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STRENGTH OF CEMENTED FLY ASH SOIL

Mahdi Keramatikerman
Engineer, Arup Australia, 61-73 Sturt Street,
Suncorp Tower, Townsville QLD 4810, Australia

Amin Chegenizadeh
Senior Lecturer, Department of Civil Engineering,
Curtin University of Technology, Kent Street, Bentley, Perth, Western Australia 6102, Australia

Hamid Nikraz
Professor, Department of Civil Engineering,
Curtin University of Technology, Kent Street, Bentley, Perth, Western Australia 6102, Australia.

***Abstract*— Stabilisation is one of the common way to improve geotechnical performance of a soil specimen. Stabilisation has been conducted in many research and real practices. Replacement of soil with by-product is very interesting due to positive geo-environmental impact. Application of Portland cement to stabilise soil is one of the common way to increase the strength of soil. This study considers the effect of curing time and PC percentage on the UCS values and compaction characteristics of fly ash mixed with PC and soil. The PC changed from 1 to 4%. The curing time considered as 3 to 28 days.**

Keywords— **UCS, Fly ash, cement, clay, stabilisation**

I. INTRODUCTION

Usage of by-product is one of the areas that researchers found it to be interesting. On other hand, complete replacement of soils with fly ash is one of the interest in this area due to shortage of soils. Fly ash in civil project has been widely used. Some studies used fly ash as additive while the others used together with slag. In general additives has specific role in making soil stable. There are examples in literature fibre [1-5], geo-grid [6], tire [7-9], lime [10-12], fly ash [13-16] or agricultural waste [17-19]. Apart from experimental testing, numerical modelling also been conducted [20-25] on pavement application of those materials. In addition, sometime the issue is relevant to contamination which can be seen in [26-35] or effect of directional issue [36-48]. As can be seen the interest of usage of other materials. This study focuses on how Portland cement would affect the performance of fly ash by itself as a soil replacement.

II. MATERIALS

The used materials were:

a) Fly ash:

The characteristics of flyash can be found in the table below. The major component of used fly ash is Sio_2 and Al_2O_3.

Table 1 Fly ash ingredient

Item	Symbol	Percentage
Silicon dioxide	SiO_2	51.80%
Aluminium oxide	Al_2O_3	26.40%
Ferric oxide	Fe_2O_3	13%

b) Cement:

The Portland Cement (PC) had specific gravity (SG) 3 to 3.4. The appearance was grey powder. pH was alkaline.

c) Clay

Kaolinite clay used in this study obtained from a local provider.

III. COMPACTION TESTING

In order to get the UCS samples, the first stage was to run the compaction tests. The following results were derived as shown in Table 1. Also, Fig. 1 and Fig. 2 shows the results of OMC and MDD.

Table 2 OMC and MDD of samples

Sample ID	OMC (%)	MDD (gr/cm3)
F	46	1.2
F-PC1	48.1	1.15
F-PC2	49.6	1.12
F-PC3	50.3	1.11
F-PC4	52	1.09

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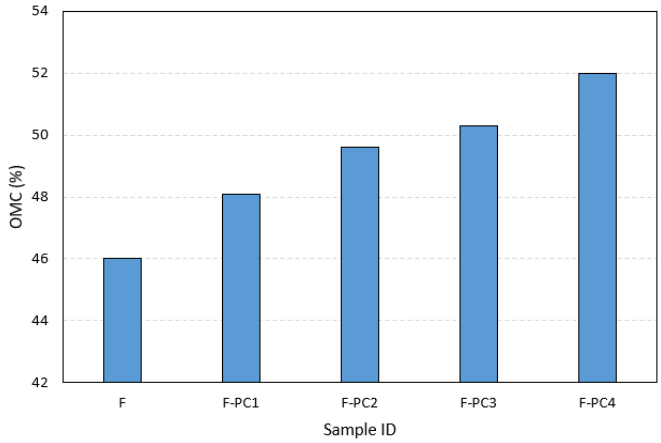

