

# APPLICATION OF FLY ASH IN STABILIZATION OF BLACK COTTON SOIL

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## ABSTRACT

*The black cotton soil which derived from Bessel rock of malwa region of often find not suitable for infrastructure projects such as highways ,railways, water reservoir ,reclamation etc,due to it's high plasticity and expansive nature. Extensive laboratory and field trials having carried out by various researchers and have shown promising results for application of such expensive soil after stabilization with additives such as sand,silt,lime and fly ash etc as fly ash is freely available in the vicinity of a thermal power plants, it can be used for stabilization of black cotton soil for various parts of civil construction. The present paper describes a study carried out to check the improvement in the in the properties of black cotton soil with edition of the fly ash in varying percentages to form a homogenous mass of a required physical properties. The paper describes a methodology adopted for placing the materials in layers of required thickness.*

**Key words :-** compaction, fly ash ,black cotton soil & stabilization

## INTRODUCTION

The Malwa Pleatue is mainly consist of basaltic traps of volcanic origin and the entire area is cover with highly expensive residual black cotton soil with liquid limit varying from 30% to 40% the soil by nature showing extensive expansion in black climate and during summer extensive shrinkage ,cracks exceeding 10 mm in width were notice on surface generally. The soil was not suitable in natural form for construction of civil engineering Projects due to following reasons.

1. Poor workability for compaction the construction schedule is critical and it is difficult to carry out the work during monsoon well optimum moisture content cannot be achieved .
2. High compressibility
3. In adequate shear strength for required slope stability

Instead of borrowing a suitable material from ling distance for stabilization it was proposed to use the fly ash that is available in nearest power plant .accordingly a detail literature review was carried out oon the subject that was followed by laboratory and field tests. This paper describe the properties of natural black cotton soil and stabilized soil with varying percentage of fly ash .The procedure adopted for mixing the soil with fly in the field and the test result having describe

## LABORATORY TESTS

Following laboratory tests have been carried out as per IS : 2720 . the tests were carried out both on mature soil in stabilize soil with fly ash collected from power plant of Grasin industries nagda ,which is in the vicinity of Indore (M.P.) all tests carried out in the civil engineering department's laboratory of medicaps institute of science technology, Indore(M.P.)

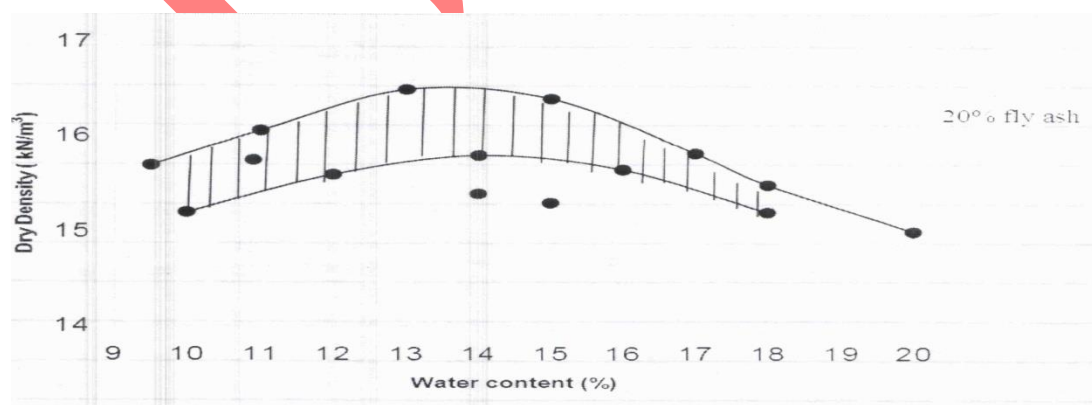
- i. Grain size distribution analysis
- ii. Atterberg limit test
- iii. Proctor compaction test
- iv. Unconfined compression test
- v. Permeability test

The soil was mixed with fly ash in varying proportion by volume .mixing was thoroughly carried out manually and tests were conducted as per the standard procedure mention as per IS code .

