A Regression Model upon Treatment of AMD Using Pervious Concrete

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Abstract

Regression modelling is used to establish the qualities of pervious concrete that treats AMD. In order to investigate the relationship between dependent and independent variables, regression modelling technique was used. This technique is used to analyze several variables. Regression analysis helps to understand the effect of each independent variable on the dependent variable. In this research regression modelling is done to establish the properties of pervious concrete that treats AMD and to understand the relationship between the AMD treatment variables. Familiar methods of regression analysis such as linear regression is used in this research. The AMD quality is modelled as the dependent variable and all other variables are independent variables. It was found that the thickness and the aggregate size of the pervious concrete slab does effect the metal concentration and PH of AMD as it passes through the pervious concrete.

Keywords

Regression model, metal concentration, mining , parameter, computer model

1. Introduction

In order to investigate the relationship between dependent and independent variables, regression modelling technique was used. This technique is used to analyze several variables. Regression analysis helps to understand the effect of each independent variable with the dependent variable. This research is done to establish the properties of pervious concrete that treat AMD and to understand the relationship between the AMD treatment variables [9]. Familiar methods of regression analysis include linear regression and ordinary least square regression. Linear regression method is a linear approach that involves modelling the relationship between dependent and independent variables, whereas ordinary least square regression is used to model unknown parameters in a linear regression method. This research focuses on linear regression method. The AMD quality is modelled as a dependent variable and all other variables are independent variables. The dependent variable is shown on the y-axis and the independent variables are shown on the x-axis.

2. Linear Regression as a Modelling Tool

This is the most applied technique in statistical analysis and modelling. It establishes the relationship between dependent and independent variables [1]. Dependent variable is the variable that will be predicted, and independent variable is a variable that influences the dependent variable. Linear regression modelling also helps to identify the most independent variable that closely affect the dependent variable. Linear regression analysis is divided into two approaches such as simple linear regression which models the relationship between the dependent variable and one independent variable and multiple linear regression is when independent variables includes two or more variables [2, 3]. In this research a multiple linear regression is used and Excel software was used to develop the linear model. Mathematically linear regression modeling is defined by:

$$y = bx + a + e \quad (1)$$

Where *y*- is the dependent variable [4], *x*– is the independent variable, *a* – y intercept, *b* – Slope, *e* – Random error As discussed in previous papers the treatment of AMD using pervious concrete is governed by many factors such as aggregate type, aggregate size, the filter thickness and the water pressure [4-6]. These variables are used here as independent variables, whereas AMD quality is the dependent variable.

1 3. Linear Regression Analysis Results

Excel was used to run the regression modelling, all calculations were done automatically in the Microsoft Excel software environment. Table 1 is a summary of the results.

Table 1: Regression Statistics

Multiple R	0.885307
R Square	0.783769
Adjusted R Square	0.675653
Standard Error	1.230292

3.1 Anova

The second part of the analysis is Analysis of Variance (ANOVA), Table 2. The focus on this part is on Significance (F), because it highlights the reliability of the results. If F is less than 0.05 (5%) the model is ok, but if it is more than 0.05 it is better to choose another independent variable [7, 9] .

Table 2: ANOVA

Source	**df**	**Sum of squares**	**Mean Square**	**F-ratio**	**Significance F**
Regression	2	21.94553	10.97276	7.249357	0.046756
Residual	4	6.054475	1.513619		
Total	6	28			

3.2 Coefficients

In this section of the regression analysis, specific information about the components are revealed. Table 3.

Table 3: Regression analysis output coefficient

Intercept	**Coefficients**	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
	1.208201	2.785937	0.433679	0.686887	-6.5268	8.943203	-6.5268	8.943203
6.7	0.476504	0.164448	2.897593	0.044225	0.019923	0.933086	0.019923	0.933086
80	-0.01051	0.013292	-0.79037	0.473533	-0.04741	0.0264	-0.04741	0.0264

Coefficient is the most important variable, it will help to make a linear regression model. The statical significance and the nature of the relationship is shown by p-values and coefficient values. The coefficient values show the mathematical relationship between independent and dependent variables and the p-values shows their significance [8]. The p-value specifies if the estimated coefficient value is wrong, the desired value of p- should be small. In Table 4 standard error shows the accuracy of the model. It reveals the average error of the model, the smaller the standard error the better, in this case 0.013 is the more reliable error since it is the smallest [9]. The t-statistics is not the important number, however, it shows the reliability of coefficients, the larger t-value indicates the more reliable coefficient [7]. In this case in Table 3 the more reliable coefficient is 0.4. The 95% interval indicates the range where the value of confidence is. The 95% confidence is shown in lower, upper, values to improve accuracy [8].

