EFFECT OF RUBBERWOOD ASH ON PEAT SOIL

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Abstract: This work is a study of peat soil improvement using rubberwood ash in the southern border of Thailand (Narathiwat province) by collecting peat soil samples according to ASTM D1587 standard with thin wall tube sample for 3 holes, depth 1.5 meters from the original surface level. Studying physical properties such as water content, specific gravity, atterberg's limits and particle size analysis and standard compaction test for engineering properties. Improvement with rubberwood ash using unconfined compression test to unconfined compressive strength. It was found that peat soil mix with 35 wt.% rubberwood ash at 28 days for curing time was the highest compressive strength of 2.64 ksc. and as a basis for further improvement of peat soil.

Keywords: Peat Soil, Rubberwood Ash, Soil Improvement.

Introduction: The soil has unique properties in each area and has its own unique identity, which differs according to the nature of the soil. Properties of the soil mass effect to the engineering work. As a result, the design of structures that use soil as a supporting material for the foundation is necessary to know the characteristics of the soil properties. Peat soil is a type of organic soil [1] that contains organic matter in the composition of not less than 30%. They are rotting decomposing plants for a long time. The soil has low drainage characteristics, with a lot of space in the soil mass when draining water from the soil will cause a lot of shrinkage. The characteristics of the peat soil has black or brown color, a high amount of organic matter, acidic and water content. Thailand, found that in Narathiwat province, which is well known in the name of "Peat", found that densely in the area of cajuput, papyrus and sedge trees. Currently, it is not popular in the use of peat soil for engineering purposes because the main problem of peat soil is an organic matter, high water content characteristics causes reduced density and resistance to lower weight than other types of soil [2]. The construction of buildings, roads that are located in the peat area must be very careful because the peat soil has very low load capacity, causing easy settlement even with a small amount of weight. Therefore, one important to prevent damage must be to study the properties of the soil as a guideline for improvement. Therefore, there is an interest to bring waste from the industry to improve together with peat soil. Improving soil are suitable for soil, such as by chemical because the binder can react chemically with the soil silica and alumina, when mixing chemicals in appropriate quantities and types soil and have better engineering properties such as higher shear strength, lower settlement rate. A binder property is well known as the pozzolanic reaction must have amount of calcium oxide (CaO) into reaction with elements of soil such as silicon dioxide (SiO_2) and aluminum oxide (Al_2O_3), forming calcium silicate hydrate (CSH) and calcium aluminate hydrate (CAH) which is a cementitious ,which is a cement material itself without to combine with lime or cement, found that rubberwood ash (RWA) has a CaO as the main component of 58.17%, which has a lot of CaO to be a pozzolanic reaction [3], CSH and CAH compounds are the main products as well as the hydration of cement reaction [4]. Interested in studying improve peat soil with industrial waste such as RWA to reduce waste material from industry.

Experimental:

Preparation of Peat Soil Sample: The peat soil sample was collected at Princess of Naradhiwas University, Narathiwat province. The sample with dark gray color, contains organic matter with thin wall tube sample for 3 holes, depth 1.5 meters from the subgrade, collecting sample by disturbed sample. The tube with a diameter of 5 centimeter and length 50 centimeter, covered with candles to prevent the loss of moisture from the sample. The sample was calcined at 105 ± 5 ℃ at least 16 h or until the weight of the sample does not change to unconfined compression test by mini compactor, comparing the energy of standard proctor test.

Physical Properties: To study physical properties before improvement such as water content, specific gravity, Atterberg's limits and particle size analysis according to soil testing standards.

Engineering Properties: The compressibility parameter and analyze the period time to find maximum dry density and the optimum moisture content for preparation standard compaction test.

Peat Soil Improvement: The RWA sample was calcined at 105 ± 5 ℃ at least 16 h or until the weight of the sample does not change and then grinding with a ball mill applied machine as shown in fig.1, using the water at the appropriate moisture value. Peat soil mix 0, 5, 10, 15, 20, 25, 30, 35, 40 and 50 wt.%RWA and curing time at 0, 7, 14, and 28 days, using unconfined compression test to unconfined compressive strength (UCS).

Standard Testing: Physical properties were testing by ASTM D 2216-98 test method for laboratory determination of water (moisture) content of soil and rock by mass, ASTM D 854–00 standard test methods for specific gravity of soil solids by water pycnometer, ASTM D-422 standard test method of particle size analysis of soils, ASTM D 4318-93 test method for liquid limit, plastic limit, and plasticity index of soils, ASTM D 427-98 test method for shrinkage factors of soils by the mercury method. Engineering properties were testing by ASTM D 1140 - 54 test method for laboratory compaction characteristics of soil using standard effort. Unconfined compression test by ASTM D 2166-00 standard test method for unconfined compressive strength of cohesive soil.

Results and Discussion:

Physical Properties Testing: The energy of standard proctor and energy from compaction using mini compactor test were shown in Table 1 and Table 2 shows physical properties of peat soil such as the peat soil has a natural water content of 58.9% more than liquid limit of 61.6% shows that the soil looks like a soft soil, a low plastic index of 26, due to the soil, which plastic index from low to moderate levels can be used as a composite material to improve quality, if the soil is more than 30 % of plastic index makes it difficult to mix materials with soil [5], a low specific gravity value is 2.4, which is a low specific gravity because organic soil with specific is 1.00-2.60, mostly the size of peat soil is 70.5% of gliding through the sieve No.200 which consists of clay, silt and sand.

