Part 3 – Civil and Chemical Engineering [389-392]

Utilization Waste Material as Stabilizer on Kuantan Clayey Soil Stabilization

Achmad Fauzi[1],
Faculty of Civil Engineering and Earth Resources,
Universiti Malaysia Pahang, Lebuhraya Tun Razak,
26300 Gambang, Kuantan, Pahang Email: fauziwahab@ump.edu.my

Wan Mohd Nazmi Wan Abdul Rahman[2]
FKASA UMP, Kuantan, Pahang

Zuraidah Jauhari[3]
Faculty of Engineering, Indo Global Mandiri
University, Palembang, Indonesia

Abstract - **The objective of this research is investigated the utilization of High Density Polyethylene (HDPE) and Glass as material stabilizer in Kuantan clayey soil stabilization. The research conducts soil engineering properties and strength test for various contents of HDP**
E and glass to different types of clayey soil from various sites in Kelantan. The Standard Compaction and California Bearing Ratio (CBR) were applied in soil samples to estimate the optimum mixture design. The samples were set up by mixing soil samples with various content of stabilizer at optimum water content. The variation content of stabilizer was 4%, 8% and 12% by dry total weight.
The accomplishment of subgrade stabilization depends on the engineering properties of clay and characteristic of stabilizer [5, 6, 7, 8, 9, and 10]. The laboratory test result were shown the engineering properties of Kuantan Clayey soil and CBR were improved by adding Cutting HDPE and Crushed Glass as stabilizer.

Keywords- Soil Engineering Properties, Soil Stabilization, HDPE, Glass, CBR

I. INTRODUCTION

Marginal soils, including loose sands, soft clays, and organics are not adequate materials for Highway construction projects. These marginal soils do not possess valuable physical properties for construction applications. The usually methods for remediation of this weak subgrade such as remove the soil and change to the new one is typically expensive. Waste materials such as fly ash, bottom ash offer a cheaper method for stabilizing marginal soils **[**5, 6, 7, 8, 9, and 10]**.** As an added benefit, utilizing waste materials in soil stabilization applications keeps these materials from being dumped into landfills, thereby saving already depleting landfill space. Changes in the engineering properties of soils as a result of adding these waste materials: High Density Polyethylene (HDPE) and Glass were studied and recommendations on implementing these effects into construction applications are offered.

II. EXPERIMENTAL PROGRAM

A. A Soil and Material Stabilizer

Two types of clayey soil from random places in Kuantan, Pahang were used as K2 and K4. Cutting and crushed mineral water plastic bottle (HDPE) and crushed glass are collected from around Kuantan cities were used as material stabilizer. Some plastic product such as soda bottles and HDPE mineral water bottle, jugs, glass waste are easy to identify and find.

B. Testing method and testing program

The soil, material stabilizer, stabilized soil were tested according to BS Standard [4]. The flowchart for doing this study is shown in Figure 1.
The engineering properties and strength testing such as Sieve Analysis, Atterberg Limit, Linear Shrinkage Limit, Specific Gravity and California Bearing Ratio (CBR), Standard Compaction Proctor tests based on BS 1377-4 1990 [4]

The grain size of clay soil retained sieve 0.075 mm tested by mechanical sieve shaker and for clay material passing sieve 0.075 mm tested by CILAS 1180 Particle Size

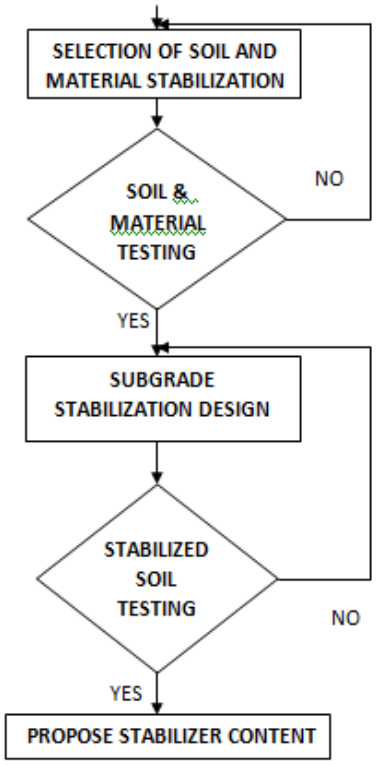

Figure 1. Research Activity Flow Chart

III. RESULT AND DISCUSSION

A. *The properties of Kuantan Clay and Stabilizer.*

The engineering properties and grain size distribution curves of Kuantan clayey soil were shown in Table I and Figure 2 respectively.

