Uses of Fly Ash in Construction Industry

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Abstract - Calcium fly ash is an industrial by-product of coke combustion. It is stockpiled and landscaped, causing serious environmental problems. Because of its great availability and its low cost, the possibility of its usage should be investigated. In the present study, clay soil was stabilization for the construction of durable urban roads is investigated using fly ash. Geotechnical analysis of soil-fly ash mixture characteristics involving physical, mechanical properties, show that the index properties of clay soil have been improved. The clay Atterberg limits improved and an increase of bearing capacity was observed with various ash ratios. A number of studies have been conducted to investigate the influence of randomly oriented fibers on the strength behavior of coarse grained and fine grained soils. The effect of fiber inclusion on the strength characteristics of soil fly ash mixtures has not been reported so as much detail as in the case of the soils .In present study, polypropylene fibers were mixed with various proportions of soil fly ash mixtures to investigate the relative strength gain in the terms of unconfined compression strength (UCS). Samples of soil fly ash mixtures were tested in unconfined compression with 0, 0.5, 1.0 and 1.5 per cent polypropylene fibers. Concrete mixes that are especially applicable to underground conduit-line construction are evaluated. Concretes inherently release free lime which, in sufficient concentration, is cross section corrosive to lead cable sheaths. Varying amounts of fly ash were used in trial concrete mixes, and the resulting reduction in free lime release was measured. The road construction industry is often looked upon as a potential consumer of fly ash. The strength of fly ash has to be improved before it can be used as embankment material. Randomly reinforced fly ash. Polypropylene fibers with different fiber length (6mm, 12mm and 24 mm) are used as reinforcement. Fly ash is compacted at maximum dry density with low percentage of reinforcement (0 to 1.50 %of weight of dry fly ash). The physical properties of these residues will be determined by the technology, design and operational conditions of the power stations. The chemical composition of the fly ash and slags depends completely on the inorganic matter within the source coal deposits and the composition of the slags and fly ashes cannot be controlled. The study was based on fly ash of Yaojie area as raw material. Corn fiber and saccharfying sludge were used as porogen and binder. By selecting different rations of Saccharfying sludge and fly ash, the paper discussed the impact on the properties of porous materials. Various zeolitic compounds such as faujasite-Na and sodium aluminum silicate hydrate have been synthesized from high fly ash by a classical hydrothermal treatment. The composition of reaction mixtures was set with a Si:A ratio of 1 by adding a transition alumina to the fly ashes. NaOH solutions with 2 and 4 molar concentrations were used to dissolve the aluminosilicates in the fly ash and produce the conditions for zeolite crystallization. Zeolitic compounds have been prepared at 150°C and 200°C temperatures for 4-24hrs.

Keywords:- Polypropylene fibers, UCS, Stabilization, Polypropylene fibers Soil.

