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Application of Peat-B as Additives in Waterproofing Liner Material

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Abstract: Wet and damp conditions will cause building damage to become faster and will increase maintenance costs each year. The goal of this study was to produce an effective waterproof coating capable of solving the problem of damage caused by water or moisture. This study uses a mixture of clay as the main material and PEAT-B as an additive to produce a waterproof layer that can be used in any construction application such as building and road construction. PEAT-B is a mixture of peat particles and bentonite. Different percentages of mixed materials will be produced to study the appropriate percentage to be used as a waterproof layer. Tests such as water permeability (Falling head), water absorption and Self-healing are used to test the effectiveness of the waterproof layer mixture. The results showed that with the increase in the percentage of bentonite in the PEAT-B mixture showed good results. The results of the study showed that B25 with mixtures such as Water (20%), Clay (80%), Peat Particles (10%) and Bentonite (25%) had produced the best results among other mixtures. By producing this waterproof layer, then the problem of leakage and water seepage on certain building structures such as concrete walls or roofs or roads will be avoided.

Keywords: Waterproof Layer, PEAT-B, Clay

1. Introduction

Moisture is one of the most serious forces affecting design. Furthermore, water is one of the elements that has the potential to damage and weaken the resilience of building structures or roads. These wet and damp conditions will cause the damage to the building to be faster and often burden the building owner if continuous building maintenance is not done. Water ingress causes the decline and deterioration of concrete structures over time. Therefore, suitable building materials need special research to overcome the negative effects, one of which is water infiltration on the building structure. According to Dean, P. (1994), when surfaces such as concrete, brick, stone etc. are used with a waterproof protective composition, it gets overall protection from corrosion and general damage [1]. This treatment significantly reduces the rate of water absorption so as to prevent water -related damage.

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Damaged and defective buildings can have various negative effects and implications for all parties. It can endanger the lives of consumers as well. Research in this matter is expected to help and overcome as well as reduce the negative effects caused by water infiltration on the structure. The application of additives in the production of waterproof coatings is an attempt to minimize the maximum amount of water or moisture from seeping into the built structure. Waterproofing coatings for buildings are done in a number of different ways to create various barriers for water so that it cannot enter the building structure. Various types of additives to produce a waterproof layer have been produced in every corner of the world. Similarly, several studies have been conducted to produce waterproof additives that extend the lifespan of building structures.

1.2 Scope of Study

This study was conducted by focusing on determining the percentage of PEAT-B to be mixed with the main material identified which is clay. Next, different percentages of PEAT-B will be used in this study. The percentage of PEAT-B is determined based on the total weight of PEAT-B to be used. The mixture of this main material and PEAT-B material is expected to produce a waterproof layer. In the mixing process, the researcher will use clay that will undergo a testing process in the laboratory. This waterproof layer will be tested by looking at the rate of permeation that will occur in this material through a permeability test that will be conducted in the laboratory. The results of the study will be analyzed and the measurement of tolerability will be determined to the permeability rate of the resulting mixture.

2. Materials and Methods

2.1 Materials Used

The selection of the right and appropriate materials is very important for getting satisfactory results. In this study will use 3 materials namely clay, peat particles and bentonite.

2.1.1 Clay

The clay used in this study was obtained from Research Centre of Soft Soil University Tun Hussein Onn Malaysia, (RECESS UTHM). The clay has high porosity but low permeability. In addition, the clay will be dried and ground until got a fine texture. Then, that clay will go through sieve process to obtain very fine particles before being mixed with other materials.

2.1.2 PEAT-B

Peat-B is a mixture of existing materials consisting of a peat particle and bentonite. The bentonite used in this study was a gray powder which can be found in stores. Bentonite can be added to waterproof concrete walls and floors, or added to mortar to increase its plasticity. Bentonite also serves as an important additive in bitumen emulsions [2]. Bentonite is a term used in science to describe smectic clay in its sedimentary form, which has a high amount of clay mineral (usually montmorillonite) [3]. This clay mineral has a large specific surface area, great plasticity, and low hydraulic conductivity and can swell as it absorbs water. [4]. Peat and Bentonite will go through the same process as clay which is the process of drying, ground and sifting before being mixed to get a fine texture. This is because, the study by Li et al. (2004) from structural analysis micro nanoparticles that it not only acts as a filler but as hydration activators and improvement of the microstructure in cement mixtures [5].

