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A REVIEW ON THE STABILIZATION OF BLACK COTTON SOIL USING DIFFERENT MATERIALS

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Abstract - *There are different types of soil materials available with different properties and stability conditions. Black cotton soil is among those and considered unsuitable for the construction of structures on it due to its undesired properties like high plasticity, compressibility, and low bearing strength. This paper presents a review of available research done to stabilize and increase the bearing capacity of black cotton soil using different stabilizers and their effect on the maximum dry density, optimum moisture content and California bearing ratio is compared to get a best combination of available admixtures.*

Key Words: Maximum dry density (MDD), Optimum moisture content (OMC), California bearing ratio (CBR), Black cotton soil (BCS), RBI Grade 81, Stabilization.

1.INTRODUCTION

About 20% of India's area is covered with expensive soils including some parts of Indian states like Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, and Karnataka (Mckeen 1998). Expensive soils are not considered good in construction due to their swelling and shrinkage behavior, which causes the failure of structure. Failure occurs due to change in the volume of soil which creates the destructing movements in the overlaying structure. Available solution for this problem is to stabilize the soil to reduce its swelling behavior and to increase its bearing capacity. There are many researches available regarding the stabilization of expensive soil by the addition of different chemicals and waste materials that can cause problems in the nature. Examples are fly ash from the coal burning, stone dust from the crushers, and brick powder from the kiln and many more which requires a dumping land and due to their fine particle size there are possibilities of these particles to reach the respiratory system of living beings causing the breathing problems. The best way is to utilize such waste material in the soil stabilization. (Sharma and Singh 2020) analyzed the use of waste material for soil stabilization and provided the modelling for the relations in between CBR, MDD, and OMC by performing experiments on certain sampling proportions derived using Minitab software. (Patil et al) conducted an experiment to stabilize black cotton soil with RBI Grade 81 with soil having low CBR value (<3%) and got the result with an increase of 81.4% in CBR, which is unexpected desired level of CBR for pavement design. Addition of RBI Grade 81 makes soil stiff, increases MDD and reduces OMC. (Malik and Priyadarshee) has conducted an experiment with black cotton soil using different non-cementitious materials and obtained the optimum values as fly ash 10.2%, rice husk 5.9% and stone dust 13.4% to get the optimum MDD as 1.547gm/cc and OMC 23.7%. (Reddy et al) has performed an experiment to stabilize black cotton soil using lime and brick powder (Brick kiln dust) and obtained the optimum values as lime 20% and brick powder 80%. The CBR value increase was 11.83% and corresponding MDD and OMC were 1.73gm/cc & 29% respectively at an optimum amount of lime and brick powder. (Lkeagwuani et al) conducted an experiment to check the stabilization of black cotton soil using lime and sawdust ash and obtained the optimum percentage as 4% & 16% respectively with an increase in CBR value as 9.5% and corresponding MDD and OMC as 1.45gm/cc and 28.8%. (Mazhar et al) did an experimental work on black cotton soil using alkali-active material like binder, fly ash, and slag and obtained the optimum values as 5, 70, and 30 % respectively and get the MDD as 1.91gm/cc and OMC 18.8%. (Singh and Vasaikar) has performed an experiment for BCS Stabilization using lime and got their results as 15.20% increase in CBR value, 1.5gm/cc MDD and 12% OMC. (Etim et al) has performed an experiment to check the strength of BCS using lime and iron ore tailings admixture and obtained an optimum percent of 8% for both and got their results as increase in CBR value as 50%, MDD 1.56gm/cc and OMC 23.50%. (Sharma et al 2020) conducted a test on the soil form north region of India and added different proportion of RBI Grade 81 in it, an optimum value was obtained at 8% of RBI Grade 81 with 92% of soil which gave a CBR of 49.8%. There are many such research available and results are almost similar for the same type of soil and same proportion of the additives, main motive of this review is to find the best additive for the expensive soil like BCS that give an optimum value for the higher CBR and

MDD results as compared with the results obtained in case of parent material.

2. ANALYSIS

For experimental comparison CBR, MDD and OMC were considered as main parameters because when we determine the strength of soil, these tests are commonly performed. A summary of the studied researches is shown in the table 1. This summary is showing the title of the research and various optimum additives added to increase the strength of soil. Corresponding CBR, MDD and OMC values are also given in the table.

Table -1: Details of test results for different researches studied.

Sr no.	Author	Title	Additive	CBR	MDD (g/cc)	OMC
1	Patil et al	Design of flexible pavement on black cotton soil stabilized with RBI grade 81	RBI grade 81	81%	1.464	24.50%
2	Malik & Priyadarshee	Compaction & swelling behavior of black cotton soil mixed with different non - cementitious material	Different non-cementitious material			
			Fly ash -10.2%	-	1.579	22.60%
			Rice husk - 5.9%	-	1.459	28.60%
			Stone dust-13.4%	-	1.602	20%
3	Reddy.et.al	lime stabilization of black cotton soil with lime & brick powder mix as subbase material	Lime: -20% & Brick powder: -80%	11.82%	1.73	29%
4	Lkeagwarni et al	stabilization of black cotton soil using sawdust & lime as a sub- grade	Sawdust & Lime 16% & 4%	9.50%	1.45	28.80%
5	Mazhar	stabilization of expensive clay by fiber- reinforced alkali-activated binder & experimental investigation & prediction modelling.	Alkali-activated materials	-	1.91	18.80%
6	Singh & Vasaikar	Stabilization of black cotton soil using lime	Lime: - 6%	15.20%	1.5	12%
7	Etim et.al.	Stabilization of black cotton soil with lime & iron ore tailings admixture.	Lime and Iron ore tailings admixture. (8% both)	50%	1.5	23.50%

