Effect of Polypropylene and Fly Ash on Properties of Soil

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Abstract :
In the present work, strength of black cotton soil are improved by using fly ash and Polypropylene plastic fibers. The purpose of this investigation is to identify and quantify the influence of fibers variables (content and length) on performance of fiber reinforced soil-fly ash specimens. The result of investigation showed that the fiber inclusions increased the strength and properties of soil-fly ash specimen such as Increase in CBR values for soil, Improve the unconfined compressive strength of soil fly ash mixtures.

1. Introduction

A series of laboratory tests are carried out. Polypropylene fibers are randomly mixed with black cotton soil with different aspect ratio of 2 mm and 3 mm. These proportions of fibers are taken as 0.5% and 1.0% by the weight of dry soil. Two different percentage of fly ash taken as 10% and 15% by dry weight of soil. The Present work showed that when the Polypropylene fibers and fly ash mixed with soil then it increased the properties of soil, Increase in CBR values for soil by addition of fibers, Improve the unconfined compressive strength of black cotton soil.

2. Material And Methodology

2.1 Materials Used

Soil : Locally available Black cotton soil is used.
Fly Ash : It is obtained from Thermal Power Plant, Eklahare, Nasik. It is taken as 10% and 15% by dry weight of soil.
Polypropylene fibres : These are obtained from dolphin float Pvt Ltd, Pune. These fibers used with aspect ratio of 2mm and 3mm. They are taken as 0.5% and 1.0% by the dry weight of soil.

Table 2.1: Properties of Black Cotton Soils Sample Obtained.

Sr.No	Properties	Value
1	Coefficient of uniformity (Cu)	2.44
2	Coefficient of curvature (Cc)	0.51
3	Specific gravity (G)	2.53
4	OMC	17.48%
5	MDD	1.65 gm/cc
6	Free swell index	100%
7	Liquid limit	84%
8	Plastic limit	33%

Table 2.2: Properties of Plastic (Polypropylene) fibers

Sr.No	Properties	Value
1	Length	5,10 & 15mm
2	Aspect ratio	2.0 & 3.0mm
3	Density	0.90-0.91
4	Tensile strength, MPa	400-600
5	Elongation at break	15-25
6	Specific gravity	0.91
7	Nature	Inert
8	Heat resistance	≤130
9	Burning point (^{0}c)	590

Table 2.3: Chemical Composition of Fly ash

Silicon dioxide, SiO_2	38-63
Aluminium oxide, Al_2O_3	27-44
Ferric oxide, Fe_2O_3	3.3-6.4
Calcium oxide, CaO	1.3-5.0
Potassium oxide, K_2O	0.0.4-0.9
Sodium oxide, Na_2O	0.07-0.43
Magnesium oxide, MgO	0.01-0.5

Table 2.4: Physical Property of Fly ash

Specific Gravity	2.16
Loss of Ignition	1.90
Moisture	0.30
Swelling index	37

2.2 SAMPLE PREPARATION

1) All the soil samples are compacted at their respective MDD and OMC, corresponding to the modified proctor compaction tests.
2) The General expression for the total dry weight W of a soil fly ash fiber mixture is
W = Ws + Wf + Wp Where Ws is wt of dry soil, Wf is wt of FA and Wp is wt of PPF.
3) The different values adopted in the present study for the percentage of fiber reinforcement are 0.5% and 1.0% by weight of soil. The different values of ratio of AR are 2mm & 3mm.
4) The different values taken for percentage of FA mixed with soil are 10% and 15% by wt of soil. The combination of fibers and FA are firstly mixed into the air-dried soil by hand, making sure that all the fibers and FA are mixed thoroughly, a fairly homogenous mixture is obtained, and then the required water is added.

