CONSISTENCY OF ATTERBERG LIMIT PROPERTIES FOR CRUSHED LIMESTONE AGGREGATE BASE COURSE BETWEEN STOCKPILE AND IN PLACE MATERIAL

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Dedicated to my beloved family

"Special thanks for their motivation, concern and help"

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ABSTRACT

This paper presents the test results and discuss the properties consistency for crushed limestone aggregate materials collected from the stockpile and from in-place after wetting, mixing, laying, grading and compacting on site using a 25 tonne roller compactor with a layer thickness of 300mm. A number of test was carried out to investigate the liquid limits and plasticity index properties of the crushed limestone. A total of 48 samples was collected, i.e. 24 samples from the stockpile and 24 samples from in-place. The samples collected from all the stockpiles i.e. from both Doha and Kuala Lumpur meets the ASTM D4318 test for plastic limits ranging from 22 to 25 and for the plasticity index (PI) ranging from non plastic to a maximum of 4. The results for the in place material samples showed an increase in values for both the Kuala Lumpur and Doha site in comparison to the results from the stockpiles with the plastic limits ranging from 23 to 35 and the plasticity index ranging from non plastic to 10. The results varied by location with the in-place samples from Kuala Lumpur complied with both the plastic and plasticity index limits while the in-place material results from Doha complied with the liquid limits but exceeded the plasticity index limit of 6. The results obtained and the observation made in this study suggests that limestone properties consistency varies with region, location and type of limestone with Kuala Lumpur limestone mainly consisting of composed crystallised carbonate rocks and formed marble rocks with minor intercalation of phyllite whereas the Doha limestone is overlain by younger strata that form a number of messa-type hills.

ABSTRAK

Kertas ini membentangkan keputusan kajian dan perbincangan sifat ketekalan untuk bahan agregat batu kapur yang di kumpulkan dari longokkan simpanan dan juga dari di-tempat selepas penambahan air, campuran, pengredan dan pemampatan di tapak mengunakkan “roller” pemadatan ketebalan lapisan setebal 300 mm. Sebilangan ujian telah dijalankan untuk mengkaji had cecair dan index keplastikan bagi agregat batu kapur. Sejumlah 48 sampel telah di ambil, iaitu sebanyak 24 sampel dari longokkan simpanan dan sebanyak 24 sampel lagi di ambil dari di-tempat. Sampel sampel yang telah diambil dari kesemua longokkan simpanan dari Doha dan juga dari Kuala Lumpur me ujian had cecair iaitu antara 22 dan 25 dan juga untuk index keplastikan antara tidak plastik dan maxima 4. Keputusan ujian untuk sampel yang diambil dari di-tempat menunjukkan peningkatan dibandingkan keputusan sampel dari longokkan simpanan iaitu keputusan untuk had cecair antara 23 dan 35 dan index keplastikan antara tiada plastik ke 10. Ini menunjukkan perbezaan keputusan mengikut lokasi iaitu sampel yang diambil dari tapak di-tempat dari Kuala Lumpur menepati piawan untuk had cecair dan juga index keplastikan manakala untuk sampel yang diambil dari di-tempat dari Doha menunjukan tidak menepati piawaan untuk had cecair dan juga index keplastikan. Keputusan yang telah diperolehi dan pemerhatian mencadangkan had kekenyalan batu kapur berbeza mengikut rantau, lokasi dan juga jenis batu kapur itu sendiri. Batu kapur dari Kuala Lumpur terdiri terutamanya dari batuan karbonat terhablur dan marmar yang dibentuk dengan interkalasi phylitte yang kecil manakala batu kapur dari Doha dibentuk dari strata yang lebih muda yang membentuk bukit jenis messa.

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CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 Research background

Limestone material is found in abundance in Malaysia and often not used in pavement as the base layer due to its high carbonate content which has been found to have major impact on strength gain, however this material meets the requirements in terms of its california bearing ratio, physical and mechanical properties for aggregate road base applications. Limestone once quarried, crushed and produced, meets all the requirement of specification for atterberg limits and grading but the in place value immediately after mixing of water, spreading and compaction often does not meets the same specifications.

With the ever expanding and developing Klang Valley region and the recent announcement by the government to improve and further expand the infrastructures especially roads and transportation networks in this region, the demand for crushed aggregate has risen rapidly. Klang Valley region consists mainly of natural limestone below ground which was quarried up to the early nineties but many of them were closed down due to the low demand. Currently crushed granite aggregate is heavily relied upon in the industry even though the cost of quarrying, producing and transporting is much higher in comparison to limestone.

This study is proposed to be carried out to check the properties consistency of stockpiled materials against the in place materials. It is hoped the results obtained from this laboratory and field tests can be used to establish a consistent relationship between the stockpile and the in place compacted crushed limestone aggregate. This will help to greatly reduce the rate of rejection of in place material which will obviously reduce the cost and time of project at the same time maintaining the quality expected and meeting the design assumptions.

1.2 Problem statement

A higher Atterberg limits than the specified value in the testing standards exhibited by the in-place limestone aggregate base course will be rejected for use in the permanent works. However experience shows that the approved limestones which meets the specifications requirements often failed in terms of Atterberg limits from samples collected after spreading works and compaction is carried out, any rejection at this stage will have an impact on the project. This results in limestone aggregate not being accepted as aggregate base course material.

1.3 Objective

The objectives of this study is to:-

i. To understand the problem of crushing/degrading during compaction process which results in more fines leading to a higher value of Atterberg limits.

ii. To collect data related to material Atterberg limits from the stockpile and in-place.

iii. To analyse data to determine relevant behaviour.

1.4 Scope and limitations of study

The scope and limitations of this study is to,

i. Investigate suitability of limestone crushed aggregate base course material.

ii. Sample investigated is from the stockpile and in-place limestone aggregate base course.

iii. Properties of limestone aggregate base course to be investigated is the Atterberg limits i.e. one of the requirements in the standard.

iv. The negative impact will be the swelling of the limestone aggregate base course.

1.5 Importance of study

This study is to establish the comparison of the limestone Atterberg limit properties i.e. the plastic limit, liquid limit and the plasticity index of the stockpile versus in place material so that the test results so obtained shall be used to determine the acceptability of the in place material. This can greatly benefit large infrastructure projects involving major roadworks whereby the limestones quarried locally can be used as an economical alternative for road base construction currently using crushed granite which has gone up commercially due to its higher cost of production.

1.6 Organization of Thesis

Chapter 1 describes the background of research, problem statement, objectives, scopes and significance of research.

Chapter 2 describes the literature review of the general geology, features, weathering, slaking, swelling potential of limestone, requirements of road base material, atterberg limits and study by other researchers.

Chapter 3 deliberates the preparation of the stockpile and the methodology adopted for the receiving site preparation, delivery, spreading, levelling, compaction and the sampling plan, the locations where the samples will be collected and the tests that will be conducted on the field and laboratory.

Chapter 4 discusses the analysis of the test result collected from the stockpile and the in-place material from both the site in Kuala Lumpur and Doha.

Chapter 5 presents the conclusions for the research and discusses possible future research that can be done by other researchers.

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