I. INTRODUCTION

FLY ash (FA) is one of environmental risks associated with electricity production from fossil fuel combustion, with costly landfill disposal and environmental health problems. FA can be classified as Class C, Class F or Class N (ash that does not meet Class C, Class F specification1). Based on ASTM C 618 standards, Table 1. Class C fly ash can be used as stand-alone material, while Class F is commonly blended with chemical additive. Common binders include cement, lime, and fly ash. Additives reduce both the water content and bind the soil particles, which results in an increase in strength and stiffness. In practice, reducing the water content of high- water content soils to the optimum water content (OWC) is difficult and time-consuming. Therefore, the use of fly ash additive is attractive because fly ash is an industrial by- product that is relatively inexpensive, compared with cement and lime . Fly ash utilization for soil stabilization, that would be land filled, promotes sustainable construction through reduction of energy use and reduction of greenhouse gases. Pandian, Studied the effect of two types of fly ashes (Class F) and (Class C) on the CBR characteristics of the black cotton soil, the CBR is effect depend on the soil cohesion and fly ash type and ratio. Phanikumar and Sharma, study the effect of fly ash on engineering properties of expansive soil. Parameters like plasticity, compaction, strength and hydraulic conductivity of expansive soil was studied. The plasticity was reduced by about 50% by the addition of 20% fly ash .Depending upon the soil type, the effective fly ash content for improving the engineering properties of the soil varies between 15 to 30% . Also it was proven that ash can be used successfully as an additive for the base and sub-base layer construction of pavement, as well as for the construction of embankments in compressed soils. The established techniques of soil stabilization by adding cement, lime or fly ash and reinforcement in form of discrete fibers cause significant modification and improvement in strength characteristics of soils. Fibers are added and mixed randomly with soil or fly ash. One of the primary advantages of randomly distributed fibers is the absence of potential planes of weakness that can be developed parallel to oriented reinforcement. One of the most promising approaches in this area is use of fly ash as a replacement to the conventional earth material and fiber as reinforcement will solve two problems with one effort i.e. elimination of solid waste problem on one hand and provision of a needed construction material on other. Also, this will help in achieving sustainable development of natural resources. A proportion of concrete fly ash as used in underground cable conduits.ine construction. When fly ash was used in a mix, it was employed as a replacement for part of the cement that otherwise would have been required. Fly ash content, coarse aggregate size, and mix proportions were varied. The resulting effect, both on calcium-hydroxide release and on thermal resistivity, is reported. In addition, some fundamental data, pertaining to the optimum fly-ash-cement ratio with respect to free calcium hydroxide, are presented. Calcium hydroxide in sufficient concentration will cause corrosion of lead cable sheaths. The thermal resistivity of the concrete envelope has a definite effect on the load capability of cables installed in a duct system. The layer-by-layer type of conduit-line construction used on the Commonwealth Edison Company system employs 1-inch spacing between individual precast concrete ducts. Fly ash is generally considered to possess pozzolanic characteristics. A pozzolanic is a finely divided siliceous or siliceous and-aluminous material which will chemically combine in the presence of water with calcium hydroxide to form cementitious compounds. Amorphous silicon and aluminum oxide stituents of the fly ash react with the free lime to form cementitious compounds. These compounds add to the long time strength to concrete. Over the last few years, environmental and economic issues have stimulated interest in development of alternative materials that can fulfill design specifications. The established techniques of soil/ fly ash stabilization by adding cement, lime and reinforcement in form of discrete fibers cause significant modification and improvement in strength characteristics of soils/ fly ash. One of the most promising approaches in this area is use of fly ash as a replacement to the conventional earth material and fiber as reinforcement will solve two problems with one effort i.e. elimination of solid waste problem on one hand and provision of a needed construction material on other. Also, this will help in achieving sustainable development of natural resources. However, the comprehensive work is required to comprehend the influence of discrete polypropylene fibers inclusion on the strength characteristics of fly ash. The fiber content ranging from 0 to 4 % by weight of fly ash was used with constant fiber aspect ratio of 30. The study indicates increase in friction angle. The study on soil fly ash mixture reinforced with 0.5% and 1% polyester fibers (20 mm length) was conducted in India by Kaniraj S.R. and Havanagi V.G. (2001), which indicated the combined effect of fly ash and fiber on soil. an attempt is made to investigate the behavior of fly ash reinforced with polypropylene fibers with different length and in varying amounts. Domestically Mongolia uses about 6 million tonnes of coal per annum generating approximately 500-600 thousand tonnes of ash. the new power stations come to operation the amount of coal combustion by-products will dramatically increase. It is thus imperative for Mongolia to identify beneficial ways to utilise coal ash. Therefore, rational utilization of coal combustion by-products is one of the major research themes for our researchers. One of the most promising researches in coal utilization is preparation of geopolymers/alkali activated binder. Geopolymers are an amorphous to semi-crystalline three-dimensional aluminosilicate polymers considered to be a substitute to OPC (ordinary Portland cement). This material shows not only high strength and chemical and thermal stability, but also has the added bonus of lower carbon dioxide emissions during production than OPC. Fly ash is commonly used as raw materials for geopolymersynthesis. corn deep processing industry is developing rapidly in recentyear in Northeast China, which made the by-product of corn fiber and saccharfying sludge increase day by day. The study attempts to make use of all the three kinds of by-products. In the experiment, corn fiber and saccharfying sludge were used as porogen and binder to produce the new multi-functional material. This will not only reduce solid waste’s harm to the environment, but also develop a new porous material, which has great social and economic benefits. Application of fly ashes strongly depends on the chemical and mineralogical compositions and unique to each ash. In contrast to many countries which have utilized fly ash effectively, Mongolia has given little attention to its utilization. the utilization of fly ash for preparation of other valuable material such as zeolite represents some interest to the scientific audience and may lead to a new application of fly ashes. Mongolian fly ashes contain a high amount of Ca and lower Al, which could behave differently than low Ca fly ashes during the zeolite synthesis.

II. LITERATURE REVIEW

1. Pandian, Studied the effect of two types of fly ashes (Class F) and (Class C) on the CBR characteristics of the black cotton soil, the CBR is effect depend on the soil cohesion and fly ash type and ratio.
2. Phanikumar and Sharma, study the effect of fly ash on engineering properties of expansive soil. Parameters like plasticity, compaction, strength and hydraulic conductivity of expansive soil was studied.
3. The plasticity was reduced by about 50% by the addition of 20% fly ash.
4. The present research work involves the analysis of a fly ash sample to determine its classification according to ASTM- C 16standards, and to investigate the possible improvement of clay engineering properties when mixed with fly ash.
5. A review of the literature revealed that various laboratory investigations have been conducted independently either on fly ash / lime stabilization of soil or fiber reinforced soil by many investigators like Mitchell and Katti (1981),Maher *et al* (1993), Consoli et al (2001),Ingles and Metcalf (1972), Brown (1996),Gray and Ohashi (1983) ,Gray and Al-Refeai (1986), Gray and Maher (1989), Al- Refeai (1991), Michaowski and Zhao (1996), Michaowski and Cermak (2003), Ranjan et al (1996),Consoli et al (2002).
6. Kumar S. and Tabor E. (2003) studied the strength behavior of silty clay with nylon fiber for varying degree of compaction.
7. The study on soil fly ash mixture reinforced with polyester fibers was conducted in India by Kaniraj S.R. and Havanagi V.G. (2001).
8. The authors have not come across any study about effect of polypropylene fibers (with respect to content) on soil fly ash mixtures.
9. Kulman has summarized ways in which calcium hydroxide or free lime can result in lead-sheath corrosion.
10. typical case of chemical corrosion of lead cable sheatlhs was Discovered on the Commonwealth Edison Company system in June 1962.
11. Maher studies about the advantages of randomly distributed fibers are the absence of potential planes of weakness that can be developed parallel to oriented reinforcement.
12. The effect of polymer fiber inclusion on plain fly ash was studied by Chakraborty and Dasgupta (1996) by conducting triaxial tests. The fiber content ranging from 0 to 4 % by weight of fly ash was used with constant fiber aspect ratio of 30. The study indicates increase in friction angle.
13. The study on soil fly ash mixture reinforced with 0.5% and 1% polyester fibers (20 mm length) was conducted in India by Kaniraj S.R. and Havanagi V.G. (2001), which indicated the combined effect of fly ash and fiber on soil.
14. Kaniraj S.R. and Gayatri V (2003) indicated that 1% polyester fibers (6 mm length) increased strength of raw fly ash and change their brittle failure into ductile one.
15. Dhariwal, Ashok (2003) carried out performance studies on California bearing ratio values of fly ash reinforced with jute and non woven geo fibers. All these investigations were limited in their scope. In present study, an attempt is made to investigate the behavior of fly ash reinforced with polypropylene fiber with different length and in varying amounts.