3.3 Residuals

The residual stage shows the difference between predicted values and actual values. For the first data aggregate size is 6.7mm, the residual is -0.29, so to get the actual value we add predicted value and residual in this case the actual value is = 2.29+(-0.29) = 2m, see Table 4.

Table 4: Regression analysis, Residuals

Observation	Predicted 1	Residuals
1	2.299611	-0.29961
2	3.560311	-0.56031
3	3.140078	0.859922
4	6.657588	-1.65759
5	6.237354	-0.23735
6	6.447471	0.552529
7	6.657588	1.342412

4. Development of the Linear Regression Model for AMD Purification

Regression modelling in this study is used to compare two variables which is the thickness of the pervious concrete slab and the aggregate size. Figure 1 shows a negative relationship, since the slope is inversely proportional. The relationship between these two variables clearly shows that they are indirectly proportional to each other. This means to get the best result of the treatment of Acid Mine Drainage the thickness of the concrete slab must increase with a decrease in aggregate size. This clearly shows that the pervious concrete that is made up of thicker slab and small stones will have higher filtration capacity than the slab that is thinner with big stones. This regression modelling was done using excel spreadsheet. To derive the equation that was found from the graph in Figure 1 was used to get the values of x and y.

$$y = a + bx$$

$$a = \frac{(\Sigma y)(\Sigma x^2)-(\Sigma x)(\Sigma xy)}{n(\Sigma x^2)-(\Sigma x)^2} = -3.8462$$

$$b = \frac{n(\Sigma xy)-(\Sigma x)(\Sigma xy)}{n(\Sigma x^2)-(\Sigma x)^2} = 145{,}77$$

$$\boldsymbol{y = -3.8462x + 145,77} \qquad (2)$$

Equation 2 is the regression equation; this equation is the center of regression analysis.The objective of finding this equation is to analyze the relationship between thickness of concrete and the aggregate size. The dependent variable is the thickness. Variable x which is the concrete aggregate size is the explanatory variable since it indicates the change in variable y.

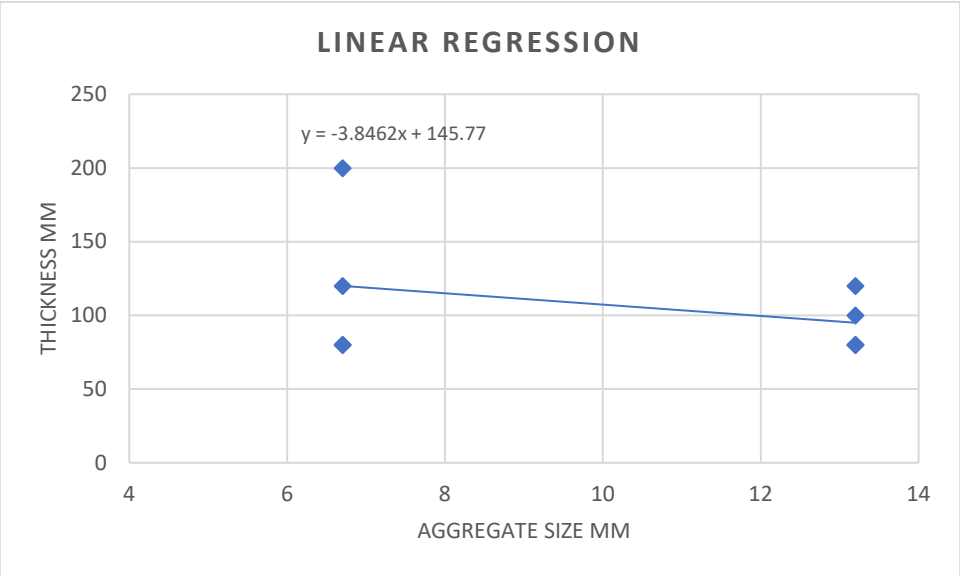

Figure 1: Linear regression Model.

4.1 Model testing

Checking the results of AMD treatment using these two variables (Thickness and aggregates size) is very important. For this analysis only one sample of AMD is used which is R4. Results are analyzed based on pH value after AMD treatment, Table 5.

Table 5: AMD pH after Treatment using E4 AMD Sample

E4 AMD pH BEFORE TREATMENT 6.29		
Aggregate size	**Thick**	**PH after treatment**
6,7	80	6,9
13,2	80	7,2
6,7	120	8,2
13,2	120	6,5
6,7	200	7,8
13,2	200	7,2

Table 5 shows the pH of AMD after it was treated using different thickness of concrete block. Figure 2 shows a positive relationship, as the thickness increases the pH of AMD also increases as it passes through the concrete.