Table 1: Physical properties for bentonite. [6]

Properties	Values
Colour	Grey powder
pH	9.62
Specific Gravity, (*Gs*)	2.14
Liquid Limit, *LL (%)*	419
Plastic Limit, *PL (%)*	190
Plasticity Index, *PI (%)*	229

2.1.3 Water

The use of the amount of water in the dough is very important to get a good dough texture to produce a quality sample. If there is too little water the dough will become hard and difficult to mix. In this study, the percentage of water to be used in the control samples was as much as 20%, 25%, 30% and 35% of the weight of clay for each sample. The test results will determine the percentage of water consumption for the next sample.

2.2 Samples preparation

Samples of this waterproof layer will be prepared according to the requirements of the experiment to be tested. For water permeability test samples, 1 sample disturbed clay samples was used and taken directly from the Recess area. Furthermore, another sample will be tested with Self-Healing and Absorption test. The materials will be mixed into a sample. From these materials, 12 samples of waterproof layer will be produced. This sample will be tested to see its effectiveness as a waterproof layer. The 12 samples will be divided into 3 categories and each category has 4 samples. Then, each sample produced will use a different percentage of material. The size of sample is 95 X 95 X 10 mm. Types of materials to be tested:

i. Clay (Control Sample)
ii. Clay + Peat Particle (Peat-Clay)
iii. Clay + Peat Particle + Bentonite (PEAT-B)

Table 2 show the percentage of materials use in the control sample. The percentage of material mixture for sample Peat-Clay and PEAT-B will be shown in the result and discussion section. This is because for the next sample use percentage depends on the results of the control sample.

Table 2: Percentage of Materials in the Control Sample

CODE SAMPLE		C80	C75	C70	C65
Moisture Content (water)	%	20	25	30	35
	gm	56	70	84	98
Clay	%	80	75	70	65
	gm	224	210	196	182

2.3 Laboratories testing

There are two methods for testing waterproofing materials. This is due to testing and knowing the ability of the material before proceeding with the next test.

2.3.1 Falling Head Permeability Test

Permeability means when the ability of water to flow through the saturated soil. Low permeability indicates that the water is flowing slowly or pounds does not flow at all through empty space. For this study, falling head permeability test that referred to ASTM D2434 standards was used to get the coefficient of permeability of clay. *Eq.* 1 show the formula to calculate coefficient of permeability.

$$k = \frac{2.303aL}{1000xAxt} log_{10} \left(\frac{h_1}{h_2}\right) (m/s) \; Eq. 1$$

Where:

A = Area tube
L = Length of sample
A = Area of sample
t = Time
h1 = Initial reading
h2 = Final reading

2.3.2 Self-Healing Test or Leakage Test

The self-healing test that has been spearheaded by RAWELL PTE LTD (LIVERPOOL) and the University of East London have been used (Masirin, 2007). This test has also been used to market RAWMAT, a type waterproofing materials for building construction in the United Kingdom in 2003. The process of self-healing will occur when water is exposed to the waterproof layer begins to act and rejoins the existing cracks on clay.

2.3.3 Water Absorption Test

This method aims to measure the absorption rate water into pieces of waterproof layer with different percentages of PEAT-B. This experiment uses the ASTM C642 standard for concrete. This test method is for shows the effectiveness of the mixture of waterproof layer produced against concrete durability and can also make comparisons between 3 sheet samples which use different percentages of batter ingredients. *Eq.* 2 show the formula to calculate rate of water absorption.

$$Peratus\ resapan\ air\ \% = \frac{w_2 - w_1}{w_1} \times 100\% \; Eq. 2$$

Where :

$\boldsymbol{w_1}$ = Weight of sample before submersion.
$\boldsymbol{w_2}$ = Weight of sample after immersion for 24 hours.

