers to work in a bent position. Such postures can increase the potential risk of disorders of the musculoskeletal system, especially the lower back area.

LBP is a pain that is felt in the lower back area, which is on L4 / L5 or L5 / S1 discs, can be either local pain or radicular pain or both. This pain is often accompanied by spreading pain towards the legs and feet. LBP is a general effect of manual work performed with non-ergonomic body position [3,4]. Age factors, heavy workload, increased working hours and whole body vibrations are risk factors for LBP complaints [5], [6]. LBP is a type of occupational disease, which can result in loss of work ability, reduce work productivity, and increase the risk of accidents [7].

The initial survey showed that more than 75% of the red earth excavation workers often began to work more slowly and take stolen breaks on the sidelines of activities, to reduce perceived back pain. Pain is felt due to the effect of lifting activity and carrying of soil excavation in a bent and twisted position. Displacement, removal and transportation of heavy texture soil excavations carried out in a bent work posture causes an increase in compression pressure on the lower back and this risks creating low back pain potential. Research on soil excavation workers who use shovels shows the potential for LBP to occur due to bending postures [8]. Other studies have shown that the trunk angle when working can increase the potential for low back pain [9]. Workers who are exposed to LBP rarely seek medical treatment because the medical cost factor is quite expensive. The method that is often done to reduce LBP is by massage, consuming painkillers, smeared with oil sequence or left alone [10], [11]. One risk factor for pain that is rarely known to workers is ergonomic factors [12] - [15]. These reasons cause the handling of LBP complaints to workers is not optimal.

Ergo-physiology is one type of intervention that combines improvement in work posture and physiotherapy training to reduce LBP pain. Posture improvement is given so that workers work with more ergonomic postures at each stage of work. For physiotherapy training, the Willian Extension exercise method is used, a specific exercise developed to strengthen muscle muscle which reflects lumbo-sacralspine, especially the abdominal muscles and gluteusmaximus muscles and stretches the lower back extensor muscle group [16]. This study focuses on knowing the effects of ergo-physiological interventions on reducing the risk of work posture and LBP.

2. METHODS

This research is an experimental research using treatment by subject design. The intervention of ergo-physiology is done in form of physiotherapy training and work posture improvement. Physiotherapy training applies William flexion exercise method. The training is in form of Home Exercise Program which is done before and after the activity three times a week for three weeks with the training duration of 30 minutes. The monitoring of Home Exercise Program is done by using subject log book which contains the record of types and duration of the activities and monitoring by using hand phone. This intervention used participative ergonomic approach. Research samples were taken from concrete-brick molding workers in Kupang city who had fulfilled sample eligibility. 30 of the red soil digger workers who had fulfilled the criteria were taken as samples. Assessment on the work posture used video camera and the results were analyzed by implementing REBA method, meanwhile the assessment on LBP used the modified LBP Oswestry questionnaires. The data of research results were analyzed descriptively and continued by the examination of average difference before and after intervention using T pair difference test for the normally distributed data and Wilcoxon Sign Rank examination for the data that were not normally distributed, with the significance level of 5% for each.

3. RESULTS AND DISCUSSION

The Characteristics of Research Subject

The subjects of the study consisted of 19 men and 11 women. The mean age of the subjects was 37.05 ± 9.24 years, classified as productive age. Previous research has stated that after the age of 30 years, the intervertebral disc degenerates to reduce the ability to withstand compression loads [8]. The mean body weight of the subjects was 59.03 ± 5.25 kg (range: 54-68 yrs) and height was 162.24 ± 10.25 cm (range: 153-172 cm). The subject body mass index was 22.64 ± 3.22 kg /m^2 (range: 18.68-25.63 kg /m^2) in the category of normal nutritional status. The work experience of the subject is 16.5 ± 11.15 years. Most subjects (58.50%) have junior high school education.

Work Posture

Work posture is the position of body parts when doing a cycle of movements and postures that workers often do. The measurement of work posture uses REBA by analyzing each position of the body while working from digging, moving excavation results, carrying and lifting to the transport truck. Work posture is formed due to physical stress due to activity in the skeletal muscles. The presence of this pressure causes the body to respond by forming a

certain posture. The results of the analysis show differences in work posture scores before intervention (period P0) and after intervention (period P1) (Figure 1).

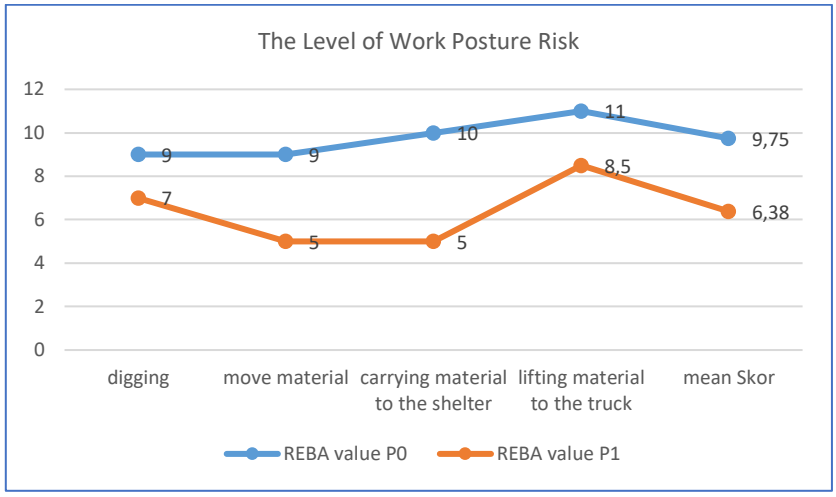

Figure 1. The Level of Work Posture Risk Before and After Intervention

Figure 1 shows the average risk level score of the P0 period posture at level 9.75. There are two sub-activities that have a risk level score above the average score, namely the sub-activity of transporting red earth excavation material to the shelter and lifting the excavated material to trucks in succession at levels 10 and 11. The high risk of work posture on the sub-activity is because when move the excavation material, body posture is in a position of bending and twisting with successive elevations reaching 30º and 40º or more. As a result of the position of the excavation material below the thigh height and the height of the truck above the workers' shoulder height, it allows the trunk to reach the maximum tilt angle [2]. Such postures cause an increased risk of injury and muscle complaints [17], [18]. In period P1, the level of risk of posture decreased at level 6.38 (34.56%) and was statistically significant ($p < 0.05$). Decreasing the level of risk is caused by improvements in work posture for each sub-activity. The biggest decrease occurred in sub-activity sub sub activity lifting minerals to shelters, namely 5.0 (50%) followed by sub-activities to move minerals, ie 4.0 (44.44%). Decreasing the level of risk is below the average score of P1 (6.36). There are improvements, causing body parts such as legs, arms and back to be more natural / ergonomic when carrying out activities to move minerals, transport and lift onto trucks. Ergonomic body position can reduce musculoskletal complaints [7], [8], [18], [19]. Qualitatively, ergo-physiological interventions reduce the level of risk from high to moderate levels.

LBP Reduction

The results showed a decrease in LBP complaints after intervention. The reduction in LBP complaints is shown in Figure 2.

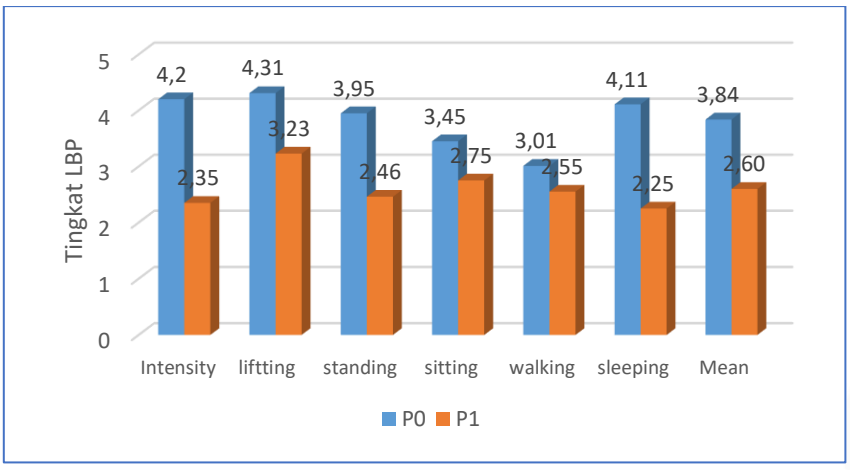

Figure 2. LBP levels felt in various activities in P0 and P1 periods

The intensity of lower back complaints felt by subjects before the ergo-physiology intervention was at the level of 4.20. Increased complaint score due to increased risk of work posture. It was reported that increased risk of work posture correlated with the potential for LBP [13], [17]. The activity of digging the ground and carrying the excavation results in a bent posture and the activity of moving the excavated material to the left or right side, and lifting it to the top of the truck beyond the optimum lift height will form a twisting posture. The working posture of bending and twisting will form a different trunk flexion and trunk twisting slope angle based on the type of activity performed [2]. The greater the slope angle of the style, the greater the force of force on the low back disc. The amount of force on the low back disc will increase the potential for LBP to occur [22], [23]. The intensity of this complaint is not only felt by the subject during the main activity, but also felt when doing other activities outside the main activities such as lifting weights, standing, sitting, walking and sleeping. Pain intensity was felt to be higher when the subject carried out lifting activity ie 4.31, sleep activity with pain intensity level of 4.11, compared to other activities (figure 2). The appearance of pain when carrying out activities outside the main activity shows that LBP experienced by the subject is chronic. Chronic LBP is a type of pain that is felt for longer ie 1-3 months or more [20], [21]. Chronic LBP pain is often caused by long-lasting work in a non-ergonomic [19], [23].

The combination of improved work posture and physiotherapy training, effectively reduced pain intensity to 2.35 or 44.05% and was statistically significant ($p < 0.05$). The decrease in LBP in this study is lower than previous studies on brick making workers [24]. The decrease in the intensity of complaints was more pronounced when the subjects carried out lifting activities, and while sleeping with scores of 1.88 (52.46%) and 1.65 (40.56%) respectively. Posture improvement and physiotherapy training in the right and regular manner and intensity can increase muscle flexibility and produce intermittent and continuous stretching of the lower back muscles so as to stimulate the golgi tendon. This stimulation will cause the muscle relaxation reflex in question [25]. This combination of treatments can reduce pain and spasm around the lower back area, increase the strength of the back muscles and local circulation and increase the stability and flexibility of the back muscles and improve posture [16], [25] - [27]. Regular training with an intensity of 3-5 times a week can reduce back pain under low back pain [24], [28]. Physiotherapy movements have an important role in strengthening back muscles, increasing aerobic capacity, and physical fitness in general, as well as reducing stress and shock effects due to static loads [17], [29], [30].

4. CONCLUSION

The conclusion of this reseach was the ergo-physiological intervention effectively reduced the risk level of work posture and LBP in red earth digger workers by 3.37 (34.56%) and 1.24 (32.29%) respectively compared to the initial conditions. Redesign of the spade handle is needed so that the work posture is more optimal.

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ANALYSIS OF THE IMPLEMENTATION OF OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM ON WORKERS PRODUCTIVITY ON STRUCTURAL FINISHING WORKS OF REINFORCED CONCRETE COLUMNS

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Abstract. The implementation of the project from year to year is significantly improved on implementation aspects of cost, quality, and time, in order to manage the use of human resources to be realistic. Occupational health and safety in a company is often ignored especially for companies which are doing project developments. This also affects the occupational safety of the workers and occupational illness arisen after the projects have been implemented. So in running safe business, occupational health and safety management Systemshould be implemented consistently. The research was conducted in the project of Dialog Villa Petitenget, Cendrawasihstreet, Denpasar, with 15 workers as sample. The implementation of occupational health and safety management systemcan ease the workload of the workers of the structural finishing works of reinforced concrete columns. This is proved by analysis on the treatment group ((p-*value*< 0.05). This shows that the workloads felt by group P2 (group which implement occupational health and safety management System are lighter than the ones felt by group P1 (group which do not implement the system). The decrease in workload felt by group P2 is 4.2%. The implementation of occupational health and safety management system can increase work productivity on the construction project of reinforced concrete structure columns. This is proven by the productivity analysis result which shows that the productivity increase experienced by group P2 is 25% with significance level (p-*value*<0.05). Thus, the implementation of occupational health and safety management system on the structural finishing works of reinforced concrete columns is proven to be able to improve work productivity

Keywords : Occupational health and safety management, column finishing, productivity

1. INTRODUCTION

The project implementation from year to year is significantly improved on the implementation aspects of cost, quality, and competition time which is more intense in construction field. Resources which have effects on the project are man, materials, machine, money, and method. Resources are factors that define the success of a construction project. Even a very little project, if it is not supported by human resources that are good in quality and production, will not give maximum and satisfying result.

In order to manage the use of human resources to be realistic, contractors have to know the level of workers' productivity. It is much needed to monitor and map about what will happen in a project because of the use and utilization of labor. For this reason, it is necessary to know the factors that influence worker productivity [1].

The implementation of a health and safety management system (SMK3) needs to be a standard procedure inherent in the company [2]. the application of this SMK3 needs to be studied properly the impact of its profits on workers and companies.

Based on the discription above, it is considered that research on the effects of the implementation of occupational health and safety management system in work productivity is needed to conduct. The results are expected to be able to improve work results and quality that leads to the increase of profits for both workers and the companies.

The objectives of this research are: (a) to know the reduction of workloads in the structural finishing works of reinforced concrete columns after the implementation of occupational health and safety management system, (b) to know and measure the increase of labors productivity in the structural finishing works of reinforced concrete columns after the implementation of occupational health and safety management system.

This research is limited in reviewing the benefits of the implementation of occupational health and safety management system in increasing the performance or work productivity especially in the implementation of structural finishing works of reinforced concrete columns. The item examined is the structural finishing works of reinforced concrete columns.

2. METHODS

This research was conducted experimentally using treatment by subject on a villa construction project. Reseach location is at Cendrawasih street, Petitenget, Kuta, Badung, Bali. The time for conducting this research is two weeks from 15 May 2017 until 27 May 2017. This research is conducted for 8 working hours (8 a.m. – 5 p.m.). The sampling applies probability sampling method with nonrandom sampling technique, that is by using saturated sampling where the whole population is chosen as sample, so the samples obtained are 15 persons.

