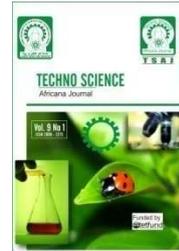




Techno Science Africana Journal

Journal homepage: www.technoscienceafricana.com



STABILIZATION OF GRAVEL SOIL WITH FLYASH FOR USE AS SUBBASE

MATERIAL

ASHIRU SANI

Department of Civil Engineering, Kano University of Science and Technology Wudil

ARTICLE INFO

ABSTRACT

Keywords:

Fly-ash,
Cement,
Sub-base,
Cost,
Stabilization

Correspondence author:

Email:

Phone:

Group F fly ash was used to replace filler in the stabilization of gravel soil with cement. Different proportions of cement /fly ash was used in replacing filler with 5%, 10%, 15%, 20% fly ash while, cement content was fixed at 5% of flyash content at each proportions. Compaction test, California bearing ratio test and Unconfined compressive strength test were performed on the gravel soil treated with the different composition of cement and fly ash. Strength indices result clearly showed that the optimum replacement level of 15% gave the best result, hence recommendation of this replacement level for the stabilization of gravel soil. Successful utilization of the fly ash in the stabilization of gravel soil will be an effective way of disposing this waste.

INTRODUCTION

Most developed and developing countries all over the world have huge resources of waste materials such as fly ash, stone dust, and waste plastic. The quantities of wastes that are accumulating in developed and developing countries are causing disposal problems that are both financially and environmentally expensive. One method of overcoming the waste challenge is the utilization of these waste materials for engineering purposes. Since wide scale coal firing for power generation began in the 1920s, many millions of tons of ash and related by-products have been generated. The

current annual production of coal ash worldwide is estimated to be around 600 million tones, with fly ash constituting about 500 million tones put at 75–80% of the total ash produced[1].

Thus, the amount of coal waste (fly ash), released by factories and thermal power plants has been increasing throughout the world, and the disposal of the large amount of fly ash has become a serious environmental problem. The present day utilization of ash on worldwide basis varied widely from a minimum of 3% to a maximum of 57%, the world average usage amounts to 16% of the total ash[1].

A substantial amount of ash is still disposed of in landfills and/or lagoons at a significant cost to the utilizing companies and thus to the consumers.

Increasing demand of energy has resulted in worldwide consumption of approximately 2.2 billion tons of coal for electricity generation in(2001). In Turkey, 54.7 million tons of coal was consumed in thermal power plants in the same period [2-5]. Consumption of coal for electricity generation leads to production of fly ash in large scale . In Turkey, 13 million tons of fly ash is annually produced due to utilization of vast lignite reserves for power generation [4,5]. The global production of fly ash is estimated to be 600 million tons per year [5].

Kumar, et al.,(2012)[7] investigated on stabilization of flyash cover at subbase level of flexible pavement, test results showed that maximum load carrying capacity is obtained for treated flyash subbase compared to untreated flyash subbase. Baha,et al.(2012)[8] investigated on the effect of cement stabilized subgrade on cost of the flexible pavement, cost analysis results showed

that the optimum cement content between the decrease on pavement costs with increase on subgrade CBR value has been determined. Therefore, it is the aim of this research to investigate the effect of different proportions of fly ash as filler in subbase on cost of flexible pavement.

This paper present the effect of cement on gravel soil modified with flyash to ascertain the suitability of the soil for use as pavement materials. Fly ash is a waste by-product from thermal power plants, which use coal as fuel, it is available in abundance and at low cost. Previous researches shows Fly Ash as good pozzolana depending on its class or group. [9] reported the soil stabilization with RHA and fly ash mixed with natural soil.

MATERIALS AND METHODS

Soil-Aggregate

The gravel soil used for sub base was obtained from buyucekmece Istanbul. This soil is classified as A.1 Based I.S classification with gradation as presented in Table-1

Table 1 Gradation of subbase materials used.

SIEVE	LIMITS OF GRADATION SPECIFICATIONS	% PASSING	% RETAINED
75	100	100	-
37.5	85-100	100	-
9.5	45-100	60	40
4.75	25-85	33	27
0.425	7-40	8	25
0.075	0-12	4	4

Fly Ash

Fly ash used was collected from Istanbul thermal power plant and it is classified as

class F fly ash. The chemical composition of the flyash is as presented in Table 2

Table 2 Chemical composition of flyash

Composition	Fly ash
SiO ₂	50 %
Fe ₂ O ₃	31%
Al ₂ O ₃ + TiO ₂	17%
CaO	1.1%
MgO	0.3%
SO ₃	0.45%
Na ₂ O	0.11%

Cement

Cement was used as activator materials was obtained from Istanbul, is ordinary Portland cement.

homogeneous mixture. The partial replacement of filler in the sub base constituent gradation was done in the proportions, 0%, 5%, 10%, 15%, and 20% fly ash while cement was fixed at 5% .

