The relation of compressive strength and tensile strength of bamboo fibber for soil stabilization

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The relation of compressive strength and tensile strength of bamboo fibber for soil stabilization

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Abstract. Bamboo can be used in construction planning because based on its properties, the mechanical strength of bamboo has high tensile strength and high compressive strength so that it can be used for soil reinforcement. Bamboo which has good quality will also have good mechanical properties as well because bamboo which has good compressive strength, laboratory results also show that bamboo has good tensile strength as well. Thus, there is a correlation between compressive strength and tensile strength in bamboo which is an environmentally friendly material as a soil strengthening material. The data in this study were using bamboo Apus and Javanese bamboo. Because bamboo is often used in industry and is easily available in Semarang. This study uses a simple linear method (Ordinary Least Squares). Simple linear regression model is one of the regression models that are often used in regression analysis. The dataset divided into 2 part, namely by comparing 60% of training data and 40% of testing data. The result from the data testing showing linier regression (least squares) estimate becomes very sensitive to random errors in the observed target, producing a large variance and the following results are obtained Correlation Coefficient 0.99607873, Mean Squared Error 12. 58799, Variance Score 125.60. The results show that the correlation coefficient is 0.99607873, it's mean that the linear model is close to number 1 meaning that this model is a good model because the correlation coefficient value is close to 1 so there is a positive relationship between or positive correlation between the compressive and tensile tests.

1. Introduction

Indonesia is a tropical country; the advantages of tropical countries are many florae that can grow up well and thrive in Indonesia. One of them is bamboo. Many types of bamboo thrive in Indonesia, but we don't yet know the benefits of bamboo which can actually be used for industries. Bamboo has fibber content and fibber adhesive. Bamboo fibber is a natural fibber that has several advantages over synthetic materials. Natural fibber has a low price, low density, renewable and biodegradable material and is not harmful to health than synthetics fibber. Exploration of new natural fibbers is widely carried out by various industrial sectors, such as composites for automotive applications and to replace synthetic fibbers [1], [2]. Bamboo fibber is a natural fibber that has many advantages. Because the higher size of

the fibber and the larger size of the fibber are better quality of bamboo. From the result test and analysis: fibber content, fibber length, intercellular adhesive of lignin and diameter of bamboo fibber that is higher causing the bamboo stems are stronger and stiffer [3].

Bamboo can be used in construction planning because based on its properties, the mechanical strength of bamboo has high tensile strength and high compressive strength so that it can be used for soil reinforcement [4]. As a construction material, the use of bamboo for structural materials has good strength, is easy to implement, is cheap and is environmentally friendly [5], [6]. Bamboo can be used in construction planning because based on its properties, the mechanical strength of bamboo has high tensile strength and high compressive strength so that it can be used for soil reinforcement [7]. Bamboo which has good quality will also have good mechanical properties as well because bamboo which has good compressive strength, laboratory results also show that bamboo has good tensile strength as well. Thus, there is a correlation between compressive strength and tensile strength in bamboo which is an environmentally friendly material as a soil strengthening material. To find out the correlation between variables and to determine the level of change in a variable against other variables, this study uses a simple linear regression method [8] because regression is the process of identifying relations and their effects on object values. So that the regression has the goal of finding a function that models data by minimizing errors or the difference between the predicted value with the actual value [9].

2. Methods

2.1. Research data

The data in this study were using bamboo Apus and Javanese bamboo. Because bamboo is often used in industry and is easily available in Semarang. Each bamboo is divided into 3 parts, namely the lower stem, middle stem and upper stem. After it is divided into 3 parts, bamboo is compressed and tensile tested in a bamboo mechanical laboratory. So, the research data are test data from the laboratory in the form of a compressive test and bamboo tensile test.