Hypothesis of this reseach: (a) the effects of the implementation of occupational health and safety management system can reduce the workloads of the workers of the structural finishing works of reinforced concrete columns. (b) the effects of the implementation of occupational health and safety management system can increase the work productivity of the structural finishing works of reinforced concrete columns.

To support the collection process, the data is collected by implementing survey method. The research instruments are stationary and pulse. The processing data technique applied in this research is comparative descriptive with the steps as follows: editing, tabulating the data, and analyzing the data. The data is processed through some analysis: descriptive analysis, normality analysis, homogeneity analysis, and comparative analysis or difference test.

3. RESULTS AND DISCUSSION

SMK3 Implementation system

Occupational health and safety are the most important factors in the achievement of the project targets and objectives. The moral disadvantages are, for example, many workers experience permanent disability and the worst impact is death. The implementation of occupational health and safety management system is regulated in the government regulations number 50 in year 2012. Objectives of the implementation of occupational health and safety management system are:

1. To increase the protection effectiveness of occupational health and safety by applying planned, measured, structured, and integrated ways.
2. To avoid work accident and reduce occupational diseases, by involving: management, labors/ workers, and labor union.

Characteristics of the Subject

The characteristics of the workers to be in the subjects in this research are as follows:

Table 1. Reseach Subject Characteristics

No	Variables	Average	SD	Range
1	Age (year)	29.15	3.07	2 - 10
2	Body Weight (kg)	64.21	4.17	58 - 76
3	Body Height (cm)	168.43	3.46	165.5 - 173.5
4	Year of Experience (year)	5.50	2.06	2 - 10

Table 1 shown the age range of workers is between 20 and 40 years. This age is still in the productive age with weight in the range of 60-78 kg and work experience plowing fields using hand tactors between 2 and 10 years. This shows that the physical condition of the subject is in productive conditions with sufficient work experience. Work experience is one of the factors that influence the level of worker's skills, complaints that occur in the workload and work productivity [2].

Working Environment Condition

The results of the measurement of the working condition at the rice field workplaces conducted from morning to evening (08.00 am to 04:00 pm). This environmental condition data was tested for normality by using Shapiro-Wilk test and obtained normal working environment data results (p> 0,05) both in group P1 (before improvement) and P2 (after repair). The result of different test of working environment condition is presented in Table 2 below.

Tabel 2. Working Environment Condition

Variable	P1 Group		P2 Group		t	p
	mean	SD	mean	SD		
Tempe-rature (°c)	27.2	2.5	27.7	2.4	4.071	0.305
Relative Humidity (%)	74.6	3.4	75.0	2.9	3.184	0.185
Light Intensity (lux)	407.6	32.5	416.8	29.3	8.329	0.061
Sound Intensity (dBA)	71.8	3.4	71.3	3.1	1.813	0.216

SD = Standard Deviation

From the results of microclimate condition analysis, it showed that the working environment microclimatic conditions of the craftsmen of the gems both in group P1 and group P2 were still within comfortable working condition for the workers. Temperature variables, relative humidity, light intensity, and noise (sound intensity) did not have a significant difference between the groups P1 and P2 (p> 0.05). This means that the working environment between P1 and P2 can be considered the same and consistent.

Table 2 showed that the working environment microclimatic conditions of the craftsmen of the gems both in group P1 and group P2 were still within normal condition and comfortable for the workers. The threshold value of air temperatures for workers is 33°C and the relative humidity for Indonesian workers is between 70% - 80% [3]. If works outdoors in sun exposure, it is suggested as well that headgear is worn by the workers to prevent excess heat to the face and head [4], and other body armor so that workers can work comfortably. The highest sound intensity threshold that is tolerable by human being for working time of not more than 8 hours a day is 85 dBA [5].

Workloads

Workload is measured by the pulse of the workers both at rest (resting pulse) and at work (working pulse). This workload data is tested in normality by using Shapiro-Wilk test. From the test it is found that the resting pulse and the work pulse in both groups (P1 and P2) are normally distributed (P> 0.05).

Prior to analysis of the effect of treatment, first comparability of resting pulse. This is done to see the initial conditions of the worker whether the difference is signficant or not. It is necessary to see if the workload change is purely due to the effects of research intervention or any external factors contributing to the change in the workload. The comparability of the resting pulse on this worker is done by using t-pair test. The result of the analysis shows that there is no difference between P1 and P2 in the resting pulse (p> 0,05) as shown in Table 3. It means that the initial condition of worker workload can be considered the same. Treatment effects were also analyzed using a t-pair test with the results shown in Table 3.

Table 3. Workloads Analysis on Workers

Variable	Group P1		Group P2		t	p
	Mean	SD	Mean	SD		
Resting Pulse (beats/ minute)	70.3	1.9	71.1	1.4	0.219	0.113
Working Pulse (beats/ minute)	120.4	3.3	115.3	3.7	-1.014	0.000

SD = Standard Deviation

Table 4 shows that the before activity workload condition between the two groups was not significantly different or could be considered the same (p> 0.05). While conditions after work there are significant differences between P1 and P2. Judging from the average of workload there was a significant decrease between group P1 and

group P2 by 4.2%. Table 4 also shows that the workload for the fieldworkers using hand tractor is classified as a moderate workload. A mean work rate of 120.4 and 115.3 beats/minute is between 100-125 beats/minutes is moderate workload [6]. There needs to be an improvement in the work station to provide solutions to the problems of the workers so that they can reduce the workload [7,8]. The decrease in workload is due to SMK3 intervention. SMK3 is part of ergonomics. Ergonomic interventions with changes in work systems will lead to decreased workload [9,10,11].

Work Productivity Analysis

Productivity is a comparison between output and input. Productivity is affected by some factors namely management and individual factors. In this research, the work productivity of group P1 is 0.1000440; meanwhile the productivity of group P2 is 0.1251000. The result of statistic analysis shows that the work productivity of group P2 is greater than the control group P1 ($p<0,05$). In order to know the effect of treatment, the mean difference test between each group (group P1 and P2) is tested using pair t-test. The analysis results are shown in Table 4 below.

Table 4. Production and Work Productivity Comparison Analysis

	Mean	N	Std. Deviation	Std. Error Mean	p
Productivity P1	0.1000440	15	0.00700348	0.00180829	0.000
productivity P2	0.1251000	15	0.00881299	0.00227550	

From the above analysis result, it can be concluded that productivity of the treatment group is greater than the control group ($p<0,05$). This proves that the implementation of occupational health and safety on the column reinforcement is very effective in the increase of work productivity.

Meanwhile, from the examination result, the increase of work productivity in group P1 is caused by the reduction of workloads and level of muscle complaints, so the workers in group P1 can work optimally. The increase of productivity also affects the acceleration of the project time which later will lead to savings in production cost. In Tawaka's research [12], it is also concluded the same thing; with the implementation of occupational health and safety management system can increase the work productivity of workers in female laundry. Performing SMK3 and ergonomic interventions in the industrial world will increase the production and productivity of workers [13,14,15]. Increased productivity can be done by designing new work systems [16, 17,18].

4. CONCLUSION

From the result of the analysis and discussion above, it can be concluded that:

a. The implementation of occupational health and safety management system can reduce the workloads of the workers of structural finishing works of reinforced concrete columns. This is proven by the analysis on the treatment group (*p-value*<0,05). This shows that the workloads felt by group P2 (the group which implement the system) are lighter than group P1 (the group which do not implement the system). Reduction of the workloads experienced is 4.2%.
b. The implementation of occupational health and safety management system can increase the productivity in the structural finishing works of reinforced concrete columns. This is proven by the result of the productivity analysis which shows that the increase of productivity experienced by group P1 is 25% with the level of significance (*p-value*<0,05). Thus, the implementation of occupational health and safety management system on the structural finishing works of reinforced concrete columns can increase the work productivity

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WASTE PROCESSING WITH PLANT MEDIA IS A PATH TO SUSTAINABLE TOURISM IN NUSA LEMBONGAN TOURISM AREA

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Abstract. This research was conducted in Nusa Lembongan Island, Bali, with the aim to know the waste management model which using model of pond with plant media, in accordance with Government Regulation No. 82 Year 2001 on the management of water quality and air pollution control. In maintaining the environment (*green tourism*) since 2000, Bali has developed *Tri Hita Karana* Award and Accreditation Program (THK Awards Program) to hotels in Bali. Water recycling process is one of the conditions that must be possessed by hotel industry with environmental vision. The tourism industry in Bali has a positive impact on economic growth but is suspected as a polluter of the environment. Tourism industry activities cannot be separated from the need to water. Disposable waste discharges cannot cause contamination of the environment itself. Result of physical, chemical and biological quality parameter analysis either *in situ* (in location) or laboratory. Quantitatively, the manmade pond has potential to become an alternative water resource and needs some process. One method of pond treatment in Indonesia are *constructed wetlands* due to the diversity of vegetation, the simple construction, flexible, easy and inexpensive operation and maintenance and has aesthetic value. The pollutant reducing vegetation in the pond at this research is jasmine because it is easy to grow, doesn't need special maintenance, and from some studies it was proofed to be effective in reducing BOD and COD at average of 73%.

Keywords : Water Quality, Waste, Contamination, Water Jasmine

1. INTRODUCTION

One problem which is faced by Bali as a tourist destination in Indonesia is in realizing sustainable development which includes three aspects, namely economic, social and cultural and environment sustainability. Besides that, increasingly complex environmental problems today, originated from biased development planning between prioritizing local revenues (PAD) rather than ecology. This causes accumulation into environmental pollution, so that the cost of environmental impacts that must be paid by the community and government is much bigger than the economical benefits.

One industry in Bali that is able to give a positive impact on economic development (± 75%) is the tourism industry [1]. Ironically, besides being the largest contributor to local revenue, the tourism industry is also suspected of being the most dominant environmental polluter in Bali. Tourism industry activities will not be separated from the need for water, because water is used for bathing, washing and toilet activities, laundry, kitchen / restaurant activities and others. Household waste from tourism industry activities must undergo a recycling process before being disposed, so that it can be reused, for example for watering gardens and irrigating fish ponds, or returning the environment without causing environmental pollution (Government Regulation No. 82 Year 2001) [2], and Article 18 paragraph (1) Law No. 32 Year 2009 concerning Environmental Control and Management.

Since 2000 the Bali Provincial Government has launched the Tri Hita Karana Awards and Accreditations (THK Awards) program to the hotels in Bali. Where one of the requirements that must be met by the hotel is the problem of the recycling process of industrial waste or Water Treatment Recycle Process is one of the requirements that must be owned by industry which has environmental concern. sound industry [3]. This is to encourage the hotel management to apply THK optimally [4], so that there will be no conflict with the surrounding community in the future, and thus, the hotel activities will continue sustainable.

2. METHODS

a. Research Design

Wastewater has three characteristics [5], namely: physical, chemical and microbiological. Therefore, the management of household waste that is disposed directly to the environment will contribute waste material that requires oxygen consumption for removal by the microorganisms. This can decrease the amount of oxygen that dissolved in the water quickly and which will disturb the ecosystem in the environment.

Household waste management needs to be carried out before being discharged into the water so that it doesn't disturb the creature's life. The manmade pond model is simple technology with very cheap and easy application to treat household wastewater. To determine the effectiveness of the manmade pond system in reducing the pollutants, it is necessary to measure the decrease pollutant in every step of the process.

The results from the parameters of physical, chemical and water biological quality of water, in location *(in situ)* and laboratory compared with the maximum limit of water quality in tourism area, and Determination of Pollution Index in accordance with the Decree of the State Minister of Environment No. 115 Year 2003, about Guidelines for Water Quality Determination.

b. Research Design for Manmade Pond Models

Wastewater of hotel such as toilet waste, kitchen waste, laundry waste will be flowed to pond A which contains charcoal, gravel and sand, and under the pond is put a pipe with a diameter of 3 ", and the pipe installation follows the flow of the pond, and the below pipe is given 3 mm hole in every 10 cm. Waste water such as soap and oil will float on the surface of the pond because it has a lighter density than the water. Pipes under the pond will flow the water to pond B, where in pond B contains some sand, coral, coconut shell charcoal and planted with Jasmine plants, and beside and under the pond is put pipes with a diameter of 3 ". The planted pipe on the bottom of the pond is given a hole in 3 mm in every 10 cm. Pipes that are planted in the bottom of pond B will drain water to Pool C or control tanks. In pond C is planted with Eichhorniacrassipes (Water hyacinth). It functions to clear the water. In pond C (sediment) functions to separate the smooth sediment from the water in the pond. Finally the treated water is stored in pond D, which is a fish pond.

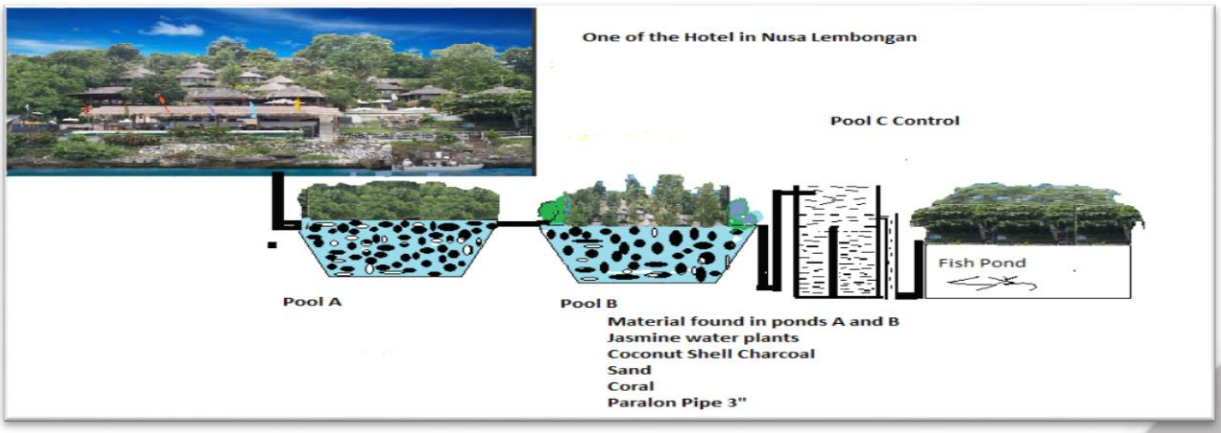

Figure 1 Manmade Pond Model

c. Sampling Techniques

Sampling technique at the water treatment installation is done twice, first before the entry of waste, second after the water comes out from the pond C. The sampling technique is the same as the first model. There are eight parameters of water quality and two parameters of microbiology, so there are ten water quality parameters.

d. Variables

The variables and the equipment used in this research can be seen in Table 1

Table 1 The variables and the equipment used.