Mixture Composition and Preparation

Fly ash and cement were intimately mixed together in a given proportions to form

Table 3 Summary of Sub-base Mixes

S. No.	(FLYASH/CEMENT) Percentage replacements (%)	Sub-base Mix Ratio (FL+(FA(FA+C))):...A1:...A2
1	0	(100% +0%):...A1...:A2
2	5/5	(95%+(5%(95%+ 5%))):...A1...:A2
3	10/5	(90% +(10%(95%+5%))):...A1...:A2
4	15/5	(85% +(15%(95%+5%))):...A1...:A2
5	20/5	(80% +(20%(95%+5%))):...A1...:A2

Notes

(FL+(FA(FA+C))): indicates: Filler + (Fly ash + Cement)
+A1..A2..: indicates remaining part of gradation of both Fine aggregate and coarse aggregate

(OMC) with corresponding maximum dry density of each mixes, in accordance with ASTM-D2216 and ASTM-D1557. Also the California bearing ratio (CBR) and unconfined compressive strength (UCS) of each mixes in table 3 were determined in accordance with ASTM 1883-73 and ASTM D2166-06 respectively.

Testing Methods

The laboratory tests were performed to determine optimum moisture content

RESULTS AND DISCUSSION

The results of optimum moisture content versus fly ash/ Cement in Fig 1.

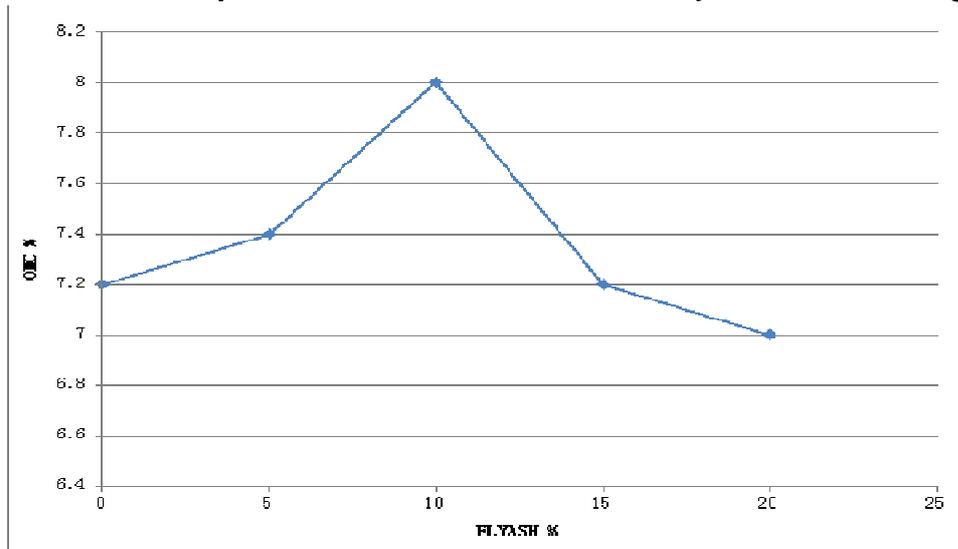


Figure 1: OMC against percentage replacement of filler with FA/C

It can be seen from Figure1. that, there is an increase in OMC from 0% replacement to 10% replacement. After 10% replacement the OMC then decreases to 20% replacement. It can be seen the OMC has a maximum value at 10% replacement.

Whereas, at 15% and 20% replacement of filler, the percentage of cement needed to enhanced the cementing properties of class F fly ash in the mixes is small causing the OMC to reduced considerably.