III.MEHODOLOGIES EXPERIMENTAL STUDIES

Experiment on uses of fly ash in soil stabilization:-

Various ratio ranging from 5to 20% by wt together with 5% by wt cement were added to soil sample.
A soil specimen particle size distribution presented in Table I. The soil was classified according to American Association of State Highway and Transportation Officials (AASHTO) as GC. The engineering properties of the soil show that the soil has a high liquid limit, low dry density, Table I.
The physical properties and chemical composition of fly ash sample under study were carried out in Sudanese Geological Researches Laboratories Table II.

TABLE I SOIL ENGINEERING PROPERTIES

No.	Parameter	Value
1	Optimum moisture content	23%
2	Max. dry density	1.55 g/cm3
3	Liquid limit, LL	55.3 %
4	Plastic limit, PL	25.6 %
5	Plasticity index, PI	29.7 %rameters Percent of Compositions

Table II CHEMICAL COMPOSITIONS AND INDEX PROPERTIES OF FLY ASH

Parameters	percentage of compositions		
	Gray Ash	Typical class C	Typical class F
SiO_2	40.47	40	55
Al_2O_3	ND	16	26
Fe_2O_3	1.08	6	7
$SiO_2+Al_2O_3+Fe_2O_3$	47.55	63(50 min)	88(50min)
CaO	18.52	24	9
MgO	0.18	2	2
SO_3	0.03	3	1
LOI	18.97	6.0	6.0
Specific Gravity	1.029	-	-

LOI: Loss of Ignition
According to ASTM- C618, Gary Ash sample is an off specification (i.e., does not meet Class C or Class F specification).

(b)Strength Characteristics of Soil Fly Ash Mixtures Reinforced with Randomly Oriented Polypropylene Fibers.

Materials Used

Fresh fly ash samples were collected from Nashik Thermal Power Station, Eklahare, Nashik (Maharahtra), India. The chemical composition and physical properties of fly ash are shown in Table 1.The fly ash is classified as class F fly ash as per ASTM C 618 (ASTM 1993). The polypropylene fibers RP12 were used. Polypropylene fibers are hydrophobic, non corrosive and resistant to alkalis, chemicals and chlorides.

Sample Proportions

An experimental work was carried out on soil fly ash mixtures considering following proportions)\Soil FlyAsh.

a) Plain soil sample without fly ash.
b) 50% soil sample with 50 % fly ash.
c) Plain fly ash sample without soil..

Polypropylene fibers (RP12) were added in above combinations of soil fly ash in varying percentage of 0.5%, 1.0 % and 1.5 % by dry weight of soil fly ash mixture respectively.

Method of Soil Fly Ash Mixture Proportions

The general expression for the total dry weight W of a soil fly ash fiber mixture is
W = Ws + Wf + Wps
Where Ws, Wf and Wps are weights of soil, fly ash and polypropylene fiber respectively. The proportions of soil, fly ash and fiber in soil fly ash mixture are defined as the ratio of their respective dry weight to the combined dry weight of soil fly ash. Thus, above equation can be written as W = (Ps+Pf+Nps) (Ws+Wf) Where Ps= proportion of soil= Ws/(Ws+Wf); Pf= proportion of fly ash =Wf/(Ws+Wf) and Nps=Polypropylene fiber content =Wps/(Ws+Wf).

Sample Preparation and Testing

The samples were prepared by dry blending of soil and fly ash, with required amount of water obtained from standard proctor test. In preparation of fiber reinforced samples; the fibers were added to moist mixture of soil fly ash. Strength characteristics of soil fly ash mixtures, with or without fibers, were measured in the terms of unconfined compression strength.

(c) Investigation of Cement-Fly-Ash Concrete Mixtures for Underground Conduit Construction

Materials Used

Fresh fly ash samples were collected from Nashik Thermal Power Station, Eklahare, Nashik (Maharashtra), India. The chemical composition and physical properties of fly ash are shown in Table 1. The fly ash is classified as Class F fly ash as per ASTM C618 (ASTM1993). The polypropylene fibers RP6, RP12 and RP24 were used. Polypropylene fibers were added in fly ash in varying percentage of 0.5 %, 1.0 % and 1.5 % by dry weight of fly as respectively.