3. Results and Discussion

3.1 Self-Healing Test

i. Self-Healing Test or Leakage Test on Base Material (Clay) With Different Water Percentage Rates.

Self-healing tests on the Base Material which is Clay were performed with impose different percentages of water. This is done to get how much the percentage of water that needs to be mixed with the clay to obtain a single substance the best waterproofing that is able to prevent leakage to the lining waterproofing is recommended. Based on Table 3and Figure 1, the mixture C80 clay material with water as much as 20% of the total weight of the sample (280 grams) gives a droplet stop time value (Ts) smaller than or faster than a larger percentage value of water, i.e. 7 minutes only. This is because it is capable absorb and close the pores produced by the pierced knife penetrating the waterproof layer of the control sample. Based on these results, sample C80 was used for the test phase mixed with peat particle (P).

Table 3: Time of drop stop For Mixture Type for Control Sample

CODE of SAMPLE	SAMPLE CONTENT	TIME OF DROP STOP, Ts (Minutes)
C80	Water (20%:56gm) + Clay (80%:224gm)	7
C75	Water (25%:70gm) + Clay (75%:210gm)	13
C70	Water (30%:84gm) + Clay (70%:196gm)	19
C65	Water (35%:98gm) + Clay (65%:182gm)	23

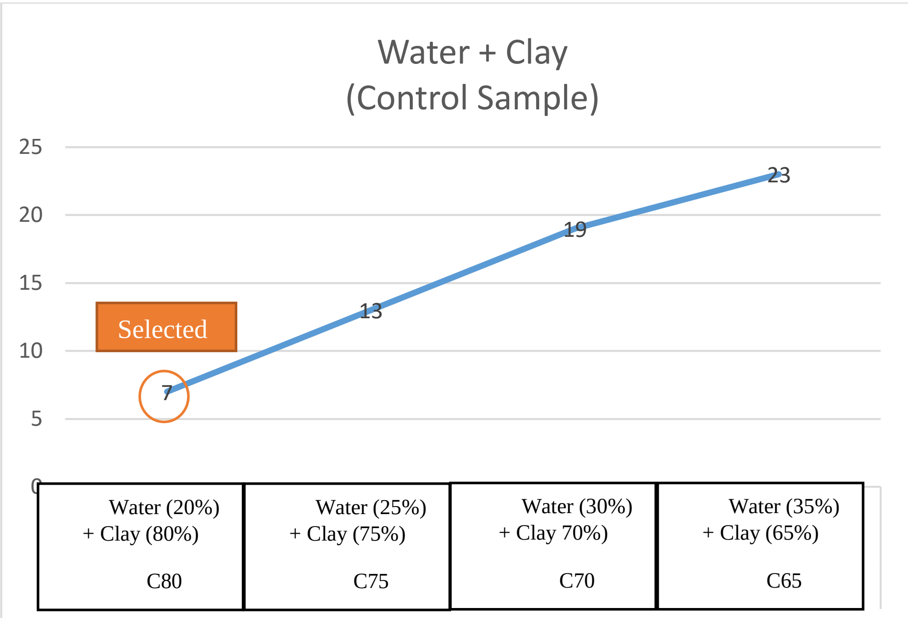

Figure 1: Time of drop stop Against Mixture Type for Control Sample

ii. Self-Healing Test or Leakage Test on Base Material (Clay) Best (80%), Best Water Percentage Rate (20%) and Percentage Rate Different Peat Particles

This phase of self-healing test is performed on a mixture of Basic Material which is Clay of 80% (224gm) by different weight of Peat Particles (P) from enter a water percentage of 20% (56gm). This is done to get what percentage of peat particles need to be mixed with clay for get one of the best waterproof material that is able to prevent it from happening leakage to the proposed waterproof layer. Based on Table 4 and Figure 2, a mixture of P10 clay material with peat particles (P) of 10% (28gm) of the total weight of the original sample (280 grams) gives a time value stop droplets (Ts) are smaller or faster than the percentage value of more water large, i.e. 12 minutes. This occurs probably due to when the particle content peat increases then the pores of the cavity increase in the mixture and causing the ability to prevent recipes from occurring is diminished and the stop droplet time (Ts) is getting larger. Based on these results, a mixture of P10 used for the next test phase which is to be mixed with Bentonite material (B).