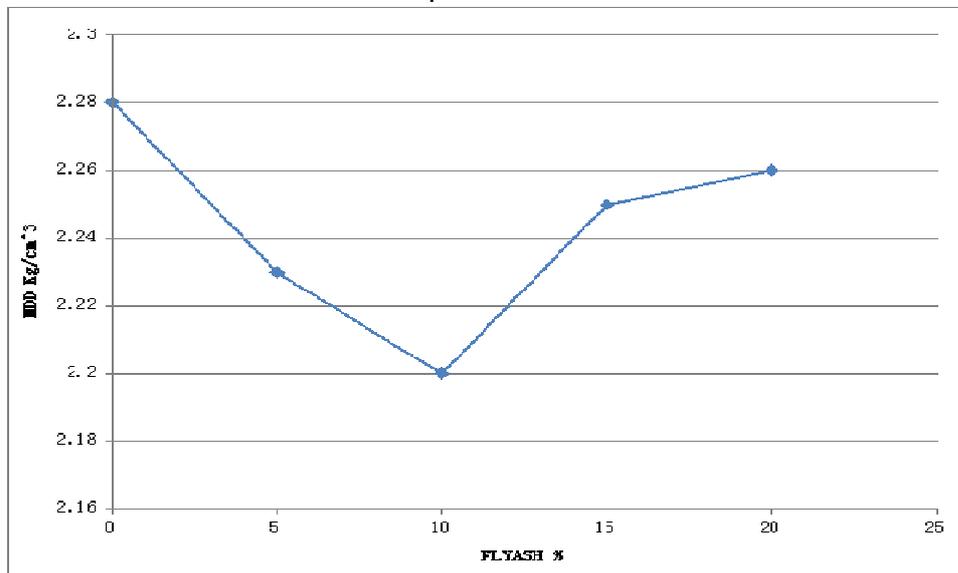


Figure 2: OMC against percentage replacement of filler with FA/C

The relationship between Maximum Dry Density (MDD) and percentage replacement of filler with FA/C is as presented in Figure 2 as shown above, the MDD results showed higher value of

2.28kg/cm³ at 0% replacement whereas at 5%, 10%, 15%, and 20% replacement MDD were 2.23kg/cm³, 2.20kg/cm³, 2.25kg/cm³ and 2.26kg/cm³ respectively.

The 10% replacement has lowest value of MDD and 20% replacement has maximum MDD value but less the control.

CALIFORNIA BEARING RATIO (CBR)

The results of CBR versus Fly ash/ Cement content is shown in figure 3. below.

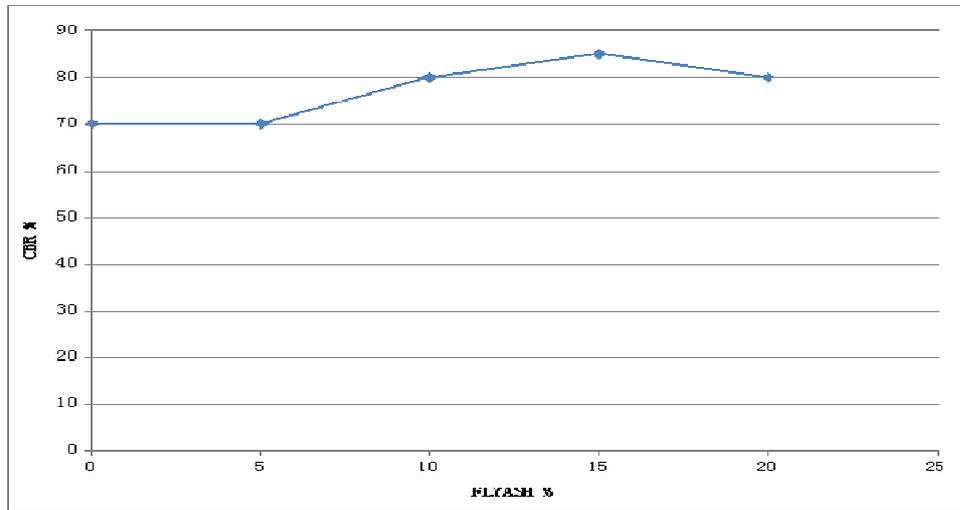


Figure 3: CBR against percentage replacement of filler with FA/C

The CBR value generally increased with FA content with peak value at 15% FA content after which a decline in CBR value was observed. Peak CBR value of 84% is an indication that the soil treated with 15% FA can be used as subbase material including 5%, 10% and 20% because all the CBR value obtained exceeded 50%..

UNCONFINED COMPRESSIVE STRENGTH(UCS) TEST RESULTS

The results of unconfined compressive strength versus Fly ash/cement content shown as presented in Fig.4 below.

The suitable amount of FA & C replacement were used to test the unconfined compressive strength and the results given in figure 4 was cured for 7 days in air due to collapsed of specimen when immersed in water.

