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Potential of Marine Clay as Raw Material in Geopolymer Composite

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Abstract. In this research, marine clays has been studied its potential as a matrix composite materials that tend to be used as alternative materials to concrete. The study shows that marine clays which mixed with appropriate proportion of alkaline activator could have strength requirements for masonry cement. The alkaline activator that been used for the geopolymerisation reaction is sodium silicate and sodium hydroxide. Its compressive strength in early time reached 9-15 MPa.

Introduction

Marine clay commonly found on shore at Peninsular Malaysia, almost all coastal area covered by marine clay. In Kuala Perlis, especially, the increases sediment of clays scatted at jetty port will cause the seabed became shallow. The increases in sedimentation of marine clay in sea floor, especially in critical areas such as at marine ports will cause a shallow depth of that significant area. Costly maintenance scheduled to be implemented to enable the port to operate as usual. Marine clay dredging out known as waste disposal and it is left to dry on land surface. This will lead to an environmental issue.

Different place make different properties of marine clay. Marine clay contains a high proportion of calcium, silica, aluminum, iron and other trace metal. The properties of saturated marine soil differ significantly from moist soil and dry soil. Marine clay is microcrystalline in nature and clay minerals like chlorite, kaolinite and illite and non-clay minerals like quartz and feldspar are present in the soil. The soils have higher proportion of organic matters that acts as a cementing agent [1]. Previous research have been conducted on the use of marine clays as non-conventional construction materials [2] and treating the unconfined marine clay by adding in significant amount of cement have improving its compression strength [3]. Other research have been studied the potential of significant raw materials as geopolymer such as an application of fly ash as geopolymer structure members, performance in under sulfate and acid exposure [4], application of geopolymer as precast concrete and application as coating to fire protection [5].An application of Marine clay mixed with palm oil clinker as an artificial aggregate has been discussed by Chan [6].

Table 1.0 show the chemical compositions of fly ash determined by XRF (% Mass) was study by A.M. Mustafa Al Bakri [7].

Table 1: Chemical Composition of fly ash [7]

Chemical Composition	(% by weight)
SiO_2	52.11 %
Al_2O_3	23.59 %
Fe_2O_3	7.39 %
TiO_2	0.88 %
CaO	2.61 %
MgO	0.78 %
Na_2O	0.42 %
K_2O	0.80 %
P_2O_5	1.31 %
SO_3	0.49 %
MnO	0.03 %

Materials and Experimental Details

Raw Material

Marine Clay used in this study was sampled from Kuala Perlis area in Perlis, Malaysia. Sample of marine clay is collected along seashore in Kuala Perlis at varies depth 0.3 – 1.0 m. Six (6) spotted point for sampling location. The sample taken have been remarked as MC 01 for sampling at point 1, then MC 02 for sampling at point 2 and continuous marking for other sample. From visual inspection, the soil had dark grey colour, containing some organic features like decompose and decaying of organic matter.

Investigation on chemical compositions on dry marine clays was tested using X-ray Fluorescence (X-RF). This action was taken to analyze the initial composition of marine clay. From this characterization, the entire particle that made marine clay is identified.

Preparation of Solution

Sodium Silicate and Sodium hydroxide were used to prepare the composite samples in this study. The preparations of the solution have been discussed by Mustafa Al Bakri [8]. The alkaline activator is prepared by mixed the water glass and NaOH solution with the ratio of 2.5. NaOH solution was prepared with concentration 12 molarity.

Mixing Process

The dry marine clay mixed homogenously with alkaline activator in ratio 1:2. The synthesis pastes were moulded in the 50mm cubic cube according to ASTM C109 [9]. The samples were cured at a temperature 70 °C for 24 hr and maintained at room temperature until the testing was conducted [7].

Testing

Compression Strength Test

In this study, one of the important properties of composite mixing is its strength in compression. The strength in compression has a definite relationship with all the other properties of concrete, i.e. the other properties are improved with the improvement in compressive strength. The compressive strength is taken as the maximum compressive load it can carry per unit area.