Table 1. Research data set

No	Compressive Strength Bamboo	Tensile Strength Bamboo
1	23,44111	104,413
2	23,52175	116,903
3	25,75317	151,884
4	29,05486	135,452
5	25,75317	71,4299
6	22,45148	105,532
7	26,31861	103,437
8	30,57603	133,492
9	23,73955	159,948
10	30,32786	113,434
11	18,45692	209,618
12	26,04016	114,951
13	29,6131	92,4915
14	32,70244	175,021
15	31,78677	161,291
16	32,96406	152,9976
17	27,67353	177,1609
18	33,09971	197,2987
19	40,69636	185,6226

No	Compressive Strength Bamboo	Tensile Strength Bamboo
20	39,00068	211,6445
21	38,34043	220,6654
22	37,46906	227,5125
23	58,62798	302,2489
24	53,60009	191,174
25	46,73803	104,8787
26	50,40375	98,74123
27	37,02163	120,618
28	33,48729	178,3365
29	47,24848	141,0167
30	37,33303	172,3682
31	23,73955	274,68
32	25,43523	294,3
33	28,50471	255,06
34	30,04243	294,3
35	22,42453	235,44
36	23,35888	245,25

2.2. Generalized Linear Models

From the results of the study found that there is a correlation between the compressive strength and tensile strength. Data consists of two variables in which the variables are interconnected and relationships are expressed in mathematical equations that state the relationships between variables. The relationship between variables (correlation) is then analysed whether the correlation between variable there is a strong and positive correlation or even no correlation at all and is negative. Correlation analysis aims to measure "how strong" or "degree of closeness", a relation that occurs between variables. To find out the correlation between the compressive test and tensile test, this study uses a simple linear method (Ordinary Least Squares). Simple linear regression model is one of the regression models that are often used in regression analysis. In this model, there is only one independent variable with a linear regression function. Called simple because this model only involves one independent variable and is called linear because it is linear in parameters and linear in its independent variables [9], [10].

2.3. Ordinary Least Squares

To determine the relationship between compressive strength and tensile strength of bamboo, this study uses a simple linear method (Ordinary Least Squares) because it only uses 2 variables so that it includes a simple linear regression model. The Linear Model is included in the regression method because the target value is expected to be a linear combination of features. In mathematical notation, if the value is predicted then:

$$\hat{y}\,(w,\,x) = (w_0 + w_1\,x_1 + \ldots\ldots\ldots + w_p\,x_p)$$

Where vectors $w = (w_1, \ldots, w_p)$ as coefficients and w_0 as intercepts. Linear regression is appropriate as a linear model with the coefficient $w = (w_1, \ldots, w_p)$ to minimize the amount of residual squared between targets observed in the dataset, and targets predicted by the linear approach. Mathematically it solves the problem of form.

$$\min \|\, X\,w - y \,\|_2^2$$

Linear regression is the use of a straight or flat function (for regression cases). Learning in this linear model is located on how to determine the two parameters w and a based on a set of training data so as

to minimize errors or errors. The fit X, y method will store the coefficient value w on the linear model. To illustrate the relationship of two-dimensional correlations in the regression model using diagrams. The straight line shows how linear regression will minimize the number of residual squares between responses observed in the dataset, and responses predicted by linear estimates.

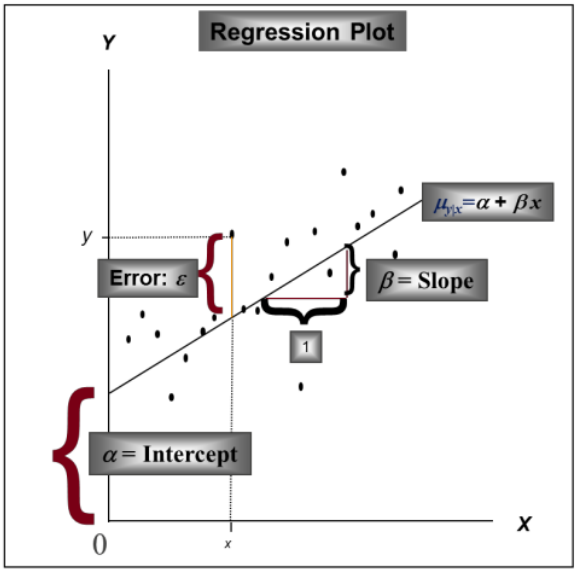

Figure 1. Regression plot

The estimated correlation coefficient for least squares depends on the independence of the feature. When features are correlated and matrix column X has a linear dependency, the least-squares estimate becomes very sensitive to random errors on the observed target so as to produce large variants. The Smallest Ordinary Box minimizes the number of deviation boxes around the regression line.

