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THE CHEMICAL PROPERTIES OF GRANITE AND BERANANG LATERITE AGGREGATE BY USING SEM-EDX

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ABSTRACT

The chemical properties of coarse aggregate give significant impact on the concrete performance as it is the highest constituent in the concrete mix. The paper presents the chemical properties of granite and Beranang laterite aggregates upon the morphology and chemical composition of them in concrete mix. A separate batch was prepared consisting 200 g of granite and Beranang Laterite each. These batches were tested upon morphology and chemical compositions by using SEM-EDX set up. Based on the results, it was shown that the major composition of granite is silicon, carbon and oxygen whereas for Beranang Laterite shown silicon, carbon, silicon and ferum as its major compositions. There is a slight difference between two of them due to the different process in producing the aggregate. For granite, it is produced by cooled magma whereas the Beranang Laterite is produced by a weathering process which results in the chemical composition difference. In conclusion, both aggregates shared similar morphology and chemical compositions and proved that they are able to contribute to the concrete strength.

Keywords:
Chemical Properties of Aggregate, Laterite Aggregate, Laterite Concrete, Alternative Concrete Mix, Green Concrete

INTRODUCTION

Generally, approximately 60–75% of the volume concrete comprises by the aggregates. Indirectly, the properties and types of aggregate would affect the overall performance and economical value of the concrete (Rawaz Kurda, 2018). The rapid development has pushed the aggregate demand curve out to the right and become a massive pressure on supply of constituent materials of concrete to satisfy the industry demands (Natt Makul, 2020). Utilization natural resources such as river sand and granite as aggregates in concrete have led to deterioration of ecosystems. Therefore, the current research focus is on alternative materials for fine and coarse aggregates to balance the curve. One of the high potentials to be used as alternative material is laterite aggregate**.**

In early 1800s located in South India, laterite was used as aggregate in construction field (Basavana Gowda *et. al.*, 2018). In the beginning, the word laterite has been used by Buchanan in early 1807 to describe a vesicular and ferruginous to the unstratified and porous materials with yellow ochre (Zubair Saing et. al., 2018). It was found that a large deposit of laterite in tropical region around the world such as Africa, Thailand, Indonesia, India and other tropical regions globally. In addition, the laterite aggregate also can be found at Peninsular of Malaysia especially in Kelantan, Pahang, Johor, Selangor, Kedah and Negeri Sembilan. However, even though laterite aggregate was easily and abundantly available in Malaysia, it is not fully utilized in construction due to several unknown factors (Mohammad Razip Selamat et. al., 2017). In order to full utilize the laterite aaggregate, the properties of it need to be investigated especially on the chemical properties to ensure that Malaysian laterite aggregate has the suitable chemical properties to be used in concrete mixes. The main focus of this study is to analyse the chemical properties of granite and laterite aggregate and their impact on the strength and performance on concrete mix comprising these two materials as coarse aggregate.

METHODOLOGY

Materials

In the research, the laterite aggregate is collected from the ground surface which was located at Beranang, Selangor as exhibited in Figure 1. The granite aggregate was supplied by the Kajang Quarry, Selangor. Both types of aggregates were used with the particle size within the range of 5 mm to 10 mm. All test carried out upon the aggregate was based on the standard and guidelines from the BS EN 12620 (2008). The stockpiles of laterite aggregate collected need to be treated to eliminate the deleterious materials and to make sure the moisture content in the aggregate is in the saturated surface dry as shown in Figure 2. This is in order to make sure the chemical test carried out will produce accurate results.

Figure 1: The laterite aggregate is taken from ground surface at Beranang

Figure 2: The granite and laterite are treated for properties preservation

EXPERIMENTAL PROGRAMME

The experiments have been set up to determine the morphology and the chemical composition of granite and laterite aggregate which involved SEM testing, EDX testing and Distribution Test.

SEM-EDX for Morphology of Aggregates

The experiments of Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray spectroscopy (EDX) enables the chemical properties to be laid out as one of the analytical technique to reflect the chemical characterization. A total of 200 g of laterite aggregate was prepared for the test. The aggregate is being coated with gold or titanium to let the energy of the electron beam of the electron microscope eject a core shell electron and dissipates some of the absorbed energy which make the outer shell electron to fill its place and release different energy. This energy is emerged in the form of x-ray which has spectrum based on the origin. This will allow the compositional analysis of laterite aggregate that excited the energy source. The position of the peaks in the spectrum identifies the elements where the intensity of the signals will correspond the element concentration.

