Studies of Cement and Crumbed Rubber mixed Fly Ash

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***Abstract*— To study the effect of method of curing, stabilized fly ash samples were cured under temperature and humidity controlled condition inside the laboratory for periods of 7, 14, 28 and 150 days. After curing these samples were immersed in water for 6-8 hours before conducting unconfined compression tests. Unconfined compression tests were carried out on statically compacted samples. The influence of following variables on the strength of stabilized and unstabilized fly ash was investigated.**

- Variation in density and moulding water content on stabilized and unstabilized fly ash.
- Variation in method of testing and curing.
- Type of stabilizers and its combination.
- Curing period.

The results of the unconfined compressive strength (UCS) of will affected by the different variables, present in this report.

Key Words :Stabilized, Unstabilized , Fly ash, Moulding
Sub area : Construction Technology
Broad Area : Transportation Engineering

I. INTRODUCTION

Road network is vital to the economic development, trade and social integration. It facilitates smooth conveyance of both people and goods. Size of the road network, its quality and access has a bearing on transport costs. Besides, road network promote specialization, extend markets and thereby enable exploitation of the economies of scale. Global competition has made the existence of efficient road transport and logistics systems in delivery chain an absolute imperative. Easy accessibility, flexibility of operations, door-to-door service and reliability has earned road transport an increasingly higher share of both passenger and freight traffic vis-à-vis other transport modes. Transport demand in India has been growing rapidly. In recent years this demand has shifted mainly to the advantage of road transport, which carries about 87 per cent and 61 per cent of passenger and freight transport demand arising for land based modes of transport (i.e. roadways and railways taken together) respectively. Road transport has grown despite significant barriers to inter-State freight and passenger movement compared to inland waterways, railways and air which do not face rigorous *enroute* checks/barriers. Given the importance of road network, it is vital to have comprehensive data on road infrastructure to assist in policy planning and investment decisions.

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II. LITERATURE REVIEW

The energy requirement has become high because of rapid growth of population and industries. To meet the energy requirement, thermal power plants are utilizing large quantity of coal for power generation. This result in the production of huge quantity, 140 million tons of fly ash as waste by-product. At present in India, only 3% to 5% of fly a produced annually is being utilized for manufacture of pozzolana cement, bricks, fine aggregate in concrete and construction of fills. The unutilized huge quantity of fly ash has drawn the attention of researchers to explore new strategies for bulk utilization. Fly ash embankment is one of the thrust areas to consume fly ash in bulk.

In this chapter, a brief review of work done in the recent past on fly ash, about its properties, characteristics, stabilization mechanism with cement and crumbed rubber and suitability of it as embankment fill are presented.

Fly ash is a heterogeneous material containing complex inter and intra-particle heterogeneity. It is a fine grained cohesionless material, normally grey in color. The color of fly ash depends on the presence of oxide of iron and carbon content. The specific gravity of fly ash is lower than that of normal soil solids, because of the presence of hollow spheres. Major constituents of fly ash are oxides of silica, alumina and iron, costituting about 95% by weight of its total composition. Other constituents are oxides of calcium, magnesium, sodium, potassium and sulphur. Oxides of sodium and potassium react with water and get converted into respective hydroxides. The reaction products, sodium hydroxide (NaOH) and potassium hydroxide (KOH) promote the formation of calcium silicate hydrate (C-S-H) jels, The presence of amorphous alumino silicates are responsible for the pozzolanic reactivity of fly ash. Because of this property and fineness of particles, fly ash reacts with calcium hydroxide in the presence of moisture and produces cementitious bonds. These bonds bind particles of fly ash together and form a hardened matrix. Presence or crystalline phases of silica posses very low reactivity with lime at ordinary temperature than amorphous silica.

In the present study, fly ash collected from a single electrostatic precipitator of Badarpur thermal power plant, New Delgi was used. Based on origin, composition and nature, fly ash can be classified as lignitic fly ash – class C or anthracitic fly ash – class F. Both classes of fly ash have pozzolanic reactivity in the presence of moisture. Fly ash utilized for present study of class F.

Though fly ash has wide variety of applications in civil engineering industries, its consumption is less compared to production. Bulk utilization of fly ash is possible when it is used as embankment fill. Fly ash possesses most of the important and favorable geotechnical characteristics for its usage as embankment fill. It is light weight material as compared to natural soils and hence are most suitable as embankment fill over soft compressible ground. A well compacted fly ash embankment would exert 60% of the pressure on soft foundation compared to the conventional coarse grained material.

Studies carriedout by various investigators indicate that fly ash is such a material which is less sensitive to water content during compaction. This is one of the most favorable property, even in wet condition the construction of fly ash embankment is possible. Compaction of fly ash can be done with rapid increase in density within five to six passes of using either static or vibratory roller, thus making the construction cost ejective.

As fly ash possess high angle of shearing resistance, greater stability of slopes could be achieved. The primal consolidation of fly ash embankment is practically over during construction stage itself because of its high rates of consolidation property. Above all its availability in abundant could be utilized effectively avoiding depletion of natural geo material wealth and offsetting problems like disposal and environmental pollution.

