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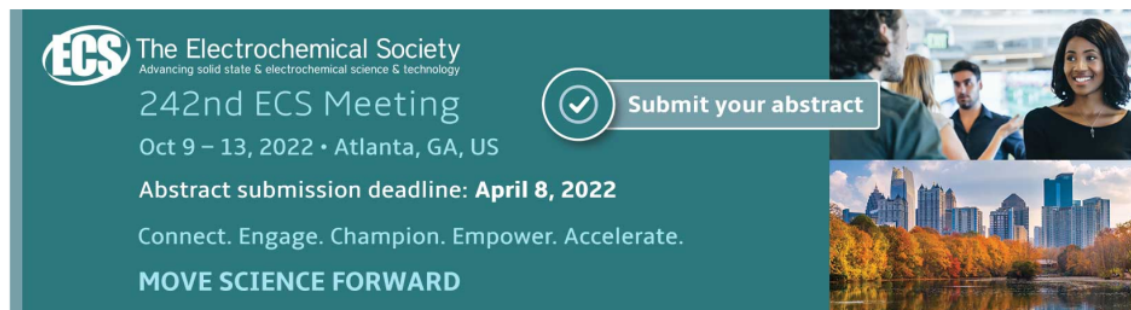
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Characteristics study of buton granular asphalt as filling material of column

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Abstract. Granular Asbuton is a natural material that occurred millions of years ago. Asbuton is a huge natural asphalt reserve. The bitumen content of Asbuton is located in an inter-mineral cavity that is difficult to remove. If the layer is dug and then obtained Asbuton chunks, the Asbuton remains a unit between the bitumen and the mineral granules, even if it is crushed to a small size, the bitumen and minerals remain united. The proportion of bitumen and minerals in granular Asbuton has basic properties, such as grain size distribution, ability to drain water, compression properties when compressed, shear strength, carrying capacity, and innovation in reducing soil deformation and decline. This study aims to examine the characteristics of physical and mechanical properties, determine the amount of bearing capacity and, evaluate the deformation pattern of asphalt granular column foundation systems. Testing uses SNI and ASTM standards. Based on the results of testing the characteristics of Granular Asbuton obtained the value of $q_u \text{ max} = 0.131 \text{ kg / cm}^3$, in the conditions of the optimum water content of Proctor. The value of California Bearing Ratio (CBR-Unsoaked) was 1.79%. So from the results obtained, that the use of Granular Asbuton greatly affects the stability of the soil that will be used as the construction material because of this material functions as a binding material from other materials and can be given other activating materials that can increase the bearing capacity.

1. Introduction

Science and technology are growing so rapidly in this period, with very fast growth in a very short time. The development of science and technology is certainly followed by the industrial world which is in desperate need of the existence of raw materials for the mining industry. For example with asphalt exploration is very beneficial for human welfare. The benefit of this asphalt material is to bind rock so that it cannot be separated from road surfaces due to traffic (waterproofing, protect against erosion), like aggregate and adhesive material and reduce accidents especially for vehicle drivers [1].

Asbuton is a natural material that occurred millions of years ago. Asbuton is a huge natural asphalt reserve. Asbuton is formed naturally due to the geological process, which is derived from petroleum which is pushed to appear on the surface to infiltrate between porous rocks. The bitumen content of Asbuton is located in an inter-mineral cavity that is difficult to remove. If the layer is dug and then obtained Asbuton chunks, the Asbuton remains a unit between the bitumen and the mineral granules, even if it is crushed to a small size, the bitumen and minerals remain united. The proportion of



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bitumen and minerals in Asbuton ranges from around 15% - 30% of bitumen and minerals around 85% to 75% [2].

Asbuton was first discovered by a Dutch citizen named Hetzel in 1920. Subsequently, in 1936, Hetzel broke the Asbuton deposit on the island of Buton. Asbuton deposits are scattered in several regions on Buton island, among others in Rongi, Kabungka, Lawele, Repe, Rota, Madullah, but from a number of Asbuton deposits there are only Kabungka and Lawele deposits which are currently being explored [3]. Mixing cement with water and soil, which normally forms a cement-sand column in situ, is very commonly used in soft soil improvement methods (soft ground improvement). In the installation of cement-sand columns, either slurs cement (wet mixing) or powdered cement (dry mixing) will be injected into the soil under pressure.

