GEOTECHNICAL PROPERTIES AND MORPHOLOGICAL PROPERTIES OF RAW AND PROCESSED GEBENG BAUXITE

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B.ENG (HONS.) CIVIL ENGINEERING

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Thesis submitted in fulfilment of the requirements
for the award of the degree of
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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering (Hons.) in Civil Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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LIST OF SYMBOLS

°C	degree Celsius
%	percentage
ρ	density

ABBREVIATIONS

VT	Vane shear test
UU	Tri-axial unconsolidated undrained test
UCT	Laboratory unconfined compression test
ASTM	American Society for Testing Materials
NORM	Naturally occurring radioactive materials
LOI	Loss on ignition
pH	Potential hydrogen
IMSBC	International Maritime Solid Bulk Cargoes
FESEM	Field Emission Scanning Electron Microscope
XRF	X-Ray Fluorescence
PSD	Particle size distribution
Fe_2O_3	Iron (III) Oxide
Al_2O_3	Aluminium Oxide
TiO_2	Titanium Dioxide
SiO_2	Silicon Dioxide
Ppm	Parts per million

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ABSTRACT

This research is to identify the differences between the geotechnical properties of raw and processed Gebeng bauxite. Raw bauxite deposits usually contain a higher percentage of clay and siliceous materials. The silica present in the bauxite usually are concentrated in the finer grained fraction of the bauxite deposit. The fine particles in bauxite will cause the bauxite to have higher moisture content and increases the risk of liquefaction to occur during the bauxite's transportation in cargo. The main objective of having beneficiation process before cargo transporting is to minimize the silica content which contributes to the finer fraction in bauxite, as well as to improve the geotechnical properties of bauxite so that it passes the specification of International Maritime Solid Bulk Cargoes Code (IMSBC) for cargo shipping purpose. In this research, a series of laboratory tests will be conducted and the results will reflect the geotechnical properties of Gebeng Bauxite and the correlation of the bauxite's properties can be done. Both the raw and processed Gebeng Bauxite samples will undergo moisture content test, specific gravity test, particle size distribution, Field Emission Scanning Electron Microscope (FESEM) and X-ray fluorescence (XRF) to obtain the desired data.

ABSTRAK

Penyelidikan ini bertujuan untuk mengenal pasti perbezaan antara bauksit Gebeng mentah dan bauksit Gebeng yang telah diproses dari segi sifat-sifat geoteknik. Bauksit mentah biasanya mempunyai peratus tanah liat dan bahan–bahan bersilika yang tinggi. Silika yang berada dalam bauksit biasanya menyumbang kepada zarah halus dalam bauksit. Zarah halus yang berada dalam bauksit akan menyebabkan bauksit mengandungi kandungan kelembapan yang tinggi dan meningkatkan risiko pencairan untuk berlaku ketika dalam pengangkutan kargo. Objektif utama untuk menjalankan proses pembasuhan bauksit sebelum pengangkutan kargo adalah untuk mengurangkan kandungan silika yang menyumbang kepada zarah halus dalam bauksit, dan untuk meningkatkan sifat-sifat geoteknik bauksit supaya ia memenuhi spesifikasi yang ditetapkan dalam Kod IMSBC (Intternational Maritime Solid Bulk Cargoes Code) untuk tujuan pengangkutan kargo. Dalam penyelidikan ini, berbagai ujian makmal akan dijalankan dan keputusan ujian makmal tersebut akan melambangkan sifat-sifat geoteknik untik bauksit Gebeng dan kolerasi untuk sifat-sifat bauksit boleh didapatkan. Kedua-dua bauksit Gebeng mentah dan bauksit Gebeng yang telah diproses akan menjalani ujian kandungan kelembapan, ujian graviti tentu, taburan saiz zarah, Field Emission Scanning Electron Microscope (FESEM) dan X-ray fluorescence (XRF) untuk mendapatkan data yang diingini.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF RESEARCH

After silicon and oxygen, the third most abundant element that exists in the earth's crust is Aluminium. In earth's crust, Aluminium is also the most abundant metal. It makes up for about the earth's solid surface's weight by 8% (Schreiner, 2004). Aluminium remained so rare and was not segregated until 1825. It was said to be valued more highly compared to silver. Unlike silver and gold, Aluminium in its pure form is too reactive thus it didn't occur in this pure state and that's is the reason that this element remained uncovered for so long. Alternatively Aluminium is found and discovered as bauxite, ore which its colour is reddish-brown. In 1821, first discovered by Pierre Berthier, a French geologist, the ore - bauxite was named after the Les Baux town which is located in France and was well known for consisting high levels of aluminium (Martin, 2001). Bauxite can be found across the globe, and mining Bauxite is only the simple part of the process. The harder part takes place when it comes to extraction of the metal. It was not until an American and a Frenchman both cracked it at 1886. Bauxite is the chief ore of aluminium, a mixture of hydrated iron oxide ($Fe_2O_3 \times H_2O$) and hydrated aluminium oxide ($Al_2O_3 \times H_2O$) (Schreiner, 2004).

Bauxite is a rock or soil formation that is composed primarily of aluminium hydroxide minerals. In the industrial perspective point of view, Bauxite is considered as a natural material that which can extract alumina from it in a Bayer plant (Lozej, 1993). The alumina will be extracted from bauxite through the Bayer process, where the ore is mixed with sodium hydroxide and then heat up inside a pressure chamber with temperature of 150 °C to 200 °C until the alumina dissolved and then being filtered out.