Table 2.5: Detail of Soil-Fly Ash-PPF Mixtures for Tests Conducted

Soil (%)	FA (%)	PPF (%)	AR (mm)
100	0	0	0
89.5	10	0.5	2
89.5	10	0.5	3
89	10	1.0	2
89	10	1.0	3
84.5	15	0.5	2
84.5	15	0.5	3
84	15	1.0	2
84	15	1.0	3

3. Result And Discussions

3.1 OPTIMUM MOISTURE CONTENT (OMC)

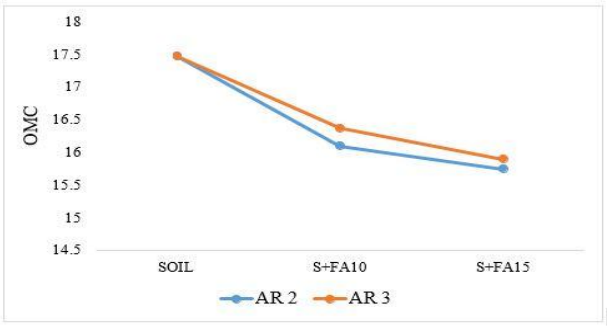
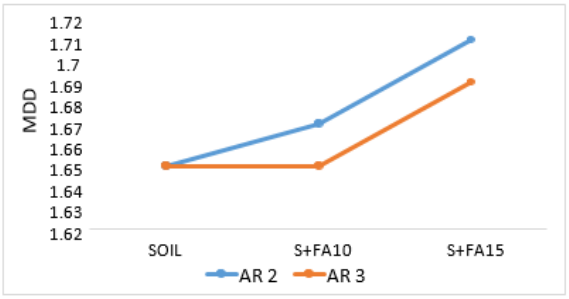


Figure 3.1.1OMC with 0.5% PPF with 2,3 AR & 10%, 15% FA**Figure 3.1.2**OMC with 1% PPF with 2,3 AR & 10%, 15%FA

Figure 3.1.1 shows Variation of OMC of soil with 0.5% PPF with 2 & 3 AR & 10% & 15% FA and Figure 3.1.2 shows Variation of OMC of soil with 1.0% PPF with 2 & 3 AR & 10% & 15% FA. OMC decreases with the increase in percentage of FA & PPF. Addition of FA & PPF reduces the water content of soils to the OMC level. OMC of soil decreased from 17.48 to 15.75 in case of AR 2 & OMC of soil decreased from 17.48 to 15.90 in case of AR 3 with the addition of FA & PPF. OMC were determined in accordance with IS 2720 Part VII-1980

3.2 MAXIMUM DRY DENSITY (MDD)



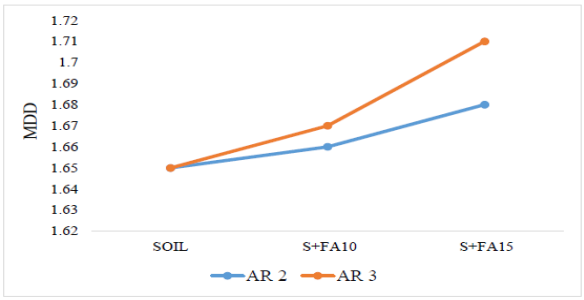
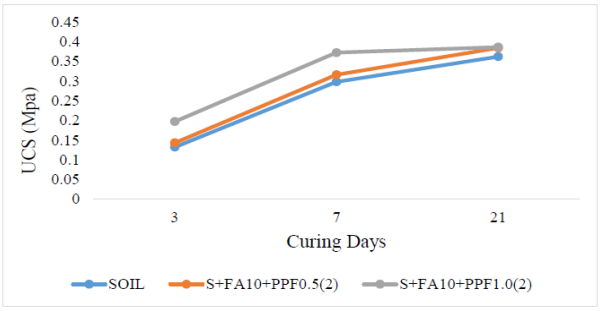


Figure 3.2.1MDD with 0.5% PPF with 2,3 AR & 10%, 15%FA**Figure 3.2.2**MDD with 1% PPF with 2,3 AR & 10%, 15%FA