Table 1.
Chemical composition andphysical properties of fly ash

Composition /Property	Value	Composition /Property	Value
Chemical composition			
Silicon dioxide(SiO_2)	55.30	Titanium oxide, TiO_2	01.30
Aluminum oxide, Al_2O_3	25.70	Potassiumoxide, K_2O	00.60
Ferric oxide, Fe_2O_3	05.30	Sodiumoxide, Na_2O	00.40
Calciumoxide,CaO	05.60	Magnesiumoxide, MgO	02.10
Physical Property			
SpecificGravity	02.16		
Loss on Ignition (%)	01.90		
Moisture (%)	00.30		

Method of Sand Fly Ash Mixture Proportions

The general expression for the total dry weight W of a fly ash fiber mixture is
W = Wf + Wps ----------- (1)
where Wf and Wps are weights of fly ash and polypropylene fiber respectively. As a fraction of the dry weight of fly ash, Wps is expressed as, Wps= nps Wf, where nps is the fiber content.

Sample Preparation and Testing

the fibers were added to moist mixture of fly ash. Test specimen's were prepared using mould by compacting samples at maximum dry unit weight and optimum moisture content determined by conducting a Standard Proctor Test.

(d)Preparation of Geopolymer Type Binder from Mongolian Fly Ash and Its Characterization:-

For the experiments ash samples of about 100-500 kg were taken and statistically sampled for chemical and mineralogical characterization. Both fly ashes were mixed with the 6, 8 and 10M sodium hydroxide solution with a laboratory type handmade cement mixer for 5 minutes. After obtaining uniform consistency, the pastes were placed in cubic metal moulds with 20 mm edges. Samples were wrapped in a plastic bag in order to prevent liquid evaporation and cured at 70DC for 1 day. After 24h the moulds were removed from the oven and the samples characterized. The compressive strength of the Geopolymer samples was measured by the Universal testing machine (Jinan, WDW-50). At least 4 samples were used to determine the compressive strength value. the mineralogical composition of the synthesized samples was determined by X-ray diffraction (XRD). XRD patterns of the powders were obtained with a "Maxima X XRD-7000" diffract meter using CuKa radiation. Fracture surface of the crushed Geopolymer samples was observed by SEM (Hitachi, Table top). Water adsorption was measured by weight change ratio of dry and 30 min boiled samples. Skeletal density of Geopolymer samples was determined by their weight to volume ratio. Radiation measurements were performed by y-spectroscope according to Mongolian standard [6]. MNS 5072:2001. SEM micrographs were observed by Hitachi table top and FE-SEM (JEOL JSM-6701F).

(e) Research on Preparation of Porous Materials by Fly Ash and Corn Fiber

A. Perimental materials

The fly ash used in the experiment was from power plant of Yaojie, Gansu; sludge and corn fiber were from Songyuan Cerestar China Resources Corporation.

B. Material preparation

Fly ash of Yaojie was screened with 200 mesh screen; sludge was put into 40°-50° dry box for 5 hours, then was screened with 200 mesh screen after grinding; corn fiber was

Put into 35° dry box for 2 hours, then was ground and screened with 200 mesh screen.

C. Material analysis

The Yaojie fly ash chemical composition analysis.

TABLE 1.YAOJIE FLY ASH CHEMICAL COMPOSITION ANALYSIS

Composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	TiO_2	Ignitionloss	Total
Content/%	59.75	25.29	6.47	6.48	1.18	0.65	4.71	99.82

TABLE 2. THE CORN CHEMICAL COMPOSITION ANALYSIS

Compositio %	**Whole Grain**	**Corn fiber**	**Germ**	**Endosperm**
Part of the total grain	100	6	10	84
Crude protein	12.6	66	21.7	12.4
Fat	4.3	1.6	29.6	1.3
Carbohydrate	79.4	74.1	34.7	85.0
Crude fiber	2.0	16.4	2.9	0.6
Inorganic matter	1.7	1.3	11.1	0.7