TABLE I. ENGINEERING PROPERTIES OF KUANTAN CLAYEY SOIL

CODE NO.	DESCRIPTION	CLASSI-FICATION	PASSING SIEVE NO (%)			LL (%)	PI (%)	Gs	SL (%)
			10	40	200				
K2	Yellow Whitish clay with sand	A-6	94.96	82.59	36.36	35.50	10.04	2.58	5.20
K4	Yellow brownish clay with sand	A-5	91.74	71.99	37.37	28.65	10.41	2.65	5.00

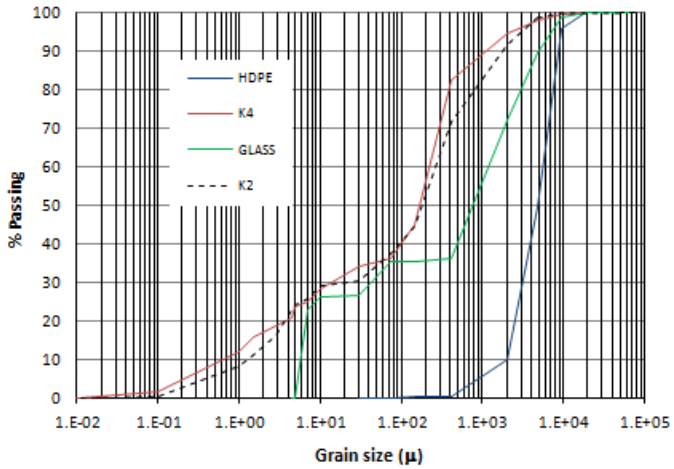

Figure 2. Particle Size Distribution Curve for Clayey soil, HDPE and Glass

Sample K2 and K4 are silt-clay materials and classified as A6 oand A5 in AASHTO Classification System respectively [2]. General subgrade rating for these soil are fair to poor.

The chemical element of Kuanatn Clayey soil K2, K4 soil were tested by integrated electron microscope and energy-dispersive x-ray Spectroscopy (SEM-EDS) was given in Table 2.

TABLE II. CHEMICAL ELEMENT FOR KUANTAN CLAYEY SOIL

No.	Element	K2	K4
		Weight (%)	Weight (%)
1	C $CaCo_3$	0	5.05
2	O SiO_2	54.21	58.97
3	Al Al_2O_3	6.82	12.81
4	S_i S_iO_2	34.33	18.99
5	K MAD	2.23	1.16
6	Fe Fe	2.41	3.02

Specific Gravity of Kuantan Clayey Soil, K2, K4, HDPE, and Glass were 2.58, 2.65 and 2.53, 0.96 respectively

Clay mineral for Kuantan clay K2 and K4 were halloysite Halloysite mineral is not a dangerous type of clay to encounter if it is found in tunnels or road cuts and sub grade because of its not expandable nature.

B. *Kuantan Clayey plasticity*

For K2 and K4 sample, the test results were shown that decrease of plasticity with increase of stabilizer (HDPE and Glass) content in mixed. In general term, the higher plasticity index, higher potential to shrink as the soil undergoes moisture content fluctuations. The variation of atterberg limit for original soil and stabilized soil were shown in Figure 3 and 4.

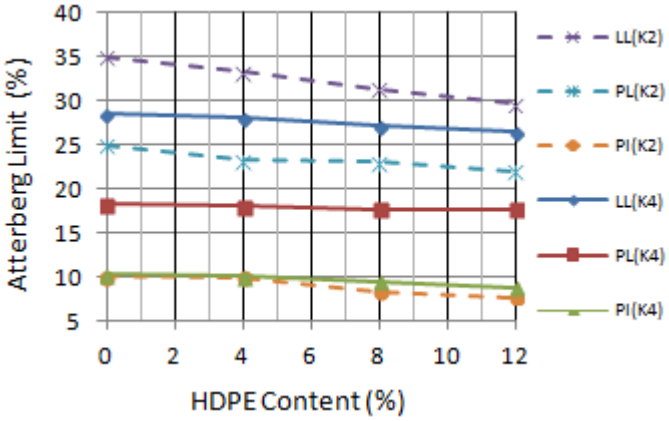

Figure 3. Variation of Liquid Limit (LL), Plastic Limit (PI) with HDPE Content.

