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ANALYSIS OF LIMESTONE MAGNETIC SUSCEPTIBILITY VALUE AS A CEMENT MANUFACTURING MATERIAL USING BARTINGTON MAGNETIC SUSCEPTIBILITY METER

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ABSTRACT

Limestone is the main ingredient for cement formation, 80% of the amount of Limestone used in cement formation, but there is very little research on Limestone, even though Limestone is very influential on the maximum compressive strength of cement. The purpose of this study was to obtain a new standard for cement based on the abundance of magnetic minerals indicated by the value of their Magnetic susceptibility, especially in Limestone which is the maining redientin cement manufacture, and also the lack of research on the susceptibility and types of minerals contained in Limestone. The method used in this study is a magnetic method where the magnetic susceptibility value of the sample is measured using a Magnetic Susceptibility Meter type MS2B. Limestone magnetic susceptibility value from PT. Semen Padang has a range of values from 17.6 x 10^{-8} m^3/kg to 90 x 10^{-8} m^3/kg and has a dominant value, where Limestone has little or almost no Superparamagnetic grains, the reisonly one sample that has Superparamagnetic grains. Based on the range of magnetic susceptibility values obtained the magnetic properties of Limestone from PT. Semen Padang is Antiferromagnetic and has a type of magnetic mineral, namely Hematite.

Keywords : Limestone, Magnetic Susceptibility, Cement,Bartington Magnetic Susceptibility Meter MS2B

I. INTRODUCTION

The role of cement is very important for human life because most of the materials used in the construction of infrastructure and properties in the world are cement. Limestone is one type of non-metallic mineral that isused as a raw material for making cement [1]. One of the main ingredients for making cement is Limestone. Limestone is a sedimentary rock that comes from marine organisms that have died and turned into Calcium carbonate (CaCO3) [5]. Limestone can be white, yellowish white, or gray to black depending on the mineral impurities [12];[6].

Calcium carbonate is the main component of limestone with a percentage of Ca content of 92.1%.Limestone also consists of other constituent components such as Fe (2.38%), Mg (0.9%), Si (3%), In (1.4%), Ti(0.14%), Mn (0.03%) and Lu (0.14%) [7]. Calcium has a high content compared to other components in Limestone, so a processing process is needed to get pure Calcium. Calcium from limestone processing can be used as a building mix material, rubber industry, tires, paper, filters for paint, soap, and toothpaste [12];[5]. While other components are present in Limestone with low levels, if there are excessive levels it will cause toxic effects by Fe and Mn compounds, as well as carcinogenic effects by Si compounds [9];[10]. From the description, it is known that Limestone contains magnetic minerals, although only about 2%.

The Rock Magnetism Method is one of the geophysical methods that investigates the magnetic properties of a rock. The instrument used is a Magnetic Susceptibility Meter. The magnetic property test of a material is considered to bevery effective,inexpensive,sensitive,fast,and non-destructive[2].

The magnetic properties of rocks can be determined by knowing the characteristics of magnetic minerals such as the concentration of magnetic minerals, type of magnetic minerals, magnetic domains, grain

size, and Curie point of magnetic minerals. Determination of the concentration of magnetic minerals toget the susceptibility value in a material is using a Susceptibility Meter[3].

The magnetic susceptibility of a material is the quantity of that material to be magnetized when subjected to a magnetic field[11]. Susceptibility can also determine the magnetic properties and types of magnetic minerals contained in a material [4]. The number of magnetic minerals has different magnetic susceptibility values depending on the content of magnetic iron oxide compounds such as *hematite (Fe_2O_3), magnetite(Fe_2O_4),* and *maghemite(Fe_2O_3)*[8].

II. METHOD

Sample preparation and measurement were carried out at the Geophysics Laboratory,Department of Physics, FMIPA, Padang State University using a magnetic susceptibility meter type MS2B and produced amagnetic susceptibility value. The research began with preparation, sample preparation, measurement, and data processing which was carriedout from January 17,2022, to March 17,2022.