The liquid limit and plastic limit of soil with various percentage of fly ash given in table 1.

s.no.	Soil + fly ash	Liquid limit (%)	Plastic limit (%)	Plasticity index
1.	Only soil	33	18	15
2.	Soil + 10% fly ash	30	16	14
3.	Soil + 20 % fly ash	28	15	13
4.	Soil + 25% fly ash	27	13	14
5.	Soil + 30 % fly ash	25	13	12

The proctor tests carried out is summarized in fig 1.



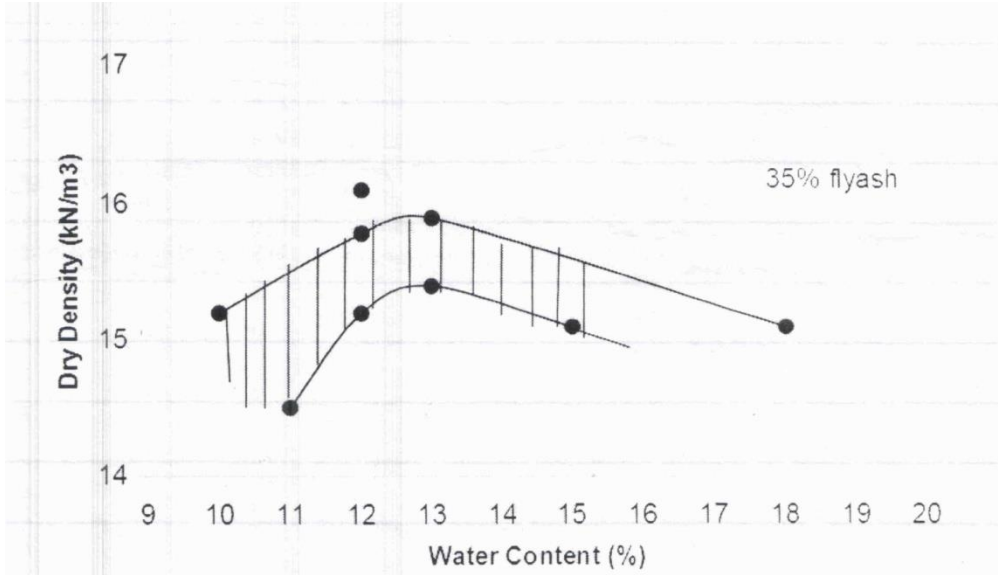


FIG 1. TYPICAL RELATIONSHIP BETWEEN DRY DENSITY AND WATER CONTENT

The grain size distribution of the natural & fly ash is shown in fig.2

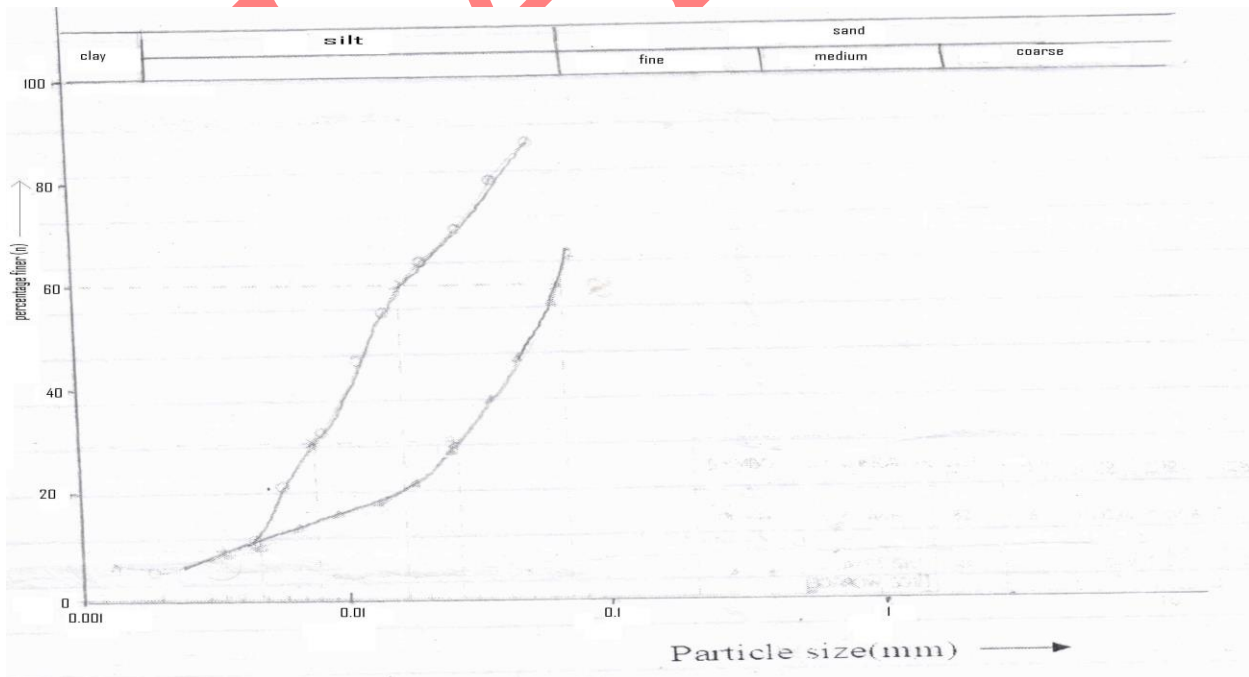


FIG : GRAIN SIZE ANALYSIS OF BORROW SOIL AND FLY ASH

Unconfined compression strength tests have been carried out on cylindrical sample of 35 mm dia. & 25 mm height prepared using miniature compaction apparatus with 15 % moisture content .the sample were allowed to cure by air drying for 15 days the samples were tested with a constant strain rate of 0.625 mm per min. the result are given in table 2.

Description	Sample dimension before tests in Dia (mm)	Height of sample (mm)	Wet density (kn/m <sup>3</sup> )	Water content (%)	Dry density (kn/m <sup>3</sup> )	Unconfined compressive strength(kn/m <sup>2</sup> )
Soil	33	70.20	18.51	2.61	18.04	2697
Soil + 10%flyash	33	70.20	18.46	2.34	17.74	3533
Soil + 20%flyash	33.10	70.30	17.53	2.22	17.15	2850
Soil + 25 %flyash	33.20	70.35	16.47	1.80	16.17	2805
Soil + 30%flyash	33.25	70.40	15.40	1.64	15.13	21.65

#### DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH OF SOIL FLY ASH MIXTURE.

The permeability of natural & stabilized soil was measured using a falling head test in the laboratory and results are given in table 3.