No	Variabel	Unit	Equipment
A	Fisik		
1	Temperature	^{0}C	Thermometer
2	TDS	ppm	Analitic scales
B	Kimia		
1	DO	ppm	DO meter
2	pH	-	pH meter
3	BOD_5	ppm	Spektrofotometer
4	COD	ppm	Spektrofotometer
5	NO_3	ppm	Spektrofotometer
6	NO_2	ppm	Spektrofotometer
C	Biologi		
1	E.Coli	MPN/100 ml	Test tube
2	Coliform	MPN/ 100 ml	Test tube

e. Variables Measurement

Fair, at al. in Ardana [6] stated that in a research of water quality, not all parameters of water characteristic be examined. It depends on the purpose of the research. For water quality analysis can be done in 2 ways, namely directly in the location *(in situ)* and preservation methods carried out in the master laboratory for the water that can last a long time.

Water quality parameters which is changing quickly must be measured directly, its temperature and pH. The water quality parameters that can be frozen are directly put into the dark bottles and sterile bottles then transported to the laboratory.

f. Method Analysis

1) Method analysis of water quality

In this study the method of water quality analysis shown in table 2

Table 2 Water quality analysis methods

No	Variabel	Unit	The analytical method used
A	Fisik		
1	Temperatur	^{0}C	Mercury expansion
2	TDS	ppm	Gravimetri
B	Kimia		
1	DO	ppm	Electochemistry with DO meters
2	pH	-	pH meter
3	BOD_5	ppm	Spektrofotometrik
4	COD	ppm	Spektrofotometrik
5	NO_3	ppm	Spektrofotometrik
6	NO_2	ppm	Spektrofotometrik
C	Biologi		
1	E.Coli	MPN	Most Probably Number
2	Coliform	MPN	Most Probably Number

2) Statistical Analysis Method

The t- test for testing hypotheses is the difference between two average parameters if the sample size is small (n <30) and the standard deviation of the population is unknown, but is considered the same ($\sigma 1 = \sigma 2$)

$$t\text{-test} = \frac{(X1 - X2) - Do}{Sp\ V\left(\frac{1}{n1} + \frac{1}{n2}\right)} \quad \text{..... (1)}$$

$$Sp\ V\left(\frac{1}{n1} + \frac{1}{n2}\right) \quad \text{..... (2)}$$

$$Sp = V \frac{(n1 - 1)S^2 1 + (n2 - 1)S^2 2}{n1 + n2} \quad \text{..... (3)}$$

Information:
Critical values are seen from t-student tables with v = n1 + n2 - 2
When two-sided tests: Ho: μ = μo Ho: μ ≠ μo
The critical value is t (α, v) Reject Ho when t-count> t ((α / 2, v)

3. RESULTS AND DISCUSSION

The quality of wastewater is the conditions of material of DO, pH, BOD_5, COD, NO_2, and NO_3 that contain in the water. The results of the research is shown in Tables 3 and 4.

Waste Management of Manmade Pond Models.

Taking sample at the water treatment is done twice, before the entry of waste and in the water reservoir. The results of the sample analysis of water can be seen in Table 3

Table 3. Measurement results before and after processing of Manmade Pond models

No	Variabel	Unit	Before processing	After processing
A	Fisik			
1	Temperatur	^{0}C	30,31	21,20
2	TDS	ppm	399,10	229
B	Kimia			
1	DO	ppm	1,80	4,50
2	pH	-	9,10	6,07
3	BOD_5	ppm	3,25	2,92
4	COD	ppm	40,02	24,65
5	NO_3	ppm	22,21	5,9
6	NO_2	ppm	0,80	0,5
C	Mikrobiologi			
1	E.Coli	MPN/ 100 ml	989	96
2	Coliform	MPN/ 100 ml	900	388

The results of the waste water are then compared to the second class water quality standard, because the waste water will be used for fish ponds and watering plants. Second-class water quality standard is water which can be used for water recreation, fish cultivation, veterinary, irrigation and others.

Temperature and TDS

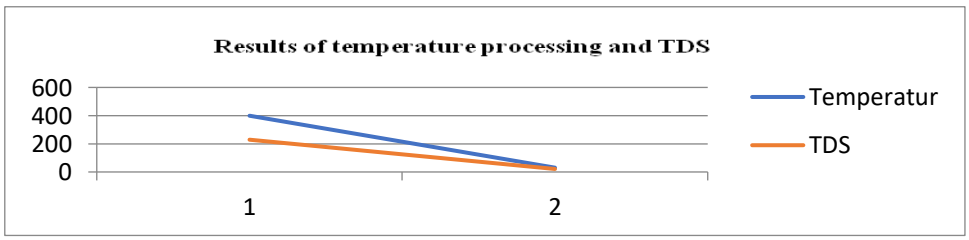

Figure 2. Results of temperature processing and TDS

The results showed that the manmade pond system is efficient enough to reduce the physical oxygen demand of 69.9% and TDS 57%.

DO and pH

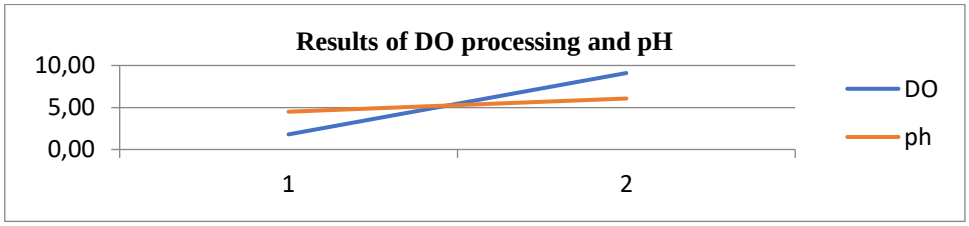

Figure 3 Results of DO processing and pH.

The results of chemical parameter analysis showed DO and pH did not exceed the maximum and minimum limit of quality standard of the water. DO has a significant change of 250 % and pH of 66.7%.

COD_5 and BOD

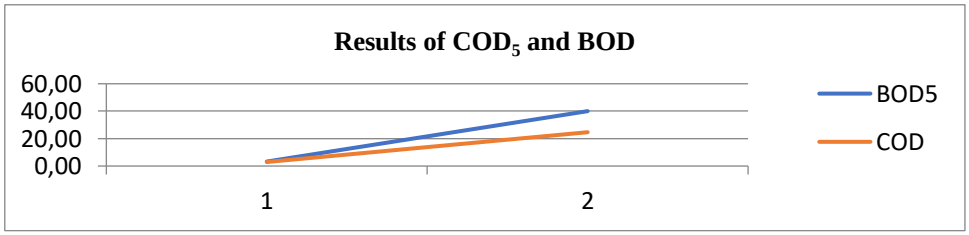

Figure 4 Decrease of COD_5 and BOD

The results showed that manmade pond system is efficient enough to reduce biological oxygen demand (BOD). The efficiency of BOD_5 reduction reached an average of 89.8% and COD is 61.6%. According to Kadlec and Knight [7], the mechanism of reduction of BOD and COD in manmade ponds is as follows: Jasmine and water hyacinth plants that grow in wetlands play a role in supplying the oxygen needed by microorganisms to remove organic and household waste. The oxygen is obtained from photosynthesis carried out by the aquatic plants which are then transformed through plant roots into the water.

NO2 and NO3

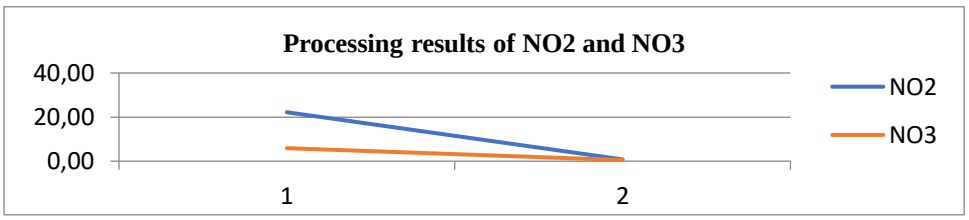

Figure 5 Decrease of NO_3 and NO_2

NO3 parameter decreased ± 26.6% but from the results of parameter processing it was over the quality standard limit for the class I, II, III quality criteria, where the NO3 parameter level was 5.9 ppm. but the standard quality criteria for class I, II and III water is 0.06 ppm. On the other hand, NO3 does not exceed the standard quality for all water classes.

Table 4. Result of t-test analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	332.021	257.985		1.287	.230
	VAR00002	1.400	.325	.821	4.313	.002

Comparison of the chemical content of the water of manmade pond models between before and after treatment using the t-test, it was found that the average water content between before and after treatment was not significantly different at the 5% of significance level. But when using a significance level of 20% between before and after the treatment, it is significantly different. This shows that after the treatment there is a decrease of the chemical content between t-test and t-table, where t-test is greater than the t-table which means a significant effect.

4. CONCLUSION

Based on the discussion and results of the research above, it can be concluded that the quality of the wastewater from the hotel which is treated using manmade pond with some plants and material such as coconut charcoal, sand and coral has advantages and disadvantages. In terms of the place manmade pond requires a rather wide place, but in terms of the environment this model is very well developed, because it has two functions (1) as a waste processor (2) as a park and a waste disposal site. Quality of wastewater from the hotel compared with the Decree of the Minister of Environment Year 1995 has not exceeded the threshold, but one parameter that has exeed the threshold is NO2 from water class I, II and III, which was low polluted. From the manmade pond model is very good because it can reduce the physical, chemical and biological variables in average of 73%.

5. SUGGESTION

Based on the conclusions above, it can be suggested that:

1. The hotel wastewater treatment process needs to be sustainable to get better results, especially in the waste process, so that no pollution.
2. Using appropriate waste treatment model and environmentally oriented to get multiple good results.

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UTILIZATION OF FLY AND RICE HUSK ASHES WASTE IN THE MAKING OF LIGHTWEIGHT BRICK IN SUPPORTING CONSTRUCTION MATERIALS IN BANYUWANGI

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Abstract. The high specific gravity of concrete, which ranges around 2400 kg/m³, will affect the loading of relatively large and heavy structures. This will affect the total weight of the building which can lead to wasteful dimension of foundations which tend to affect the structural behavior in high earthquake areas; the more the weight of the structure, the greater the effect of the earthquake for the building. One alternative material to reduce the weight of the building is lightweight building materials, such as light brick. This study aims to determine the characteristic properties of mortar which is the lightweight brick base material by using the proportion of fly ash and rice husk ash as a substitute for heavy cement with the addition of aluminium powder and when the duration of steam curing is 6 hours at 60oC. The results of the maximum mortar compressive strength occur in a mixture of PC90%: Psr100%: FA10%: AP0%, which is equal to 13.5 MPa. As for the mortar with added ingredients in the form of aluminium powder, the maximum compressive strength of the mixture of PC90%: Psr100%: FA10%: AP0.2%, which is equal to 5.1 MPa. The correlation between specific gravity and compressive strength of mortar can be seen from the low value of specific gravity and high value of compressive strength on the mortar occurring in a mixture of PC90%: Psr100%: PS10%: AP0% with a value of 1.6 kg / cm2 and 5.1 MPa.

Keywords : Aluminium Powder, Specific Gravity, Compressive Strength, Light Mortar, Steam Curing

1. INTRODUCTION

The weight of big building can result in the dimension of foundation that tends to be wasteful and affect the structural behavior in high earthquake areas: the more the weight of the structure, the greater the effect of the earthquake for the building based on the concept of static earthquake in SNI 03-1726-2002 [1]. Therefore, There are many researches on lightweight concrete to reduce the specific gravity of concrete so the concrete will be lighter and reduce the risk of earthquake. One alternative material to reduce concrete weight is by adding developer substance namely Aluminium Powder, because by adding Aluminium Powder to the mixture, it will occur chemical reaction releasing some gas, and after the mixture hardens, porous structure will be formed so that it will become lighter (Scheffler and Colombo, 2005, in Shofi'ul's research.) [2].

Until now, there have been more innovations developed in making concrete; one is by utilizing waste which is not maximally utilized as the additional substances for concrete such as fly ash and husk ash. The substances in fly ash and husk ash have pozzolan characteristics. It is hoped in this research that the waste used to substitute some of the cement weight can increase the compressive strength of lightweight mortar.

In this research, lightweight concrete will be made into concrete in form of mortar since based on its constituent materials, aerated concrete can be categorized as mortar because lightweight concrete does not use coarse aggregate and with the purpose to get good basic composition so that it can be used later as lightweight concrete brick to be put on the walls.

The treatment process of this lightweight mortar applies steam curing, namely a treatment using water vapor because it can be beneficial in keeping the heat of hydration of the mortar. The purpose of the use of water vapor is to get high initial strength (Paul and Antoni, 2007) [3]. The process of steam curing lasts for 6 hours by the temperature of 60ºC.

2. METHODS

Literature study is done by reviewing journals, books, news, and other sources related to this research, so it can be used as basis of this research as well as references to get expected results. Besides, it is also to learn how to test materials. The examination is carried out in several stages including:

Study on Materials Preparation

This stage is to prepare the material so that research is ready to be carried out. The materials needed for the research are fine aggregate, cement (PC), water, fly ash, husk ash, and aluminium powder.

Test on Materials Characteristics

On the test of materials characteristics, it is carried out specific gravity test and volume weight test for cement (PC); specific gravity test, infiltration water test, mud content test, and sand gradation analysis for fine aggregate; meanwhile for materials like fly ash, husk ash, it is only carried out specific gravity test and gradation analysis.

