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Evaluation of Ripper Productivity (Caterpillar D8R) Based on Strengthness of Rock at PT Kitadin Embalut Site Tenggarong Subdistrict Kutai Kartanegara East Kalimantan Province

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ABSTRACT
The purpose of this study is to examine the updates based on the level of productivity of the ripper and the uniaxial strength of the rock. First to know the ripper productivity and second to know the value of the compressive strength of the rock. After that to determine the relationship between the level of riper productivity with uniaxial strength of the rocks.Location research area at PT. Kitadin Embalut site is to conduct the preparation, observation and measurement directly in the field. Productivity level is calculated by volume and length method. The parameters measured are the depth of penetration, the width of ripper, the length of the track and the timing of the update. To know the strength of the rocks is done a strong uniaxial test pressure rocks in geotech lab. Uniaxial Compressive Strength test refers to SNI 2825: 2008. The minimum test sample size is 3 pieces with a sample dimension of 2 <l / d <2.5 where the samples are taken randomly from the results of the ripper. Linear regression analysis needs to be done to determine the level of relationship between two variables and how much influence the independent variable to the dependent variable.Result of research on evaluation of ripper productivity based on rock strength of PT. Kitadin is then obtainedthe average productivity of ripper (Caterpillar D8R) at the research site is 315.74 m3/hour for the Siltsone while for sandstone 250.09 m3/hour. From uniaxial strength test (UCS) average rock strength at research location is 7.27 Mpa for Siltsone whereas for sandstone 11,75 Mpa. The results of linear regression analysis between rock strengths obtained based on uniaxial compression rock strength (UCS) has a very close. For siltstone obtained correlation value (r) -0.968 and sandstones (r) -0.934. For the value of regression equations for rocks Y = 417.322-13.961X and sandstone "Y = 487.591-20.203X" the relationship of both is inversely proportional.

INTRODUCTION

PT. Kitadin is a private company engaged in coal mining. In the activity of extracting material, it is necessary to dig the overburden material, if the material to be unloaded is soft then the excavation can be directly carried out by loading equipment (direct digging), but if the material is hard then there should be rippied of the material in order to loaded and then transported.

Ripping is a method of unloading rock mass mechanically, the working principle is to penetrate the shank (teeth of ripper) into the mass of the rocks and is extracted by bulldozers with a certain direction and distance (Sahu.,2012). In the mechanism of renewal, the penetration of the ripper tooth into the rock mass determines whether a rock mass can to be replaced. If penetration can be done, then the ripper can be drawn by bulldozer, so that rocks can be exposed. The deeper the penetration, the greater the volume of exposed rock and the increased productivity of the ripper. The harder the mass of the rock that is being reared the more shallow penetration and the productivity level of the ripper decreases so that the renewal evaluation needs to be done (Basari. H., 2004).

Aim of Research :
The purpose of research on the evaluation of the productivity of the tool ripper based on rock strength at PT. Kitadin is as follows:
1. To Know the level of productivity of ripper
2. To Know the value of rock compressive strength.
3. To Know the relationship of productivity level and rock strength.

METHOD

Research conducted at PT. Kitadin embalut site there are two data taken that is primary and secondary data.Primary data taken to support the research is the depth of ripper, width of ripper, track length and kind of litology in the field. Data that is known from the company to assist in processing primary data so that data into a unity that will be processed. In addition, secondary data is required for supporting data in preparing the research report. These secondary data are: map of research location, regional achievement map, company profile, specification data of rake tool and material tool needed in field (geological hammer and meter).

Methode of analysis data includes simple linear correlation and linear regression analysis. The rock strength obtained from laboratory test results is then correlated to the productivity level of the ripper. The relationship of both can be described in graphical form, then calculated correlation coefficient, coefficient of determination, test and regression analysis using SPSS.

RESULTS AND DISCUSSIONS

The research was conducted at Pit S12GN PT. Kitadin site Embalut. In the research location there are two of rock is siltone and sandstone where digging is done by using ripper. In the digging of rock tools used are Caterpillar type D8R buldozzer equipped with ripper in the process of updating. The type of ripper used for disassembly is an adjustable parallelogram where the tooth can be adjusted according to the existing material conditions (variatif). Single shank (giant) is a type of shank used for disassembly with maximum digging depth 1.22 m with tip type used is long tip.

