An Experimental Study on Rock Flour Fly ash of Bentonite

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Abstract— Most countries with arid and semi-arid climate will have problems with expansive soils such as cracking and breaking up of pavements, lightly loaded structures, canal liners etc., by consolidating under the load and by changing volumetrically along with seasonal moisture variation. These expansive soils in India are available in the form of Bentonite deposits. Bentonite is highly plastic thixotropic clay rich in Montimorillonite clay mineral. Bentonite is well known for its suitability as molding material in pottering and utensils, drilling mud to support the vertical sides of bore holes, and in grouting technology. Despite several favorable properties of Bentonite for the above presence which exhibit large volume changes upon wetting and drying due to the presence of Montimorillonite clay mineral with expandable lattice structures. In view of huge cyclic volumetric changes, these deposits are discouraged for construction activity. However, when it is inevitable to construct structures or run a highway, a canal or a pipeline in these deposits, suitable remedial techniques to combat the damages caused by them are to be adopted. Damages caused by expansive soils are controlled by proper application of stabilization agents like Fly Ash and Rock Flour will be added to Bentonite. In the present work, attempts were made to study the influence of Rock Flour and Fly Ash when mixed with Bentonite in reducing the expansive nature. For this purpose, Rock Flour and Fly Ash in different proportions by weight of Bentonite is mixed with Bentonite and the geotechnical properties of these mixes were Found. The results indicate that the plasticity properties of Bentonite were significantly modified upon the addition of Rock Flour and Fly Ash & they noticeably influence of Compaction, Strength, Swell and Consolidation properties of Bentonite soil.

Key words: Rock Flour Fly ash, Bentonite

I. Materials Used

A. Bentonite:

Bentonite is formed by weathering of volcanic ash, rich in Montimorillonite mineral. Such soils are widely spread in arid regions like Rajasthan of India, Africa, Several states in the USA, Mexico and other parts of the world. Bentonite is highly plastic and thixotropic which enabled its wide use as drilling mud to stabilise bore holes and sites of trenches. It is also used to reduce the side friction in pile driving and to reduce the negative skin friction, for the construction of diaphragm walls and in grouting as impermeable line. Sodium saturated Bentonite are prepared and used for most of the above applications due to its superior plasticity and gelling properties.

B. Rock Flour

Stone crushing in India is basically a labor intensive small scale industry, where most of the operations are performed manually. During the stone crushing operation, large size stone, mined from quarries in the size range of 200–300 mm, is crushed to smaller usable sizes, generally 6, 12, or 25 mm.

C. Fly Ash

In many countries, coal is the primary fuel in thermal power plant and other industry. The fine residue collected from field is known as Fly Ash and considered as a waste material. The fly ash is tossed out of either in the dry form or mixed with water and discharged in slurry into locations known as ash ponds. Production of Fly Ash worldwide is huge and increasing day by day, by which it is causing hazardous to our environment.

II. Properties of Additives Added:

The Properties of Additives are fly ash and Rock Flour added to Bentonite clay their properties as follows.

III. Experimentation

Rock Flour and Fly Ash materials are cheaply available in our market, the Experimentation results shown in the below graphs and Tables decreases the swelling pressures, plasticity Index and Increase the density and Shear strength of the Soil with increase % of additives added.

Properties	Properties	Bentonite Clay	Rock Flour	Fly Ash
Grain Size Distribution	Gravel (%)	0	9	9
	Sand (%)	0	81	81
	Silt (%)	29	10	10
	Clay (%)	68	-	
Atterberg's Limits	Liquid Limit (%)	218	-	
	Plastic Limit (%)	51	-	
	Shrinkage Limit (%)	12	-	
	Plasticity Index (%)	167	Non Plastic	Non Plastic
Compaction Characteristics	MDD(g/cc)	CH	1.87	1.87
	OMC (%)	2.81	5	5
Unconfined Compressive Strength MDD(kpa)				1.26
Swell Characteristics	Differential Free Swell Index	30	-	450(%)

