Stabilization of Black Cotton Soil using Brick Dust and Fly Ash

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Published in IJIRMPS (E-ISSN: 2349-7300), Volume 11, Issue 2, March-April 2023

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***Abstract*: This research paper aims to improve the engineering properties of black cotton soil by adding fly ash and brick dust. Tests were conducted on raw black cotton soil and mixed soil with different percentages of fly ash and brick dust. The results show that the mixed soil had enhanced properties. Soil stabilization can be achieved using this technique. Keywords include soil stabilization, fly ash, brick dust, and standard proctor test.**

Introduction

Soil stabilization refers to the process of improving the engineering properties of soil to make it more stable and durable. This is typically done to improve the load-bearing capacity of soil for construction or reduce soil erosion. This process is found using additives like fly ash, rice husk, lime, portland cement, brick dust etc.

Materials Used

The materials used in this experiment include black cotton soil collected from Barkher, Madhya Pradesh, fly ash from Betul, MP, and brick dust from Amdar, MP. The raw black cotton soil was obtained from a farm field in Barkher, dried, and shattered for testing. Its properties include a liquid limit of 42.5%, plastic limit of 25%, plasticity index of 17%, optimum moisture content of 14.1%, maximum dry density of 1.65 g/cc, California Bearing Ratio of 2.27%, and free swell index of 43.8%. These properties indicate that the black cotton soil is unsuitable for many types of construction due to its low shear strength and bearing capacity.

Properties of Raw Black Cotton Soil

The black cotton soil we are using here comes from a farm field of Barkher, MP. It was dug from below the surface around 1.5 to 2 feet. Then it was dried and shattered to perform the experiments.

Sr. No.	Properties	Values
1	Liquid Limit	42.5%
2	Plastic Limit	25%
3	Plasticity Index	17%
4	Optimum Moisture Content	14.1%
5	Maximum Dry Density	1.65 g/cc
6	California Bearing Ratio	2.27%
7	Free Swell Index	43.8%

Experiments in Detail

The project aims to improve the properties of black cotton soil by adding fly ash and brick dust in varying proportions. Different samples of black cotton soil were mixed with different percentages of fly ash and brick dust to prepare test specimens. Laboratory tests were conducted to determine the index and engineering properties of both the raw and modified soil. The tests were performed on varying percentages of fly ash and brick dust (5%, 10%, 20%, and 25% each by dry weight of soil). The results were compared to those of the raw black cotton soil to evaluate the effectiveness of the modifications. The maximum dry density was found at 40% of the mixture, consisting of 20% fly ash and 20% brick dust.

Parameters	**UOM**	**Fly ash & brick dust mixture percentage**				
		0%	**10%**	**20%**	**40%**	**50%**
Liquid limit	%	42.5	40.3	37.9	33.5	29.8
Plastic limit	%	25	23.6	22.2	20.2	18.9
Plasticity Index	%	17	16	14.8	13.1	11.5
Optimum Moisture Content	%	14.1	13.6	13	11.9	11
Maximum Dry Density	g/cc	1.65	1.69	1.72	1.77	1.75
California Bearing Ratio	%	2.27	2.53	3.26	4.02	4.22
Free Swell Index	%	43.8	42.9	39	35.6	32.7

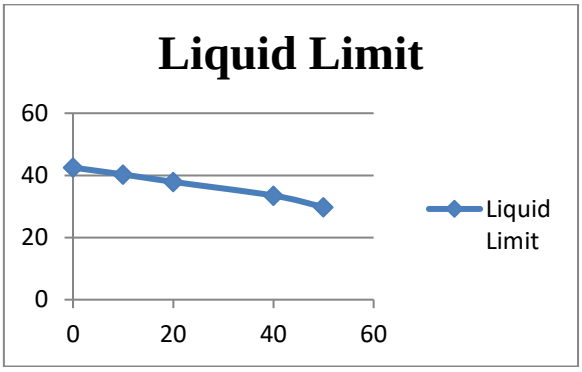
***Note :** The percentages mixture contain brick dust and fly ash in equal proportions, i.e. 50% mixture contains 25% of brick dust and fly ash each, same applies to all other mixture percentages.

Liquid Limit Test of soil sample after mixing

A series of liquid limit tests are performed on black cotton soil with varying percentages of fly ash and brick dust, and the corresponding test results are demonstrated below.

Content	**Liquid Limit (%)**
Raw Soil	42.5
10% mixture	40.3
20% mixture	37.9
40% mixture	33.5
50% mixture	29.8

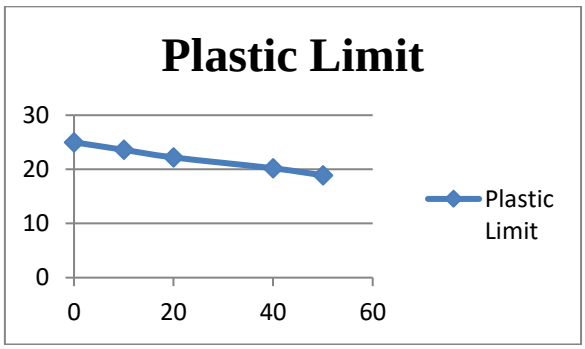
The results are quite visible here; with addition of the mixture upto 50%, the liquid limit decreases from 42.5% to 29.8%.



