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Effect of Cement Stabilized Kaolin Subgrade on Strength Properties

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Abstract: Subgrade performance generally depends on the load bearing capacity of soil. This load is often affected by degree of compaction, moisture content and soil type. Poor subgrade should be avoided by removal, replace and add stabilizer agent to provide a suitable strength for subgrade. This study presents the effect of cement stabilizer on California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) for kaolin clay in low traffic volume road. The test conducted includes determination of liquid limits which leads to plasticity index for tested sample. Standard proctor test have been conducted to determine the optimum moisture content and maximum dry density of kaolin clay by using soil stabilizer with 0, 7 and 13% of Ordinary Portland cement (OPC). The CBR and UCS was conduct to determine the strength of kaolin clay at optimum moisture content and 7 days curing period to obtain minimum strength of the soil. Finding of this study shows cement stabilizer effectively increase the strength of kaolin clay. 8 % of cement was found to be the optimum percentage of cement content value to be added into kaolin soil which complies with the Malaysia Public Work Department (PWD) specification.

Key words: Stabilizer, kaolin, unconfined compressive strength test, california bearing ratio

INTRODUCTION

A low volume road can be understood as roads having low Average Daily Traffic (ADT) or low cumulative number of Equivalent Standard Axle Load (ESAL) traversing over the design life of the road (Hainin *et al*., 2011). Most roads in rural areas are low-volume roads. A well planned, located, designed, constructed and maintained low-volume road system was essential for community development, flow of goods and services between communities and resource management activities. It is important to know how much the subgrade soil can support the capacity on the applying load from the traffic without any failure. Material replacement or stabilization methods are usually used to increase the subgrade strength in order to provide a suitable platform for construction traffic (Terashi *et al*., 1980; Kitazume, 2005; Gofar and Kassim, 2007a; Gofar and Kassim, 2007b). To achieve high-quality subgrade, proper understanding of soil properties, proper grading practices and quality control testing are required. In this study, CBR and UCS test was conducted to determine the strength of subgrade at the OMC by using cement with 0, 7 and 13%. For low volume traffic road, both stabilized base materials and stabilized existing subgrade must have a minimum CBR of 80% and U CS of at least 0.8 Mpa for pavement layer based on Malaysia Public Work Department (PWD) specification for Low Volume Roads (JKR, 2012).

MATERIALS AND METHOD

Kaolin was used in this study as suitable materials for subgrade construction with the Plasticity Index of less than 55% (Hainin *et al*., 2011). Kaolin was selected based on their suitable characteristics, accessibility and availability as local subgrade materials in tropical area. Samples of kaolin clay for testing were supplied by Kaolin Malaysia Company. The properties of kaolin clay were determined based on Atterberg Limit Test and specific gravity (BSI, 1990; Head, 1980). Table 1 show the soil properties of Kaolin. Based on the Unified Soil Classification System (USCS), this soil is classified as fine-grained with symbol of CH. In order to enhance the strength properties of subgrade materials, Ordinary Portland Cement (OPC) was used as a stabilizer agent to be mixed with each soil type.

Table 1: Kaolin properties

Soil type	Liquid limit (LL)(%)	Plastic limit (PL) (%)	Plasticity index (PI)(%)	Specific gravity
Kaolin clay	54.0	29.2	24.8	2.65

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RESULTS

Standard proctor test: Figure 1 shows the compaction results for 0, 7 and 13% cement stabilized soil. The Maximum Dry Density (MDD) and OMC obtained for 0% cement are 1.68Mg m^{-3} and 17%, respectively (Fig. 1a). Meanwhile, the MDD and OMC for 7% cement are 1.64 Mg m^{-3} and 19.5%, respectively (Fig. 1b) and for cement of 13%, the MDD and OMC are 1.59 Mg m^{-3} and 20%, respectively (Fig. 1c). It was found that, the highest value of MDD occurred when the cement content is 0% as shown in Fig. 2a. This result has been supported by the OMC result (Fig. 2b) whereas the OMC for the 13% is higher than the 7%.