This study on Limestone was carried out by sample preparation to the data analysis stage. The measurement of the susceptibility value on Limestone obtained χ_{lf} and χ_{hf} values to determine the abundance of magnetic minerals. Furthermore, the $\%\chi_{fd}$ value was used to determine the concentration of *Superparamagnetic* particles,where the higher the $\%\chi_{fd}$ value,the smaller the crystal size (<0.03µm) and finer grains.

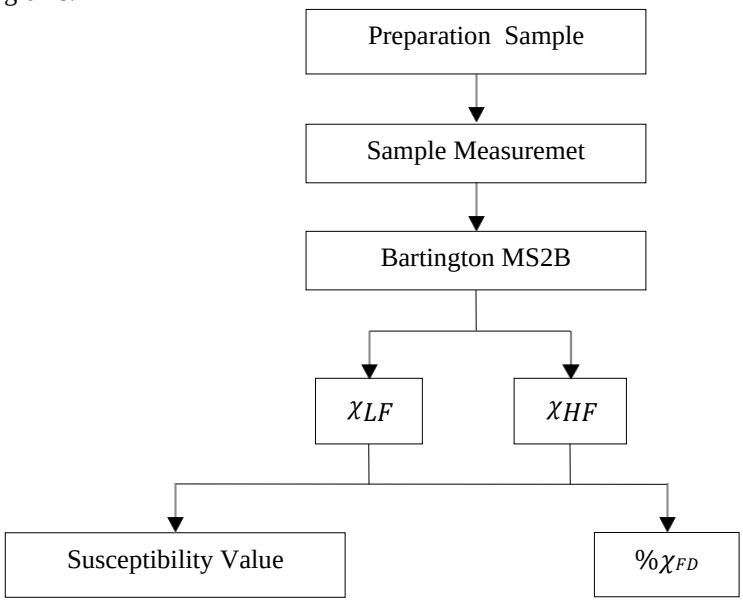

Fig.1.Research Framework

1) Sample Preparation

Preparation of the sample was carried out by inserting the sample into the holder until it wasfull and then labeling, then weighing the labeled sample using a Digital Balance tool *(Ohaus Balance SN EO 271119030112)*. There are 24 samples to be prepared, consisting of 5 weeks with details each week consisting of 4 to 5 samples.

Fig.2. Digital Balance *(Ohauss Balance SNEO 271119030112)*

2) Sample Measurement

Measurement of magnetic susceptibility values is divided into two categories based on frequency, first low field (χ_{lf}) and second high field (χ_{hf}). Limestone sample measurements were carried out 3 times on each sample us in the Bartington Magnetic Susceptibility Meter MS2B type. Measurements were made to obtain the results of susceptibility dependence frequency ($\%\chi_{fd}$).

Fig.3.Bartington Magnetic Susceptibility Meter MS2B Type

3) Data Processing and Interpretation Techniques

The measurement of the susceptibility value that has been carried out aims to determine how the magnetic properties of the Limestone sample and to determine the types of minerals contained in the Limestone sample. Furthermore, the results of the measurement ratio in the low field (χlf) and high field (χhf) are expressed by susceptibility dependence frequency ($\%\chi fd$) with the formula:

$$\%\chi_{fd} = \frac{\chi_{lf} - \chi_{hf}}{\chi_{lf}} \times 100\% \qquad (1)$$

The results of the measurement of the $\%\chi fd$ value were used to determine the presence of Superparamagnetic grains in the sample. The higher the $\%\chi fd$ value, the more *Superparamagnetic* grains contained in a material.

III. RESULTS AND DISCUSSION

The results of the measurement of the Limestone magnetic susceptibility value from PT. Semen Padang uses the Bartington Magnetic Susceptibility tool with the MS2B sensor, which can be seen in Table 1.