The Making of Test Specimens

Test specimens are made by using cube in size of 5x5x5 cm. The composition of materials used in making test specimens is in accordance with the planned composition. The composition of lightweight mortar uses the ratio of cement and fine aggregate 1:2,75 with the substitution of some of the cement weight using three kinds of waste and aluminium powder as additional material. The mixture proportion used in making lightweight mortar can be seen in table 1, with the description as follows:

PC= Cement
Psr= Sand
AP= Aluminium powder
FA= Fly Ash
AS= Husk Ash

Table 1: Proportion of Mortar Mixture

Mixture	Code
Normal	A
$PC_{80\%} : Psr_{100\%} : FA_{20\%} : AP_{0\%}$	B
$PC_{80\%} : Psr_{100\%} : FA_{20\%} : AP_{0,2\%}$	C
$PC_{80\%} : Psr_{100\%} : AS_{20\%} : AP_{0\%}$	D
$PC_{80\%} : Psr_{100\%} : AS_{20\%} : AP_{0,2\%}$	E

Treatment of Lightweight Mortar

Treatment of test specimens is done by applying curing steam method. This method is applied by using water vapor which is beneficial in maintaining hydration heat in concrete by reducing hydration heat resulted from chemical reaction between cement and other mortar materials. The treatment is done for 6 hours at temperature of 60^0C.

Lightweight Mortar Test

The tests done on mortar are tests on mortar content weight, specific gravity, and compressive strength.

Analysis of Test Result and Discussion

Results of test on the specimens are noted and it will be discussed the effects and behavior of the lightweight mortar by using fly ash and husk ash as substitution for some of cement weight and the addition of aluminium powder with steam curing treatment at temperature of 60^0C for 6 hours.

3. RESULTS AND DISCUSSION

Results of Material Characteristics Testing

Results of material characteristics testing can be seen in Table 2.

Table 2: Results of Material Characteristics Testing

Material	Characteristic Test	Test result
Fine aggregate	Specific gravity	2,39 gr/cm^3
	Sand Infiltration	3,27 %
	Cleanliness of the mud in a dry manner	4,1 %
	Filter Analysis	Zona 1
Fly Ash	Specific gravity	2,3 gr/cm^3
Fly Ash	Specific gravity	1,79 gr/cm^3

Table 2 shows the testing results of the characteristics of material used as mortar mixture. The value of sand specific gravity is 2,39 gr/cm³. The requirements of aggregates used to make concrete based on SNI-04-1989-F [4] is that the specific gravity of fine aggregate is 2,5-2,7 gr/cm³ so it can be concluded that the sand does not fulfill the requirements. However, this sand is still used as a material in lightweight mortar mixture. Based on the testing of water absorption, the sand does not fulfill the requirements because the good value of water absorption based on ASTM C-128 is maximally 2%. Meanwhile in the testing of dry cleaning sand against mud, the level of mud contained in fine aggregate must not more than 5%, so it can be concluded that the fine aggregate used meet the standards.

The Making of Lightweight Mortar Test Specimen

In this research, mortar was made of the mixture of light pasta + fine aggregate (sand in Setail river, Banyuwangi) with 6 specimens in form of 5x5x5cm-sized cubes for each variant. The test was carried out in the age of 7, 14, 21, and 28 days. Mortar treatment uses steam at the temperature of ±60ºC for 6 hours. The steps of making are as follows:

1. Prepare materials such as fine aggregate, cement, waste, and aluminium powder. Based on SNI 03-6882-2002 [5], the calculation of material needed to make lightweight mortar in form of 5x5x5cm-sized cube for 6 specimens is:
    1. Cement: 0,5 kg
    2. Sand: 1,375 kg
    3. Water: 242 ml

    For the substitution of some of cement weight by using waste, the mixture proportion is in accordance with Table 2.
2. After that, it is done the making of mortar, in accordance with the planned mixture proportion.
3. After the materials are stirred evenly, the mixture then is put into the mold with the amount based on the research needs and is placed in dry place. Then after 24 hours, the mortar is put into steam machine and treatment (curing) is done at the temperature of ±60ºC for 6 hours. The result is visually presented in Figure 1.

Figure 1: The result after the mixture is put into the mold and left for 24 hours.

Making mortar with the addition of aluminium powder will make it expands in ±40 minutes after being put into the mold.

4. The next step is removing the specimen from the mold after it is cold, and the next treatment is by wrapping and soaking it in water. For the specimens which use aluminium powder before the wrapping process, expanded parts are scrapped so that the specimen can be precise. Steamed and wrapped mortar can be seen in Figure 2.

Figure 2: Steamed and wrapped mortar

In picture 2, it is seen hollow and non-hollow mortar surface. Hollow surface mortar is resulted from the effects of the addition of expander material (aluminium powder) which gives air inside. The smaller and more equal the hollow will give the mortar more stable and better value of its compressive strength and weight.

Testing of Lightweight Mortar Characteristics

The testing of lightweight mortar characteristic done is testing of content weight, specific gravity, and compressive strength of mortar. The result recapitulation of content weight testing can be seen in Figure 3.

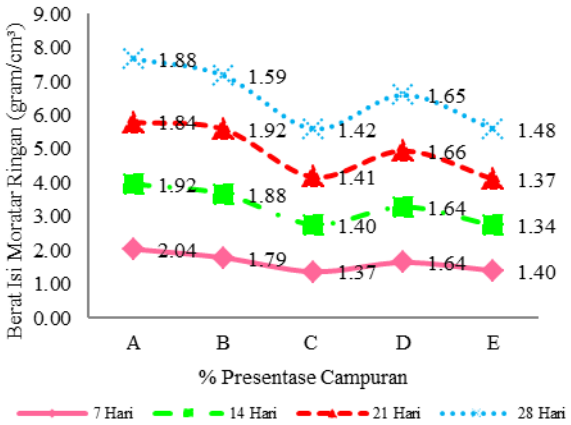

Figure 3: Graphic of Result Recapitulation of Mortar Content Weight Testing

Picture 3 shows the testing result of lightweight mortar content weight is increased and decreased. The decline of the value of mortar content weight occurs in the mixtures containing aluminium powder; they are mixture C and E. The decline in mixture C is 21,96% of the content weight of mortar mixture B and in mixture E is 15,24% of the content weight of mortar mixture D. This is because the usage of additional material in form of aluminium powder will create air bubbles in cement mixture which is called aerated concrete. This is in accordance with statement in a research (Scheffer and Colombo, 2005; in the research of Shofi'ul, et.al. 2014) that by adding aluminium pasta into the mixture, there will be a chemical reaction releasing some gas, and after the mixture hardens, porous structure will be formed so that it will be lighter [2]. Recapitulation of the result of mortar specific gravity testing can be seen in Table 3.

Table 3: Recapitulation of the Result of Mortar Specific Gravity Testing

Mixture	28 Days Testing	
	(gr/cm^3)	(kg/m^3)
Normal (A)	1.91	1910
$PC_{80\%}$: $Psr_{100\%}$: FA $_{20\%}$: AP $_{0\%}$ (B)	1.89	1890
$PC_{80\%}$: $Psr_{100\%}$: FA $_{20\%}$: AP $_{0,2\%}$ (C)	1.49	1490
$PC_{80\%}$: $Psr_{100\%}$: AS $_{20\%}$: AP $0_{\%}$ (D)	1.86	1860
$PC_{80\%}$: $Psr_{100\%}$:AS $_{20\%}$: $AP_{0,2\%}$ (E)	1.59	1590

Table 3 shows the recapitulation of the result of mortar specific gravity testing for testing age of 28 days. The difference of the value of specific gravity is because the mixture used is different. The greatest decline in the result of specific gravity value testing happens in the mixture of $PC_{80\%}$: Psr $_{100\%}$: FA $_{20\%}$: AP $_{0,2\%}$ (C). Lightweight mortars with the additional material in form of aluminium powder (mixture C and E) have fulfilled minimum requirements for the specific gravity of lightweight brick since the value of specific gravity <1800 kg. Meanwhile based on the survey on the specification of lightweight brick at market, from some of lightweight brick producer such as PT. Citicon Bata, PT.Primacon Bangun Persada, CV. Anugrah Ajitama and PT. Facon Interlite have specific gravity value of 550-650 kg/m^3, so it can be concluded that the value of specific gravity produced by lightweight mortar is not in accordance with the value specification of lightweight brick specific gravity at market. Recapitulation of testing result of mortar compressive strength can be seen in Table 3. In table 4, type of mortar compressive strength is based on SNI 02-6825-2002 [6] for testing age of 28 days. Lightweight mortar mixture C and E belongs to mortar category O. This is because the compressive strength value of mixture C and E >2,4 MPa, meanwhile for mixture A, B, and D for testing age of 28 days are in order belongs to N, S, and N types of mortar category. The best quality is dominated by mixture B which uses fly ash since the fly ash which is hydraulic can react by binding free calcium released by cement during hydration process and the effects of lightweight mortar treatment using steam curing so the mixture can get high initial strength. This is proved by mixture A that is treated without using steam and get lower compressive strength value.

Table 4: Result Recapitulation of Mortar Compressive Strength Testing

Mixture	Day Testing (MPa)			
	7	14	21	28
Normal (A)	7.8	8.7	10.1	10.7
$PC_{80\%}$: $Psr_{100\%}$: $FA_{20\%}$: AP $_{0\%}$ (B)	8.7	9.1	12.4	13.5
$PC_{80\%}$: $Psr_{100\%}$: $FA_{20\%}$: $AP_{0,2\%}$ (C)	3.2	4.8	5.1	5.1
$PC_{80\%}$: $Psr_{100\%}$: $AS_{20\%}$: AP $0_{\%}$ (D)	6.5	6.5	6.6	7.4
$PC_{80\%}$: $Psr_{100\%}$: $AS_{20\%}$: $AP_{0,2\%}$ (E)	2.3	2.9	3.1	4.9

Based on survey on the specification of lightweight brick in the market, the bricks produced by some producers such as PT. Citicon Bata, PT. Primacon Bangun Persada, CV. Anugrah Ajitama, and PT. Facon Interlite have compressive strength values from 3,5 MPa to 4,5 MPa. So it can be concluded that the value of compressive strength produced by lightweight mortar already fulfills the specification of compressive strength value of lightweight brick in the market, but the value of specific gravity does not meet the specification. Therefore, lightweight mortar with additional material in form of aluminium powder is still poor in quality. So it is needed the constituent materials of mortar with lighter specific gravity such as fine aggregate.

4. CONCLUSION

The utilization of fly ash and husk ash waste as substitution for cement and the addition of aluminium powder in making lightweight mortar can affect the value of mortar characteristic in testing age of 28 days, in which the values are 1.56 g/cm^3, 1,59 g/cm^3, 1,58 g/cm^3 for specific gravity and 4,2 MPa, 5,1 MPa, 4,9 MPa for compressive strength. So, from the result of the research, it is known that the higher the value of mortar specific

gravity, the higher the value of compressive strength produced. The maximum compressive strength value occurs in the mixture of FA+AP which is equal to 5,1 MPa. In terms of the compressive strength, based on SNI 03-6882-2002 about mortar specification, lightweight mortar belongs to O type since the value of compressive strength is <5,2 MPa.

5. ACKNOWLEDGEMENT

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DESIGN OF MATHEMATICS LEARNING VIDEO FOR CLASS XI STUDENTS OF SMA SARASWATI I DENPASAR

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Abstract. In accordance with the assessment of KI-3 and KI-4 on mathematics subjects still have problems in understanding the concept of student learning so that it affects the learning outcomes. With these constraints, in this study researchers combined scientific approaches with learning videos. The design used in this study uses an experimental experimental design called True experimental design, namely the Posttest Only Control Design. The material given at the time of the research action includes the material Limit Functions, Derivatives, and Integral. Through the steps of the research that has been carried out, the final test results are obtained in the experimental class 45% of students belong to a category with very good concept comprehension ability, and 2.5% of students included in the concept comprehension ability category are still lacking in Limit Function material. Then in the material the percentage derivative in the very good category is 50% and the sufficient category is 5%. In Integral material, 50% of students are in the very good category and 50% are in the good category.

Keywords : Learning Video, Scientific Approach, Experiment Method, Limit Function, Derivative, Integral.

1. INTRODUCTION

In the 2013 curriculum, especially in KI-3 and KI-4 emphasized students' understanding of knowledge and skills. In accordance with the assessment of KI-3 and KI-4 in mathematics subjects still have constraints on understanding the concept of student learning so that it affects the learning outcomes.

Based on the 2013 Curriculum, KI-3 is a competency that is knowledgeable in that students understand knowledge (factual, conceptual, and procedural) in science, technology, art, culture, and humanities with insights on religion, nationality, state and civilization related to phenomena and events. the eyes look. Then KI-4 is a skill that is a skill that students try, process, and present various things in the concrete domain (using, parsing, assembling, modifying, and making) and abstract realms (writing, reading, counting, drawing, and composing) according with what is learned at school and from various other sources in the same perspective / theory [1].

The purpose of this study was to produce Mathematics teaching materials in video learning and to find out whether effective learning videos were used as learning media in the Mathematics learning process for students of class XI Science at SMA SARASWATI 1 DENPASAR. With this aim, whether or not the use of video learning on students is effective or not is measured by understanding mathematical concepts. Video is a message delivery medium including audio-visual or media-viewing media. Audio visual media can be divided into two types, first, equipped with sound and picture equipment functions in one unit, called pure audio-visual media. [2].

The making of this learning video was made for students of class XI Science in even semester by using Adobe Premiere in Compulsory Mathematics in even semester. Adobe Premiere Pro is a program created for video editing and part of the Adobe Creative Suite, graphic design series, video editing, and web application development created by Adobe Systems. Premiere Pro supports several types of video editing and plug-in cards for process acceleration, support for additional file formats, and video / audio effects that add to the completeness of Premier Pro [3].

2. METHODS

The type of research that will be used in this research is experimental research. The design used in this study uses an experimental experimental design called True experimental design, namely the Posttest Only Control Design. In this design there are two classes of samples to be distinguished, namely the experimental class and the control class. The experimental class was treated by learning by using a scientific approach to the ability of mathematical concepts and the use of learning videos, while the control class was not treated, meaning learning using the usual method of previous teaching or conventional learning approaches. The Posttest Only Control Design used is as follows [4]:

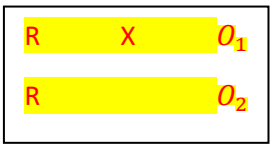

Figure 1. Post test-only Control Design

Information :
X : treatment that is learning with using scientific and video approaches learning
O1 : post test in the experimental class with treatment
O2 : post test in the control class without treatment

RESEARCH POPULATION AND SAMPLE

Population is the whole individual who will be targeted in the form of research [5]. As for the population is all students of class XI IPA (LAB) SMA SARASWATI 1 DENPASAR in the academic year 2017/2018. The population can be seen in the following table.