Deformation that occurs on the road body without strength reaches 0.553 m while the reinforcement of 3 m and 5 m each is 0.246 m and 0.225 m. Grouting is the injection of liquid material into the cavities of the soil or space between the soil and a nearby building, usually carried out through a drill hole and pressurized. Further research on the reinforced granular column for deep soil stabilization [4]. In this study, the granular column was wrapped in geosynthetic and installed on the deep soil to be stabilized. Settlement evaluation of soft clay reinforced by stone columns, considering the effect of soil compaction [5]. In this paper, the Plaxis program is used as a software to analyze the decrease in soft soils using the Mohr-Coulomb criteria for soft soil, sand, and rock. This study aims to examine the characteristics of physical and mechanical properties, determine the amount of bearing capacity and, evaluate the deformation pattern of the sand grouting column foundation system.

Model test on granular soil columns for ground improvement of very soft soil [6]. The results of the study using a granular column that pairs in organic soil as soil reinforcement using laboratory test models with vertical loads. Tests were carried out to determine the shear strength, vertical deformation, pore water pressure and press the soil before and after the granular column installation was carried out. The test results obtained a vertical strain comparison measured by an oedometer test at a voltage of 25 kPa, without using a granular column of 35% and using a granular column of 17.5% and a decrease of 50%. Most decreases occur en 2.5 times the column diameter. Given the granular column load that is given can increase the strength of organic soil.

Effectiveness of Raft and Pile Foundations in Reducing Soil Reduction by the Numerical Method [7]. Raft and Pile foundation designs were introduced in this study to reduce soil degradation. The Finite Element Method is used to investigate the effectiveness of the raft and pile foundations to reduce soil degradation, especially on highways built in swamp areas. Furthermore, numerical models are used to study the effects of the type and depth of foundations installed in the field. Soil degradation and deformation were analyzed in this study to determine the effectiveness and possible application of this foundation model in the field. The results of the finite element method used indicate that the type of raft and pile foundation significantly decreases the magnitude of the reduction from the road body due to surface loads. Deformation that occurs on the road body without strength reaches 0.553 m while the reinforcement of 3 m and 5 m each is 0.246 m and 0.225 m.

Column grouting method to overcome the liquefaction of soil under the foundation [8]. The results of his research stated that grouting is the injection of liquid material into the cavities of the soil or space between the soil and the building nearby, usually carried out through a drill hole and pressurized. Most grouting is designed to obtain changes in soil properties simultaneously or over a period of time, after injection. The main purpose of the grouting technique is to get stronger, denser, and less permeable on soil or rock. Grouting of foundation soil is intended to increase stability and reduce compressibility both permanently and temporarily. Non-cohesive soil with no finer gradation than medium sand, giving grouting cement is often done using low pressure.

Reinforced Granular Column For Deep Soil Stabilization. In this study, the granular column was wrapped in geosynthetic and installed on the deep soil to be stabilized [9]. From the results of this test, the small diameter granular column is better than the large-diameter because the pressure in the small-diameter column is lower, the ultimate load capacity increases as the stiffness increases, the geosynthetic granular column can reduce up to 50% of soil which does not use granular column

reinforcement, geosynthetic reinforced ultimate granular column load capacity can increase 2 to 3 times that without granular column reinforcement and theoretical analysis and model test results yield that the granular column encapsulated geosynthetic is efficient for soft soil repair.

2 Experimental program

2.1 Materials

2.1.1 Asbuton granular

The location of granular asbuton extraction used in the study was located on the island of Buton indicated by the location coordinates at Kabungka Pasarwajo District 5 ° 23'2.62 "S and 122 ° 53'33.67" E. (Figure 1). Basic property testing, asbuton over boulder used is included in the sample class which is coarse-grained with non-plastic index properties. The overall physical properties of granular asbuton used are presented in table 1.