Chemical Composition of Aggregates

Beranang Laterite aggregates colour from slightly orange to dark brown as shown in Figure 1.1, due to their existences in tropical forest and the climate affect the colour of the Beranang Laterite aggregates as they go through a weathering process as they are exposed to alternate drying and wetting that affect the properties of the Beranang Laterite aggregates. Laterite aggregates are rich in secondary oxides of aluminium, iron or both and highly weathered. In Table 3 below, contains the chemical composition that is present in the Beranang Laterite aggregates.

Table 1: The Chemical Composition of Laterite aggregate used in tests

Oxide Components	Percentage Limits
Silica	22 to 48
Hermatite	20 to 40
Alumina	30 to 53
Silica-Sesquioxide Ratio	0.28 to 0.95

The chemical characteristics of the Beranang Laterite aggregates can be determined by conducting the composition of chemical in the aggregate to identify whether the Beranang Laterite aggregates are suitable to act as partial replacement aggregate in a concrete mix. Same experiments were conducted on granite aggregates and the results were compared to laterite aggregate.

RESULT AND DISCUSSION

Morphology of Aggregates

Figure 3 shows the granite and Beranang Laterite aggregate shape. The surface texture of Beranang Laterite aggregate is rougher compared to granite aggregate which is smoother.

Figure 3: Laterite aggregate (Left) and granite aggregate (right)

For the morphological of the aggregates, it can be identified by their exterior aspects in the figure above such as surface texture, colour and shape. The surface texture of Beranang Laterite aggregate is rougher compared to granite aggregate which is smoother. The morphology of aggregate contributes significant impact to the overall concrete performance because most of the constituents of concrete mix is from aggregates. This is supported by the previous researchers Richard Ohene Asiedu (2017), as it had stated that the strength of concrete is contributed by the strength of aggregate indirectly. It is included that the surface texture and the shape of the aggregate that is helping in term of bonding the constituents of concrete mix altogether and indirectly give higher strength to the concrete mix.

In addition, the sharp and rough shape of aggregates will bond better as compared to the round shape of aggregates in the concrete mix. This is highlighted by Sneka, M.Nirmala and Dhanalakshmi (2018) stated that the rougher the aggregate is, it will contribute more to the bonding inside the concrete matrix. Thus, it is important to have a rough and hard texture of concrete with sharp and rough surface in order to improve the bonding inside the concrete mix and give significant impact on the overall concrete performance (Yan Feng *et. al.*, 2019). The direct impact on the aggregate properties upon the performance of concrete has been discussed in previous researches (Folagbade & Osadola, 2019). The electron image of granite aggregate and Beranang Laterite aggregate morphology that identifies the both aggregates physical characteristics were shown in Figure 4 and 5. Both of them showed the presence of the roughness surface; however, for Beranang Laterite, the surface of the aggregate is rougher as compared to the granite aggregate.

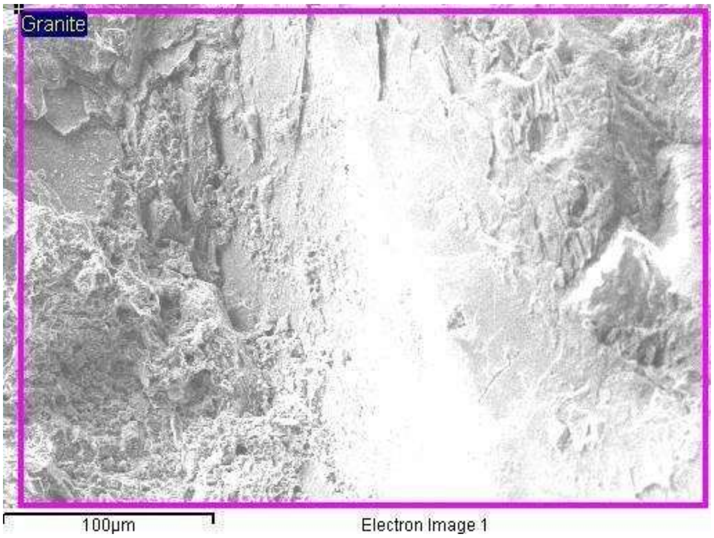

Figure 4: The morphology of granite aggregate.