Table 1. Research Population

No	Class	Gender		amount
		Man	Woman	
1	XI IPA 1	17	27	44
2	XI IPA 2	22	19	40
3	XI IPA 3	18	27	45
amount		57	73	129

Source: Administration of SMA SARASWATI 1 DENPASAR

The sampling technique in this study is cluster random sampling (area sampling) technique which is a random sampling technique in determining the experimental class and control class [6]. The classes that were sampled were class XI IPA 2 as an experimental class using a scientific approach and utilization of learning videos, and class XI IPA 3 as a control class in mathematics learning the subject of Limit Functions, Derivatives, and Integral.

PROCESS OF MAKING VIDEO LEARNING

Learning videos are systematically designed by referring to the applicable curriculum and in developing it applying the principles of learning so that the program allows students to make the learning material easier and more interesting. Physically learning videos are learning programs that are packaged in videotapes and presented using VTR or VCD player equipment and TV monitors [7].

The process of making mathematics learning videos in this study is using the Adobe Pemiere Pro cc software 2017. The following are the stages of making the learning video:

1. Prepare the video file that will be edited.
2. Open the Adobe Premiere Pro cc 2017 program, then the Welcome Screen will appear as shown below.

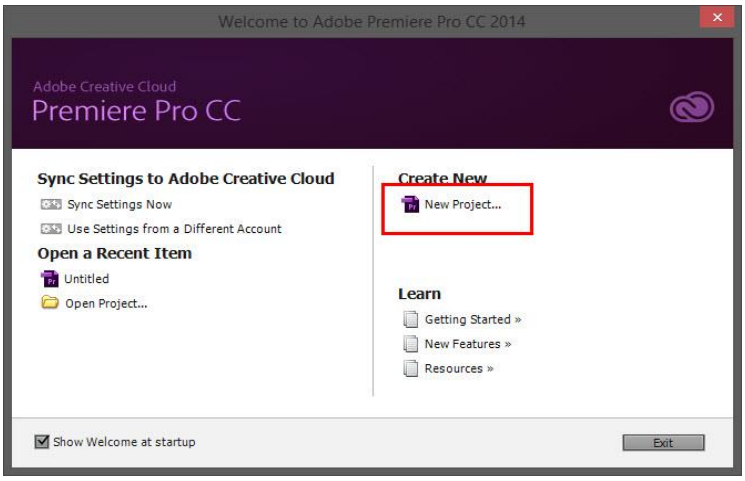

Figure 2. Step 2 video creation

3. Then specify the editing title and also the file storage location for editing to easily find when you want to continue the next video editing.

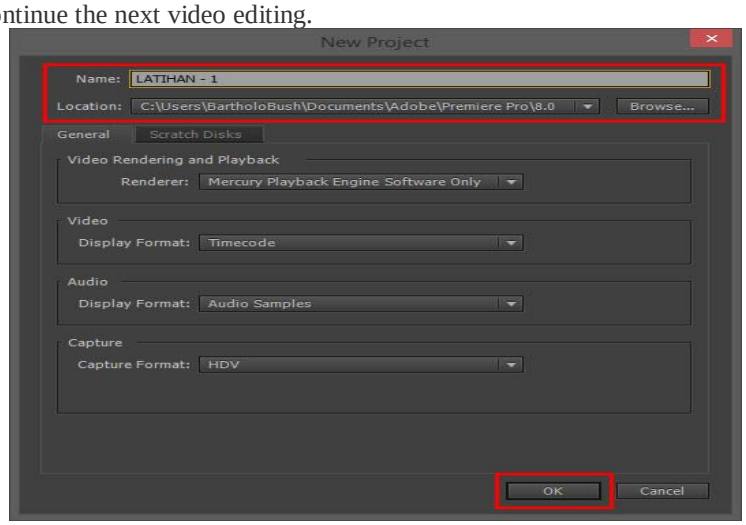

Figure 3. Step 3 video creation

4. Then the Adobe Premiere Pro display will appear as shown below.

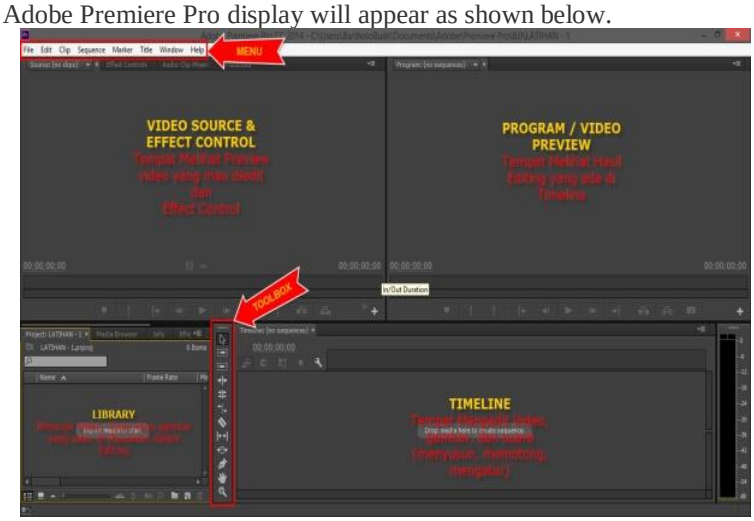

Figure 4. Step 4 video creation

5. Enter the Video File that will be edited by clicking the File> Import> search menu and selecting the File that was prepared earlier.

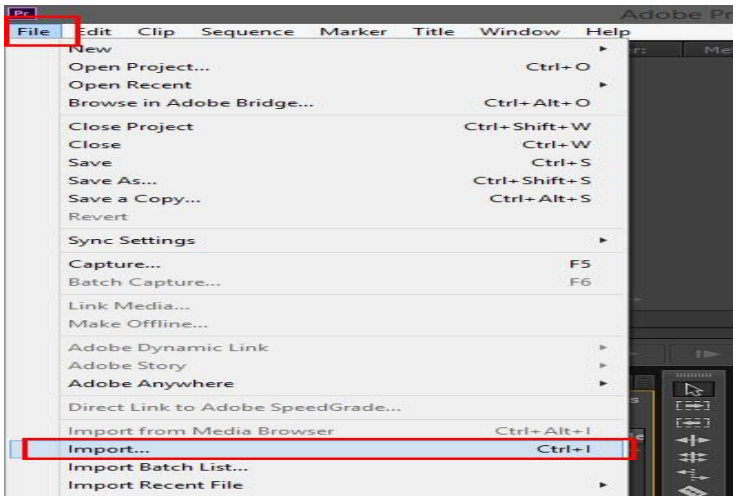

Figure 5. Step 5 video creation

6. Then the video will enter the Library in the lower right corner, as shown below.

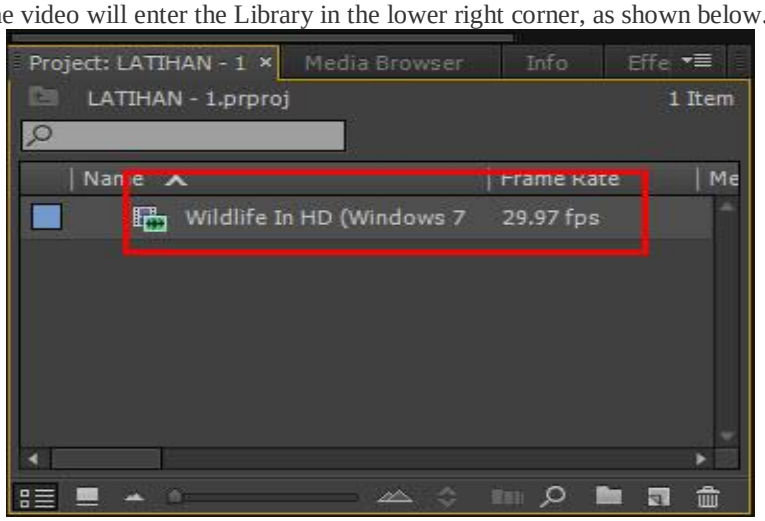

Figure 6. Step 6 video creation

7. To edit a video, we need to insert a video into the Timeline by clicking and dragging the video to the Timeline.

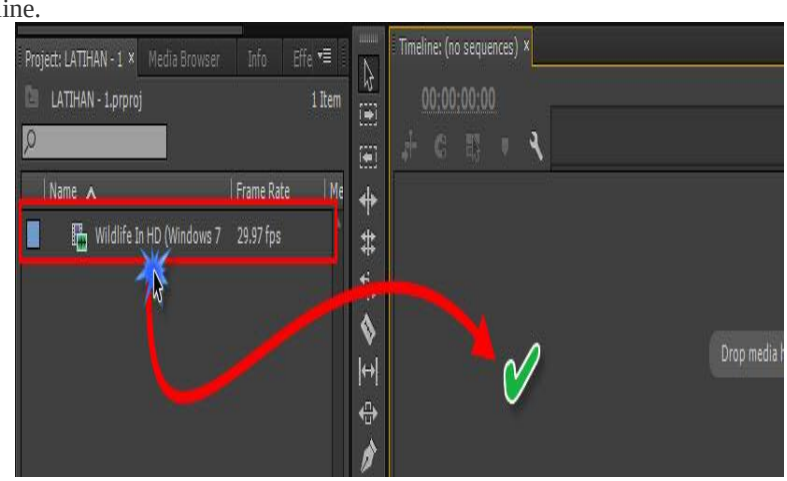

Figure 7. Step 7 video creation

8. Then later in the Timeline we can edit videos according to our wishes.

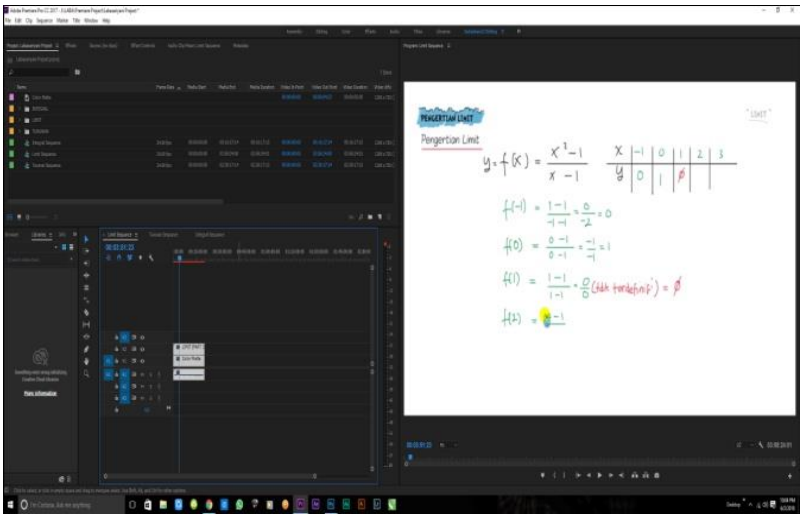

Figure 8. Step 8 video creation

9. Save the Editing results by clicking File> Save.

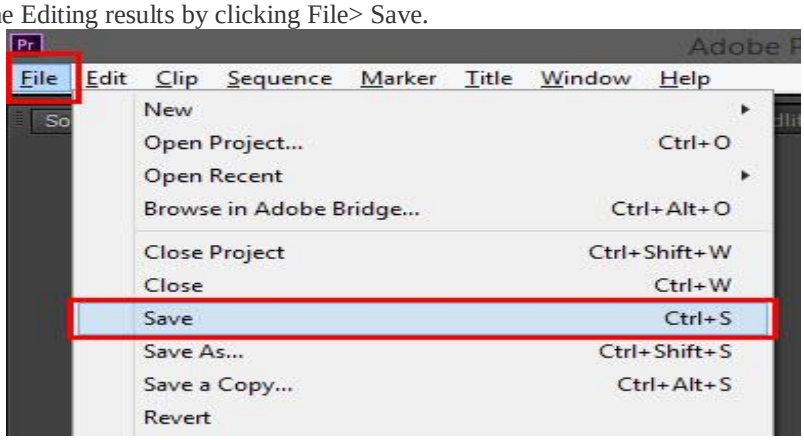

Figure 9. Step 9 video creation

10. After all videos have been edited, the next video rendering process is carried out.

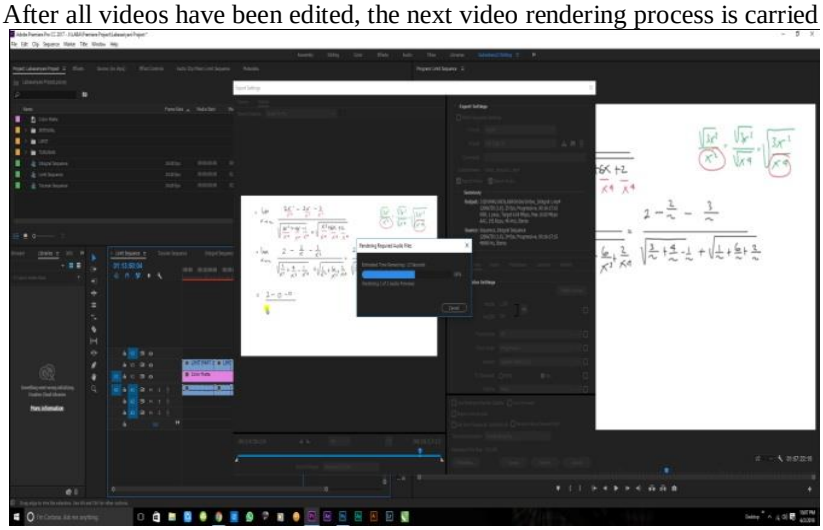

Figure 10. Step 10 video creation

3. RESULTS AND DISCUSSION

The scientific approach in learning in this study is intended through the steps of the scientific approach can lead students in understanding the concept of the material being studied in this case is the Limit Function,

Derivation, and Integral. Steps in the scientific approach by using teaching materials that have been designed in such a way as to support students in understanding concepts not just memorization.