Figure 3.2.1 shows Variation of MDD of soil with 0.5% PPF with 2, 3 AR & 10%, 15% FA. Figure 3.2.2 shows Variation of MDD of soil with 1.0% PPF with 2, 3 AR & 10%, 15% FA. dry density of soil increases with the increase in percentage of FA & PPF. Maximum dry density of soil increases from 1.65 to 1.71 with 15% FA & 0.5% PPF with AR 2. Maximum dry density of soil increases from 1.65 to 1.71 with 15% FA & 1.0% PPF with AR 3. As the percentage of FA increase till 1.0% of PPF the strength of soil increase as the silica content in the soil increases and soil get the cementitious property which increase the densification of soil. MDD were determined in accordance with IS 2720 Part VII-1980

3.3 UNCONFINED COMPRESSIVE STRENGTH



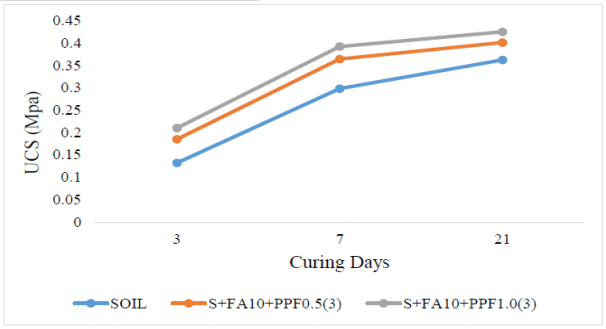
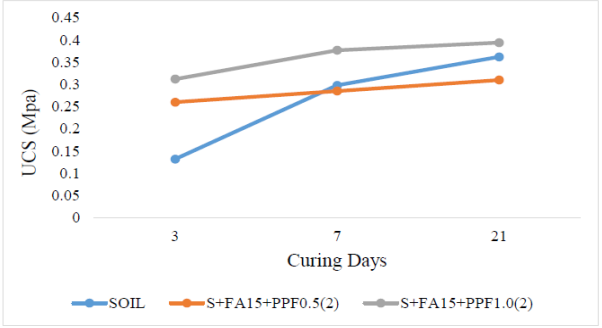


Figure 3.3.1UCS with 10% FA, 0.5%, 1% PPF & 2 AR**Figure 3.3.2**UCS with 10% FA, 0.5%, 1% PPF & 3 AR

Table 3.3.1 UCS of soil with 10% FA & AR 2, AR 3

Curing Days	3 days	7 days	21 days
SOIL	0.132	0.298	0.362
S+FA10+PPF0.5(2)	0.143	0.316	0.384
S+FA10+PPF1.0(2)	0.197	0.372	0.386
S+FA10+PPF0.5(3)	0.186	0.364	0.401
S+FA10+PPF0.5(3)	0.21	0.392	0.425

Figure 3.3.1 shows Variation of UCS with 10% FA, 0.5% & 1.0% PPF with 2 AR. Figure 3.3.2 shows Variation of UCS with 10% FA, 0.5% & 1.0% PPF with 3 AR. UCS of soil sample increases with the increase in percentage of FA & PPF with curing time. UCS was increases from 0.298 to 0.392 for 7 days curing with the addition of 10% FA & 0.5% PPF with AR 3.



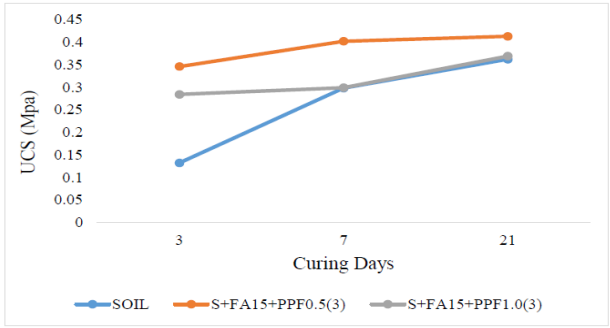


Figure 3.3.3UCS with 15% FA, 0.5%, 1% PPF & 2AR**Figure 3.3.4** UCS with 15% FA, 0.5%, 1% PPF & 3AR