sr.no.	Soil mixture	Permeability (m/sec)
1.	Natural soil	13.6*10 <sup>-7</sup>
2.	Soil with 10% fly ash	9.14*10 <sup>-7</sup>
3	Soil with 25% fly ash	6.9*10 <sup>-7</sup>

#### PERMEABILITY TEST RESULTS

### FIELD TESTS

Field trails were carried out by construction an environment measuring 4 meter wide and 25 meter long ,keeping height about 600 mm .each layer of 200 mm loose thickness was placed which varying fly ash content the layers were placed such that fly ash layer is sandwiched between 2 soil layers as per detail given table no. 4

Fly ash content (%)	Thickness of layers in (mm)		
	Bottom soil layer	Middle fly ash layer	Top soil layer
10	90	20	90
20	80	40	80
25	75	50	75
30	70	60	70

**TABLE 4. THICKNESS OF LAYERS**

After spreading layers of require thickness a disc harrow equipment was used for uniform mixing of soil and fly ash. Then the required quantity of water was manually spread over the layer to achieve the require moisture content of 50% the compaction is carried out with a 12 ton smooth wheal roller. Each layer of mix prepared as above was compacted with 8 passes of the roller the material after compaction was find to be quite hard and no significant penetration of the roller wheel was noted during last 2 passes. After compaction the thickness of layer was find to be 120 – 130 mm it was initially 200mm loose thickness.

To check the adequacy of compaction following controlled tests were carried out on each of the compacted layer.