The scientific approach consists of five steps, namely observing, asking, reasoning, trying and communicating [1]. At the observation stage at the first meeting the presentation of the Limit Function material had not used the learning video, and the discussion of the matter was still using LKS. At this first meeting, students were not used to using worksheets with the steps of a scientific approach, so that there were still many students who were confused about the stage of observing the problem in the LKS. They did not observe carefully and immediately answered the questions given. The solution for researchers to deal with the problem is to provide direction to observe problems in the worksheet carefully and not in a hurry. At the second and third meetings students are getting used to the stage of observing the problems in the LKS but there are still students who have difficulty understanding the material presented. With these constraints, researchers began to combine the scientific approach with the learning video in the fourth meeting and so on until the Limit Function material was over, then continued with Derivative and Integral material with the same action steps as in the Limit Function material.

At the questioning stage at the first to third meeting, students are given the freedom to ask the researcher directly or the questions are written on the Student Worksheet (LKS). During the first meeting up to the third there were some students who still asked not to be directed by what they observed. At this questioning stage, there is also the next step which is reasoning. The solution of the researcher to overcome this problem is by starting to use learning videos in explaining the material then giving fishing questions to students, so that students can ask them according to what they observed before.

Then the next step is to try, at this stage most students have started to get used to answering the questions in the LKS, but there are still students in the group members who do not participate to complete the steps in LKS, so that the researchers' solutions to overcome the problem is that researchers urge all groups to write the names of students who did not participate in group activities. The name that does not participate will be reduced in value. After the researchers reminded each group, at the second and third meetings most students participated in group activities. Although there are still students playing around but still participating.

The fifth stage is communicating. After students complete the activities in LKS, the next step is to communicate, the researcher asks representatives of one group to communicate the results of their activities. At the first meeting, no group dared to come to the front of the class to communicate the results of their activities. The solution of the researcher to overcome this problem is the researcher announces to the students, for the group that dares to go forward to communicate and the value of the group is good, the researcher will reward the group. So students are enthusiastic to communicate the results of their activities. At the second meeting students were very enthusiastic to communicate their activities, so the class became noisy. The solution of the researcher to overcome the problem is to announce to students, to be orderly in the activity of communicating it, for those who make chaos will be removed from the class. While at the third meeting the students had begun to order to communicate the results of their activities.

In the process of implementing learning with a good scientific approach, the material Limit Functions, Derivatives, and Integral is very difficult to know the ability to understand students' concepts one by one. Therefore, researchers provide tests to students both experimental and control classes at the end of each lesson. This is intended to be able to know the ability to understand students' concepts one by one. After the learning process is carried out in the experimental class and control class, the researcher conducts a final test (posttest) to find out the students' learning outcomes about the material that has been delivered in the class.

In this study the data collected is data about the ability to understand students' mathematical concepts with a scientific approach. The data collection of the learning process is by using the Test. The test used is Posttest. Posttest is a test conducted after the treatment is given to find out the understanding of students' mathematical concepts. The type of test that will be given is a subjective test (form of description). The test is used to determine the ability of students to understand concepts in solving problems according to indicators of understanding concepts.

The following is the final test results of each teaching material in the experimental class namely XI IPA 2:

Table 2. Final test data for each material in the experimental class (XI IPA 2)

Respondent Number	VALUE		
	LIMIT FUNCTION	DERIVATIVE	INTEGRAL
1	59	65	75
2	70	75	75
3	80	80	80
4	65	65	75
5	80	80	85
6	75	77	77
7	80	80	80
8	80	80	80
9	80	80	85
10	77	79	79
11	75	75	75
12	80	80	80
13	80	81	85
14	75	80	80
15	80	82	85
16	80	80	80
17	75	80	80
18	65	70	79
19	75	75	75
20	75	75	75
21	75	75	75
22	75	75	75
23	65	71	75
24	75	75	75
25	55	70	70
26	75	75	75
27	80	82	85
28	80	82	82
29	80	80	80
30	80	80	80
31	80	80	80
32	80	80	80
33	75	78	79
34	80	80	80
35	65	75	75
36	65	73	73
37	75	75	75
38	80	80	80
39	80	80	80
40	75	75	78

Here are the final test results from the control class, XI IPA 3:

Table 3. Final test data for each material in the control class (XI IPA 3)

RESPONDENT NUMBER	VALUE		
	LIMIT FUNCTION	DERIVATIVE	INTEGRAL
1	75	70	75
2	60	65	75
3	75	70	75
4	75	75	75
5	75	75	80
6	75	75	75
7	75	73	75
8	65	75	75
9	70	72	80
10	75	75	75
11	65	75	75
12	65	70	73
13	65	73	75
14	70	75	75
15	80	80	80
16	80	78	80
17	75	80	80
18	80	75	80
19	75	75	75
20	75	75	75
21	65	75	65
22	75	75	75
23	70	75	75
24	75	75	75
25	80	81	80
26	75	75	75
27	65	70	70
28	65	65	70
29	65	75	75
30	70	75	75
31	75	75	75
32	75	75	75
33	55	70	70
34	75	75	75
35	75	80	80
36	70	80	80
37	71	75	75
38	75	75	75
39	75	75	75

RESPONDENT NUMBER	VALUE		
	LIMIT FUNCTION	DERIVATIVE	INTEGRAL
40	70	75	75
41	70	75	75
42	65	75	75
43	60	75	75
44	65	75	75
45	70	80	79

From these data, the data obtained from the research are obtained as follows:

a. Experiment Class Data Analysis

The last test was given at the last meeting which included all the material that had been studied at each meeting. The highest value obtained for the Function Limit material is 80 while the lowest value is 59. The highest value for Derivative material is 82 and the lowest value is 65. Then for the highest value on Integral material is 85 and the lowest value is 70. From the value obtained students in this final test, then obtained the average value for the material Limit Functions, Derivatives, and Integral are 75.03, 77.0, 78.43 respectively. The frequency and percentage of students' ability to understand concept of experimental class are presented in the following table:

Table 4. Frequency data and percentage of concept ability of experimental class students (Class XI Science 2) for Limit Function material.

Student scores	Concept Understanding Ability Category	Frequency	Percentage
80,0 – 100,0	A	18	45%
66,0 – 79,9	B	15	37,5%
56,0 – 65,9	C	6	15%
40,0 – 55,9	D	1	2,5%
0,0 – 39,9	E	0	0%
amount		40	100%

Table 5. Frequency data and percentage of concept ability of experimental class students (Class XI Science 2) for Derivatives material.

Student scores	Concept Understanding Ability Category	Frequency	Percentage
80,0 – 100,0	A	20	50%
66,0 – 79,9	B	18	45%
56,0 – 65,9	C	2	5%
40,0 – 55,9	D	0	0%
0,0 – 39,9	E	0	0%
amount		40	100%

Table 6. Frequency data and percentage of concept ability of experimental class students (Class XI Science 2) for Integral material.

Student scores	Concept Understanding Ability Category	Frequency	Percentage
80,0 – 100,0	A	20	50%
66,0 – 79,9	B	20	50%
56,0 – 65,9	C	0	0%
40,0 – 55,9	D	0	0%
0,0 – 39,9	E	0	0%
amount		40	100%

Based on tables 4 through 6, it can be seen that after using the scientific approach and video learning in mathematics learning, it is known that 45% of students belong to a category with very good concept comprehension ability, and 2.5% of students belong to the concept comprehension category. still lacking in the Limit Function material. Then in the material the percentage derivative in the very good category is 50% and the sufficient category is 5%. In Integral material, 50% of students are in the very good category and 50% are in the good category.

b. Control Class Data Analysis

The last test was given to the control class at the last meeting. The highest value obtained for the Function Limit material is 80 while the lowest value is 55. For the highest value in the Derivative material is 81 and the lowest value is 65. Then for the highest value in Integral material is 80 and the lowest value is 65. From the value obtained students in this final test, then obtained the average value for the material Limit Functions, Derivatives, and Integral are 71.13, 74.6, 75.49 respectively. The frequency and percentage of students' ability to understand concept of control class is presented in the following table:

Table 7. Frequency data and percentage of concept ability of control class students (Class XI IPA 3) for Limit Function material.

Student scores	Concept Understanding Ability Category	Frequency	Percentage
80,0 – 100,0	A	4	8,9%
66,0 – 79,9	B	28	62,2%
56,0 – 65,9	C	12	26,7%
40,0 – 55,9	D	1	2,2%
0,0 – 39,9	E	0	0%
amount		45	100%

Table 8. Frequency data and percentage of concept ability of control class students (Class XI Science 3) for Derivatives material.

Student scores	Concept Understanding Ability Category	Frequency	Percentage
80,0 – 100,0	A	6	13,3%
66,0 – 79,9	B	37	82,2%
56,0 – 65,9	C	2	4,5%
40,0 – 55,9	D	0	0%
0,0 – 39,9	E	0	0%
amount		40	100%

Tabel 9. Data frekuensi dan persentase kemampuan konsep siswa kelas kontrol (Kelas XI IPA 3) untuk materi Integral.

Student scores	Concept Understanding Ability Category	Frequency	Percentage
80,0 – 100,0	A	9	20%
66,0 – 79,9	B	35	77,7%
56,0 – 65,9	C	1	2,3%
40,0 – 55,9	D	0	0%
0,0 – 39,9	E	0	0%
amount		40	100%

In accordance with the data from Tables 7 to 9, it is known that 8.9% of students belong to a category with very good concept comprehension abilities, and 2.2% of students in the concept comprehension category are still lacking in the Limit Function material. In the material, the percentage of very good percentage category is 13.3% and the sufficient category is 4.5%. In Integral material, 20% of students are in the very good category and 2.3% are in the sufficient category.

4. CONCLUSION

Through the final test results of each material in the experimental class and control class, it can be concluded that the use of Adobe Premiere software is able to produce mathematics teaching materials that are very effective for students in understanding mathematical concepts that can be seen from the students' learning outcomes in the experimental class.

5. ACKNOWLEDGEMENT

Our gratitude goes to the Director General of Higher Education who has funded this research, the Head of SMA SARASWATI 1 DENPASAR who gave permission to researchers to be able to conduct research along with teachers and students who have participated in research activities so that this research went smoothly, and the editor and the LOGIC Journal reviewer for publication.

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ANALYSIS OF St. 42 STEEL HARDNESS AFTER BEING HEATED TO 8000C AND QUICKLY COOLED WITH FRESH WATER BY APPLYING ROCKWELL METHOD

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Abstract. The hardness of machine components which, in operation time, collide and rub against each other and are made of St.42 steel needs to be found out. Therefore, research on the hardness of St.42 steel especially those which are heated needs to be carried out so that it can be chosen as machine component properly. This research tests the change of the surface hardness by applying Rockwell method and is the continuation from a former research. Steel is a technical material which is often used as machine components, so that its strength against external loads is really needed to be known. External loads which are often occurred on machine components are friction load, torsion load, tensile load, bent load and mash load. This research aims to find out how much the change of the hardness of standard St.42 steel surface after being heated at temperature of 800^0C and quickly cooled by using fresh water which is carried out in laboratory of material testing, Department of Mechanical Engineering, State Polytechnic of Bali. The result shows that the hardness of the surface of steel which is heated until 800^0C and quickly cooled by using fresh water is more lenient than the standard St.42 steel, although it is tested by applying either Rockwell B (HRB) or Rockwell C (HRC) methods. The change of the strength based on Rockwell B method shows the decrease in surface hardness until 19,81%; from 29,93 (Kgf/mm^2) to 24,0 (Kgf/mm^2). In Rockwell C method there is also decrease in surface hardness which is equal to 20,23%; from 54,7(Kgf/mm^2) to 43,63 (Kgf/mm^2).

Keywords : Hardness, steel, heat treatment

1. INTRODUCTION

Hardness is the ability of metal to not change in shape and size permanently if an outside load is given. There are three methods of hardness measurement namely: penetration, elastic hardness, and abrasion hardness. Penetration method is applied by pressing harder metal on the test specimen with certain time, load, and size. This testing is done in hardness testing machine (Brinnle, Rockwell, and Vickers). Elastic hardness method is applied by measuring the rebound height of a poly hammer dropped from a certain height to a test object in a measuring tube, then the height of the rebound data is entered into a formula. The harder the tested material, the higher the rebound will be, and vice versa. Abrasion method is applied by scratching the test object with a type of object that is standardized from hard to soft. If one can cause scratches, it can be determined empirically rather than the hardness of the metal [1].

The hardness of material, steel in this case, is measured based on the depth of maximum penetration occurred on test specimen, then it is calculated by using relevant formulas based on the testing method applied [2]. To find out the hardness of steel, hardness testing should be administered. The execution of hardness test in this research is in collaboration with mechanical engineering students in fourth semester using the material hardness testing machine of *Precision Hardness Tester-GNEM OM-150* in the Laboratory of Material Testing and

Metrology, Mechanical Engineering Department, Bali State Polytechnic. Every class of the fourth semester students is divided into four groups.; Each group consists of six to seven students. Hardness test is a mechanical properties test which is aimed at finding out the material hardness. The testing is administered by pressing the surface of test specimen using standard penetrator with the load time of 10 seconds. This hardness test is obviously based on test standard which has been specifically set in form of indicator of test performance achievement [3].

For the next, research data collection is continued by filling table format which is used as the primary data of hardness result. In order to be able to administer hardness test, the practitioners have learned about material technology and attend necessary training. The test has to pay attention to and obey the rules applicable in laboratory of material test and metrology beside health and safety factors which are indeed required for each test kit [4].

Material hardness is one of mechanical properties of materials which are mostly affected by carbon element and its compounds. Mechanical properties of steel is really needed to be known so that, when it is used, it can hold loads and safe to be used, so the function of steel or other materials can be effective. Carbon element in steel obviously affects the quality and strength of steel which can be achieved by heat treatment, for example. Mechanical properties of steel can be known through some processes of test in laboratory of material test. Tests of steel strength in general are testing of tensile, twisting, surface hardness and bending which can provide information on the mechanical properties of steel, [5].

Reliable machinery or equipment is a machine / tool system that can produce a safe work process for the operator and its environment when operated, the sustainability in maintenance and repairs is guaranteed, produce competitive products in the market, [6]. To fulfill the above criteria, the selection of materials for machine components / tools must be in accordance with the designation and resistance to loads based on their mechanical properties.