California bearing ratio (CBR): From the result showed that the California Bearing Ratio (CBR) value (Fig. 3) increased due to the percentage of cement content. The CBR value equal to 16, 76 and 110% for 0, 7 and 13% cement, respectively. From design guideline Malaysia PWD for low volume roads, the stabilize materials subgrade must have minimum CBR of 80%. This shows that only 13% of cement achieved the specification.

Unconfined compressive strength test (UCS): Figure 4 above shows the graph of UCS versus percentage cement. The UCS value obtains are 189kPa, 1660kPa and 2250 kPa for 0, 7 and 13% cement, respectively. For low

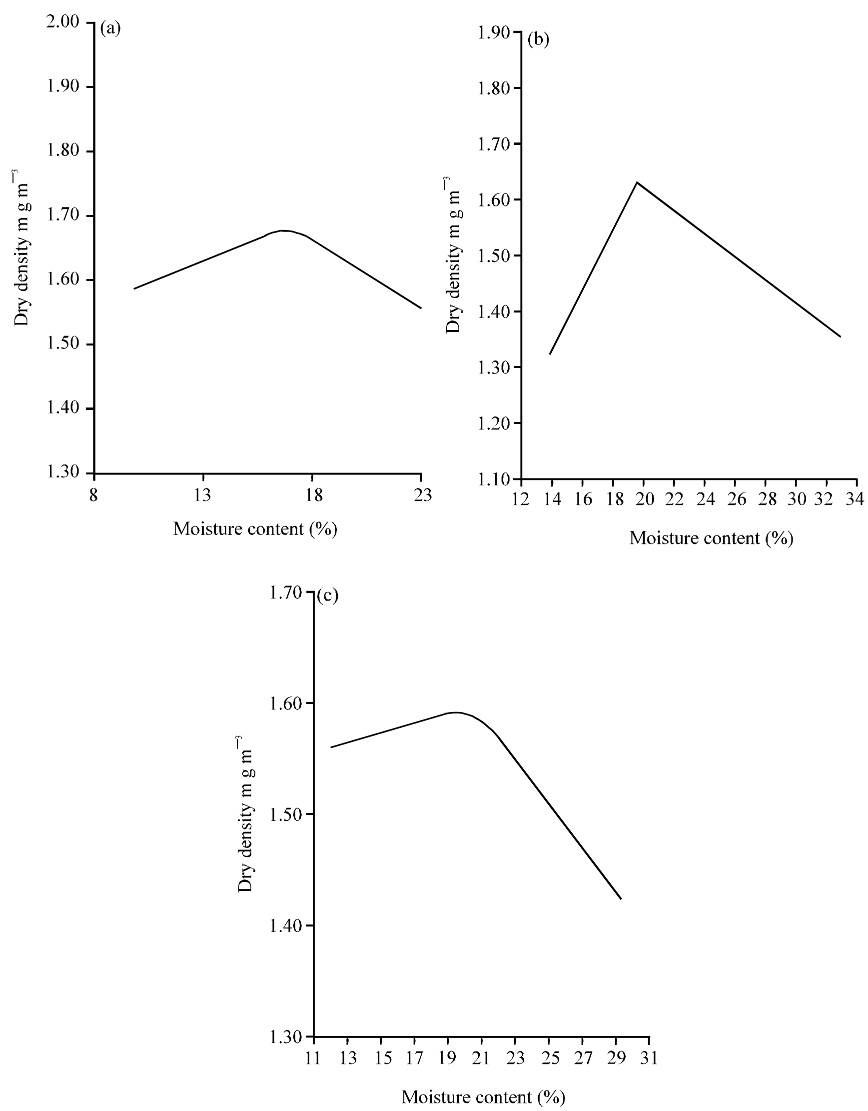

Fig. 1(a-c): Compaction for percentage of (a) 0%, (b) 7% and (c) 13% of cement content