Fig. 1. OMC values of tested samples

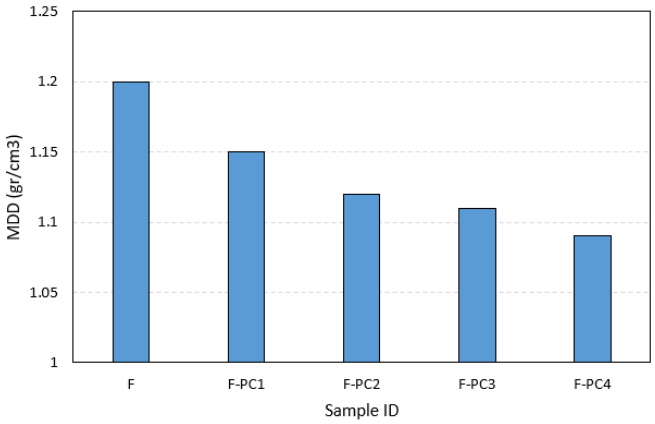

Fig. 2. MDD values of tested samples

IV. UCS RESULTS

The UCS tests was conducted on the specimens and the following results were derived:

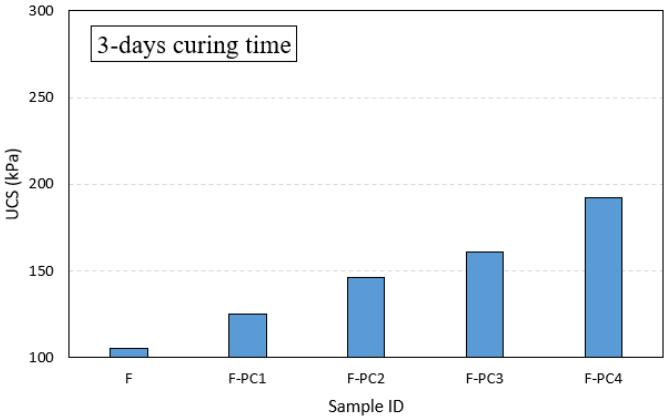

Fig. 3. UCS values of 3-days cured samples

As can be seen the trend shows increment by increasing glass percentages for 3 days curing.

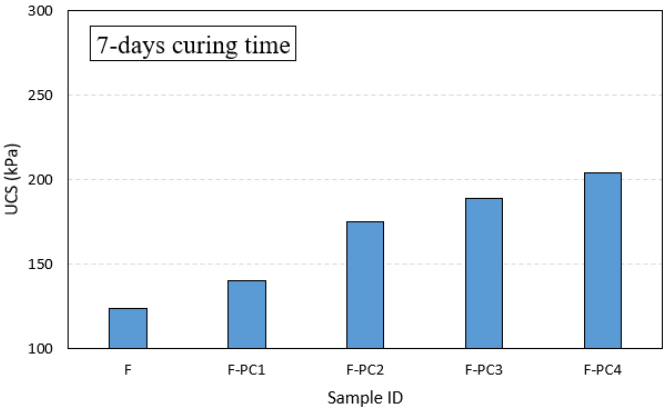

Fig. 4. UCS values of 7-days cured samples

As can be seen the trend shows increment by increasing glass percentages for 7 days curing.

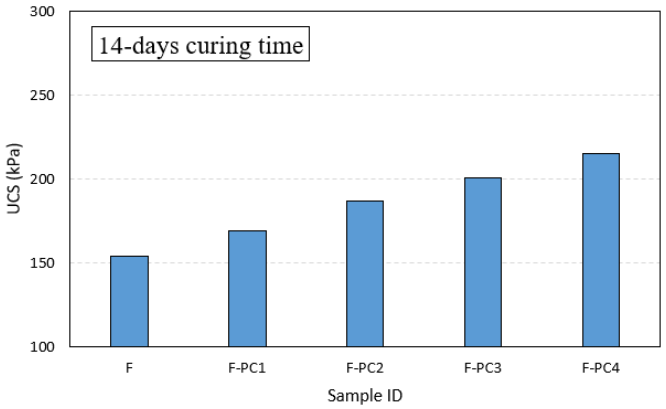

Fig. 5. UCS values of 14-days cured samples

As can be seen the trend shows increment by increasing glass percentages for 14 days curing.