Table 3.3.2 UCS of soil with 15% FA & AR 2, AR 3

Curing Days	3 days	7 days	21 days
SOIL	0.132	0.298	0.362
S+FA15+PPF0.5(2)	0.26	0.285	0.31
S+FA15+PPF1.0(2)	0.312	0.377	0.394
S+FA15+PPF0.5(3)	0.346	0.402	0.413
S+FA15+PPF0.5(3)	0.284	0.299	0.369

Figure 3.3.3 shows Variation of UCS of soil with 15% FA, 0.5% & 1.0% PPF with 2 AR. Figure 3.3.4 shows Variation of UCS of soil with 15% FA, 0.5% & 1.0% PPF with 3 AR. UCS was increases from 0.298 to 0.402 for 7 days curing with the addition of 15% FA & 0.5% PPF with AR 3.

3.4 CALIFORNIA BEARING RATIO TEST

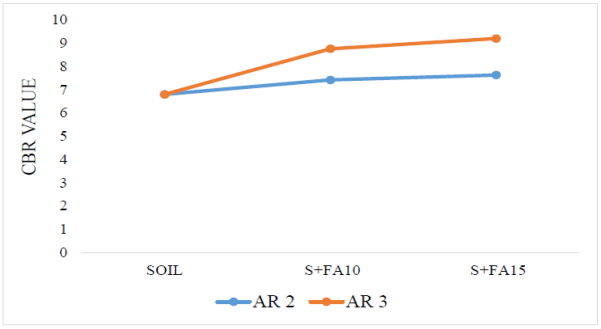


Figure 3.4.1 CBR with 10%, 15% FA, 0.5%,1% PPF & 2,3 AR

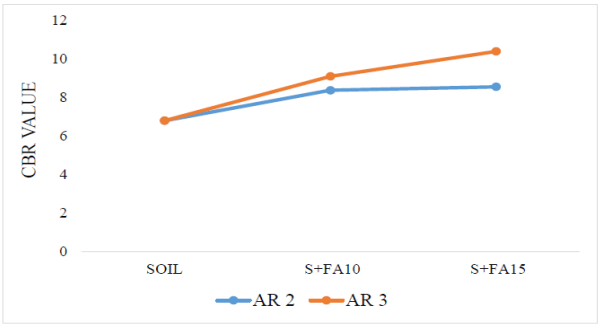


Figure 3.4.2CBR with 10%, 15% FA, 0.5%,1.0% PPF & 2,3 AR

Table 3.4.1 Unsoaked CBR for 0.5% & 1.0% PPF with 10%, 15% FA

Sample	AR 2	AR 3
SOIL	6.8	6.8
S+FA10%+PPF0.5%	7.42	8.76
S+FA15%+PPF0.5%	7.63	9.2
S+FA10%+PPF1.0%	8.36	9.1
S+FA15%+PPF1.0%	8.56	10.4

Figure 3.4.1 shows variation in CBR Unsoaked Test with 2.5 mm Penetration for different proportion of FA & 0.5% PPF with AR 2mm, 3mm. unsoaked CBR of soil sample was increases with the increase in percentage of FA & PPF. In these case, CBR was increases from 6.8 to 7.63 for 15% FA, 1.0% PPF with AR 2 & 6.8 to 9.2 for 15% FA, 1.0% PPF with AR 3. Maximum CBR observed was 9.2 for 15% FA, 0.5% PPF with AR 3.

Figure 3.4.2 shows variation in CBR Unsoaked Test with 2.5 mm Penetration for different proportion of FA & 1.0% PPF with aspect ratio 2mm, 3m. CBR was increases from 6.8 to 8.56 for 15% FA, 1.0% PPF with AR 2 & 6.8 to 10.4 for 15% FA, 1.0% PPF with AR 3. Maximum CBR observed for these case was 10.4 for 15% FA, 1.0% PPF with AR 3.