Plastic Limit Test of soil sample after mixing

Content	Plastic Limit (%)
Raw Soil	25
10% mixture	23.6
20% mixture	22.2
40% mixture	20.2
50% mixture	18.9

The results are quite visible here; with addition of the mixture upto 50%, the plastic limit decreases from 25% to 18.9%.

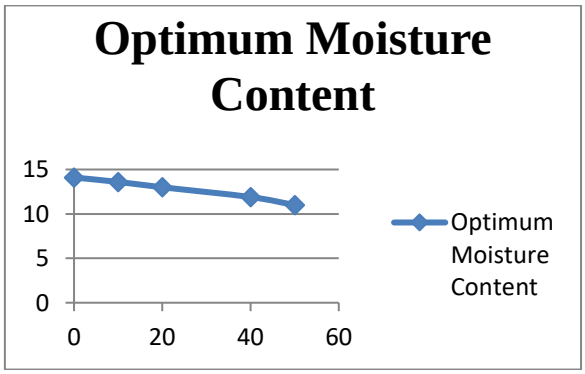


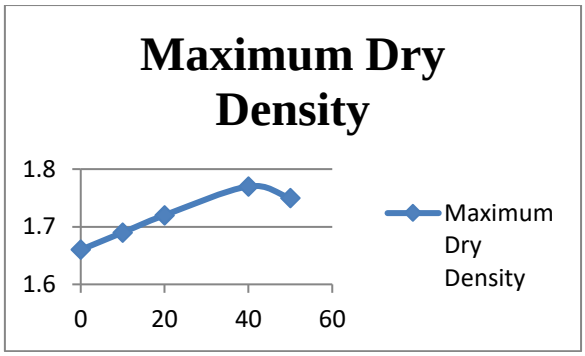
Standard Proctor Compaction Test of soil sample after mixing

A series of plasticity index tests are performed on black cotton soil with varying percentages of fly ash and brick dust, and the corresponding test results are demonstrated below.

Content	Optimum Moisture Content (%)	Maximum Dry Density (gm/cc)
Raw Soil	14.1	1.66
10% mixture	13.6	1.69
20% mixture	13	1.72
40% mixture	11.9	1.77
50% mixture	11	1.75

The OMC keeps on decreasing as we add on the mixture, but the MDD attains its maximum value (**1.77** g/cc) at 40% mixture, further addition of the mixture decreases its value.





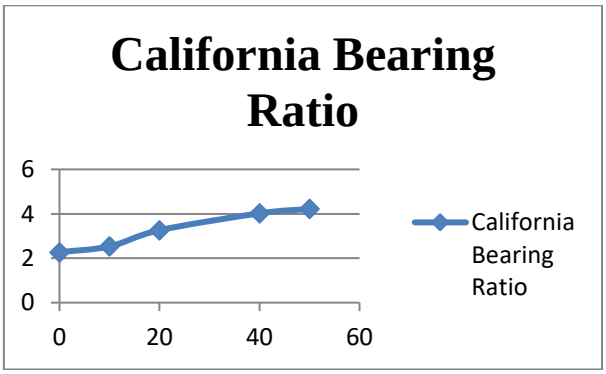
California Bearing Ratio Test of soil sample after mixing

The CBR is calculated by dividing the load required to achieve 2.5 mm of penetration by the load required to achieve the same penetration in a standard crushed rock material. The ratio is then multiplied by 100 to give the CBR value.

The following results are obtained from laboratory for CBR (California bearing ratio) value of sample soil with varying percentage of the mixture.

Content	California Bearing Ratio (%)
Raw Soil	2.27
10% mixture	2.53
20% mixture	3.26
40% mixture	4.02
50% mixture	4.22

The results can be seen that on increasing the percentage of the mixture, the CBR value increases from 2.27 to 4.22



Conclusion

With increase in percentage of fly ash and brick dust the compaction parameter i.e. MDD (maximum dry density) is increased upto 1.77g/cc at 40% of mixture and then decreases at 50% of mixture. So it is concluded that for effective soil stabilization at 40% of mixture gives better result. Other OMC (optimum moisture content) is found out to be minimum (11%) at 50% mixture content. With increase of the mixture the CBR values are also increased considerably and is found to be maximum (4.22) at 50 % of mixture content.

From the above discussion, it is inferred that addition of brick dust and fly ash to black cotton soil is an appreciable impact on the compaction parameters and bearing capacity of the soil. This mixture of brick dust and fly ash can be used for stabilization of pavement, sub grade embankment and other fields of civil engineering according to the requirements for black cotton soils.

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