D. Sintering process

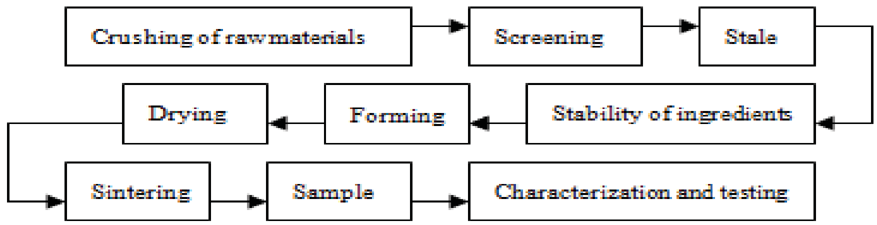
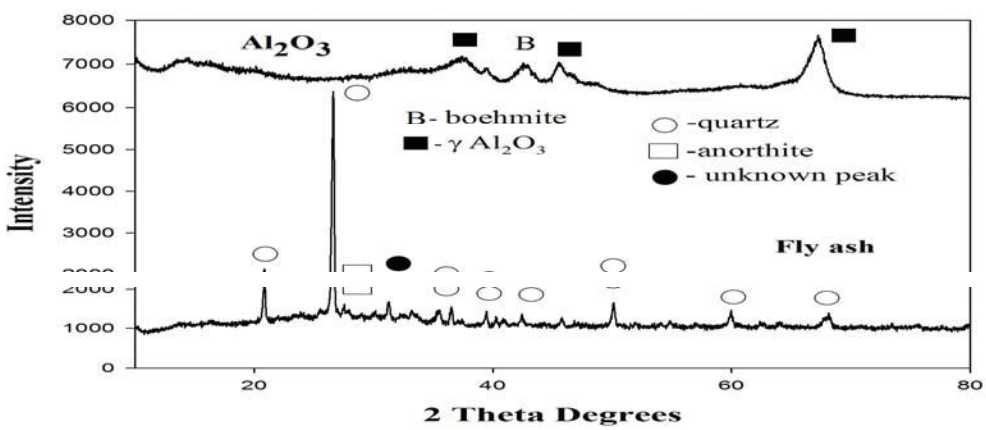


Figure 1.Fly ash sintering process diagram

(f) Preparation of Zeolitic Compounds from High Calcium Fly Ash

A. Characterization of raw materials

The chemical composition of the fly ash as determined by a classical chemical analysis is as follows, wt%: SiO2 53.89, CaO 26.6, Fe2O3 5.72, MgO 3, Al2O3 2.72, K2O 1.93, Na2O 1.913, LOI 1.115, P2O5 0.82, SO3 0.2. XRD patterns of the raw fly ash and Al2O3 are shown in Fig. XRD indicates that the fly ash consists of crystalline quartz, some anorthite and amorphous portion.



B. Experimental procedures

NaOH solutions with 2 and 4 M concentrations were prepared as activating solutions. Al2O3 powder was added to the fly ash to achieve a Si:Al molar ratio of about 1and mixed in a dry condition. Zeolite syntheses were processed using Teflon lined hydrothermal bomb with capacity of 20 cm3. Into the hydrothermal bomb were added 3 grams of fly ash+Al2O3mixture and 20 ml of the NaOH solution. The zeolite conversion was studied as a function of temperature (100, 150 and 200oC), time (4 to 24 hrs) and solution concentration (2, 4 M). After the desired time, the hydrothermal bomb was removed from the oven and cooled down by water. Then filtered and washed several times using distilled water and dried at room temperature for 24hrs. Powder X-ray diffraction (Shimadzu Maxima XRD7000) and SEM (HitachiTM1000) were used for characterizing the synthesized

IV. RESULT AND ANALYSIS

Observations from standard proctor tests and unconfined compression tests had been analyzed to study the effect of fly ash and polypropylene fibers on compaction characteristics and stress strain behavior of soil.