This process will create waste by-product which is known as bauxite residue or what we called red mud, a heavy metal laden slurry with high alkalinity which can, contain naturally occurring radionuclides at times (Gore, 2015). Nowadays, the bauxite's mining work had reached a number of 220 million tons per year, with Australia as the leading country that provides almost one-third of total production of Bauxite in the world (Gore, 2015).

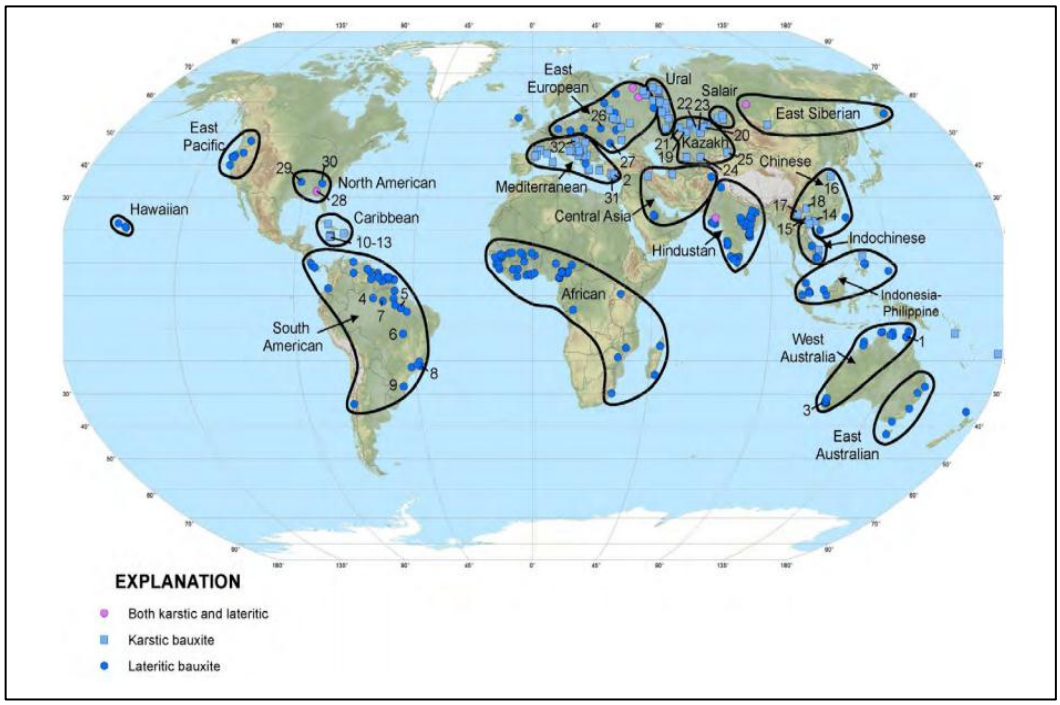

Figure 1.1: Bauxite deposit's distribution around the globe

Source: Martin (2001)

Figure 1.1 shows the bauxite deposit's distribution around the globe. At least 50 countries are known in having Bauxite deposits, with approximately 25 billion tonnes estimated world reserves. In 2000, world bauxite's production was 127 million tonnes and four country takes account for the 68% of the world production. The four country are Brazil, 9%, Jamaica, 10%, Guinea, 12% and Australia. According to their host rock, bauxite deposits are predominantly separated into two major groups, which are laterite bauxites and karst bauxites, and are mainly found throughout equatorial and tropical regions (Martin, 2001).

Based on British Broadcasting Corporation, BBC news on the topic of "Bauxite in Malaysia: The environmental cost of mining", it was reported that Malaysia had a long history in mining industry, especially in tin mining, until recently Malaysia had scarcely registered itself in the global markets and declared as a country with source of bauxite. This had changed dramatically at January 2014 when Indonesia stopped the bauxite ore export for an attempt to increase aluminium-smelting industry in their own country. Before that, Indonesia had always been the major supplier for China. Some of the mining companies from Indonesia then start to look at the hill areas above Kuantan city, where there are plenty of bauxite but with a lower quality compare to those that are available in Australia and Indonesia (Head, 2016).

As the bauxite industry in Malaysia are rising rapidly, there were tonnes of bauxite that were being exported out of the country. The potential in this industry is vital for the construction of everything from cooking foil into airplanes as bauxite is the main aluminium source in the world. The numbers are astonishing. Bauxite ore's annual output has grown from a small amount over 200,000 tonnes in year 2013, to almost reached 20 million tonnes on year 2015. Now, Malaysia is considered as the top producer in the world, considering almost half of their supply are transported to massive aluminium industry of China. China had received bauxite with a total weight of 1.27 million tons from Malaysia in the from January to September of 2014, which is 12 times the amount compared to year 2013 at the same period of time with amount of 105,000 tons, based on the custom data from China. According to a report from Kuala Lumpur, Malaysia's Minerals and Geoscience Department, it was reported that production of bauxite in Malaysia had increased fourfold from 208,770 tons in 2013 to 962,799 tons in 2014.

Based on New Straits Times Online (2015), it was reported that Kuantan, Malaysia is facing severe hazard due to mining of bauxite at that area. A scientist team has sounded warning to public that the damage caused from this poorly and undirected regulated mining activity to our environment may be so intense that the ecosystem might not recover to what it was before. The harmful effect on health of Kuantan's public could be disastrous, and this might carried on for generations. They said, this was in inclusion to the problem of where certain points of water intake being at the downstream of most of the bauxite mines. They underrated the risk that all these hazards might be cause by

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