Sample Name	Parameter	Max ($\times 10^{-8}$ m^3/kg)	Min ($\times 10^{-8}$ m^3/kg)	Average ($\times 10^{-8}$ m^3/kg)
LS 01222 - 04222	χ_{lf}(x 10^{-8} m^3/kg)	66,1	23	40,425
	χ_{hf}(x 10^{-8} m^3/kg)	65,9	23	40,325
	$\%\chi_{fd}$	0,51	0	0,202
LS 07222 – 11222	χ_{lf}(x 10^{-8} m^3/kg)	41,7	33	37,16
	χ_{hf}(x 10^{-8} m^3/kg)	41,4	32,7	36,92
	$\%\chi_{fd}$	1,09	0	0,644
LS 14222 - 18222	χ_{lf}(x 10^{-8} m^3/kg)	64,6	24,9	44,76
	χ_{hf}(x 10^{-8} m^3/kg)	64	24,7	44,44
	$\%\chi_{fd}$	0,93	0,53	0,696
LS 21222 - 25222	χ_{lf}(x 10^{-8} m^3/kg)	46,6	19,7	30,56
	χ_{hf}(x 10^{-8} m^3/kg)	46,2	19,6	30,38
	$\%\chi_{fd}$	0,85	0,26	0,562
LS 02322 - 09322	χ_{lf}(x 10^{-8} m^3/kg)	90	17,6	42,1
	χ_{hf}(x 10^{-8} m^3/kg)	88,7	17,6	41,52
	$\%\chi_{fd}$	2,13	0	1,026

Table 1 is the result of measuring magnetic susceptibility values in Limestone samples using a Bartington Magnetic Susceptibility Meter MS2B type. Measurements were made in the conditions of Low Field Susceptibility (χlf) and High Field Susceptibility (χhf) and obtained the value of Frequency Dependence Susceptibility($\%\chi fd$).

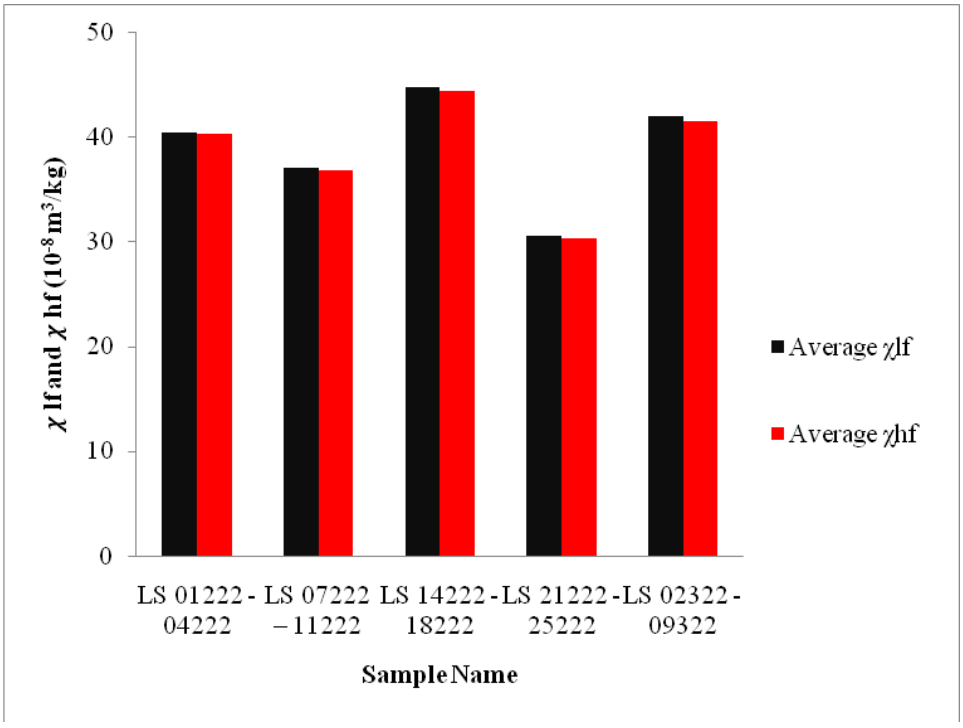

Fig.4. The Relationship Between The Average Value of a Low Field And High field Susceptibility on Limestone of PT. Semen Padang