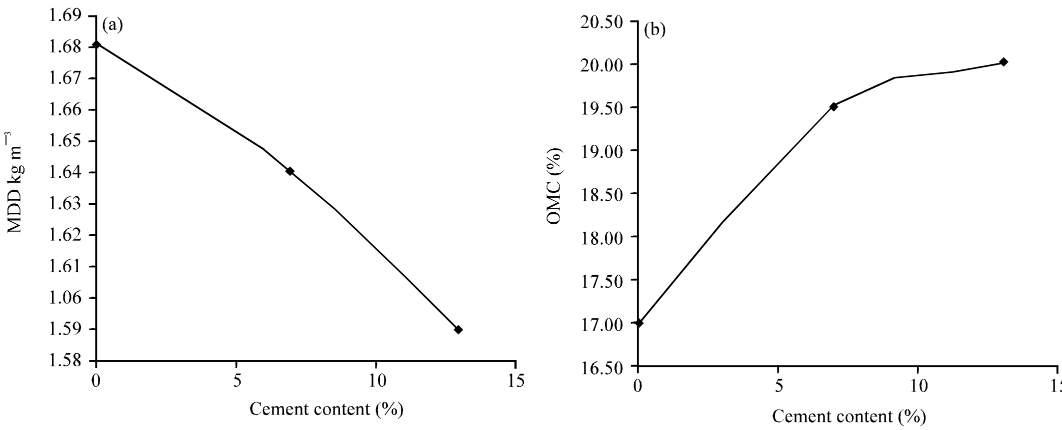

Fig. 2(a-b): (a) Maximum dry density and (b) Optimum moisture content vs. percentage of cement

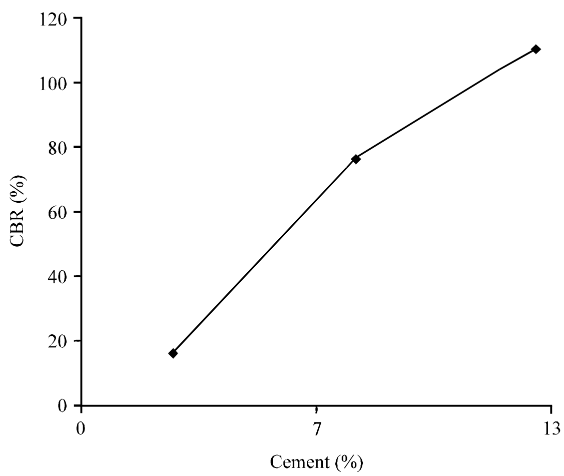

Fig. 3: California bearing ratio (%) vs. cement (%)

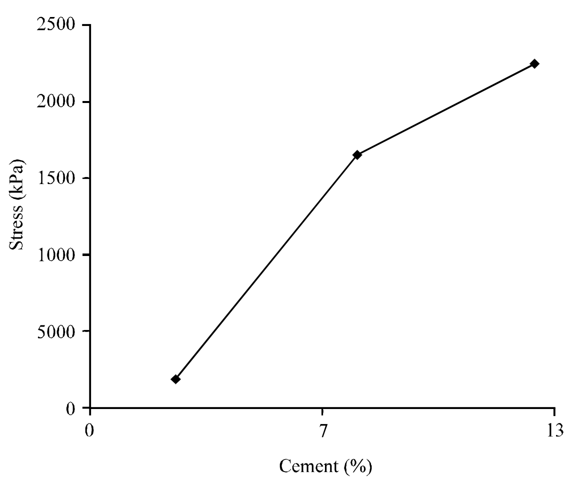

Fig. 4: Unconfined compressive strength test (kPa) vs. cement (%)

volume roads, the UCS value must achieve at least 0.8 Mpa. This shows that 7 and 13% cement pass the requirements.

DISCUSSIONS

Based on the laboratory results, it was found that the cement content contributed to the several changes and improvement of the stabilised soil properties value. From the compaction tests, it was found that a slightly different observed from Maximum Dry Density (MDD) and Optimum Mositure Content (OMC) due to the increment of stabiliser content. However, in general, the changes in the MDD and OMC were considered too small due to addition of cement content is small and hydration process is not occurred within a short period of time. Similar finding was recorded by Al-Amoudi (2002), Al-Abdul Wahhab. (2006) and Mohamedzein and Al-Rawas (2011) for a stablised cement soil. For the Unconfined Compressive Strength (UCS) test, the increase in the stiffness with the increase of cement content is probably results from the reaction of the stabiliser with the clay material in the tested soil which formed a new the formation of cementitious materials. In addition, the increase of the water demands from OPC due to hydration process contributed to the increment of the stiffness as well.