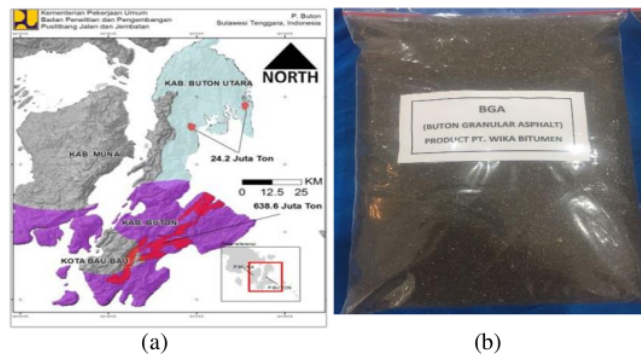


Figure 1. (a) Location of granular asbuton samples. (b) Visual granular asbuton.

Table 1. Physical properties of granular Asbuton

Testing	Unit	Result
Specific Gravity (Gs)		2,652
Sieve Analysis :		
Gravel	%	30,00
Sand	%	60,00
Silt	%	10,00
Clay	%	0,00
Standard Proctor (Compaction)		
$\gamma_{dry\ max}$	gr/cm ³	1,37
Optimum Moisture Content (ω_{opt})	%	9,13
Bearing Capacity (q_u)	kg/cm ³	0,131
Clasifikasi Soil Asbuton Granular	USCS	SL
	AASHTO	A - 1 - b
California Bearing Ratio (Unsoaked)	%	1,79

Based on the results of testing the physical characteristics showed the results of the characteristics of Granular Asbuton examination showed that the addition of coarse-grained material to expansive soil material will result in changes in soil properties leading to increased carrying capacity. From the test results show the classification parameters of Granular Asbuton soil based on USCS parameters included in the SL classification, namely the samples that are coarse-grained with non-plastic index properties, while according to AASHTO included in the classification of A-1-b is the type of

sample with assessment as subgrade material to bad [10]. Therefore this research based on the results of the parameters contains pozzolanic material which can increase the bearing capacity on expansive soil.

2.1.2 Design of research methodology

Granular Asbuton Test Method, weighed by the composition of the plan to produce a mixture of test material in accordance with the predetermined, mixing is done carefully and brooded for 24 hours until it reaches equilibrium before testing. The test object is used in the form of a cylinder with a measurement of $H = 2D$, made by mixing Granular Asbuton in the conditions of the optimum water content of the proctor. Put on the lubricated mold, then pounding each third of the part with a collision 25 times.



Figure 2. Test equipment a) unconfined companion strength, b) CBR test.

2.2 Sample preparation

2.2.1 Mixed ratio and sample preparation

Mechanical characteristics used in this laboratory study include the effect of free compressive strength testing will be carried out on the composition of granular Asbuton as a stability material using curing times for 0, 3, 7, 21 days.

2.2.2 UCT test objects

In making UCT specimens, the application of static compaction is applied to avoid damage to EPS granules. This static compaction procedure is based on research that has been carried out. For this compaction process, CBR equipment is used with a speed of 1.2 mm/minute. UCT samples with a dimension of 5.5 cm x 11.00 cm. taken for curing time for 7 days and 21 days.

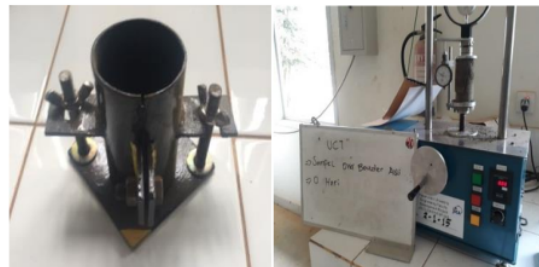


Figure 3. Making test models with static compaction

Static compaction is based on the volume of the test object and constant voltage [11]. The test material is divided into three parts, the first layer is compacted to reach $1/3$ of the mold volume and the pressure obtained is used as the stress value to be applied in layers 2 and 3.