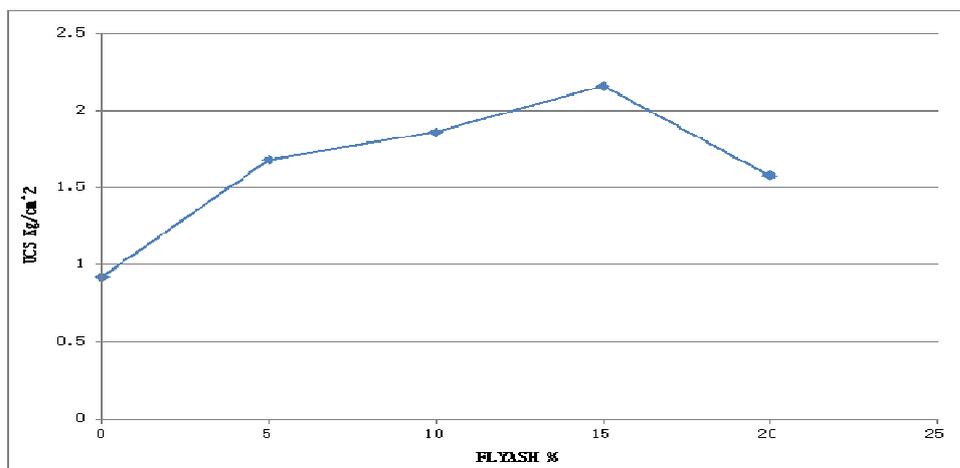


Figure 4: UCS against percentage replacement of filler with FA/C

Figure 4 shows increased in UCS from 0% replacement to 5%, 10% and 15% replacement with corresponding value of 90.22kpa, 164.8kpa, 182.4kpa, and 211.8kpa respectively. While for 20% replacement slightly reduced due to low reactivity of cementing properties of cement. It can be seen that at 15% replacement the mixture has maximum UCS value, which complied with the value of optimum moisture content of the mixture at 15% maximum.

CONCLUSION

The following conclusions were drawn from this study;

REFERENCES

- [1] Joshi, R.C, Lothia, R.P. Fly ash in concrete: production, properties and uses. In: Advances in concrete technology, vol. 2. Gordon and Breach Science Publishers; 1997.
- [2] Retrieved on August 29, 2004 from the World Wide Web: <http://www.iea.org/dbtw-wpd/Textbase/stats/coaldata.asp?country=IEA+Total&SubmitA=Submit>
- [3] Retrieved on August 29, 2004 from the World Wide Web: <http://www.iea.org/dbtw-wpd/Textbase/stats/coaloced.asp?oced=Turkey&SubmitB=Submit>
- [4] Aruntas, H. Y., "The Potential of Fly Ash Usage in Construction Sector", Journal of Faculty of Engineering and Architecture of Gazi University, vol. 21, no. 1, pp. 193-203, 2006.
- [5] Türker, P., Erdogan, B., Katnas, F., and Yeginobal., A., "Türkiye'deki Uçucu

The research gave an insight into the behavior exhibited by different percentage constituent of the mixes used as partial replacement of filler in sub-base materials. Strength indices result clearly showed that the optimum replacement level of 15% gave the best result, hence recommendation of this replacement level for the stabilization of gravel soil. Successful utilization of the fly ash in the stabilization of gravel soil will be an effective way of disposing this waste. Therefore replacement of filler with fly ash can be done up to 15% replacement. Beyond this optimum range the replacement is not desirable.

- Küllerin S.n.fland.r.lmas. ve Özellikleri", Türkiye Çimento Müstahsilleri Birliği, 2003.
- [7] Kumar.M.A.,Prasad.D.S.V.,Raju.G.V.R.P.,(2012),"Stabilization of Fly ash Cover at Subbase level of Flexible Pavement",Academic Research journals India,Vol-1,pp-11-18
- [8] Baha.V.K.,Mehmet, Y.,Alaaddin, G.,(2012),"The Effect of Cement Stabilized Subgrade on Cost of the Flexible Pavement.
- [9] Brooks, R. M. 2009. Soil Stabilization with Fly Ash and Rice Husk Ash.International Journal of Research and Reviews In Applied Sciences, Vol. 1(3), pp. 209-217.
- [10] AASHTO., "Guide for Design of Pavement Structures" American Association of State Highway of State Highway and Transportation Officials, USA, 1993.