The results of soil ash mix properties are shown in Fig.1 to Fig.5

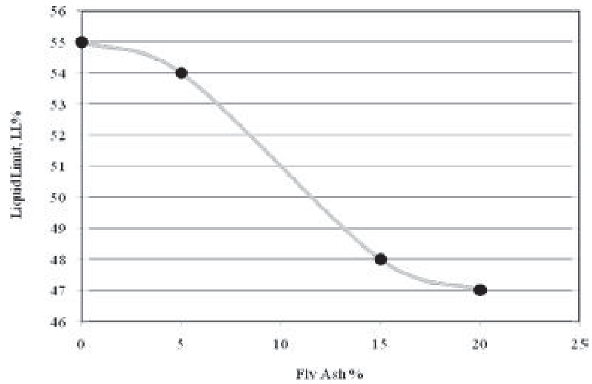


Fig. 1: Liquid Limit of Soil with Fly Ash

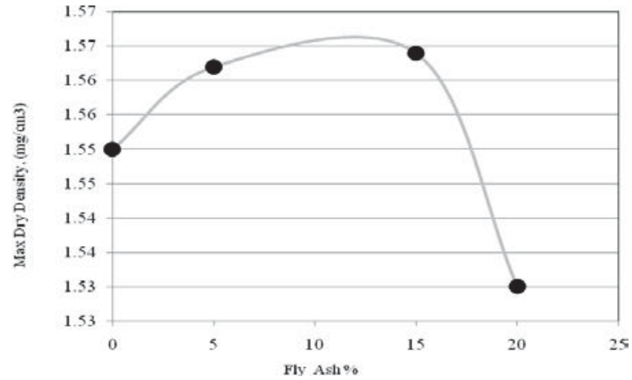


Fig. 3: Soil Maximum Dry Density with fly ash

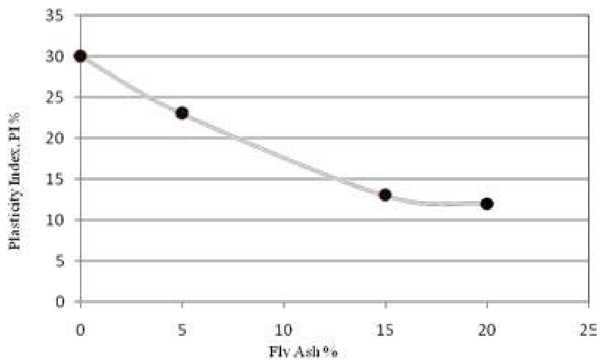


Fig. 2: Soil Plastic Index with Fly Ash

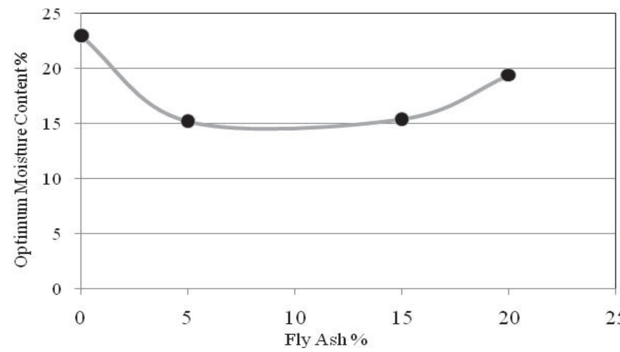


Fig. 4: Soil – Fly Ash Optimum Moisture Content

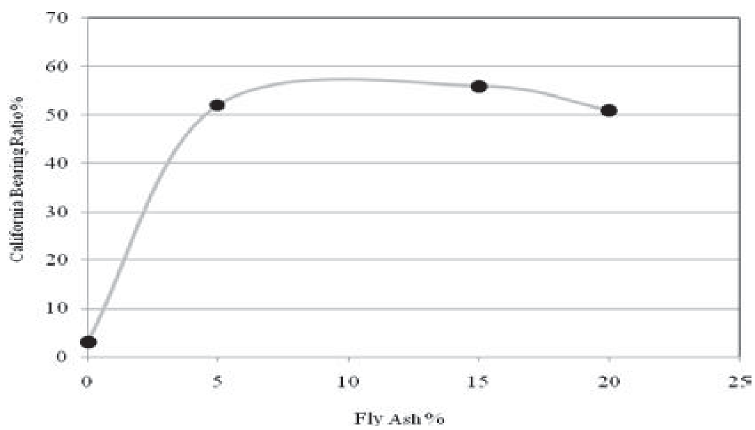


Fig. 5: California Bearing Ratio with Soil Fly Ash

Compaction Characteristic

Figures shows the light (standard) compaction curves of the soil fly ash mixtures

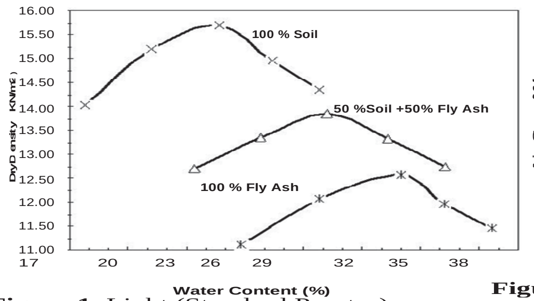


Figure 1. Light (Standard Proctor) Compaction Curves of Soil Fly Ash Mixtures (0 % fibers)

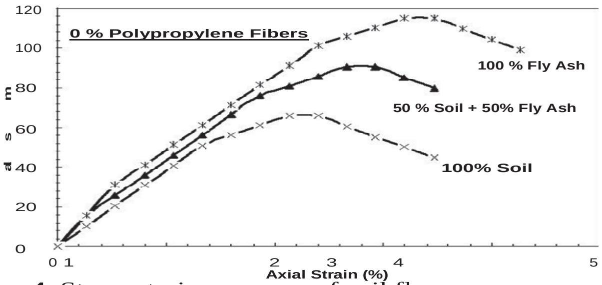


Figure 4. Stress strain response of soil fly ash mixtures without polypropylene fiber

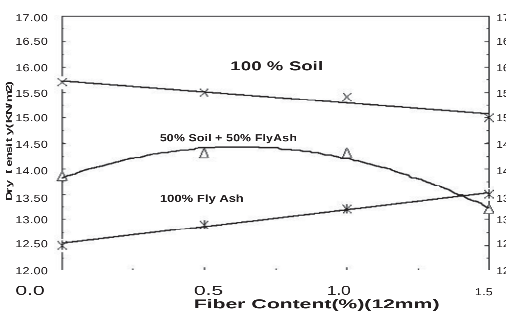


Figure 2. Variation of Maximum Dry Density with Fiber Content

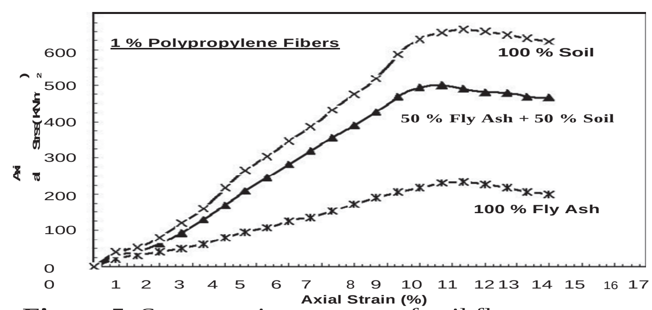


Figure 5. Stress strain response of soil fly ash mixtures with 1 % polypropylene fiber