	Swell Potential (%)		-	21
	Swell Pressure(Kpa)		-	400
Consolidation Properties	Coefficient of Consolidation C_v(cm2/sec)		-	9.81*10^ -4
Activity of Clay			3.4	3.4

Table 1: Properties

A. Variation of Plasticity Index vs. % Additive Added

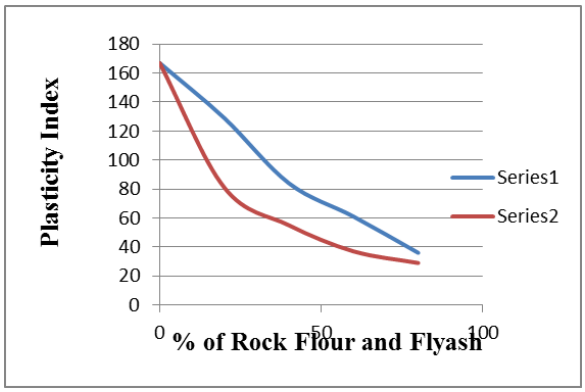

Fig. 1: Variation of Plasticity Index vs. % Additive Added

(%) Rock Flour /Fly ash	Plasticity Index(PI)	Plasticity Index(PI)
0	167	167
20	81	129
40	55	84
60	37	61
80	29	36

Table 2: Variation of Plasticity Index vs. % Additive Added

B. Variation of Maximum Dry density with % of additive added

(%) Fly Ash	(%) Bentonite	Optimum Moisture Content(OMC)	Maximum Dry Density(MDD)
0	100	30	1.26
20	80	24	1.30
40	60	22	1.31
60	40	20	1.33
80	20	17	1.34

Table 3: Variation of Maximum Dry density with % of additive added

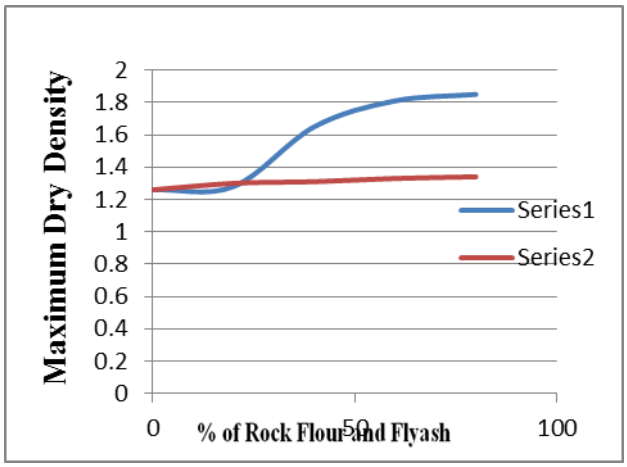

Fig. 2: Variation of Maximum Dry density with % of additive added

Increases the density of the Bentonite with an addition of Rock flour and Fly ash.

C. Variation of swell pressure with % of additive added

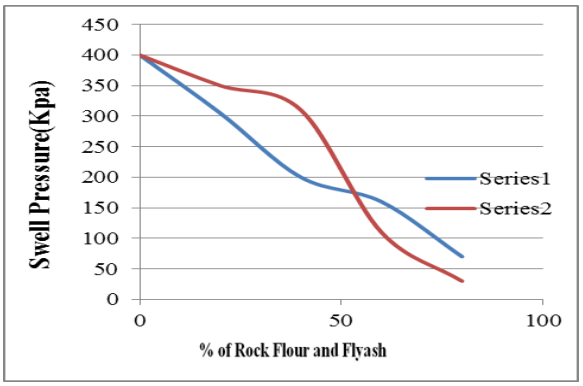

Fig. 3: Variation of swell pressure with % of additive added

(%) Fly Ash & Rock Flour	Swell Pressure(KPa)	
0	400	400
20	350	305
40	310	200
60	110	160
80	30	70

Table 4: Variation of swell pressure with % of additive added

D. Variation of Unconfined Compressive Strength with % of additive added

(%) Fly Ash & Rock Flour	UCC (KPa)	
0	50	50
20	100	120
40	75	135
60	60	125
80	30	60