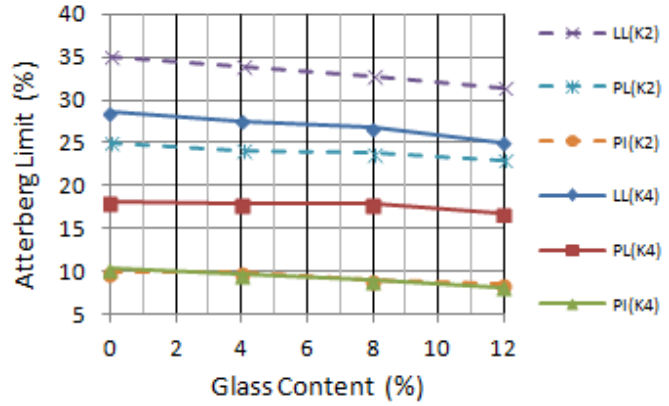

Figure 4. Variation of Liquid Limit (LL), Plastic Limit (PI) with Glass Content.

C. The Strength properties of stabilized soil

1) Compaction

The relationship between the optimum water content values of K2 and K4 in mixture and HDPE, Glass contents are shown in Figure 5. The relationship between the dry density of K2 and K4 mixture and HDPE, Glass contents are shown in Figure 6.

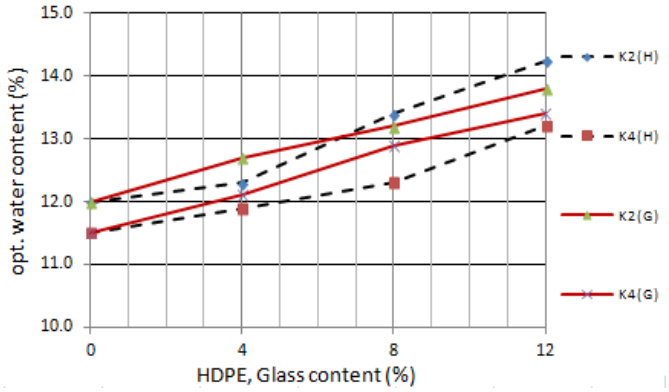

Figure 5. Relation between Optimum Water Content and HDPE, Glass Content in Stabilized Soil

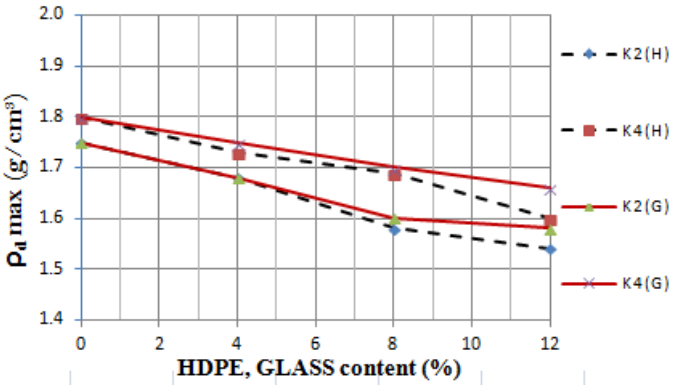

Figure 6. Relation between Maximum Dry Density and HDPE, Glass content in Stabilized Soil

For Kuantan Clayey K2 and K4 stabilized soil were shown that the maximum dry density decrease and the optimum water content increase when the HDPE and Glass content increase.

2) Soaked CBR

The relationship between the CBR values of K2 and K4 Stabilized Soil and HDPE, Glass contents are shown in Figure 7.

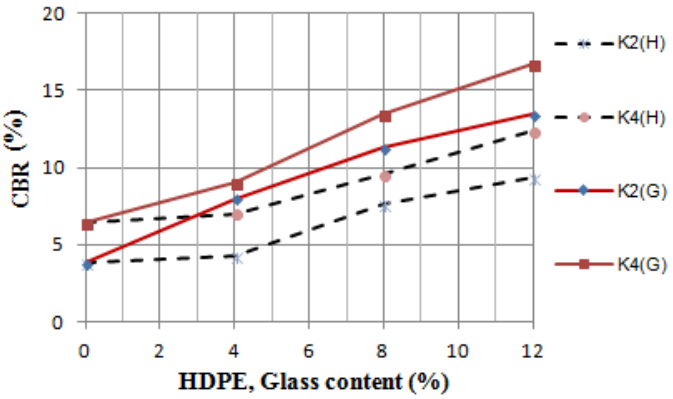

Figure 7. Relation between CBR and HDPE, Glass content in Stabilized Soil

A general trend of increasing CBR values with increasing HDPE and Glass content was observed. The gain in CBR values depend on the amount of stabilizer and water content in the mixture.

IV. CONCLUSION

The clayey soil K2 and K4 were medium plasticity soil and classified as A-6 and A-5 in AASHTO Classification System [2] respectively. The engineering properties of that soil improved by adding HDPE and Glass as stabilizer.

For K2 and K4 stabilized soil were shown: (1) the maximum dry density decreased and the optimum water

content increased when the HDPE and Glass content increased; (2) the CBR value increased when the HDPE and Glass content increased.