This study analyzed the hardness of standard St.42 steel surface compared to St.42 heat treated steel. Especially the steel is heated to 800^0C and cooled quickly using fresh water. Steel hardness testing can provide information about the maximum ability of steel to penetrate other standard materials, [4]. Material or steel hardness is the ability of a material or steel to withstand a compressive load or penetration of a certain surface area. The tensile strength of the material including the hardness of a material or steel is largely influenced by the elements of its compounds. Carbon in iron or steel definitely affects the quality or hardness of steel surfaces, [3].

This hardness testing process is done in machine which is specially designed to be able to administer test of steel hardness. The surface hardness test machine used is *Precision Hardness Tester-GNEM OM-150*, [7,8]. The test administered by using this machine can determine the surface hardness of a material especially metal or steel through testing in accordance with the standard procedure.

Aims of this research are: (1) Being able to measure changes in surface hardness that occur in St.42 steel based on the theory of heat treatment. (2) Being able know for sure the value of the change in hardness of the steel surface of St. 42 with heat treatment.

Results of this research are beneficial, such as: (1) For the researcher himself, this research is very useful for developing and deepening knowledge in the field of material technology, as well as adding skills in the implementation and operation of materials testing tools. (2) For Bali State Polytechnic institutions, this research is useful to introduce to the parties so that it can be used as a source and comparison of relevant research results. (3) For the community especially those who are dealing with the design and selection of steel materials, the results of this study can be used as a consideration in choosing technical materials or steel, especially the St. 42.

2. METHODS

Research Process and Location

Testing of this hardness is done using Rockwell method, where there are two types of Rockwell hardness testing, namely: testing using a standard press or spherical dedentor and the other using a cone-shaped press. For the two test methods above, the testing procedure is the same, only the use of the type of dedentor is different, so each of these tests produces a valid standard of hardness, namely Rockwell B which is abbreviated as HRB, and Rockwell C which is abbreviated as HRC, [9].

The standard testing process carried out is: ground level before the specimen is installed on the hardness testing machine; make sure the available voltage is 220 Volts. Install the penetrator or dedentor according to the type of test that will be carried out correctly, set the amount of load that must be given. Turn on the Precision Hardness Tester-GNEM OM-150 engine by pressing the switch on the On button, the test engine's focus lamp lights up, leave it for about five minutes as initial preparation. Next, turn the loading handle according to the instructions so that the hardness value can be read correctly on the hardness indicator. Thus the hardness testing process is repeated according to the number of specimens to be examined, which are 30 times each [3].

The process of this research is carried out through two stages. The first stage is the preparation of the test object including giving heat treatment to the test object and the second stage is the data collection on the hardness testing machine. The preparatory work is intended to have the surface of the test material smooth and flat, while

the heat treatment of the test object in the heating kitchen is intended to harden or soften the test object compared to the standard specimen [7,8].

Research sites; This research was conducted in collaboration with students who conducted material test practical activities in the fourth semester at the Materials Test and Metrology Laboratory, Mechanical Engineering Department, Bali State Polytechnic. Students are divided into five groups and each group consists of four to five students. Each group is given both types of specimens, namely standard and hardened specimens, one unit of each. The results of the test data for each group are averaged according to the type of specimen that the data is taken as the data put in this study table [10].

The Parameter Observed

Hardness test using the *Precision Hardness Tester-GNEM OM-150* machine with the Rockwell method is the most practical one compared to using two other methods namely Brinell method and Vickers method, because the hardness value of the test object can be read directly on the measuring instruments contained in the test machine. So, the Rockwell method does not use any formulas like the Brinell method or the Vickers method. Hardness test using the Rockwell method, besides being faster, is also more accurate because the engine directly shows the hardness value of the test object. However, the three methods of testing the hardness mentioned above are still acknowledged and the results are valid, as long as they are carried out with standardized testing standards.

Research on the hardness of similar specimens using the Brinell and Vickers methods has been reported in the research report in the July 2016 LOGIC journal and the March 2017 LOGIC journal. Therefore, this study is very necessary to report the results of the hardness test using Rocwell B and Rocwell C methods through LOGIC journal, Research and Community Service Center, Bali State Polytechnic.

3. RESULTS AND DISCUSSION

Test Results

Tests were carried out carefully and systematically starting from the testing of standard St.42 and St.42 perimeter (hardening) specimens. The results of testing carried out by each student group for each type of test object using a diamond ball and cone shaped penetrator. The data obtained is then put into format and table as follows.

Test object (round shape) : St.42 (Standard) and (Hardening)
Test object thickness : 8.4 mm
Diameter of test object : 9 mm
Ball penetrator diameter : 1/16 inch
Loading : 100 kgf
Loading time : 15 seconds
Test type : Rockwell B

Table 1. Data of Standard and Hardening St.42 Steel Hardness (Rockwell B)

No	HRB St.42Standar (Kgf/mm^2)	HRB St.42Hardening (Kgf/mm^2)	Hasil Rerata HRB (Kgf/mm^2)
1.	34	28	
2.	27	25	
3.	31	24	
4.	28	26	
5.	29	27	
6.	32	24	HRB Standar = 29,93
7.	33	23	
8.	31	22	
9.	33	21	
10.	32	20	
11.	31	28	
12.	28	25	
13.	34	24	
14.	27	26	
15.	31	27	

No	HRB St.42Standar (Kgf/mm^2)	HRB St.42Hardening (Kgf/mm^2)	Hasil Rerata HRB (Kgf/mm^2)
16.	32	24	
17.	33	23	
18.	29	22	
19.	33	21	
20.	32	20	HRB Hardening = 24,00
21.	34	28	
22.	27	25	
23.	31	24	
24.	28	26	
25.	29	27	
26.	32	24	
27.	33	23	
28.	31	22	
29	30	21	
30.	33	20	

Source: Data of the Standard St.42 Hardness Test

Next is the test result of standard and hardening St.42 steel which gets heating and quick cooling with fresh water, tested using a cone-shaped diamond penetrator with a peak angle of 110^0 resulting in the hardness of Rockwell C.

Test object (round shape) : St.42 (hardening and standard)
Test object thickness : 8.4 mm
Diameter of test specimen : 9 mm
Cone diamond penetrator : 1200 (peak angle)
Loading : 150 kgf
Loading time : 15 seconds
Test type : Rockwell C

Table 2. Data of Standard and Hardening St.42 Steel Hardness Test (Rockwell C)

No	HRC St.42standar (Kgf/mm^2)	HRC St.42hardening (Kgf/mm^2)	Hasil Rerata HRC (Kgf/mm^2)
1.	55	44	
2.	52	47	
3.	64	43	
4.	62	40	HRC Standar = 54,70
5.	50	42	
6.	63	46	
7.	61	45	
8.	51	41	
9.	53	48	
10.	54	43	
11.	55	43	
12.	52	40	
13.	64	42	
14.	62	46	
15.	50	45	
16.	63	41	
17.	61	48	
18.	51	43	HRC Hardening = 43,63
19.	53	44	
20.	54	47	
21.	55	43	
22.	52	40	
23.	64	42	
24.	62	46	
25.	50	45	
26.	63	41	
27.	61	48	
28.	51	43	
29.	55	43	
30.	53	40	

Source: Data of Hardening St.42 hardness test

Discussion

Furthermore, from each data in the hardness test table above, it can be read the standard St.42 test object hardness and the hardness of St.42 hardening steel. In testing using the Rockwell B method, the standard hardness of St.42 is 29.93 kgf / mm^2, while in St.42 Hardening, the hardness shows a decrease which is equal to 24.0 kgf / mm^2. So, the hardness of St.42 steel, after being heated to 800^0C and cooled using fresh water, was decreased by 19.81%. Furthermore, Rockwell C testing is carried out by replacing the ball-shaped penetrator with cone-shaped diamond penetrator and the loading is set at 150 kgf, while the loading time is the same; it is 15 seconds.

The test used the Rockwell C method, the standard hardness of St.42 was 54.70 kgf / mm2, whereas for St.42 Hardening, the hardness showed a decrease which was 43.63 kgf / mm2. So, for the St.42 steel after being heated to 800^0C and cooled using fresh water, the hardness decreased by 20.23%.

Hardness testing using the Rockwell method is according to standard procedures, this study uses a spherical penetrator with a diameter of 1/16 inch and a load of 100 kgf for testing Rockwell B hardness. Meanwhile, Rockwell C hardness testing uses a cone penetrator with a peak angle of 1200 and a load of 150 kgf.

The data from the research results of the two types of specimens above show a difference in hardness, such as a change in one of the mechanical properties of the specimen, especially St.42 hardening steel with 800^0C heating and quick cooling using fresh water. In fact, the test data of St.42 steel specimens which were heat treated and cooled quickly using fresh water, the hardness decreased by about 20% compared to the standard St.42 steel test hardness.

4. CONCLUSION

Based on the results of the research and the data analysis, it can be concluded that: (1) Rockwell B hardness test, namely St.42 Hardening Steel hardened by heating to 800ºC and quick cooling using fresh water turned out to have lower hardness compared to the standard St.42 steel. It was proven from the hardness data of Hardening HRB St.42 which equals to 29,93 kgf / mm^2, while the Standard HRB St.42 hardness = 24.00 kgf / mm^2. (2) Testing of Rockwell C hardness is: St.42 Hardening Steel which is hardened by heating to 800ºC and quick cooling using fresh water turns out to have lower hardness compared to standard St.42 steel. It was proven from the hardness data of Hardening HRB St. 42 = 54.70 kgf / mm^2, while the hardness of Standard HRB St.42 = 43.63 kgf / mm^2. (3) There is a match between the results of the Rockwell B and Rockwell C hardness studies, with the same results of steel hardness study using the Vicker method as well as hardness testing using the Brinell method, which has been carried out before and has been published in the LOGIC Journal of Bali State Polytechnic.

5. SUGGESTION

Based on result and discussion above, suggested that: (1) It is necessary to test the same specimen by gradually changing the heating temperature to a certain extent in the next research, (2) It is very necessary to test the same specimen with different loading times in the next research.

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RISK ANALYSIS OF PROJECT SCHEDULING USING MICROSOFT EXCEL

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Abstract. Scheduling plays a very important role for the successful implementation of construction projects. One of the biggest risks in scheduling is in terms of project costs and duration uncertainty. To anticipate these uncertainties, scheduling methods have been developed using probabilistic duration, including PERT and Monte Carlo Simulation methods. In this research the simulation process was carried out using Microsoft Excel which was integrated with @Risk's add-ins. From the results of the analysis, the project duration obtained from the scheduling model with the CPM method, conventional PERT and Monte Carlo simulation produces an average value that is close to the same. The difference occurs in the standard deviation value, the conventional PERT method produces the smallest standard deviation, followed by a Monte Carlo simulation using the PERT distribution and the last is Monte Carlo simulation using the TRIANGULAR distribution. From the results of the sensitivity analysis, it was found that the dominant input variables that affect the duration of the project are the duration of activities that most often enter the critical path or those that have a great critical index. Meanwhile, project costs are influenced by a combination of the duration of activities on the critical path and activities that have a great direct cost.

Keywords : Risk Analysis, Project Scheduling, Monte Carlo Simulation

1. INTRODUCTION

Projects, especially construction projects, are always full of uncertainty, for example in terms of uncertainty over costs and completion times, which can cause a risk of losses for both contractors and project owners. To minimize the impact of these risks, you need tools to analyze them. Some scheduling methods such as CPM and PDM have not included risk factors explicitly in determining the duration of each project activity, in which they still uses deterministic duration (exact number) which is considered most likely to occur. One alternative is to overcome the above problems by using Monte Carlo simulation method [1,2]. This method uses stochastic input like PERT, but with a choice of various probability distribution curves.

This study attempts to discuss the use of the Monte Carlo method to simulate project scheduling by entering the duration and cost of each probabilistic activity. The models made are then analyzed using the PERT method and Monte Carlo simulation for later compared to the results. The simulation process is carried out using Microsoft Excel which has been integrated with @Risk, an auxiliary application (add-ins) in Microsoft Excel to run Monte Carlo simulations.

The aims of this research are: (a) Compare the duration of the project from various scheduling methods. (b) Knowing the input variables that mostly affect the duration and cost of the project.

This research is expected to be useful for other parties who are interested in risk analysis, including: (a) For contractors, they can make a more realistic project scheduling model, taking into account possible risk factors. (b)

For owners, they can simulate their investment risks, for example to answer the question "how many opportunities for my project to finish on time, and how much does it cost?" (c) For students, this can be used as learning material.

Scope of the problems are: the scheduling model in this study is entirely fictitious, solely for learning purposes in order to better understand the concept of risk analysis simulation especially in project scheduling.

2. METHODS

Broadly speaking, the sequence of work steps taken in analyzing a risk using a Monte Carlo simulation is as shown in Figure 1.