Fig 1. Ripper in the Sandstone and Siltone

Productivity Level of Ripper

Calculation of productivity level is done by volume is length times wide and depth. The productivity of the ripper is calculated as a measure of the ability of the ripper to disassemble the material which is then expressed in volume per unit time, generally m^3/hour. The calculation of productivity level is based on Volume by length, where in this method a ripper will complete a measured trajectory line then record how much time it takes, starting from the beginning of point ripper begin to start to plug into rock layer until finish one track renewal. The volume of material is calculated based on the width of trace of ripper, depth of penetration and the length of the renewal trajectory.On observations made over 10 days with 10 different observations with rock types are sandstone and siltsone.

Table 1. List of length, width and depht of*ripper*

No	Length (m)	Width (m)	Depth (m)	Time (s)	Name of Rock
1	11.50	0.83	0.70	30.12	Siltstone
2	11.50	0.83	0.71	29.45	Siltstone
3	11.50	0.83	0.70	27.56	Siltstone
4	11.50	0.83	0.70	28.90	Siltstone
5	11.50	0.83	0.73	28.00	Siltstone
6	11.80	0.83	0.70	31.10	Siltstone
7	11.80	0.83	0.69	30.80	Siltstone
8	11.80	0.83	0.70	30.20	Siltstone
9	11.8	0.83	0.7	29.2	Siltstone
10	11.8	0.83	0.7	27.23	Siltstone
Avg	11.65	0.83	0.70	29.26	Siltstone

Primary data From Pit S12GN Kitadin . PT. Embalut.

Formula to look for productivity of ripper.

Productivity/Ciclus : $q = \frac{\text{Depth of ripper X Wide of RipperX Track length}}{2}$
Productivity/Hour : Q = Productivity/Ciclus X Wide of RipperX Track length

Table 2. Productivity/hour for D8R at The Kitadin Site

No.	Track Length (m)	Wide of Ripper (m)	Depth of Ripper (m)	Time of Ripper (Second)	Productivity/Cyclus M^3/Cyclus	Productivity/Hour M^3/Hour
1	11.50	0.83	0.70	30.12	3.34	299.47

Table 3. Result of productivity PT Kitadin

No	**Tanggal**	**Produksi (m3/hour)**	**Tipe Batuan**	**Klasifikasi**
1	6/9/2016	314.26	Siltstone	Difficult
2	6/10/2016	321.50	Siltstone	Difficult
3	6/11/2016	228.20	Sandstone	Very Difficult
4	6/12/2016	309.04	Siltstone	Difficult
5	6/13/2016	268.03	Sandstone	Difficult
6	6/15/2016	247.20	Sandstone	Very Difficult
7	6/16/2016	313.04	Siltstone	Difficult
8	6/18/2016	242.10	Sandstone	Very Difficult
9	6/19/2016	264.92	Sandstone	Difficult
10	6/20/2016	320.86	Siltstone	Difficult

Primary data From Pit S12GN Kitadin . PT. Embalut.

The calculation results obtained can be seen that the average productivity level of ripper on siltsone is higher than the level of productivity ripper to sandstones. Field observations show that the siltsone has a lower strength than sandstones, which can be seen during a very difficult and time-consuming process of grinding to complete one lane. Field observations also show the type of tip used to update both materials is the same type of long tip, which according to the recommendation of caterpillar for hard material is recommended to use the type of short tip.