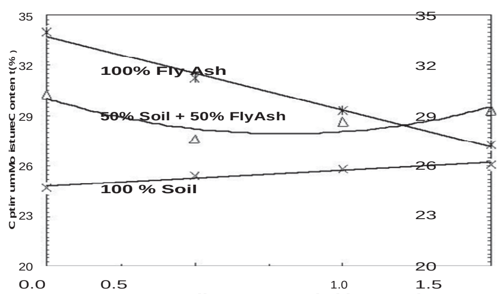


Figure 3. Variation of Optimum Moisture Content with Fiber Content

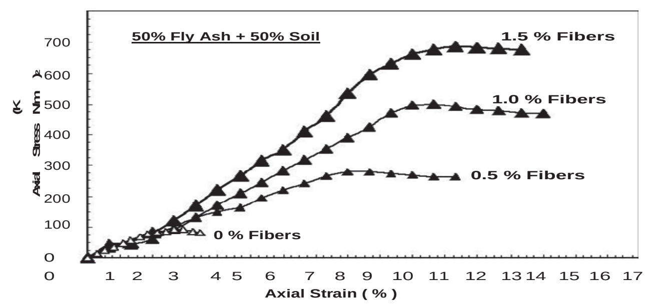


Figure 6. Stress strain response of 50 % fly ash + 50 % soil mixtures with varying fiber content.

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Impact of different pore-forming agent addition on the product performance

Impact on the product when the corn fiber's addition was 0.2%

When the addition of corn fiber was 0.2%, and the content of fly ash in raw materials were 80%, 70%, 60%, 50% and 40%, the porosity, water absorption, and density of the products were shown in table.

TABLE4. THE BURNING CONDITION WHEN THE CORN FIBER INCORPORATION WAS 0.2%

Percentage of the fly ash/%	Porosity/%	Water absorption/%	densityg/cm3
40%	57.03	40.06	0.82
50%	54.56	38.64	1.21
60%	49.76	37.89	1.56
70%	47.33	36.85	1.70
80%	45.30	35.84	1.61

Impact on the product when the corn fiber's addition was 0.3%.

When the addition of corn fiber was 0.3%, and the content of fly ash in raw materials were 80%, 70%, 60%, 50% and 40%, the porosity, water absorption, and density of the product was shown in table
.

TABLE :- THE BURNING CONDITION WHEN THE CORN FIBER INCORPORATION WAS 0.3%.

Percentage of the fly ash%	**Porosity%**	**Water absorption/%**	**Density (g/cm_3)**
40%	57.99	48.58	1.38
50%	56.45	47.98	1.54
60%	55.76	46.41	1.73
70%	54.67	44.98	1.69
80%	53.56	43.89	1.79

Impact on the product when the corn fiber's addition was 0.4%.

When the addition of corn fiber was 0.4%, and the content of fly ash in raw materials were 80%, 70%, 60%, 50% and 40%, the porosity, water absorption, and density of the product was shown in table.

TABLE6. THE BURNING CONDITION WHEN THE CORN FIBER INCORPORATION WAS 0.4%

Percentage of the flyash/%	**Porosity/%**	**Water absorption/%**	**Density /(g/cm_3)**
40%	58.21	49.31	1.49
50%	57.33	48.76	1.61
60%	56.01	48.32	1.69
70%	55.87	47.81	1.74
80%	54.11	46.99	1.79

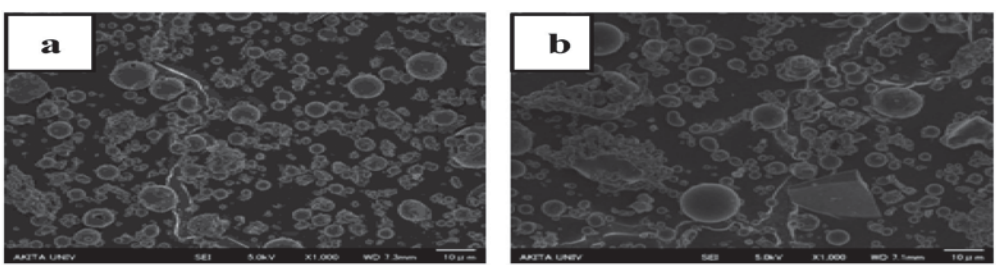
the proportion of fly ash and saccharfying sludge is fixed, the porosity and the water absorption will increase with the addition of corn fiber.

Chemical composition of the fly ashes showed in table. Higher calcium and relatively lower aluminum than other fly ashes usually used for Geopolymer synthesis. However, class C fly ash and Ca-containing admixtures were used for preparation of alkali activated complex binder and that material showed compressive strength up to 80 MPa.