Table 4: Time of Drop Stop for Mixture Type For Clay & Peat Particle Mixture (Peat-Clay Mixture)

CODE SAMPLE	SAMPLE CONTENT	TIME OF DROP STOP, Ts (Minutes)
P10	Water (20%) + Clay (80%) + Peat Particle (10%:28gm)	12
P15	Water (20%) + Clay (80%) + Peat Particle (15%:42gm)	20
P20	Water (20%) + Clay (80%) + Peat Particle (20%:56gm)	29
P25	Water (20%) + Clay (80%) + Peat Particle (25%:70gm)	33

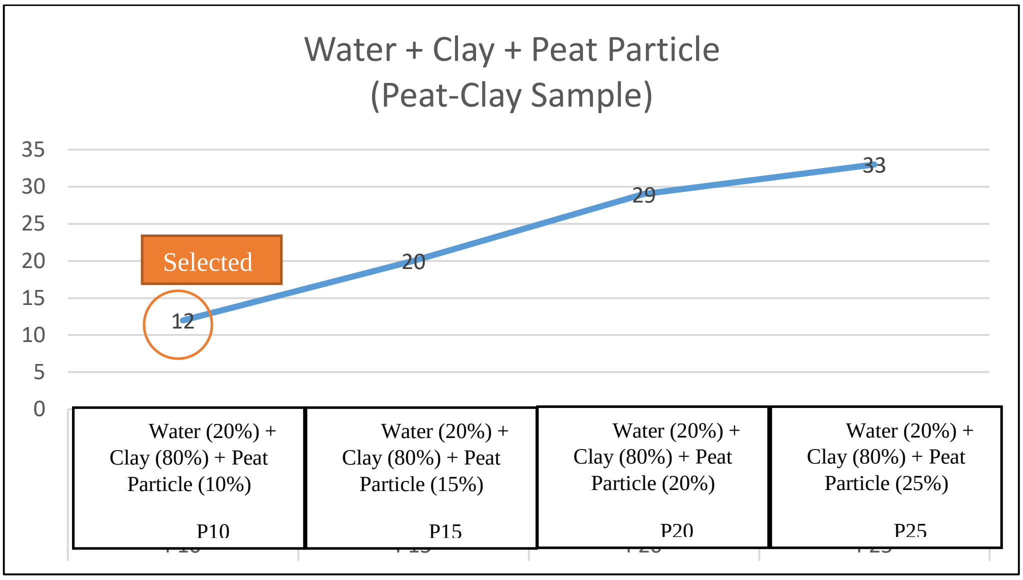

Figure 2: Time of Drop Stop Against Mixture Type for Soil Mixture Clay & Peat Particles (Peat-Clay Mixture)

iii. Self-Healing Test or Leakage Test on Best Basic Material (Clay) (80%), Best Water Percentage Rate (20%), Best Peat Particle Percentage Rate (10%) and Different Percentage Rate of Bentonite

For this phase of self-healing test, the test is done on a mixture of Basic Material namely Clay (C80) of 80% (224gm) by weight of Peat Particles (P10) of 10% (28gm) and a different percentage of Bentonite (B) material mixed with a water percentage of 20% (56gm). This is done to get what percentage of Bentonite material should be mixed with clay and peat particles to get one of the best waterproofing material possible prevent leakage to the proposed waterproof layer. Based on Table 5 and Figure 3, the mixture of clay material B25 with

Bentonite (B) material as much as 25% (70gm) of the total weight of the original sample (280 grams) gives a droplet stop time value (Ts) smaller or faster than a larger percentage value of water, 6 minutes. This happens probably due to the highest Bentonite material content is capable of creating a self-healing rate high and close the pores of the cavity in the mixture when sliced or leaked. This directly causes the ability to prevent recipes from taking place increasing with a large percentage rate of Bentonite. General knowing that Bentonite material is capable of absorbing any liquid and expands to create a state of self-healing of the clay mixture material and at the same time prevent leaks from occurring. Based on these results, the B25 mixture is the best mixture for this test phase.