Table 5: Variation of Unconfined Compressive Strength with % of additive added

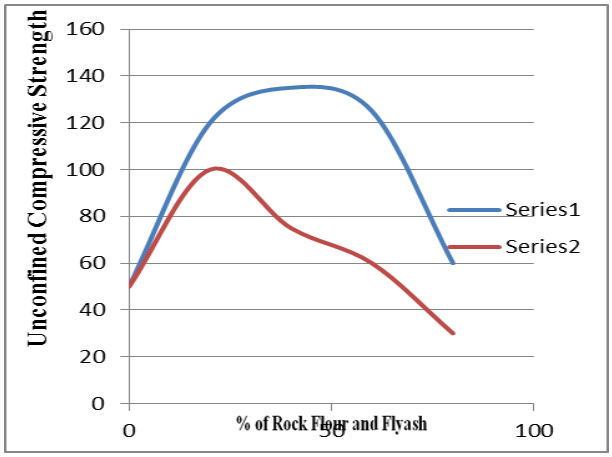

Fig. 4: Variation of Unconfined Compressive Strength with % of additive added

E. Variation of Free Swell Index with % of additive added

(%) Fly Ash & Rock Flour	Free Swell Index	
0	455	455
20	260	340

40	210	235
60	105	174
80	30	91

Table 6: Variation of Free Swell Index with % of additive added

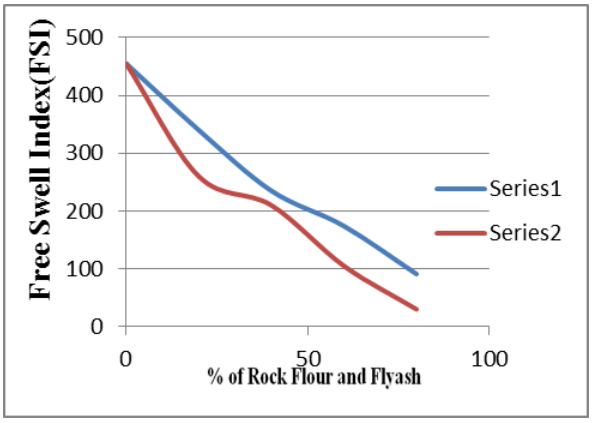

Fig. 5: Note: From all Graphs
Series 1 - Rock Flour Series 2 - Fly ash

IV. CONCLUSION

The following conclusions are drawn on the basis of experimental study,

1) The plasticity properties of the Bentonite are significantly modified by the addition of Rock Flour and Fly Ash. Plasticity index reduced by 78% for Rock Flour and 83% for Fly Ash, up to 80% replacement of Bentonite therefore Fly Ash has more influence on plasticity properties of Bentonite.
2) The effect of Rock Flour and Fly Ash on Optimum Moisture Content of Bentonite is similar but the effect of Rock Flour on Maximum Dry Density is more compared to Fly Ash. So Rock Flour has more influence on the compaction properties of Bentonite than Fly Ash.
3) Differential Free Swell Index is reduced considerably when Fly Ash is added to Bentonite than compared to that of Rock Flour as for Fly Ash it is reduced by 93% but for Rock flour it is reduced by 80% up to 80% replacement of Bentonite.
4) The addition of Rock Flour and Fly Ash decreases the swell pressure values of Bentonite for all the mix proportions, but there is a marked influence on reduction of Swell Pressure values when Fly Ash is added than compared to that of Rock Flour that is, by 93% for Fly Ash and 83% for Rock Flour up to 80 % replacement of Bentonite.
5) Unconfined compressive strength of Bentonite also gets influenced upon addition of Rock Flour and Fly Ash.
6) In general around 40% of Rock Flour and 20% of Fly Ash have considerable influence on the properties of Bentonite.
7) Hence the waste materials Rock Flour and Fly Ash obtained from Granite Crushing plant and Thermal Power Plant respectively can be effectively used to improve properties of Bentonite and also control the environmental pollution.

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