Fly ash has been used as embankment fill since long ago in England and United States. Some of the case histories (Faber and DiGioia , 1976) reveal that the fly ash embankment will provide light weight stable fill which will be stronger than most natural soils, due to age hardening characteristics of the material. The expressway connecting between Grand and Greenwood avenues in Waukegan, Illinois, USA was constructed over a fill embankment with 2.4 m of earth fill on the outside of the fly ash slopes.

Using fly ash and bottom ash, an access road embankment leading to a fly ash storage site in USA was constructed with provisions such as drainage blanket and drainage conduit etc. The slope of the embankment was 3 horizontal to 1 vertical, covered with 0.3 m of top soil on upstream and downstream slopes.

Leonards and Balley, 1982 used successfully untreated pulverized coal ash with no cementing qualities as structural fill material to support the foundation of a new precipitator for a power generating station in Indianapolis, Indiana, USA.

In india during early 70's fly ash embankment was constructed in Raichur district of Karnataka for a length of 1 km. Presently the approach embankments for Second NizamuddIn Bridge along NH 24 in New Delhi was constructed using pond ash. The embankment design incorporates use of ash and soil in layers, along with stone pitching over suitable soil cover on the sides.

Since fly ash is a non plastic, cohesionless silty and pozzolanic material, it is worthy to stabilize it before put in use as embankment fill. As reported by (Grey and Lin, 1972) properly compacted and stabilized fly ash has the requisite properties for use in load bearing fills or highway sub-base.

The research work carried out by Boominathan and Raju, (1996) reveals that lime treated fly ash can be effectively used as embankment fill due to the following reasons/merits:-

The factor of safety of stability of slopes increases by 30%.

Unconfined concessive strength is increased.

By compacting the fly ash using either smooth wheeled, pneumatic or vibratory rollers about 90-95% of MDD can be achieved easily. Use of stabilized fly ash is a solution to avoid/reduce erosion problem.

An experimental study has been carried out to evaluate the effect of various factors on strength of unstabilized and stabilized fly ash. Unconfined compression tests were carried out on fly ash samples prepared by static compaction technique to understand the strength behaviour in stabilized and unstabilized forms. Stabilizers such as cement and crumbed rubber were used to stabilize fly ash.

Unconfined compression tests were conducted on unstabilized fly ash to study the effect of variation in density and moulding water content on strength. For the stabilized fly ash the effects of following factors on strength characteristics were investigated:-

- Variation in density and moulding water content.
- Variation in method of curing.
- Variation in method of testing. .
- Type of stabilizer and their combinations.
- Period of curing.

was studied using lime and cement, Samples were prepared at two different dry densities namely maximum dry density (MDD) and (95% of MDD) state and the three moulding water contents namely optimum moisture content (OMC), and (OMC +3%).

To study the effect of method of curing, stabilized fly ash samples were cured under temperature and humidity controlled condition inside the laboratory for periods of 7, 14, 28 and 150 days. After curing these samples were immersed in water for 6-8 hours before conducting unconfined compression tests.

The details of theexperimental work carried out to meet the objective of the study are presented in this chapter. Unconfined compression tests were performed to understand the strength behaviour of unsterilized and stabilized fly ash. The present study covers the influence of various parameters on strength of fly ash such as:-

- Density and moulding water content,
- Method of curing and testing,
- Types of stabilizers and their combinations
- Curing period.

The details of the parameters and their combinations are presented in Table 7.

The experimental program includes the sequence of preparation of samples, curing the samples, conducting unconfined compression tests in accordance with the method of testing, and determination of post-test moisture content of the samples. Daily record of environmental favors such as maximum and minimum temperature, humidity and rainfall was maintained throughout the period of curing under natural environment.

To be implement for practical work :

Sr. No.	Type of curing & testing	Stabilizer (% by dry weight of fly ash)	Curing period (Days)	No. of samples
1	A	Cement 6%	7,14,28 & 150	4
2	A	Cement 6% & Rubber 5%	7,14,28 & 150	4
3	A	Cement 8%	7,14,28 & 150	4

4	A	Cement 8% & Rubber 5%	7,14,28 & 150	4
5	A	Cement 10%	7,14,28 & 150	4
6	A	Cement 10% & Rubber 5%	7,14,28 & 150	4
7	A	Cement 12%	7,14,28 & 150	4
8	A	Cement 12% & Rubber 5%	7,14,28 & 150	4

Values:

Properties	**Value**	**Remarks**
Specific Gravity	2.19	Low value of specific gravity due to the presence of hollow spheres.
Average grain size (mm)	(D50) = 0.028	
Liquid limit (%)	48 to 50	Determined by cone penetration method (IS 11196-1985) because cutting a groove using Casagrande's device was difficult.
Compaction characteristics by light weight (Standard Proctor)	MDD = 10.72 KN/m³ OMC = 36.5 %	The degree of compaction is not sensitive to water content, as the compaction curve is relatively flat.
Shear strength at (MDD – OMC state)	UCS = 65-75 KN/m² Axial strain at failure=2.25% From direct shear tests, C = 20 KN/m² ϕ = 37.5°	The sample failed with little bulging before failure.

CONCLUSION

The effect of density and moulding water content on the unconfined compressive strength (UCS) of stabilized sample. The strength gain is rapid for cement stabilized - laboratory cured - immersed and unimmersed samples. At 14 days the Up of cement stabilized fly ash was more than 50% of its 120 days UCS. The same trend holds good for naturally cured samples at MDD state.

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