Results and Discussion

XRF Analysis

The chemical compositions of marine clay listed in Table 1. As shown in the table, the major oxide components are silica (SiO_3), Alumina (Al_2O_3), Iron (Fe_2O_3) and lime (CaO). Other components such as K_2O, ZnO and CuO are present in small quantities. The result shows that the chemical composition of Marine Clay is comparable with fly ash those study by A.M. Mustafa Al Bakri [7]. The percentage of SiO_2 in fly ash is higher compare to Marine Clay. This will affect the strength of the composite.

Table 1: Chemical Composition of Kuala Perlis Marine Clay

Chemical Composition	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	K_2O	Cl	ZnO	Cr_2O_3	CuO	MgO
(% by weight)	33.5	8.82	20.19	0.947	26.3	2.78	4.82	0.042	0.038	0.084	0.21

Table 2 shows the compressive test result of the marine clay. The results indicate that marine clay taken in Kuala Perlis gives the strength that required for certain purpose of use. In 3 day (3D) after casting the mixed composition gives highest value of strength of 9.94 MPa with average of strength is 8.55 MPa. For 7 day (7D) of casting, the result shown the maximum value of compressive strength is 14.85 MPa and the average of strength is 13.13 MPa. According to ASTM C 91 [10], the requirement for masonry cement for type M in term of compressive strength was 12.4 MPa. Further study need to be carried out on other properties of the matrix composition such as soundness and durability of paste.

Table 2: Compressive Strength of Matrix Composite paste

Sample	Day Testing	
	3D	7D
MC 01	9.21	14.85
MC 02	8.75	13.02
MC 03	7.72	12.54
MC 04	9.94	13.25
MC 05	6.68	11.59
MC 06	8.98	13.54

Conclusions

Finding from this study shows that by using the marine clay will enhance the properties of matrix composite especially in compressive strength and Marine Clay also has potential as a raw material in geopolymer composite system. The result of compressive strength has shown that the average strength in 7 day casting is higher than ASTM [11] requirement on masonry cement purposes.

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References

[1] S. Basack and R. Purkayastha, Engineering properties of marine clays from the eastern coast of India. Engineering and Technology Research, (2009),p. 109-114

[2] J.H.Tay, P. C., Non -Conventional Construction Materials from Dredging Spoils. Environmental Monitoring and Assessment , (1997), p. 285-294

[3] A.H.M, K., S.H., C., & F.H., L. ,Engineering Behaviour of Cement Treated Singapore Marine Clay. Third Asian Young Geotechnical Engineers Conference , (1997), p. 231-238

[4] M.J. Dody, H.S. Djwantoro, W.E. Steenie, R. B.Vijaya, Performance of fly ash-based geopolymer concrete under sulfate and acid exposure. World Congress Geoplymer , (2005), p. 139-143

[5] B. Varela and N. Privorotskaya, The Use of Geopolymers as Concrete Coatings for Fire Protection. World Congress Geopolymers , (2005), p. 209-211

[6] C.M.Chan and R.Robani, Alternative Aggregates from Clay-POC: An Exploratory Study. International Conference on Construction and Building Technology , (2005), p. 423-432

[7] A.M. Mustafa Al Bakri, H. Kamarudin, A.K.A.K. Omar, C.M. Ruzaidi, A.R. Rafiza and M.N. Norazian in: Journal of Applied Mechanics and Materials, Vol. 110 – 116, (2011), p. 734-739.

[8] A.M. Mustafa Al Bakri, H. Kamarudin, A.K.A.K. Omar, C.M. Ruzaidi, A.R. Rafiza and M.N. Norazian, Microstructure Studies on the Effect of the Alkaline Activators Ratio in Preparation of Fly Ash-Based Geopolymer. International Conference on Chemistry and Chemical Process, p.13-17 (2011)

[9] ASTM C109/109M-07. (2007). Standard test Method for Compression Strength of Hydraulic Cement Mortar. ASTM International

[10] ASTM C 91. (2005). Standard Specification for Mansonry Cement. ASTM International

[11] ASTM D420-98. (2003). Standard Guide to Site Characteristization for Engineering Design and Construction purpose