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Implementation of Linear and Lagrange Interpolation on Compression of Fibrous Peat Soil Prediction

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***Abstract*—Previous studies have predicted the compression of fibrous peat soils using the Gibson & Lo method. But the prediction process is still done manually so it requires quite a long time. Therefore this research implements linear and Lagrange interpolation methods using Matlab software to speed up the prediction process. This study also carried out a comparison of the results of the implementation of the two methods to determine its effectiveness in making predictions. Based on the results of trials and analysis, it can be seen that the prediction of compression of fibrous peat soil using linear interpolation is more effective than using Lagrange interpolation, this can be proven by the smaller average RMSE prediction results using linear interpolation, with a difference in the average value of RMSE 7.7. Besides, prediction testing using Lagrange interpolation requires longer time, because it still does the iteration process as much as laboratory test data.**

***Keywords*—prediction, peat soil, interpolation, linear, lagrange**

I. PRELIMINARY

Peat soil is a type of soil that forms in areas with low climate change rates, usually in lowland areas and swamps. This type of soil is formed due to the accumulation of plant residues that are always moist due to waterlogging and poor oxygen circulation. Resulting in the process of humification by bacteria does not run perfectly, as a result, some plant fibers are still clearly visible and greatly affect the behavior of this soil type [1]. Peatland based on fiber content is divided into 2 types, namely fibrous peat with fiber content> 20% and non-fibrous peat with fiber content <20%. The compression behavior of fibrous peat is very different from that of non-fibrous peat, this is because fibrous peat has 2 pores, namely the macropore which lies between the peat fiber and the micropore which is inside the peat fiber [2].

Previous research has predicted the compression of fibrous peat soils that have decreased water levels in the Bareng Bengkel village, Palangkaraya, Central Kalimantan using the Gibson & Lo method. But the prediction process is still done manually so it requires a long time which is 14 days. therefore in this study, the implementation of linear and Lagrange interpolation methods is implemented in software to speed up the prediction process.

Linear interpolation is indeed very different when compared to Lagrange interpolation, but both have their advantages and disadvantages [3]. So in this study, a comparison of the results of the implementation of the two methods was carried out to determine its effectiveness in predicting the compression of Palangkaraya fibrous peat soil.

II. LITERATURE REVIEW

A. *Linear Interpolation*

The easiest form of interpolation is to determine the value between two known values based on a linear equation [4], [5]. Linear equations are also called straight-line equations because if the results of linear equations are drawn on a graph, then the shape of the curve is a straight line [6]. Linear interpolation is based on comparative theory as shown in the following figure.

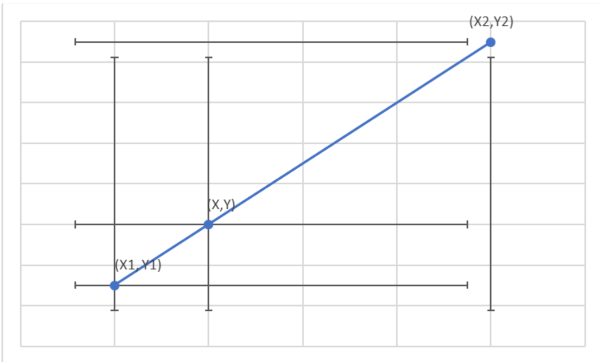

Fig. 1. Curve linear equation.

A comparison of distance (X - X1) with distance (X2 - X1) is the same as the comparison of distance (Y - Y1) with distance (Y2 - Y1) [7], [8]. So that each point between two points is known to have a linear relationship, and can be determined by calculation using the following linear interpolation equation:

$$\frac{(Y-Y_1)}{(Y_2-Y_1)} = \frac{(X-X_1)}{(X_2-X_1)} \quad (1)$$

$$Y = \frac{(X-X_1)(Y_2-Y_1)}{(X_2-X_1)} + Y_1 \quad (2)$$

B. *Lagrange Interpolation*

Some cases in practice require guessing the value of an unknown value for various pieces of information. The process of guessing the value is interpolation and extrapolation. There are many methods used to guess interpolation, one of them among these is the Lagrange polynomial method [9], [10].