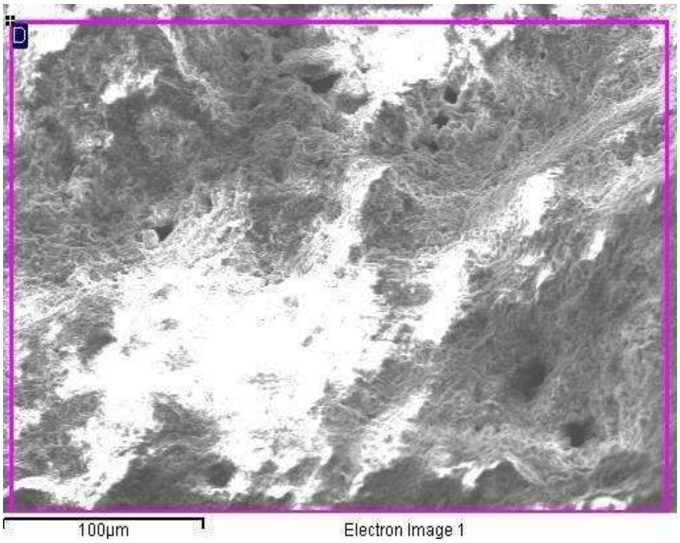

Figure 5: The morphology of laterite aggregate.

Chemical Composition of Aggregates

There will be some differences in the chemical compositions because the origin of both aggregates are different. Granite aggregates are the igneous rocks that produced from a cooled magma which are very rich in quartz and feldspar. Whereas the laterite aggregate is produced from a weathering process where the aggregate has been exposed to the extreme weather cycles which are very rich in secondary oxides iron and aluminium. Usually the laterite aggregate is available in the tropical regions where the sunlight is quite rough and has a lot of rainfall. That is why the laterite aggregate is always known as the aggregate that is highly weathered.

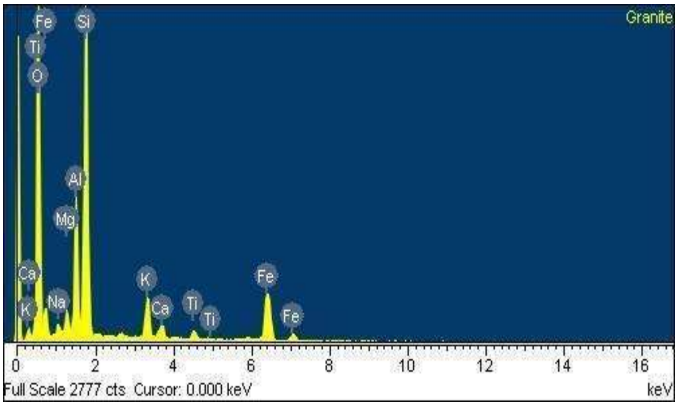

Figure 6: The chemical composition of granite aggregate

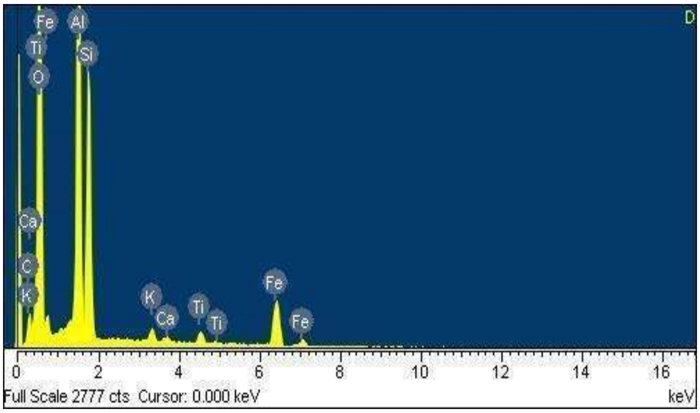

Figure 7**:** The chemical composition of Beranang laterite aggregate

Table 2: Chemical composition or elements of granite aggregate and Beranang laterite aggregate

ELEMENT	*GRANITE*	*LATERITE*
O	58.01	62.24
C	0	1.32
MG	1.26	0
AL	6.91	15.98
SI	17.76	11.38
K	3.01	0.77
CA	0.92	0.23
TI	0.96	0.90
FE	10.28	7.18
NA	0.89	0
TOTAL (%)	**100**	**100**

From Table 2 above, there are some similarities in the chemical composition between granite aggregate and laterite aggregate such as iron (Fe), calcium (Ca), silicon (Si), aluminium (Al), titanium (Ti) and potassium (K). The uncommon chemicals that laterite aggregate does not have are magnesium (Mg) and sodium (Na), which present in granite aggregate

CONCLUSION

Based on the results on the chemical characteristics of granite and Beranang laterite aggregate, it can be concluded that the major elements of the granite are oxygen, silica and ferum whereas for Beranang laterite aggregate are oxygen, aluminium and silica. Thus this experiments shows the similarity of both aggregates' chemical properties to be used in the construction industry.

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