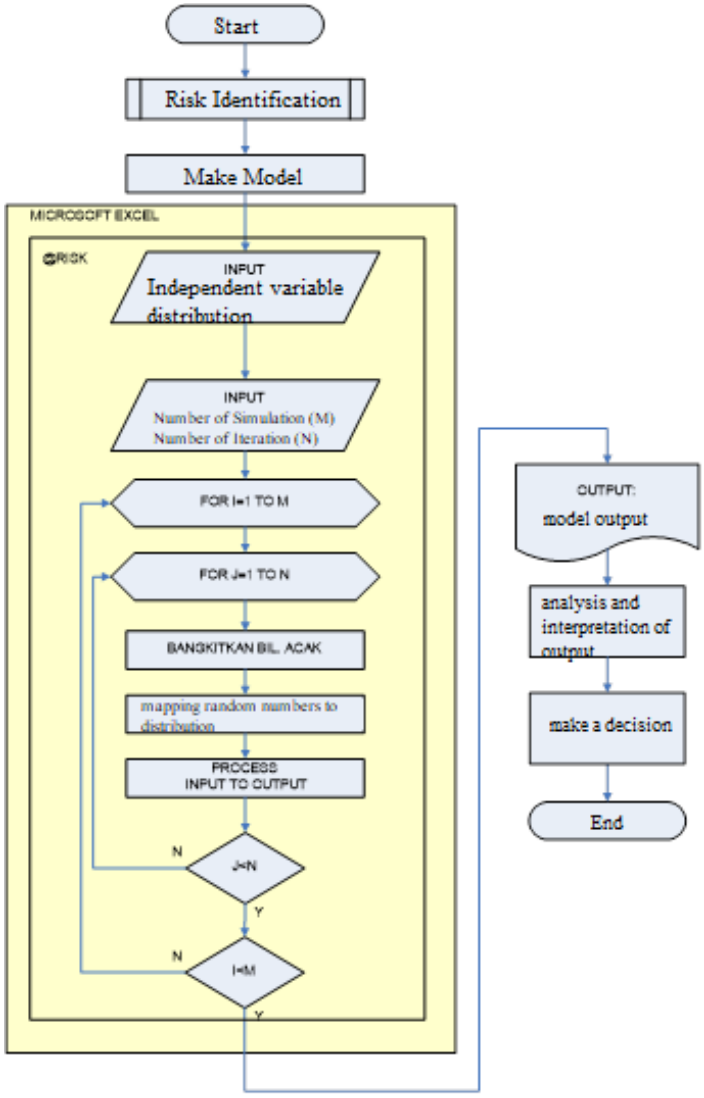

Figure 1: Flowchart of the Research Methods

3. RESULTS AND DISCUSSION

Case Model

The case model discussed in this writing is about project scheduling, which consists of 12 activities. The model is described by AON type of network planning (Activity on Node) as well as PERT / CPM (Figure 1). Input data in the form of: duration of each activity, direct costs of each activity and indirect costs of the project per day with their respective probability distributions. Next, it is simulated by the Monte Carlo method using the @Risk program that has been integrated with Microsoft Excel. The risks to be analyzed relate to the duration of the project and project costs. From the simulation results, an analysis will be conducted to find the relationship between input variables on output (project duration and project costs) and the relationship between the duration of the project and project costs (between output variables).

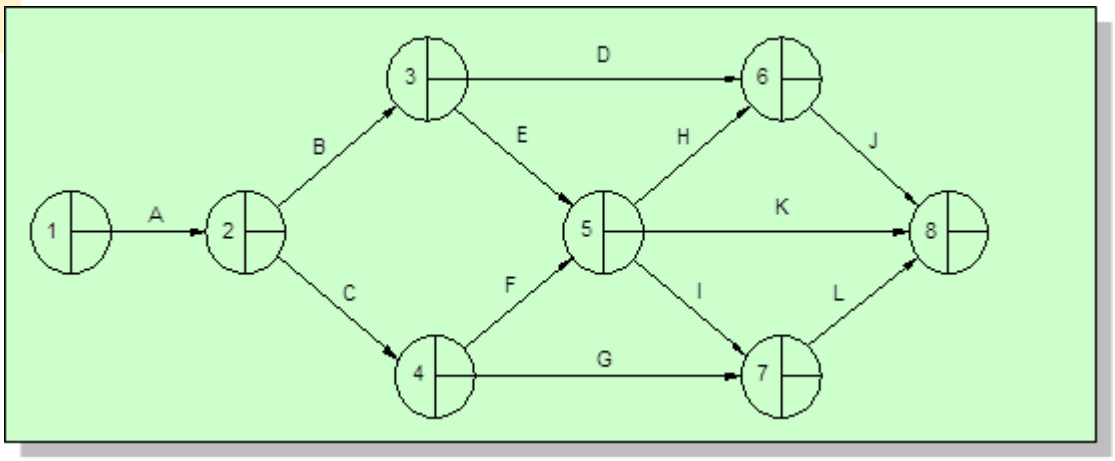

Figure 2: Network Planning Model of the Reviewed Projects

Monte Carlo simulation works based on the principles of probability in statistical science. In the sampling technique, this method uses a random number generator, to create random numbers, which are then mapped into sample input models according to the type of probability distribution specified in the model. Furthermore, the inputs are processed in accordance with the provisions of the model to become output [3,4]. This process is carried out repeatedly (iteration) until the model is considered convergent (no significant changes occur in the model output). The output can then be described in diagrams, e.g. histograms, cumulative frequency distributions, etc. [5,6].

Probability Distribution Of Input Variables

All input variable probability distributions use Triangular Distribution. Especially for the duration of the activity, it was also tried to use PERT Distribution with the intention to compare the results both with conventional PERT calculations and with Triangular Distribution.

Analysis Of Simulation Results

Simulation is done 3000 times, using options: Latin type Hypercube sampling (stratified sampling technique), Random Generator Seed: fixed = 1 (selection of this fixed type for the analysis scenario later, so that the generated sample is not changing in each simulation, so that changes in the simulation results are purely just caused by changes in input data on the variable being reviewed).

Comparison between Project Duration of Various Scheduling Methods

Project duration will be compared from various methods and scheduling assumptions, both using the CPM method, conventional PERT, Monte Carlo Simulation and "What if" scenario. The comparison results are summarized in Table 1.

If we look at the numbers in table 3.2 above, at a glance it can be seen that the conventional PERT method has the best distribution, but that result can be biased because the PERT method only takes into account one critical trajectory, whereas in fact, what often happens is more than one critical trajectory. The assumption of the PERT method which considers each activity to be independent of each other, is also not always appropriate, because it could be that one activity has a correlation with other activities. Monte Carlo simulation methods, on the other hand, can take into account the correlation between these activities.

Table 1. Comparison between project durations with various methods and assumptions

Methods and Assumptions	Average project duration	Standard Deviation
CPM	25.000	NA
PERT Conventional	24.000	1.050
Montecarlo simulation		
triangular without correlation	25.403	1.275
triangular with correlation	25.242	1.323
PERT without correlation	25.417	1.116
PERT with correlation	25.260	1.170
"What if" simulation		
Optimistic	18.000	NA
Most Likely	25.000	NA
Pessimistic	32.000	NA

NA = Not Available

Distribution Graph

Frequency distribution of model variables can be displayed in the form of Histograms or Cumulative Distribution. The histogram describes the frequency distribution of the input and output variables of the model, which shows how often the value of a variable is at a certain price, while Cumulative Distribution shows the probability of the value of a variable below or equal to a certain price. Examples of Histograms and Cumulative Distribution from simulation results are presented in Figure 3 and Figure 4.

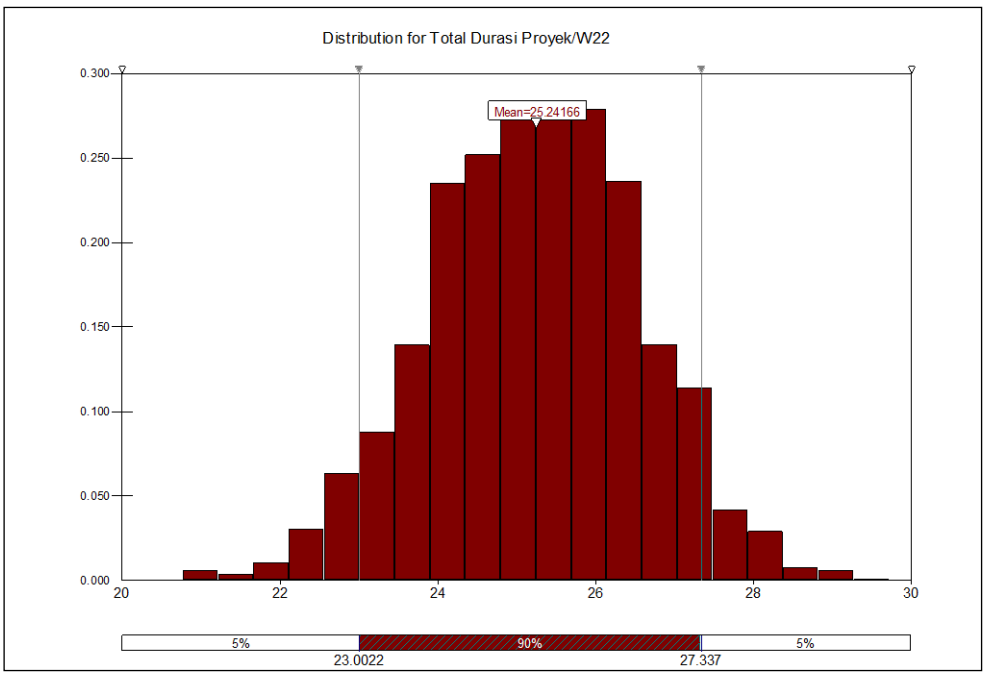

Figure 3. Histogram of Total Project Duration

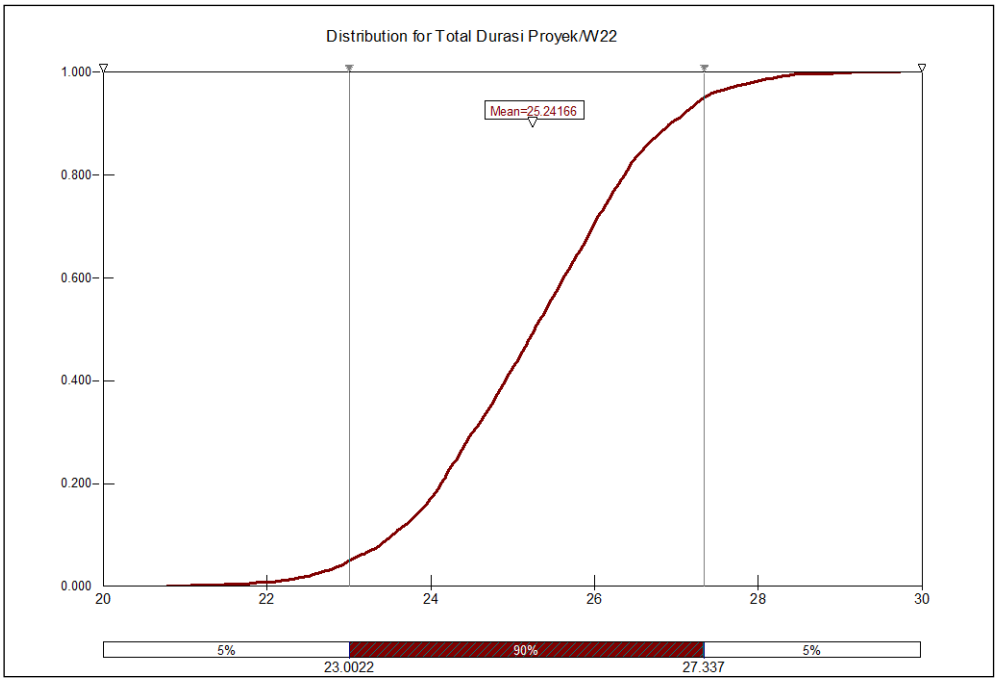

Figure 4. Cumulative Distribution of Total Project Duration

Sensitivity Analysis

Tornado graph is used to describe the results of sensitivity analysis of input variables on certain output variables. The following are examples of sensitivity analysis results for the total duration of the project and total project costs.

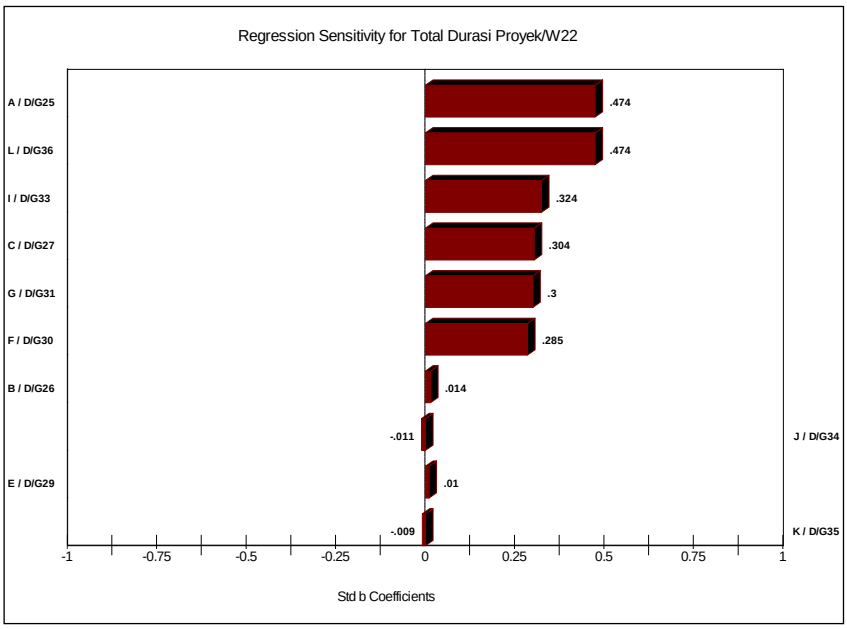

Figure 5. Regression Sensitivity of Total Project Duration

From Figure 5, it appears that activities A and L have a regression coefficient of 0.474, which means that an increase of 1 standard deviation at the duration of the activity will cause a duration increase of 0.474 times the standard deviation of the duration of the project.

4. CONCLUSION

Based on the results and discussion above, the conclusions from this study are: (a) The duration of the project from the scheduling model reviewed, both by the conventional CPM, PERT method, and Monte Carlo simulation produces an average value (mean) which is more or less equal. The difference occurs in the standard deviation value, where the conventional PERT method produces the smallest standard deviation, followed by a Monte Carlo simulation using the PERT distribution and the last is Monte Carlo simulation using the TRIANGULAR distribution. If the correlation factor between activities is included, the standard deviation in the simulation will increase. When there is more than one critical path, the conventional PERT method will give a biased result, because it only takes into account the last critical trajectory, whereas a Monte Carlo simulation can overcome this. (b) From the results of the sensitivity analysis, it was found that the dominant input variables affecting the duration of the project were the duration of the activities that most often entered the critical path or those that had a large critical index. Meanwhile, project costs are affected by a combination of the duration of activities on the critical path and activities that have a great direct cost.

5. SUGGESTION

From the results of this study, it was suggested that: (a) The hardest thing in modeling using Monte Carlo simulation is determining the distribution of model input variables. Therefore, the user should understand the nature or characteristics of the input variables and have sufficient knowledge about the probability distribution used. (b) It is necessary to develop macros (programs with VBA language in Excel) specifically to calculate the duration of the project so that it is more flexible to follow the changes that occur in the network planning model.

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