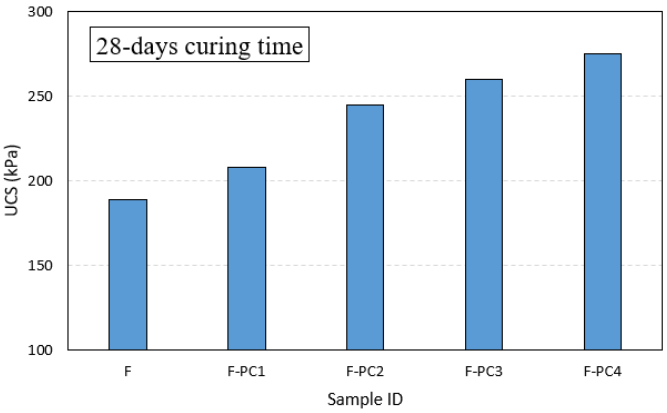

Fig. 6. UCS values of 28-days cured samples

As can be seen the trend shows increment by increasing glass percentages for 28 days curing.

V. CONCLUSION

A series of compaction tests were conducted, and the outcome shows that cement pushed the OMC to higher values and decrease the maximum dry density. The UCS results also proved that PC increased the compressive strength of flyash-cement. The curing time also increased the strength of specimens.

VI. REFERENCE

[1] Chegenizadeh, A., Nikraz, H. (2011a). "Investigation on strength of fiber reinforced clay" Advanced Materials Research 261-263, pp. 957-963.

[2] Kaniraj SR, Havanagi VG. Compressive strength of cement stabilized fly ash-soil mixtures. Cement and Concrete Research. 1999 May 1;29(5):673-7.

[3] Keramatikerman M, Chegenizadeh A, Nikraz H. EFFECT OF BENTONITE DOSAGE ON SHEAR BEHAVIOUR OF SAND-FLY ASH. International Journal of Engineering Applied Sciences and Technology (IJEAST), 2020 (accepted).

[4] Kaniraj SR, Havanagi VG. Behavior of cement-stabilized fiber-reinforced fly ash-soil mixtures. Journal of geotechnical and geoenvironmental engineering. 2001 Jul;127(7):574-84.

[5] Chegenizadeh, A. and H. Nikraz, (2011b). "Study on modulus of elasticity of reinforced clay" - Advanced Materials Research. 243-249: pp. 5885-5889, 2011.

[6] Tastan EO, Edil TB, Benson CH, Aydilek AH. Stabilization of organic soils with fly ash. Journal of geotechnical and Geoenvironmental Engineering. 2011 Sep 1;137(9):819-33.

[7] Chegenizadeh, A. and H. Nikraz, (2011c). Composite Soil: Fiber Inclusion and Strength, Journal of Advanced Materials Research 1646

[8] Chegenizadeh, A. and H. Nikraz, (2012). Composite Clayey Sand and Short Fiber, Advanced Materials Research 383, 2764-2769

[9] Sobhan K, Mashnad M. Tensile strength and toughness of soil–cement–fly-ash composite reinforced with recycled high-density polyethylene strips. Journal of Materials in Civil Engineering. 2002 Apr;14(2):177-84.

[10] Chegenizadeh, A., Keramatikerman, M., & Nikraz, H. (2018b). Liquefaction resistance of fibre reinforced low-plasticity silt. Soil Dynamics and Earthquake Engineering, 104, 372-377.

[11] Olgun M. Effects of polypropylene fiber inclusion on the strength and volume change characteristics of cement-fly ash stabilized clay soil. Geosynthetics International. 2013 Aug;20(4):263-75.

[12] Al-Rkaby AHJ, Chegenizadeh A, Nikraz H. (2017). Anisotropic strength of large scale geogrid-reinforced sand:experimental study Soils and foundations 57 (4), 557-574

[13] Chegenizadeh A, Keramatikerman M, Panizza S, Nikraz H. (2017). Effect of powdered recycled tire on sulfate resistance of cemented clay. Journal of Materials in Civil Engineering. 2017 Oct 1;29(10):04017160.