It has been seen in the results that higher CBR value is obtained in case of chemical admixture like RBI grade 81 and there was considerable increase in CBR in case of waste materials like fly ash, saw dust and brick dust. This is because chemical admixtures include enough amount of binder in it and this binder is helpful in increasing the contact strength of soil particles. Only disadvantage with such admixtures is their high cost which makes it suitable to choose the waste materials like fly ash to use for increasing the strength of soil. Figure 1 is showing a graph for the increase in CBR value for different researches with different materials used as additives.

It is clear from the graph that RBI grade 81 is giving the highest CBR increase of about 80% and then the mixture of iron ore tailings and lime is on the 2nd place with about 50% increase in the CBR value. Increase in the CBR value is also seen in case of non-binding materials like saw dust, fly ash, and brick powder which encourage their use as a soil strength improver instead of dumping these materials which causes problems in the land as well as in the air due to their fine sized particles.

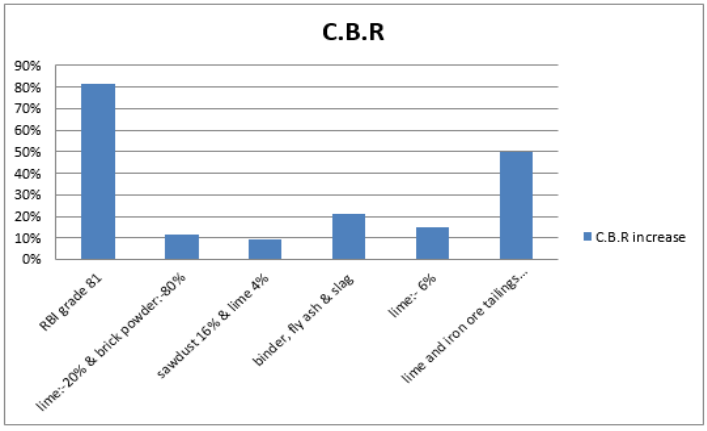

Fig -1: CBR increase using different additives in black cotton soil.

Figure 2. Is showing the values of MDD and OMC for the optimum value of additives used in the different studies.

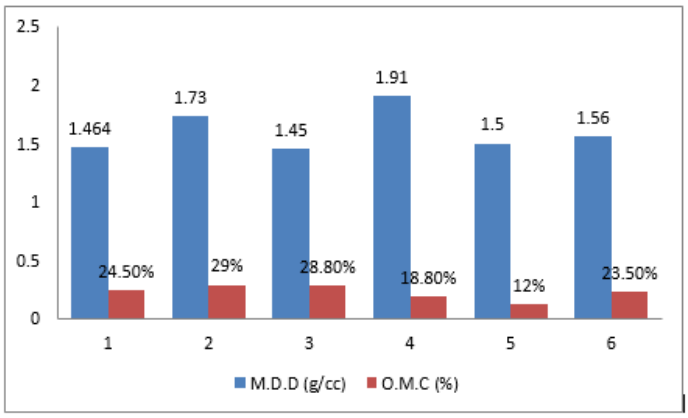

Fig -2: MDD and CBR values obtained for different additives.

5th bar in the figure is showing the results for lime as an admixture, in this case MDD of 1.5 g/cc is obtained at an OMC of 12% only which is least among all. It is observed that the value of OMC increases by 10 to 15% if we use any other additive with lime.

3. CONCLUSIONS

In this review some important points are concluded as following:

1. In case of chemical admixtures, RBI Grade 81 is most suitable with a huge increase in the CBR value of about 80%. In other test, 8% CBR was achieved as an optimum value for the CBR of about 50%. Only disadvantage associated with it is the high cost, but where we need to increase the CBR value rapidly without considering money as main factor, RBI grade 81 can be used.
2. In case of waste material additives with binder as lime, the mixture of lime and iron ore tailings are giving a higher CBR increase of about 50%.
3. In case of waste material additives without any binder, fly ash with an optimum value of 10.2% was giving a MDD result of 1.58 g/cc at an OMC value of 22.6%, Rice husk ash (5.9%) was giving a MDD result of 1.46 g/cc at an OMC of 28.6%, and stone dust (13.4%) was giving a MDD result of 1.6 g/cc with an OMC of 20%. These values were obtained on the same soil with different additives and thus the outcome shows that the stone dust is giving a higher maximum dry density value with least OMC. When both fly ash and stone dust waste are available, we can choose the stone dust for higher strength of soil.
4. In case of only binder material, lime at an optimum value of 6% was giving a CBR increase of 15.2% with MDD as 1.5g/cc and OMC as 12%. Which shows that use of lime can give the max. dry density of the soil with lesser time and at lesser value of moisture content. It also gives an idea to use such materials in the regions where water is in deficiency as low amount of water is needed in the process.
5. This whole research was based on the limited resources which can be expended using different materials which are being invented as suitable for the soil stabilization. An ideal additive is that which is considered as a waste in the nature and easy to get but can be an important reinforcement in the soil to increase its strength.

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