Lagrange polynomial interpolation is almost the same as Newton's polynomial, but it does not use finite-difference forms[11] - [13]. The Lagrange polynomial interpolation can be derived from Newton's equation. Lagrange interpolation is applied to get a certain degree of P (x) polynomial function that passes through several data points [14] - [16]. With the following equation:

$$f_n(x) = \sum_{i=0}^{n} L_i(x).f(x_i) \quad (3)$$

$$L_i(x) = \prod_{\substack{j=0 \\ j \neq i}}^{n} \frac{x - x_j}{x_i - x_j} \quad (4)$$

C. Root Mean Square Error (RMSE)

RMSE is an alternative method for evaluating forecasting techniques used to measure the accuracy of the forecast results of a model. RMSE is the average value of the sum of the squares of the error, it can also state the size of the error generated by a forecast model. A low RMSE value indicates that the variation in values produced by a forecast model approaches the variation in the value of obesity[17], [18]. RMSE is the sum of the square of error or the difference between the actual (actual) value and the predicted value, then divides the amount by the amount of time forecasting data and then draws its roots, or can be formulated as follows [19], [20]

$$RMSE = \sqrt{\frac{\sum(Aktual - Prediksi)^2}{n}} \quad (5)$$

III. Research Methods

To find out the effectiveness of the two methods in predicting the compression of fibrous peat soils, this research was tested on laboratory test data. There are 6 load variations, namely 25 kPa, 50 kPa, 75 kPa, 100 kPa, 125 kPa and 150 kPa. Laboratory test results produce compression data every day for 10 days on each of these loads. Tests are carried out on each load using two predetermined methods, namely linear interpolation, and Lagrange. The RMSE value of each trial was calculated and averaged on each trial. The test was carried out using Matlab R2915a software.

IV. Results And Discussion

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The trials were carried out with loads of 50 kPa, 75 kPa, 100 kPa, and 125 kPa. Each load was tested for 10 days. Within a few minutes the trial results have been obtained and can be seen in the following graph:

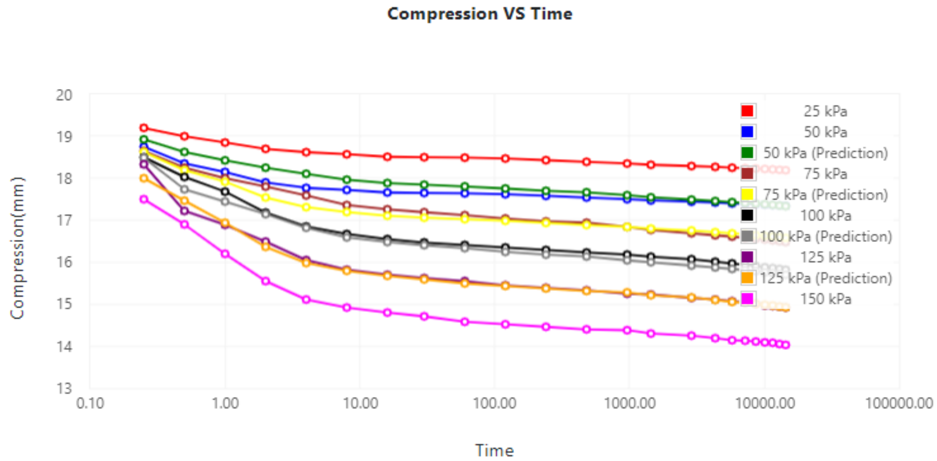

Fig. 2. Prediction results using linear interpolation.