Fig 2. The result boulder of rock from the ripper Caterpillar D8R

Table 4. Product of laboratory test fram ripper

No	Diameter (*d*) (mm)	Area (A) (mm^2)	Length (*l*) (mm)	*l*/*d*	Load Maximum (kN)	Uniaxial test (σ ca) (Mpa)	Corection Uniaxial (σ c) (Mpa)
SS1	54.13	2300.09	108.07	2.0	31.03	13.490	13.487
SS2	54.11	2298.40	108.05	2.0	23.26	10.120	10.118
SS3	54.12	2299.24	108.03	2.0	22.76	9.900	9.898
SS4	54.12	2299.24	108.03	2.0	29.91	13.010	13.007
SS5	54.12	2299.24	108.04	2.0	23.87	10.380	10.378
SS6	54.11	2298.40	108.06	2.0	36.03	15.675	15.672
SS7	54.12	2299.24	108.04	2.0	25.51	11.097	11.095
SS8	54.13	2300.09	108.06	2.0	36.70	15.957	15.953
SS9	54.12	2299.24	108.04	2.0	30.28	13.168	13.165
SS10	54.13	2300.09	108.05	2.0	37.65	16.369	16.365

(Lab. ITM Geotechnical Centre, 2016)

Result from 10 measurements, 100 samples were taken from two rock types, 50 samples of siltone, and 50 sandstone samples. Test results as in the table 3. The rock that has the greatest strength is sandstone the highest rock strength on 15 June 2016 where its strength reaches 16,365 Mpa. As for batulanau (Siltsone) the highest strength of the observation on June 17, 2016 is known to reach 10,398 Mpa power

Table 5. Clasification of lithology in research area

No	Date	Rock Tipy	Uniaxial Test (Mpa)	Clasification
1	6/10/2016	Siltstone	7.247	Hard ripping
2	6/13/2016	Siltstone	6.831	Hard ripping
3	6/15/2016	Sandstone	12.914	Very hard ripping
4	6/17/2016	Siltstone	7.758	Hard ripping
5	6/20/2016	Sandstone	11.103	Very hard ripping
5	6/21/2016	Sandstone	11.403	Very hard ripping
6	6/22/2016	Siltstone	7.513	Hard ripping
7	6/23/2016	Sandstone	12.142	Very hard ripping
8	6/24/2016	Sandstone	11.215	Very hard ripping
9	6/25/2016	Siltstone	7.032	Hard ripping

(Lab. ITM Geotechnical Centre)

Relationship of Uniaxial Test Siltstone with Productivity of Ripper:

To obtain the value of relationship between uniaxial test from silstone with the level of ripper productivity.

Table 6. Input data of simple linear regression analysis between Strength PressUnixial with Productivity on the Amazon.

No	Date	Productivity (m3/h)	Rock Tipe	Uniaxial Test (Mpa)
1	6/9/2016	314.261	Siltstone	7.247
2	6/10/2016	321.498	Siltstone	6.831
3	6/12/2016	309.042	Siltstone	7.758
4	6/16/2016	313.044	Siltstone	7.513
5	6/20/2016	320.856	Siltstone	7.032