Figure 5 shows, the CBR and UCS value increased with the increasing of the percentage of cement. From design guideline (JKR, 2012), the stabilize materials subgrade must have minimum CBR of 80% and UCS at least 0.8 MPa. Both CBR and UCS meet the requirements. For CBR graph, the minimum value at 80% provides 8% of cement stabilizer. Meanwhile, for UCS graph, at least 0.8 Mpa provide 5% cement stabilizer. As a result,

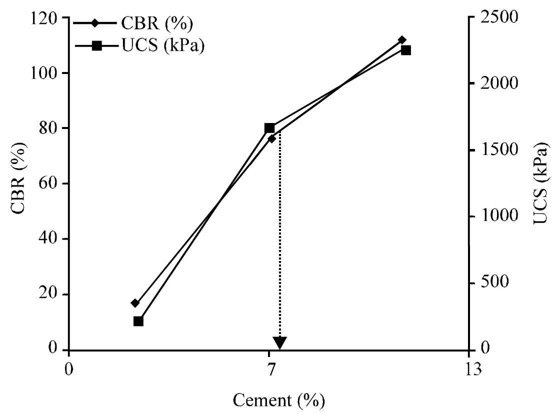

Fig. 5: California bearing ratio and unconfined compressive strength vs. percentage cement

8% of cement was chosen to specify both conditions where the CBR value at 80% and UCS strength at 1.7 MPa.

CONCLUSIONS

Based on this study, several conclusions could be made. It was found that the maximum dry density is reduced as the cement content increased and the optimum moisture content increased as the cement content increased. In addition, the UCS and CBR of the stabilized soil increased with the increment of cement content. The kaolin clay soil with 13% of cement content for CBR sample with 7 days curing period is achieving 80% CBR. As a result, 8% of cement was found as the optimum value for cement to be added into soil which comply the Malaysia PWD specification.

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REFERENCES

Al-Abdul Wahhab, H.I., I. Ahmad, S.A. Aiban and O.S.B. Al-Moudi, 2006. Stabilization of Al-Aziziyah (Eastern Saudi Arabia) Sabkha soil. Proceeding of the 3rd Gulf Roads Conference, March 6-8, 2006, Muscat, Oman, pp: 197-203.

Al-Amoudi, O.S.B., 2002. Characterization and chemical stabilization of Al-Qurayyah Sabkha soil. J. Mater. Civil Eng., 14: 478-484.

BSI, 1990. BS 1377-5:1990-method of test for soil for civil engineering purposes-part 5-compressibility, permeability and durability test. British Standard Institution, 389 Chiswick High Road, London, UK.

Gofar, N. and K.A. Kassim, 2007a. Introduction to Geotechnical Engineering, Part 1. Prentice-Hall Inc., Singapore.

Gofar, N. and K.A. Kassim, 2007b. Introduction to Geotechnical Engineering, Part 2. Prentice-Hall Inc., Singapore.

Hainin, M.R., C.R. Ismail and Y. Yaacob, 2011. Highway Engineering. Universiti Teknologi Malaysia, Malaysia.

Head, K.A., 1980. Manual of Soil Laboratory Testing, Volume 1: Soil Classification and Compaction Test. ELE International Ltd., London, UK.

JKR, 2012. Design guide for alternative pavement structures (low volume roads). Jabatan Kerja Raya Malaysia (JKR), June 28, 2012, Kuala Lumpur, Malaysia.

Kitazume, M., 2005. State of practice report-field and laboratory investigations, properties of binders and stabilised soil. Proceedings of the International Conference on Deep Mixing-Best Practice and Recent Advance, Volume 2, May 23-25, 2005, Stockholm, Sweden, pp: 660-684.

Mohamedzein, Y.E.A. a nd A.A. Al-Rawas, 2011. Cement-stabilization of Sabkha soils from Al-Auzayba, Sultanate of Oman. Geotech. Geol. Eng., 29: 999-1008.

Terashi, M., H. Tanaka, T. Mitsumoto, Y. Niidome and S. Honma, 1980. Fundamental properties of lime and cement treated soils (2nd report). Report of the Port and Harbour R esearch Institute, PARI Report 019-01-02, pp: 33-62.