Besides the above, HDPE and Glass also can eliminates need for expensive borrow materials, expedites construction by improving excessively wet or unstable subgrade by improving subgrade conditions, and promotes cost savings through reduction in the required pavement thickness.

The Soil stabilized by HDPE and Glass are solving disposal problems and promoted the sustainable in highway construction. Having considered the environmental and economical aspects, HDPE and Glass are found suitable to be used as Stabilizer in subgrade stabilization for road structure.

ACKNOWLEDGMENT

Financial support for the research was provided by University Malaysia Pahang, Kuantan.

REFERENCES

[1] Agapitus Amadi, "Evaluation of Change in Index properties of Lateritic Soil Stabilized with Fly Ash," Leonardo Electronic Journal of Practices and Technologies, 2010, pp 69-78.

[2] American Association of State Highway and Tansportation Official, " Part II Test", AASHTO, Thirteeth Edition, 1982.

[3] A. Hilmi Lav, M. Aysen Lav. Et.al, "Analysis and design of a stabilized fly ash as pavement base material," Science Direct, Elsevier, Fuel 85, 2006, pp 2359-2370.

[4] BS 1377-4 1990, "Methods of Test for Soils for Civil Engineering purposes, part 4," Compaction-related Test. BSI.

[5] Fauzi Achmad**,** Usama Juniansyah Fauzi, Wan Mohd Nazmi, "Engineering Quality Improvement of Kuantan Clay Subgrade Using Recycling and Reused Material as Stabilizer," Proceeding the 2nd International Conference on Rehabilitation and Maintenance in Civil Engineering (ICRMC-2). Solo, 2012, pp 693-708.

[6] Fauzi Achmad, Wan Mhd Nazmi, and Usama Juniansyah Fauzi, "California Bearing Ratio (CBR) Improvement of Kuantan Clay Subgrade by Using Reused Material as Stabilizer," Proceeding the 9th National Conference of the Indonesia Road Development Association (IRDA). Jakarta, 2011.

[7] Fauzi. Achmad, Wan Mhd Nazmi, and Usama Juniansyah Fauzi, "Proposes of Implementation of Sustainable Subgrade on Highway Construction in South Sumatera by Using Coal Combustion Products (CCPs) as Stabilizer," Proceeding the International Seminar of the Council of Indonesian State University (CRISU) and the Council of University President Thailand. Palembang, 2011, pp236-241.

[8] Fauzi. Achmad, Wan Mhd Nazmi, and Usama Juniansyah Fauzi, "Sub grade Stabilization of Kuantan Clay by using Lime, Port land Cement, Fly Ash, Bottom Ash," Proceedings the 3rd International conference on Disaster Mitigation and Rehabilitation combined with the 5th International conference on Geotechnical and Highway Engineering. Semarang, 2011, pp 500-506.

[9] Fauzi. Achmad, Wan Mhd Nazmi, and Usama Juniansyah Fauzi, "Sub grade Stabilization of Kuantan Clay by using fly ashes and bottom ash," Proceeding the 8th International conference on Geotechnical and Highway Engineering (Geotropika 2010), UTM. Sabah, 2010.

[10] Fauzi. Achmad, Wan Mhd Nazmi, "Sub grade stabilization by using fly ashes, Kuantan clay soil case study," Proceeding Konferensi Teknik Jalan ke 11 (KRTJ 11 Wiltim), Indonesian Road Development Association (IRDA). Bali, 2010.

[11] Kolias, V. Kasselouri-Rigopoulou Et.al., "Stabilization of clayey soils with high calcium fly ash and cement," Science Direct, Elsevier, Cement & Composites 27 , 2005, pp 301-313.

[12] Wan Mhd. Nazmi, Fauzi Achmad, "Performance of Recycled High density Polyethylene (HDPE) and Low Density Polyethylene (LDPE) Pellet on the Conventional Properties of Bitumen," Proceeding Konferensi Teknik Jalan ke 11 (KRTJ 11 Wiltim), Indonesian Road Development Association (IRDA). Bali, 2010.

[13] Wan Mhd Nazmi, Fauzi Achmad, "Influence of Recycled High Density Polyethylene on the Conventional and Morphology Properties of Bitumen," Proceedings of Malaysian Technical Universities Conference on Engineering and Technology (MUCET). Melaka, 2010.

[14] Wan Mhd Nazmi, Fauzi Achmad, "Influence of Recycled High Density Polyethylene on the Conventional and Morphology Properties of Bitumen," Journal of Engineering and Technology, MTUN, Malaysia. Special Edition, 2011.