2.3 Testing procedures

Testing of compressive strength was carried out using a universal testing machine (UTM) with the strain speed used was 0.3 mm / minute. In addition to obtaining maximum tension, the strain that occurs due to loading is also measured by installing LVDT at the time the test is carried out. The effect of curing time on compressive strength for each specimen is carried out, wherein this study the compressive strength value.

3. Experimental result and discussion

3.1 Value of compaction testing

In the standard compaction test (proctor test) obtained the maximum moisture content in the original soil is $W_{opt} = 9,13\%$ and the maximum dry content weight $\gamma_{dmax} = 1,37 \text{ gr/cm}^3$. The graph of the relationship between water content and dry content weight determines the value of adding water to the preparation of CBR soil samples which will be tested for the carrying capacity. The addition of water for CBR soil samples is 54.99 ml.

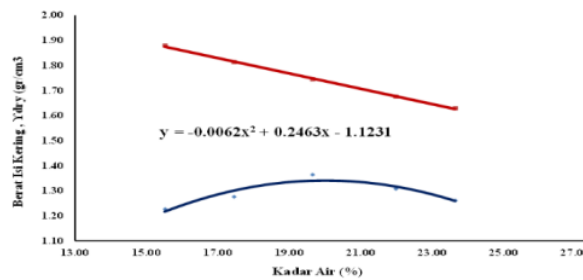


Figure 4. Relationship w_{opt} to γ_{dry} Asbuton Granular

3.2 Testing of californa bearing ratio (CBR) without immersion

The results of the CBR test for Granular Asbuton Samples were found to weigh 500 lbs.

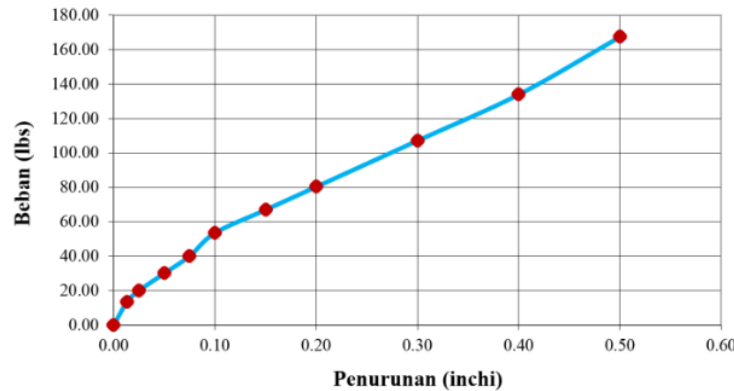


Figure 5. Graph of load relationship and decrease in CBR of granular asbuton samples

At a 0.1-inch decrease, the CBR value was 1.79%. And at the penetration of 0.2 inches by 1.79%. The CBR value that is used is in accordance with ASTM D-1833 standard where the CBR penetration value of 0.1 and 0.2 inches is equal, the value of penetration taken is the CBR value of 0.2 penetration of 1.79%.

3.3 Unconfined compression test (UCT) according to ripening

Sampel age (days)	0
quMax Value (kg/cm ²)	0,131

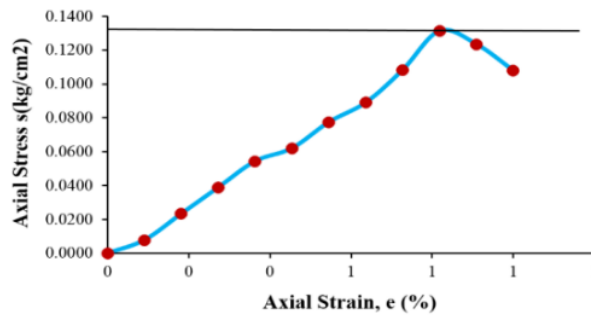


Figure 6. Graph of UCT of Granular Asbuton samples.