[14] Arora S, Aydilek AH. Class F fly-ash-amended soils as highway base materials. Journal of Materials in Civil Engineering. 2005 Dec;17(6):640-9.

[15] Chegenizadeh, A., Keramatikerman, M., Dalla Santa, G., & Nikraz, H. (2018a). Influence of recycled tyre amendment on the mechanical behaviour of soil-bentonite cut-off walls. *Journal of cleaner production*, *177*, 507-515.

[16] Mikhail, M., Chegenizadeh, A., Keramatikerman, M., Burns, G., Terzaghi, S., Nikraz, H. (2020). Application of Cane Ash on Compressive Strength of Soil Uncovered to $MgSO_4$. *International Journal of Engineering and Advanced Technology (IJEAT)* 9(4).

[17] Amiralian S, Chegenizadeh A, Nikraz H (2012a) Laboratory investigation on the compaction properties of lime and fly ash composite, Proceedings of the International Conference on Civil and Architectural applications (ICCAA'2012) 79-83

[18] Amiralian S, Chegenizadeh A, Nikraz H (2012b) Laboratory investigation on the effect of lime on compressibility of soil, Proceedings of the International Conference on Civil and Architectural applications (ICCAA'2012) 89-93

[19] Keramatikerman, M., Chegenizadeh, A., Yilmaz, Y., & Nikraz, H. (2018b). Effect of Lime Treatment on Static Liquefaction Behavior of Sand–Bentonite Mixtures. *Journal of Materials in Civil Engineering*, *30*(11), 06018017.

[20] Keramatikerman, M., Chegenizadeh, A., & Nikraz, H. (2018). Effect of Flyash on Post-Cyclic Behavior of Sand. *Journal of Earthquake Engineering*, 1-13.

[21] Jongpradist P, Jumlongrach N, Youwai S, Chucheepsakul S. Influence of fly ash on unconfined compressive strength of cement-admixed clay at high water content. Journal of Materials in Civil Engineering. 2010 Jan;22(1):49-58.

[22] Keramatikerman, M., Chegenizadeh, A., Nikraz, H., & Sabbar, A. S. (2018a). Effect of flyash on liquefaction behaviour of sand-bentonite mixture. *Soils and foundations*, *58*(5), 1288-1296.

[23] Lo SR, Wardani SP. Strength and dilatancy of a silt stabilized by a cement and fly ash mixture. Canadian Geotechnical Journal. 2002 Feb 1;39(1):77-89.

[24] Keramatikerman M, Chegenizadeh A, Nikraz H. (2017b). Experimental study on effect of flyash on liquefaction

resistance of sand Soil Dynamics and Earthquake Engineering 93, 1-6

[25] Horpibulsuk S, Rachan R, Raksachon Y. Role of fly ash on strength and microstructure development in blended cement stabilized silty clay. Soils and Foundations. 2009;49(1):85-98.

[26] Chegenizadeh, A., & Keramatikerman, M. (2017). *Mitigating sulphate attacks in geotechnical engineering* Hauppauge, New York, USA Nova Science Publishers. (pp. 1-165).

[27] Shen W, Zhou M, Zhao Q. Study on lime–fly ash–phosphogypsum binder. Construction and Building Materials. 2007 Jul 1;21(7):1480-5.

[28] Zentar R, Wang D, Abriak NE, Benzerzour M, Chen W. Utilization of siliceous–aluminous fly ash and cement for solidification of marine sediments. Construction and Building Materials. 2012 Oct 1;35:856-63.

[29] Chegenizadeh, A., Keramatikerman, M., Miceli, S., Nikraz, H., Salih Sabbar, A. (2020). Investigation on Recycled Sawdust in Controlling Sulphate Attack in Cemented Clay. *Appl. Sci.*, *10*, 1441.

[30] Kolias S, Kasselouri-Rigopoulou V, Karahalios A. Stabilisation of clayey soils with high calcium fly ash and cement. Cement and Concrete Composites. 2005 Feb 1;27(2):301-13.