3. Result and discussion

Good bamboo has a compressive strength and optimal tensile strength. As shown by laboratory results, the relationship between tensile strength and compressive strength of bamboo is directly proportional to the results for Apus Bamboo which has a greater compressive strength than Javanese bamboo species, which is 37.42 mpa for Apus Bamboo and 27.4 mpa for Javanese Bamboo. For the tensile test results showed similar results, with Apus Bamboo has a greater tensile strength on Javanese type of bamboo that is 225.7 mpa for Apus bamboo and 43.76 mpa for Javanese type bamboo. To calculate the correlation between the compressive and tensile tests with the simple linear regression method (Ordinary Least Squares) to minimize the number of deviations squares around the regression line. Linear models are straight or flat functions for regression cases with the equation:

$$f(x) = w.x + a$$

where w is the weight and a is the intercept which is a single value in machine learning called bias. So, learning (learning) in the linear model is to determine the two parameters w and a based on a set of training data. Calculation of correlation in the regression linear model with Ordinary Least Squares obtained the following results:

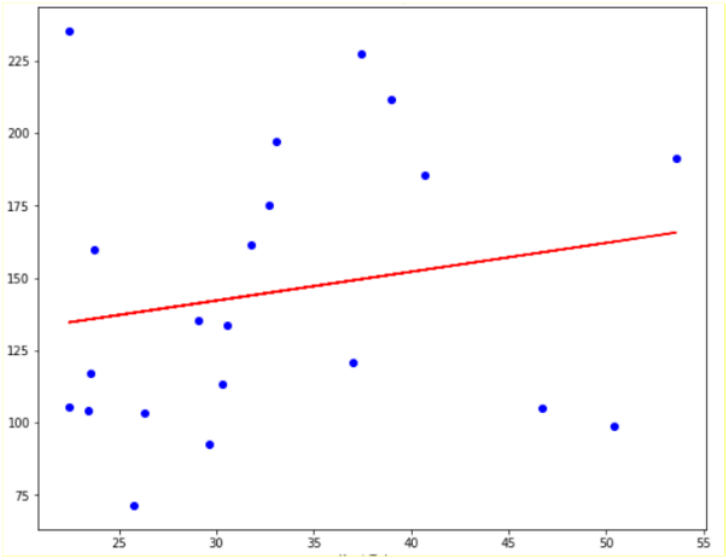

Figure 2. Regression line over test data

The data set is divided into 2, namely by comparing 60% of training data and 40% of testing data. Y is used to predict testing data.

y_pred = regressor.predict (X_test)

Straight lines can be seen in the plot, showing how linear regression tries to draw a straight line that will minimize the amount of squared residue between responses observed in the dataset, and responses predicted by linear estimates. Estimated least squares become very sensitive to random errors in the observed target, producing large variants and the following results are obtained:

Coefficients	: 0.99607873
Mean squared error	: 12.58799
Variance score	: 125.60

The results show that the correlation coefficient is 0.99607873, the linear model is close to number 1 meaning that this model is a good model because the correlation coefficient value is close to 1 so there is a positive relationship between or positive correlation between the compressive and tensile tests.

Intercept (α) means the average value of the Y variable if the value of the X variable is 0. In this study the X axis intercept value is in the range of 135 to 165. This means that we can predict the value of Y for the value of X which is in that range. The variable X does not include the value of 0 or does not approach 0, the intercept does not have a meaningful meaning, so it does not need to be interpreted, because the intercept means that the average value on the variable Y if the value of the variable X is 0.

While slope is a measure of the slope of a line. Slope is a regression coefficient for variable X (independent variable). Slope is a value that shows how much contribution (contribution) given by variable X to variable Y. Slope value can also be interpreted as the average increase (or decrease) that occurs on the Y variable for each increment of one unit of variable X.

4. Conclusion

This study is to measure the correlation between the compressive and tensile tests using a simple linear regression model (Ordinary Least Squares). The regression coefficient results are 0.9 so that the linear regression model is a good model because the coefficient value is close to 1. Thus, bamboo which has good compressive strength means it has good dance strength so that bamboo is a good bamboo for

soil strengthening. To improve the regression model, further research can combine Regression method with SVM so that the MSE value is smaller than the simple linear model.

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