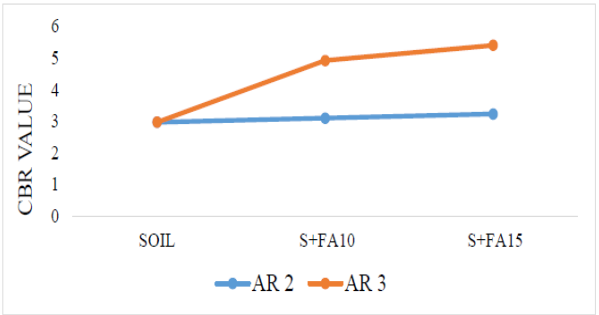


Figure 3.4.3CBR with 10%, 15% FA, 0.5%,1% PPF & 2,3 AR

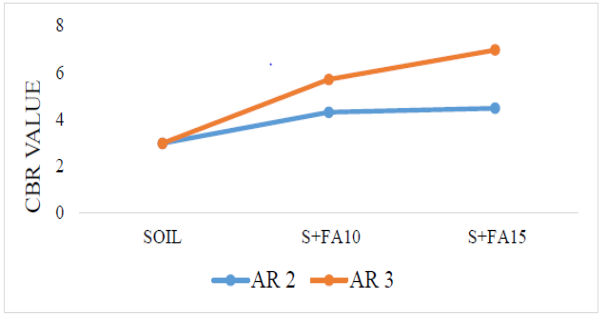


Figure 3.4.4CBR with 10%, 15% FA, 0.5%,1% PPF & 2,3 AR

Table 3.4.2 Soaked CBR for 0.5% & 1.0% PPF with 10%, 15% FA

Sample	AR 2	AR 3
SOIL	2.97	2.97
S+FA10%+PPF0.5%	3.1	4.92
S+FA15%+PPF0.5%	3.23	5.4
S+FA10%+PPF1.0%	4.3	5.7
S+FA15%+PPF1.0%	4.47	6.96

Figure 3.4.3 shows variation in CBR Soaked Test with 2.5 mm Penetration for different proportion of FA & PPF with AR 2mm, 3mm. soaked CBR of soil sample was increases with the increase in percentage of FA & PPF. CBR was increases from 2.97 to 3.23 for 15% FA, 0.5% PPF with AR 2 & 2.97 to 5.4 for 15% FA, 0.5% PPF with AR 3. Maximum CBR observed for these case was 5.4 for 15% FA, 0.5% PPF with AR 3

Figure 3.4.4 shows variation in CBR Soaked Test with 2.5 mm Penetration for different proportion of FA & PPF with AR 2mm, 3mm. CBR was increases from 2.97 to 4.47 for 15% FA, 1.0% PPF with AR 2 & 2.97 to 6.96 for 15% FA, 1.0% PPF with AR 3. Maximum CBR observed for these case was 6.96 for 15% FA, 1.0% PPF with AR 3

4. Conclusion

It was Observed that combination of FA and Polypropylene fibers are reinforced in soil is good ground improvement technique, Specially in engineering projects on weak soils. It improve the strength of soil thus increase in bearing capacity of soil. It filled void spaces between soil up to some extent, this prevents water from entering into the soil and hence helps the soil from losing its strength. It helps in reducing the soil volume change due to change in temperature or moisture content. It reduced the cost of work as well as energy consumption, It is light weighted, easy handled & economy of use etc. The optimum fiber content achieve maximum CBR values of reinforced soil. UCS & CBR value also increases with addition of FA & PPF. It concluded that Properties of black cotton soil was improved with addition of FA upto 15% by the dry weight of soil. PPF & FA inclusion into soil is effective in soil stability only when they add with proper variables (content and length) upto 1.0% PPF with 3 Aspect ratio.

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