Based on the graph of Granular Asbuton UCT based on the age of ripening, it can be seen in the sample age of 0 (days) with a q_u value of 0.131 kg / cm², the compressive strength value will increase if done ripening when viewed from the type of material being tested due to the lack of activation material with the plasticity properties will decompose properly if other materials are given reinforcement.

This happens because the material particles have a high surface charge that can attract cations (positively charged ions) and water dipoles. The occurrence of reaction and rapid agglomeration flocculation between material particles that can produce reinforcement in the ability and strength during curing. So that this type of material can be used as a pozzolanic material capable of stabilizing soft soil with the ability to reduce the pattern of decline that will occur.

3.4 Mineralogical and granular asbuton microstructure test results

The parameters of mineralogical content of the material were tested using the X-Ray Diffraction (XRD) method according to ASTM D3906-03 (2013) standard, while the micro-chemical parameters were tested using Scanning Electron Microscope (SEM) according to ASTM E986-04 (2010) standard, and the energy method dispersive X-Ray Spectroscopy (EDS / EDAX) according to ASTM standards E1508-12a [10].

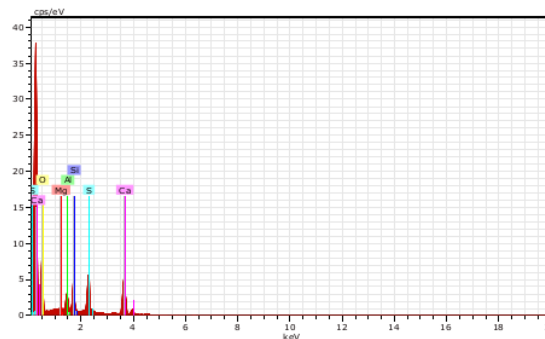


Figure 7. Energy dispersive X-Ray spectroscopy of granular Asbuton

Table 2. Energy dispersive mineralogy spectrum X-Ray spectroscopy of granular Asbuton

Spectrum : Test						
Element	unn	C norm	C Atom	C Compound	Norm. Comp	Error (3 Sigma)
	(wt . %)	(wt . %)	(at . %)		(wt . %)	(wt . %)
Oxygen	30.67	45.72	62.443		0.00	12.27
Sodium	2.27	3.38	3.21	Na ₂ O	4.56	0.59
Magnesium	2.02	3.01	2.70	MgO	4.99	0.46
Aluminium	4.43	6.60	5.34	Al ₂ O ₃	12.47	0.76
Silicon	6.15	9.16	7.13	SiO ₂	19.61	0.90
Sulfur	8.20	12.23	8.33	SO ₃	30.54	1.00
Calcium	13.34	19.89	10.84	CaO	27.84	1.31
Total :	67.08	100.00	100.00			

Microstructure behavior was tested by XRD, SEM, and EDS testing. Based on the results of the Energy Dispersive X-Ray Granular Asbuton Spectroscopy, it was illustrated that in the mineralogy spectrum of Granular Asbuton dominated oxygen content of 30.67% and calcium content of 13.34%, so that in the composition contained by the mineral can be used as pozzolanic material which can function as a binder and filler from soft soil material that can increase the bearing capacity of the material,

4. Conclusion

The results of testing the physical properties characteristics of Granular Asbuton were obtained based on USCS parameters included in the SL classification, namely samples with coarse grains with non-plastic index properties, while according to AASHTO included in the classification of A-1-b, the type of sample with assessment as a good subgrade material bad. Based on the CBR value the laboratory conditions showed a relatively low 1.79% of its use as a fill material that can function on the layered layer on the column foundation so that by looking at the results of the grain gradation and mineral content this material can be used as stabilizers on expansive soil. Asbuton Granular natural material is a natural material that has been investigated which shows pozzolanic behavior. So that it can be used as an expansive soil stabilization embankment material. Based on the test results and microstructure behavior of Granular Asbuton material compiled in the spectrum test shows that the calcium content is very dominant at 79.64% while the silicon content of 9.63% can be concluded that the Asbuton Granular mineral content contains pozzolanic composition.

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