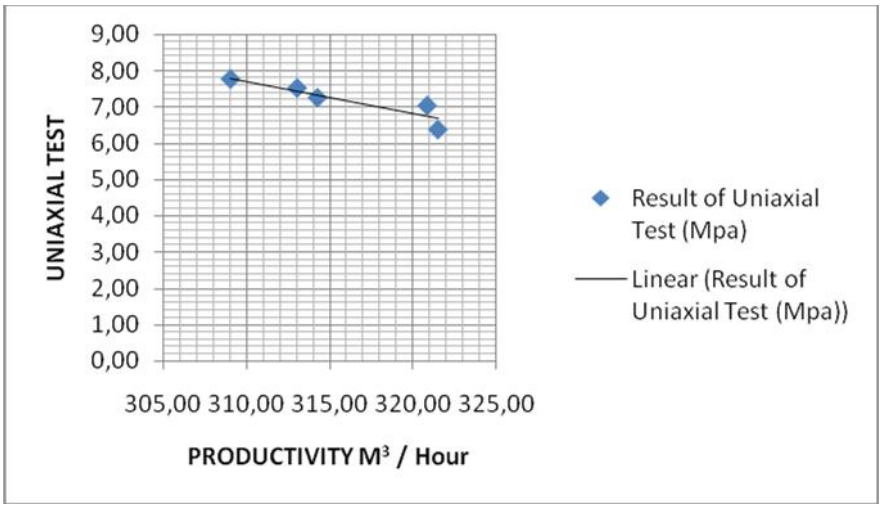

Fig 3. Relationship between ripper productivity and rock strength of siltstones

The results of linear regression analysis conducted between the uniaxial strength of siltstone with the productivity level of ripper obtained by the correlation coefficient (r) -0.968 can be concluded that the relationship between them is in very strong category. In addition from the calculation obtained correlation coefficient value -0.968, this negative value obtained can be concluded that the relationship of both inversely proportional. The higher the uniaxial strength value of the rock the smaller the productivity level obtained. The coefficient of determination (r2) 0.938, it can be concluded that the uniaxial strength of the silageone (Siltsone) has a significant influence on the productivity level of the ripper and it can be interpreted also that the uniaxial strength of the rock has a contribution of 93.8% to the change in productivity level of ripper while 6.2% by another factor not observed in this study. The regression equation Y = 417.322-13.961X means that if the uniaxial compressive variable Y is considered constant or without any addition, the productivity rate will be 417,322 and if there is an uniaxial compressive strength of rock of one unit then the productivity level will decrease by 13,961 and from t test obtained t value arithmetic -6.733 while for t table -3.182 which means H0 rejected. And because the t value is negative, it means that the uniaxial strength of the rock (UCS) is negatively related (inversely proportional) and significant to the productivity level of the ripper. The table results as in the table 7.

Table 7. Results of simple linear correlation and linear regression analysis between Strong Press Unixial with Productivity on the Amazon

Rock Type	r		R^2		Regression Formula
	Value	level of relationship	Value	level of relationship	
Siltstone	-0,968	Very Strong	0,938	Very Strong	Y=417.322-13.961X

Testing of Sandstone UCS Relations with Ripper Productivity Levels: To obtain the value of the relationship between sandstone UCS and the level of productivity of the ripper, the average data is tested during the test.

Table 8. Input data of simple linear regression analysis between Strong Press Unixial with Productivity on sandstones.

No	Date	Productivity (m3/hour)	Rock Type	Result of Uniaxial Test (Mpa)
1	6/11/2016	228.203	Sandstone	12.914
2	6/13/2016	268.030	Sandstone	11.103
3	6/15/2016	247.204	Sandstone	11.403
4	6/18/2016	242.103	Sandstone	12.142
5	6/19/2016	264.921	Sandstone	11.215