Table 5: Time of Drop Stop for Mixture Type for Clay Mixture, Bentonite & Peat Particles (PEAT-B –Clay mixture)

CODE of SAMPLE	SAMPLE CONTENT	TIME OF DROP STOP, Ts (Minutes)
B10	Water (20%) + Clay (80%) + Peat Particle (10%) + Bentonite (10%:28gm)	29
B15	Water (20%) + Clay (80%) + Peat Particle (10%) + Bentonite (15%:42gm)	24
B20	Water (20%) + Clay (80%) + Peat Particle (10%) + Bentonite (20%:56gm)	18
B25	Water (20%) + Clay (80%) + Peat Particle (10%) + Bentonite (25%:70gm)	6

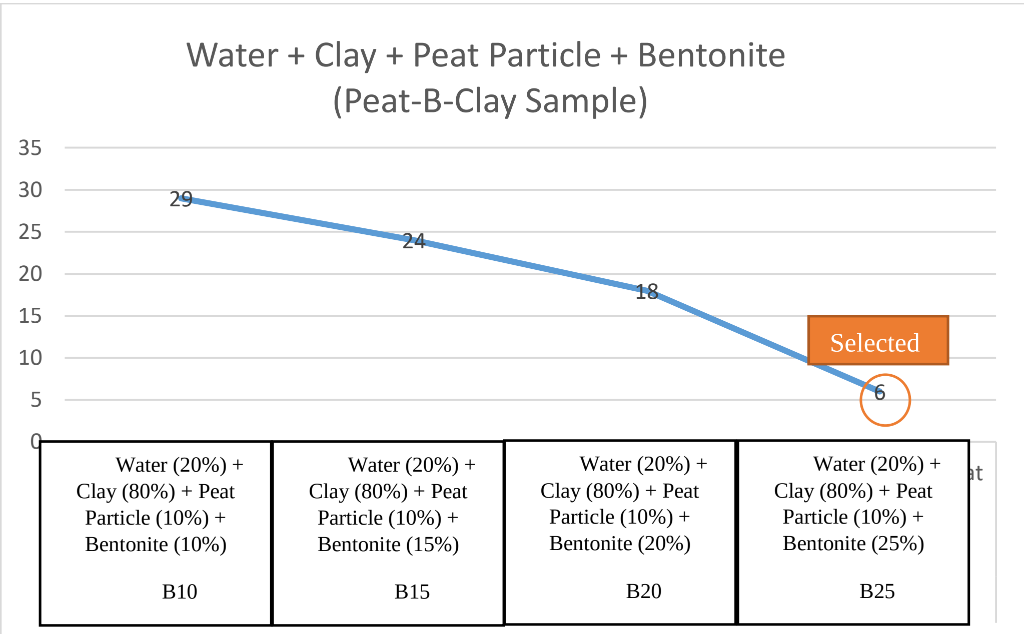

Figure 3: Time of Drop Stop Against Mixture Type for Soil Mixture Clay, Bentonite & Peat Particles (PEAT-B-Clay Mixture)

3.1.1 Comparison Between Basic Material (Clay) As Control Sample, PEAT-CLAY Mixture and PEAT-B Mixture (Innovation Mixture)

In this study, a comparison between the base materials which is clay as a control sample with PEAT-B is necessary to ensure whether there is any change in the waterproof properties of the material. On time similarly, a comparison with the PEAT-CLAY mixture was also made for knowing the effectiveness of the use of fine peat particles in soil mixtures clay.

This study found that the C80 control sample gave the best Ts value. This is because Peat-Clay samples have many pores when clay is mixed with peat particle material. The permeability of the material will decrease when there is a material such as peat particles as an additive. Therefore, the control sample material is better than Peat-Clay material as a waterproof material. However, PEAT-B, B25 samples gave slightly better Ts values compared to the control samples which is clay. This is because PEAT-B samples mixed with Bentonite material of 25% have a clay material that has a good expansion ability and is able to close the pores of the cavity found in the mixture of the material. The permeability of the material will increase when there is Bentonite material added but, further study needs to be seen how the PEAT-B mixture reacts if Bentonite material is added up to 50%. Thus, for this comparison phase, the study found that the PEAT-B material gave better results than the control sample as a waterproof material but only for the B25 sample. In the view of the researchers, a further study should be made for a mixture of clay and Bentonite without peat particles to see the effect of the mixture.