Table 1: Compaction Energy with Standard Proctor and Mini Compactor

Compaction Energy	Standard proctor	Mini compactor
Volume of mold (cm^3)	949.7	127.5
Hammer (kg)	2.5	1.45
No. of Layers	3	4
Blows/Layer	25	10
Height (cm)	30.5	13.3
Energy ($kg.cm/cm^3$)	6	6

Fig.1: A Ball Mill Applied Machine

Peat Soil Improvement: The unconfined compression test of improving peat soil mix RWA to find compressive strength and the relationship of graph between compressive strength and percent by weight of RWA as shown in fig.2. The UCS of the peat soil mix 0, 5, 10, 15, 20, 25, 30, 35, 40 and 50 wt.% RWA and curing time at 0, 7, 14 and 28 days as shown in Table 3, found that a compressive strength of peat soil is a constant trend at curing time 0, 7, 14 and 28 days of 0.99, 1.00, 1.06 and 1.03 ksc. as shown in fig.2. A compressive strength of the peat soil mix 5, 10, 15, 20, 25, 30, 35, 40 and 50 wt.% RWA is better than peat soil, when increasing the amount of RWA and curing time in the growing season, respectively when peat soil improving of 35 wt.% RWA, compressive strength increased 1.56 – 2.64 ksc., which indicating that the sample has increased toughness. RWA was mixed with the peat soil, resulting in a hydration reaction, which is a continuous reaction due to strength or increased ability to get a strength. The replacement of 35 wt.% RWA is the most appropriate, likewise, due to a lot of quantity of CaO in RWA and is the main compound, that makes the CSH and CAH increase the compressive strength.

Table 2: Physical Properties Testing

Peat soil properties	Data
Color	dark gray
Natural Water Content, NWC, %	58.9
Liquid Limit, LL, %	61.6
Plastic Limit, PL, %	35.6
Plastic Index, PI, %	26
Specific Gravity, G_S	2.4
Total Unit Weight, g/cm^3	1.79
Passing Sieve No.200 (0.075 mm.), %	70.5

Table 3: The Unconfined Compressive Strength (ksc.).

Curing time (days) / RWA (wt.%)	0	7	14	28
0	0.99	1.00	1.01	1.03
5	1.01	1.04	1.52	1.62
10	1.04	1.07	1.66	1.72
15	1.2	1.41	1.73	1.79
20	1.28	1.48	2.21	2.24
25	1.36	1.68	2.27	2.34
30	1.45	1.72	2.32	2.46
35	1.56	1.82	2.4	2.64
40	1.66	1.84	2.44	2.54
50	1.53	1.62	2.33	2.06

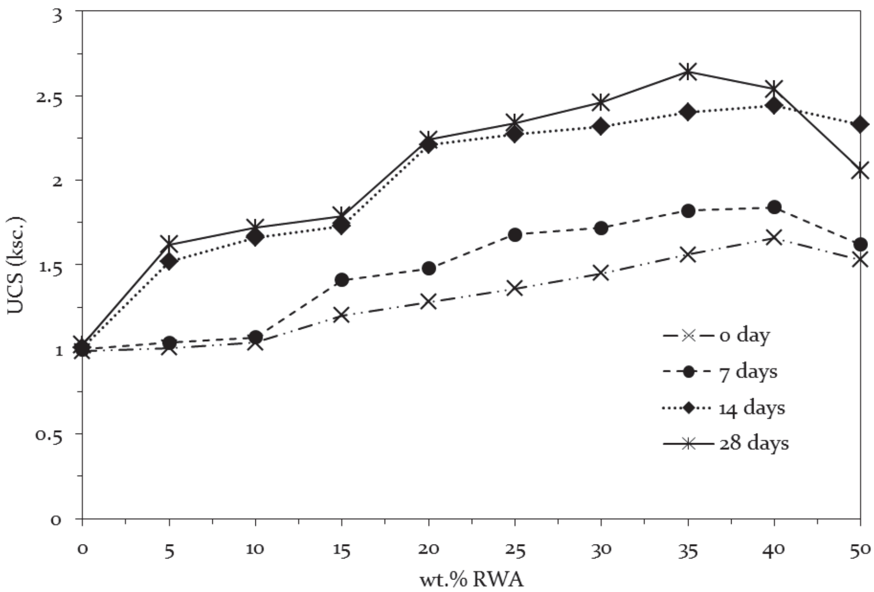

Fig. 2: UCS (ksc.) of peat soil mix wt.% RWA at Curing time

Conclusions: RWA is by product of rubber wood industry, is the fuel for burning, heating and drying the rubber wood. compared to the amount of advantage with RWA that occurs, therefore, is a disposal problem and an environmental problem due to the dumping and pollution from the dust diffusion of RWA, found that RWA has properties to improve the quality of the soil and therefore has been studied in experiments with peat soils which have a few compressive strength, due to improve the soil. Based on the test of soil mixed with RWA in various ratios, when comparing data and various relationships, found that the compressive strength of the sample obtained from amount of 35 wt.% RWA has the highest UCS, due to the amount of CaO in the RWA has a main compound into increase compressive strength. The peat soil samples that do not mix with RWA, the curring time does not effect to the compressive strength but in soil samples mixed with RWA, found that compressive strength of the soil will increase with the curing time.

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