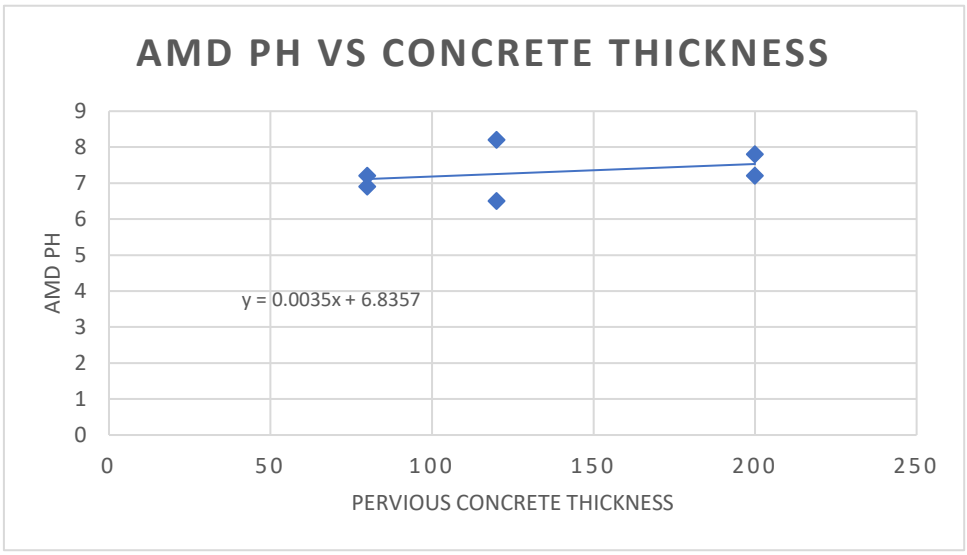

Figure 2: AMD pH Versus the concrete thickness.

The effect of aggregate size was also investigated by using different size of aggregate size, Figure 3 shows that there is a direct relationship between the aggregate size of the concrete and the pH.

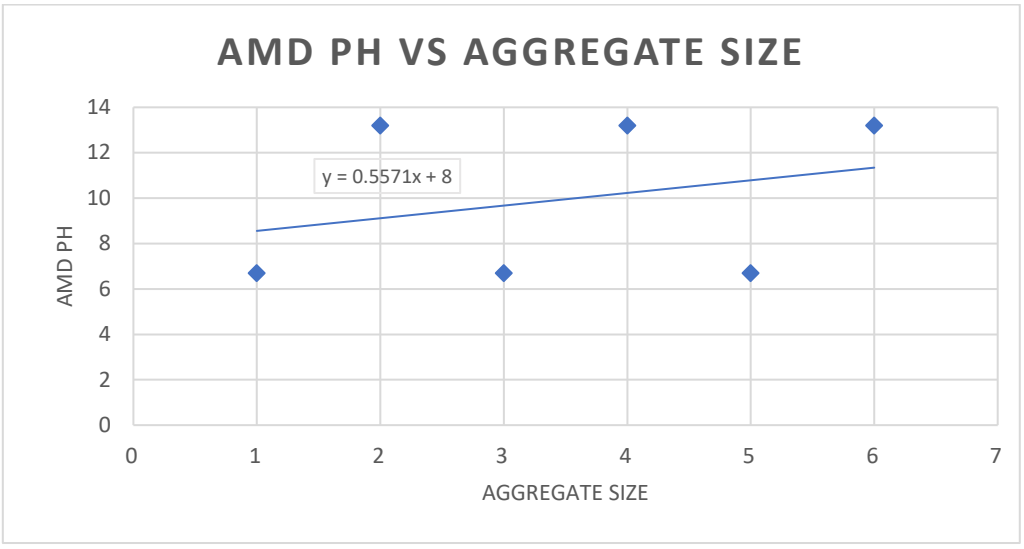

Figure 3: AMN pH and aggregate size.

5. Conclusion

The linear regression model in Figure 2 establishes the properties of pervious concrete that threat AMD. These results can be used when designing the concrete wall which is the subject of another paper. This regression model clearly shows that there is a core relationship between the aggregate size and the thickness of the pervious concrete slab [4-6, 9].

Equation 2 can be used to design a concrete block that can treat AMD depending on the pH value that is required. The thickness of the pervious concrete decreases as the aggregate size increases and vice-versa. For example if the value of aggregate size is 6.7mm using equation 2 the thickness of the concrete wall will be y = -3,8462(6.7)+ 145,77 = 120mm , the volume of the concrete doesn't make the difference on the PH value and the metal filtration, as long the thickness and aggregate size are correct. Equation 2 can be used to determine other paramerterts such as the size of the aggregate and the thickness of pervious concrete barrier.

Comparing the pervious concrete barrier to the existing AMD treatment technologies, Pervious concrete is less exp4ensive, reliable and more efficient. The pervious concrete method does not use electricity and is easy to install compared to other treatment technologies [9].

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