Based on Figure 4, the measurement of magnetic susceptibility values consisting of 4 to 5 samples perweek can be seen that the average magnetic susceptibility value is in a state of low field susceptibility (χlf) at Limestone from PT. Semen Padang was the highest in the fifth & sixth week at 90 x 10^{-8} m^3/kg and the lowest was in the fifth & sixth week at 17.6 x 10^{-8} m^3/kg. While the average magnetic susceptibility value in a state of high field susceptibility (χhf) is the highest in the fifth & sixth week at 88.7 x 10^{-8} m^3/kg and the lowest is in the fifth & sixth week at17.6x10^{-8} m^3/kg. Based on the magnetic susceptibility values that have been described, it can be determined how the magnetic properties and what types of magnetic minerals are contained in Limestone, by grouping the measured magnetic susceptibility values based on the magnetic susceptibility tables of various minerals. The magnetic properties and types of minerals contained in Limestone can be seen in Table 2.

Table2.Magnetic Properties and Mineral Types in Limestone from PT. Semen Padang

Sample Name	Magnetic Susceptibility Value(x$10^{-8}$$m^3$/kg)	Magnetic Properties	Mineral Type
LS01222-04222	23 - 66,1	*Antiferromagnetic*	*Hematite*
LS07222-11222	33 - 41,7	*Antiferromagnetic*	*Hematite*
LS14222-18222	24,9 - 64,6	*Antiferromagnetic*	*Hematite*
LS21222-25222	19,7 - 46,6	*Antiferromagnetic*	*Hematite*
LS02322-09322	17,6 - 90	*Antiferromagnetic*	*Hematite*

Table 2 shows the magnetic properties of Limestone from PT. Semen Padang is *Antiferromagnetic* and thetype of mineral contained in Limestone is Hematite. Based on equation (1), the value of Frequency Dependence Susceptibility ($\%\chi fd$) is obtained. From this value, it can be seen how the *Superparamagnetic* grain content in Limestone from PT. Semen Padang. The results of *Superparamagnetic* grain content in Limestone from PT. Semen Padang can be seen in Table 3.

Table 3.Classification Of Grain Types at Limestone PT. Semen Padang based on $\%\chi_{fd}$ Value

Sample Name	$\%\chi_{fd}$	$\%\chi_{fd}$Value	Number of Samples	Information
LS01222–04222	<2%	0–0,51	4	Has almost no SP Granules Particles
	2-10%	-	0	-
	10-14%	-	0	-
	>14%	-	0	-
LS07222–11222	<2%	0–1,09	5	Has almost no SP Granules Particles
	2-10%	-	0	-
	10-14%	-	0	-
	>14%	-	0	-
LS14222–18222	<2%	0,53– 0,93	5	Has almost no SP Granules Particles
	2-10%	-	0	-
	10-14%	-	0	-
	>14%	-	0	-
LS21222-25222	<2%	0,26– 0,85	5	Has almost no SP Granules Particles
	2-10%	-	0	-
	10-14%	-	0	-
	>14%	-	0	-
LS02322-09322	<2%	0–1,56	4	Has almost no SP Granules Particles
	2-10%	2,13	1	There is a mixture of SP and coarse grains
	10-14%	-	0	-
	>14%	-	0	-

Based on Table 3 it can be seen that the dominant Limestone sample does not contain Superparamagnetic grains, this is known from the $\%\chi fd$ value <2%. However, of all the samples, there was one sample that had a $\%\chi fd$ value between 2-10%, which was 2.13% in the LS02322 sample. This indicates that this sample contains a *superparamagnetic* mixture with coarse grains (<0.05μm). According to Dearing (1999)[2] this percentage value belongs to the low percentage group and indicates that there are almost no *superparamagnetic* grains in the limestone sample. So that all clay samples from PT. Semen Padang has almost no *superparamagnetic* grains.

IV. CONCLUSION

Based on the measurement results, the Limestone magnetic susceptibility value from PT.Semen Padang has a range of values from 17.6 x 10^{-8} m^3/kg to 90 x 10^{-8} m^3/kg and has a dominant value, where Limestone has little or almost no *Superparamagnetic* grains, there is only one sample that has *Superparamagnetic* grains. Based on the range of magnetic susceptibility values, the magnetic properties of Limestone from PT. Semen Padang is *Antiferromagnetic* and has a type of magnetic mineral, namely *Hematite*.

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