3.2 Falling Head Permeability Test

The soil permeability coefficient describes how easily a liquid moves through the soil. It is also often referred to as soil hydraulic conductivity. This factor can be influenced by the viscosity, or thickness (smoothness) of the liquid and its density. The number can also be influenced by the size of the void, or non -soil area, the continuity of the void, and the shape of the soil particles and the surface roughness. This is an important factor when determining the rate at which a liquid will actually flow through a particular type of soil. The average of the permeability coefficients is $1.55x10^{-7}m/s$. Clay is the most porous sediment but the least permeable. Clay usually acts as an aquitard and impedes the flow of water. From here, we learn that mud clays consist mainly of medium -sized particles, are fairly well dried and withstand more moisture than sandy soils.

3.3 Water Absorption

The results of the absorption test on the 3 types of samples that have been prepared, then the following is displayed comparative data that shows the absorption test for 24 hours for the three samples. Table 6 shows that samples C80 and P10 have high absorption rates however, the material which was originally dry and hard, after soaking in water for 24 hours, it became soft and easily dissolved. The water absorption percentages were 46% (C80) and 62% (P10). This indicates that this material despite having high water absorption, it will be easily dissolved and unable to function continuously as a waterproofing material. This shows the natural characteristics of clay, easily dissolved and soft when put in water. As for the B25 sample, it is still in a solid state and can be lifted after soaking for 24 hours. The water absorption percentage for this B25 sample was 18% as shown in Table 6.

Table 6: Comparison of Water Absorption Test between sample C80, P10 and B25

CODE of SAMPLE	DRY WEIGHT (gram) (A)	WET WEIGHT (gram) (B)	WATER ABSORPT WEIGHT (gram) (A-B=C)	WATER ABSORPTION PERCENTAGE (%) (C/A)	NOTED
C80	284	416	132	46%	High absorption but the material is soft and easily dissolved
P10	240	390	150	62%	Highest absorption but badly dissolved material

B25	200	236	36	18%	Absorption is low but the material is still in pre -test condition

The absorption rate of this mixture B25 was found to be low but still affordable maintaining its original form indicates it is capable of functioning in the rate of time the old as a waterproof material. Presence of Bentonite material in B25 mixture most likely the cause of this hard and solid current layer dried and still remains in its shape even though it still absorbs water. Is expected, if the immersion period is extended, most likely this mixture of ingredients will also be soft and will continue to work until it dissolved. Therefore, based on the results of this study, the mixture of B25 ingredients is that best when compared to samples C80 and P10.

4. Conclusion

As a conclusion the purpose of this study is to produce a waterproof layer by using PEAT-B additives. Based on the experiments that have been carried out on samples produced with different percentages of material mixture, mixture B25 showing the good result among the rest. As the water content increases, the cohesion decreases. This is because an increase in water content causes the separation of more clay particles large (and easier to slip). Next, the permeability of the material will decrease when there is a material such as peat particles as an additive because has many hollow pores when clay is mixed with the material peat particles. The permeability of the material will increase when the material is present Bentonite is added. This is because PEAT-B is mixed with the material Bentonite of 25% has a clay material that has the ability expands well and is able to close the pores of the cavities found in mixture of the material.

This waterproofing material can be applied to the layer between the subgrade and road base and also between the road base and the bituminous layer. But in part the outside should be lined with geotextile. In addition, this waterproof material can also be applied to build a structures such as basements, roofs, floors and wall. In conclusion, the production of waterproofing layers from soil mixtures clay and PEAT-B will reduce the problem of leakage and water retention on the structure certain buildings such as concrete walls or roofs or roads will can be avoided.

Acknowledgement

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