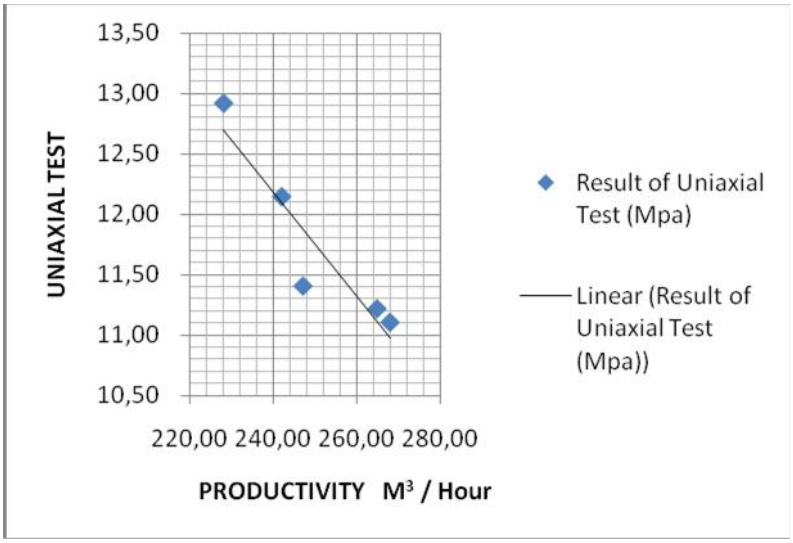

Fig 4. Relationship between ripper productivity and rock strength of sandstones

The result of linear regression analysis conducted between the uniaxial strength of sandstone with the productivity level of ripper obtained by the correlation coefficient value (r) -0.934 can be concluded that the relationship between them is in very strong category. In addition from the calculation obtained correlation coefficient value -0.934, this negative value can be concluded that the relationship of both inversely proportional. The higher the strength value of uniaxial rocks the smaller the productivity level obtained. The value of coefficient of determination (r2) 0.871hal it can be concluded that the uniaxial strength of the rock has a significant effect on the level of productivity ripper and can be interpreted also that the uniaxial strength of rock has contributed 87.1% to changes in productivity level ripper while 12.9% caused by other factors which is not observed in this study. The regression equation Y = 487.591-20.203X means that if the uniaxial compressive variable Y is considered constant or without any addition, the productivity level will be 487,591 and if there is an uniaxial compression strength of rock of 1 unit then the productivity level will decrease by 20,203. From t-test t value of t -4.511 and t table -3.182 which means Ho is rejected, and because the value of t

arithmetic negative, means uniaxial compression strength of rock (UCS) relation negatively (inversely) and significant to productivity level of ripper. The table results as in the table below.

Table 9. Results of a simple linear correlation and linear regression analysis between rock strength and ripper productivity on sandstones

Rock Type	r		R^2		Regression Formula
	Value	level of relationship	Value	level of relationship	
Sandstone	-0,934	Very Strong	0,871	Very Strong	*Y=487.591-20.203X*

Evaluation of Rock Strength and Ripper Productivity Level.

Based on the data calculation of productivity and rock strength testing it can be evaluated level kemampugaruan location research and supporting factors. More data as shown in the table 10. In the rocks was observed on June 12 the productivity level of 309.04 m3 / hr with uniaxial strength (UCS) of 7.758 Mpa, which under conditions such as Basarir & Karpuz (2004) included into hard ripping classifications of rocks reduce the productivity level of the ripper.

Table 10. Calculation of Productivity, Test of mechanical properties, and Classification of Influence

No	Tanggal	Productivity (m3/hour)	Rock Type	Uniaxial Test (Mpa)	Classification of ripping
1	6/9/2016	314.26	Siltstone	7.247	Hard ripping
2	6/10/2016	321.50	Siltstone	6.831	Hard ripping
3	6/11/2016	228.20	Sandstone	12.914	Very hard ripping
4	6/12/2016	309.04	Siltstone	7.758	Hard ripping
5	6/13/2016	268.03	Sandstone	11.103	Very hard ripping
6	6/15/2016	247.20	Sandstone	11.403	Very hard ripping
7	6/16/2016	313.04	Siltstone	7.513	Hard ripping
8	6/18/2016	242.10	Sandstone	12.142	Very hard ripping
9	6/19/2016	264.92	Sandstone	11.215	Very hard ripping
10	6/20/2016	320.856	Siltstone	7.032	Hard ripping

(Lab. ITM Geotechnical Centre)

Result from the data in the table above can be seen that in one region with the same rock has different strengths. As with sandstones and rocks, though fellow sandstone and buttocks but have different strengths. From the table above shows that sandstone has an average productivity rate of 228.20 m3 / hr and uniaxial rock strength of 12,914 Mpa on average (June 11). In this condition sandstones are classified as very hard to rip (very hard ripping) according to Basarir & Karpuz (2004). In this condition, the type of tool used is not quite right, considering the value of the update is quite difficult, it is seen from the level of productivity is quite small and the classification of renewal in the category very difficult in the rake (very hard ripping). In addition, also need to note the type of tipyang used. For rocks included in the hard-to-dig classification (veryhard ripping) caterpillar recommends short tip types while long tip types for easy ripping materials.

CONCLUSION AND SUGGESTION

Based on the formulation of the problem then can be obtained conclusion as follows:

1. The average ripper productivity level at the study site was 315.74 m3 / hour for the rocks (Siltsone) while for sandstone 250.09 m3 / hour.
2. Uniaxial Test (UCS) average rock strength at research location is 7.27 Mpa for batulanau (Siltsone) while for sandstone 11.75 Mpa
3. The level of relationship between uniaxial rock strength with ripper productivity level in the study sites showed very strong correlation in both rocks and significant. For clay rocks obtained correlation value (r) -0.968 and sandstones -0.934. The relationship between uniaxial rock strength and ripper productivity is inversely (negative), the higher the uniaxial strength of the rock, the less (slightly) productivity level.

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