[31] Keramatikerman, M., Chegenizadeh, A., & Nikraz, H. (2017c). An investigation into effect of sawdust treatment on permeability and compressibility of soil-bentonite slurry cut-off wall. *Journal of Cleaner Production*, *162*, 1-6.

[32] Kumar A, Walia BS, Bajaj A. Influence of fly ash, lime, and polyester fibers on compaction and strength properties of expansive soil. Journal of materials in civil engineering. 2007 Mar;19(3):242-8.

[33] Keramatikerman M, Chegenizadeh A, Terzaghi S. (2019) Review on Effect of Sugarcane Bagasse Ash as an Additive in Construction Industry. 2019. EJGE. Vol.24 Bun. 02.

[34] White DJ, Ceylan H, Harrington D, Rupnow T. Fly ash soil stabilization for non-uniform subgrade soils.

[35] Chegenizadeh, A., Keramatikerman, M., & Nikraz, H. (2016). Flexible pavement modelling using Kenlayer. EJGE, 21, 2467-2479.

[36] Keramatikerman, M., Chegenizadeh, A., & Pu, H. (2017a). Effect of atrazine contamination on compressibility and permeability characteristics of clay. *Geotechnical Testing Journal*, *40*(6), 936-950.

[37] Al-Rkaby AHJ, Chegenizadeh A, Nikraz H. (2016). Directional-dependence in the mechanical characteristics of sand: A Review International Journal of Geotechnical Engineering 10 (5), 499-509

[38] Chegenizadeh, A., Keramatikerman, M., Nikraz, H., Importance of Microstructural Analysis in Experimental Soil Stabilization. *Global Journal of Engineering Science*. 4(5): 2020.

[39] Keramatikerman M, Chegenizadeh A, Nikraz H. SOIL STABILISATION USING GLASS POWDER. International Journal of Engineering Applied Sciences and Technology (IJEAST), 2020 (accepted).

[40] Chegenizadeh A, Aashish M, Nikraz H, Keramatikerman M. Sulphate Attack on Cemented-Bentonite-Coconut Coir. *Results in Engineering*. 2020 Mar 3:100111.

[41] Cristelo N, Glendinning S, Fernandes L, Pinto AT. Effects of alkaline-activated fly ash and Portland cement on soft soil stabilisation. Acta Geotechnica. 2013 Aug 1;8(4):395-405.

[42] Keramatikerman M, Chegenizadeh A, Nikraz H. Effect of Slag on Restoration Mechanical Characteristics of Ethanol Gasoline–Contaminated Clay. *Journal of Environmental Engineering*. 2018 Jul 1;144(7):06018001.

[43] Degirmenci N, Okucu A, Turabi A. Application of phosphogypsum in soil stabilization. Building and environment. 2007 Sep 1;42(9):3393-8.

[44] Keramatikerman M, Chegenizadeh A, Nikraz H. Shear strength characteristics of over-consolidated clay treated with ggbfs. Australian Geomechanics Journal. 2018;53(2):141-9.

[45] Keramatikerman, M. (2018). *Investigations into Effect of By-product Binders in Improvement of Cyclic Behaviour of Soil* (Doctoral dissertation, Curtin University).

[46] Keramatikerman, M., Chegenizadeh, A., Nikraz, H. How Ground Improvement Addresses the United Nation Sustainable Development Goals: A Review. *Current Trends in Civil & Structural Engineering* 5(3): 2020. CTCSE.MS.ID.000613. DOI: 10.33552/CTCSE.2020.05.000613

[47] Mikhail, M., Keramatikerman, M., Chegenizadeh, A., Terzaghi, S., Burns, G., Nikraz, H. (2020). Influence of Bagasse Ash on Compaction Behvaiour of Soil. *International Journal of Innovative Technology and Exploring Engineering (IJITEE).* 9(5).

[48] Keramatikerman M, Chegenizadeh A, Nikraz H. Effect of sawdust on Cohesion of Sand-Sawdust mixture. International Journal of Engineering Applied Sciences and Technology (IJEAST), 2020 (accepted).