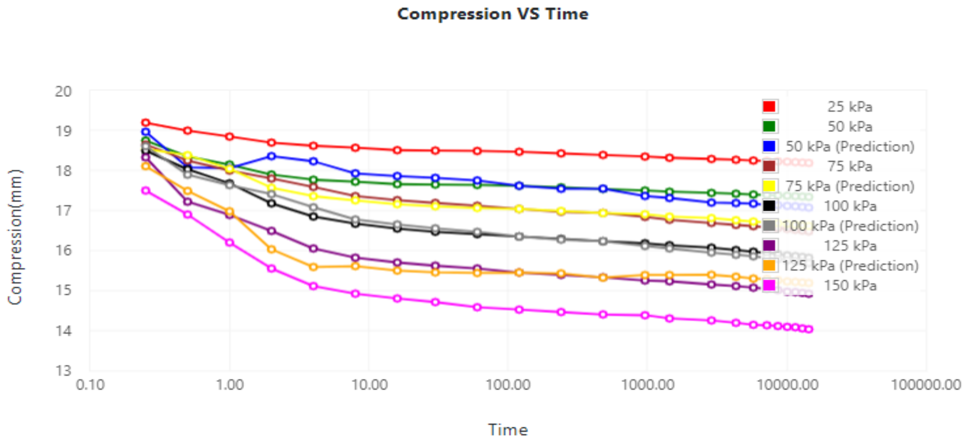

Fig. 3. Prediction results using lagrange interpolation.

Based on Figure 1 and Figure 2, it can be seen that the points predicted by linear interpolation are closer to the laboratory test data points. This can also be clarified using the RMSE calculations as the following table:

TABLE I. RMSE CALCULATION RESULTS ON PREDICTION RESULTS USING LINEAR INTERPOLATION

T \ W	50		75		100		125		Avg RMSE
1	253.0	245.5	323.0	320.0	387.0	400.0	477.0	478.5	
2	256.0	251.0	331.0	324.5	393.0	408.0	485.0	484.0	
3	258.0	254.5	336.0	328.5	399.0	412.5	489.0	490.0	
4	260.0	257.0	339.0	331.5	403.0	416.0	493.0	494.5	
5	261.0	259.0	342.0	333.5	406.0	419.0	496.0	496.5	
6	262.0	260.5	344.0	335.5	409.0	421.5	499.0	499.0	
7	263.0	262.0	346.0	337.5	412.0	424.5	503.0	501.5	
8	264.0	263.5	348.0	339.0	414.0	426.0	504.0	503.0	
9	265.0	265.0	350.0	340.5	416.0	428.0	506.0	505.5	
10	266.0	266.5	352.0	342.0	418.0	430.0	508.0	507.5	
RMSE	2.2		5.3		8.5		0.7		4.2

TABLE II. RMSE CALCULATION RESULTS ON THE PREDICTION RESULTS USING LAGRANGE INTERPOLATION

T \ W	50		75		100		125		Avg RMSE
1	253.0	268.6	323.0	315.2	387.0	394.8	477.0	461.4	
2	256.0	280.2	331.0	318.9	393.0	405.1	485.0	460.8	
3	258.0	281.4	336.0	324.3	399.0	410.7	489.0	465.6	
4	260.0	282.8	339.0	327.6	403.0	414.4	493.0	470.2	
5	261.0	285.8	342.0	329.6	406.0	418.4	496.0	471.2	
6	262.0	286.6	344.0	331.7	409.0	421.3	499.0	474.4	
7	263.0	288.4	346.0	333.3	412.0	424.7	503.0	477.6	
8	264.0	289.4	348.0	335.3	414.0	426.7	504.0	478.6	
9	265.0	291.0	350.0	337.0	416.0	429.0	506.0	480.0	
10	266.0	292.8	352.0	338.6	418.0	431.4	508.0	481.2	
RMSE	15.9		7.9		7.9		15.9		11.9

After observing the data in Table 1 and Table 2 prove that the average RMSE predicted using linear interpolation is smaller than the average RMSE predicted using Lagrange interpolation, but there are conditions where the predicted RMSE value using Lagrange interpolation is smaller than the RMSE value the results of predictions using linear interpolation, although the difference is not too large, namely the prediction test with a load of 100 kPa.

V. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the trial and analysis, the following conclusions can be concluded:

1. For the prediction of compression of fibrous peat soils using linear interpolation is more effective than using Lagrange interpolation.
2. Prediction testing using Lagrange interpolation requires a long time because it still processes iteratively as much as laboratory test results.
3. To further prove the effectiveness of the use of linear interpolation in the prediction of compression of fibrous peat soil, research can also be carried out on comparisons of linear and Lagrange extrapolation.

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