TABLE :-I CHEMICAL COMPOSITION OF USED FLY ASHES

Oxide (Mongolia)	Baganuur (Mongolia) wt.%	Shivee ovoo (Mongolia) wt.%
Si02	55.2	33.85
Al,O,	14.l5	12.15
Fe203	10.55	9.89
CaO	15.0	30.8
K,O	l.31	0.73
TiO,	0.25	0.35
MgO	1.56	6.41
Na20	-	-
P20S	-	-
SrO	0.25	0.44
MnO	0.34	l.l85
S03	1.23	3.65
Loi (l000°C)	l.05	0.30
Sum of Aluminosilicates	69.35	46

Fig. 1 shows SEM micrographs of the fly ashes



There is almost no difference between the two fly ash samples in terms of morphology. Granulometrical measurement shows little difference and particles d50were 14.5 micron in Shivee ovoo fly ash and 20 micron in Baganuur fly ash. Volume weight of Baganuur fly ash was l.08 g/cm3 and for Shivee ovoo fly ash 1.31 g/cm3.In other words, Shivee ovoo fly ash Contains more heavier particles than Baganuur fly ash. XRD revealed (not shown) that both ash samples contain more than 6 phases, while some of them have more than 10 phases which makes very difficult to fully characterize. The most intense peaks belong to quartz. Most of the calcium in Baganuur and Shivee ovoo fly ash is present as lime CaO, calcium sulphate CaS04, calcium silicate Ca2Si04, calcium aluminates CaAb04 and Ca3Ab06. The fly ash showed high calcium content which is not beneficial for true geopolymerisation reaction; we have used the definition of "Geopolymer type" material.

EFFECTIVENESS OF FLY ASH IN COMBINING WITH CALCIUM HYDROXIDE

It has been observed that the chemical effect of the fly ash in concrete shows up rather clearly when comparisons are based on the amount of free lime released in leaching tests of crushed concrete samples. The test method results in the release of calcium hydroxide much more rapidly than would occure in field condition.

RESULT OF TEST ON FLY ASH USING IN ROAD EMBANKMENT

(i) The result shows that the addition of fibers to the fly ash caused significant increase in the maximum dry density and reduction in the optimum moisture content. The rate of increase in MDD or decrease in OMC reduces as fiber length increases from 12 mm to 24 mm. The increase in MDD ranges from 1.20 % to 8.40 % over the MDD of unreinforced fly ash.

(ii) UCS and residual strength fly ash specimen's increases significantly due the reinforcement. Also, in unreinforced state, fly ash exhibits lower failure strain which increases significantly due the reinforcement. The increase in UCS due to addition of polypropylene fibers is measured in the terms of Gain ratio (Gpf), which is defined as the ratio of UCS with fibers to UCS without fibers.

(iii) CBR values of fly ash reinforced with 12 mm fiber were higher. Also it was observed that , due to addition of 1.00 % by weight 12mm fibers to the fly ash increases CBR value by 289 %.Whereas, increasing fiber content to 1.50 % by weight, increases CBR value by 330 %. Hence, the optimum dose of fiber to be added to plain fly ash was 1.00 % by weight of 12 mm fibers.

V.CONCLUSION

The addition of 15 wt% fly ash, 5wt % cement improved the index properties of clay and increased the bearing capacity.

(i) The soil under study is not appropriate for embankments, paving and foundation due to its plasticity. Nevertheless, the Atterberg limits the mixture of fly ash with the clay soil, has improved. A reduction of the liquid limit and plasticity index up to 47% and 13% respectively (case of 15 % ash), resulting in the soil maintaining its stability while decreasing the moisture content.

(ii) Fly ash can be mixed with cement and water to stabilize granular materials with few fines ash particles, producing a hard, cement-like mass. Its role in the stabilization process is to act as a pozzolanic and/or as a filler product to reduce air voids. A common application is of a cement/fly ash mixture (CF) is to stabilize coarse-grained soils that possess little or no fine grains.

(iii) The UCS and residual strength of soil fly ash specimens increase significantly due to addition of polypropylene fibers. The increase in UCS and residual strength are proportional to fiber content.

(iv) The effect of addition of polypropylene fibers is comparatively more on residual strength of soil fly ash specimens than the UCS.

(v) Normalized UCS and residual strengths are comparatively more in soil and soil fly ash specimens than fly ash specimens. For the specimens with fiber content of 1.5 % , UCS increase was nearly 13 times or 8 times the UCS of with 0% fibers, in soil and soil fly ash specimens respectively, compared to approximately 3 times in UCS of fly ash.

(vi) 1)The light (Standard Proctor) compaction characteristics of fly ash indicate that, the addition of fibers to the fly ash caused significant increase in the maximum dry density and reduction in the optimum moisture content. The increase in MDD ranges from 1.20 % to 8.40 % over the MDD of unreinforced fly ash.

(vii) The UCS and residual strength of fly ash specimens increase significantly due to addition of polypropylene fibers. The increase in UCS due to addition of polypropylene fibers is measured in the terms of Gain ratio (Gpf). The gain ratio ranges from 1.35 to 3.07.The best roasting temperature of fly ash was 950C and the best holding time was 3h.

(viii) When the addition of corn fiber was 0.2%, 0.3%, 0.4%, the porosity and water absorption of product were proportional to the addition of corn fiber, and were inversely proportional to the density.

(ix) When the addition of corn fiber was 0.4%, the highest porosity of product was 58.21%, and the highest water absorption of product was 49.31%.

(x) High-grade fly ash, when employed in substantial amounts, will greatly reduce the release of calcium hydroxide from concrete. In the case of underground conduit lines, this means that chemical corrosion of lead cable sheaths by free lime may be minimized.

(xi) For appreciable chemical effect, a minimum of 30 percent by weight, of the cementitious material of concrete should be high-grade fly ash; probably higher values, of the order OF 40 percent, should be employed in underground conduit-line sheathing

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