1. In-site density by core cutter.
2. Moisture content
3. Light cone penetration tests

The result of the density observed based on core cutter is summarized in table 5 it's shows that the maximum dry density is obtain for moisture content between 12-14%. Among various % of fly ash used the density is found 25 % fly ash in the mix .on penetration were also carried out from the compacted embankment. Typical results are given in fig.3

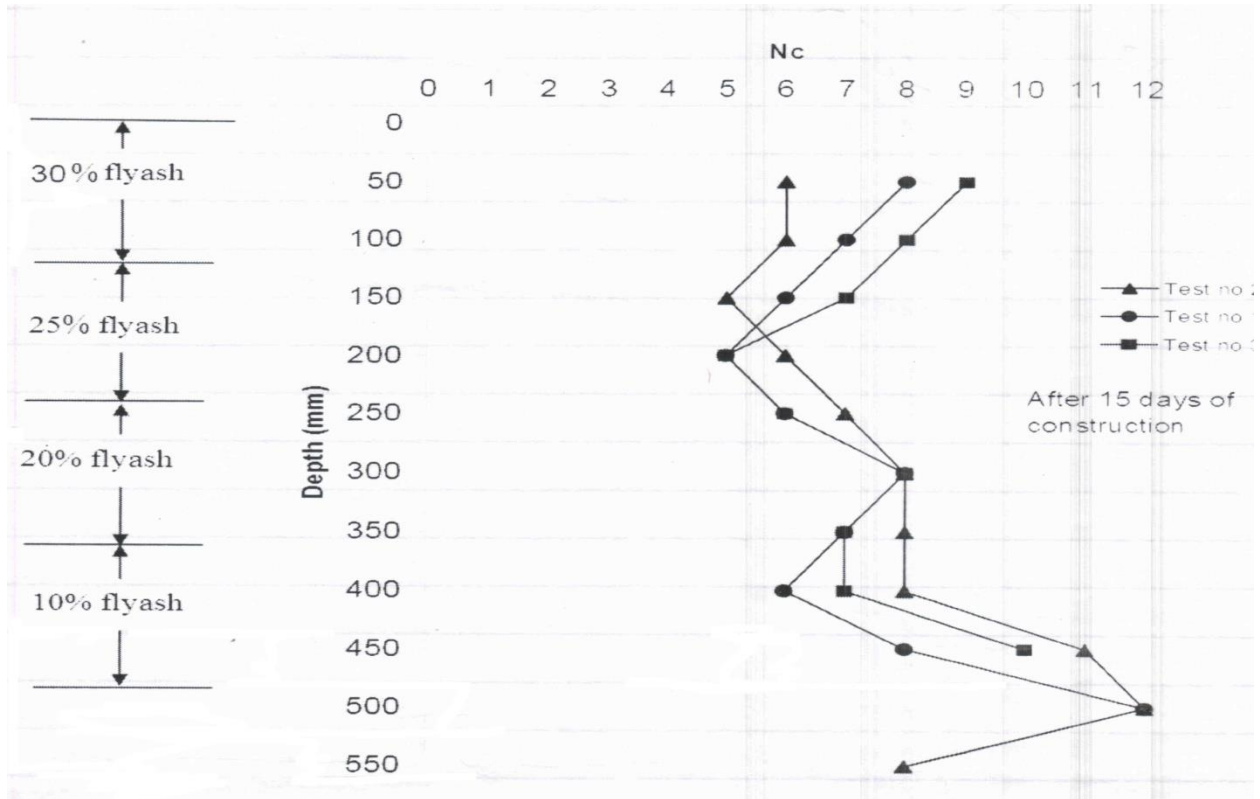


Fig 3 . results of light one penetration tests

Layer	Ash Content	b = bulk unit wt.(kn/m3) w= moisture content (%) d= dry unit wt in .(kn/m3)	(i)	(ii)
I	10	b w d	16.8 10.2 15.3	16.6 13.0 14.9
ii	20	b w d	19.0 14.2 16.7	19.9 15.0 17.5
iii	25	b w d	18.5 17.0 15.6	17.9 18.0 15.1

iv	30	b	17.6	17.6
		w	11.9	14.0
		d	15.5	15.6

Table 5 : DENSITY AND MOISTURE CONTENT OF COMPACTED LAYERS BY CORE CUTTER

## CONCLUSIONS

Based on laboratory and field tests following conclusions having made

As the natural soil has generally high plasticity (liquid limit >40) it was difficult to use directly for construction however the test carried out with different proportion of fly ash indicated that the workability and dry density are maximum with 25 % fly ash the natural soil used in construction shall be dried with moisture content below 7 % . it has also observed that placing three layers with fly ash layer sandwich between soil layers and mixing them with disc : hallow is conveniently workable .

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