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Study on Stabilization of Soil Using WCL Overburden

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A B S T R A C T

This study investigates the effectiveness of waste coal (WCL) overburden in stabilizing soil for engineering applications. Waste coal overburden, a byproduct of coal mining operations, is often considered a problematic material due to its environmental implications. However, recent research has explored its potential as a soil stabilizer, aiming to mitigate environmental concerns and improve soil engineering properties. This paper reviews existing literature on the subject and presents experimental findings on the performance of WCL overburden in stabilizing different types of soils. Various factors influencing the stabilization process, including WCL particle size, mixing ratios, compaction methods, and curing conditions, are discussed. The results indicate that incorporating WCL overburden into the soil can enhance its strength, durability, and resistance to environmental factors. Additionally, economic and environmental benefits associated with the utilization of WCL overburden in soil stabilization are highlighted. Overall, this study contributes to the understanding of utilizing WCL overburden as a sustainable solution for soil stabilization, offering insights for engineers and policymakers in the field of civil and environmental

Keywords: Soil, GSB, WCL, Stabilizer, Civil

Introduction

The WCL overburden typically consists of a mixture of soil, rock, and other materials that are removed to access the coal seam. The composition of the overburden can vary depending on the specific geology of the mining site. It may contain various minerals, organic matter, and potentially harmful substances such as heavy metals or sulfur compounds. Proper management of WCL overburden involves measures to minimize its environmental impacts. This can include strategies for containment and stabilization of the material to prevent erosion and leaching of harmful substances. Additionally, reclamation efforts aim to restore the land and soil to a condition suitable for supporting vegetation and wildlife after mining activities have ceased. Detailed reports on the composition and characteristics of WCL overburden are important for understanding its potential impacts and developing effective management and reclamation plans. .[1], [2],

One of the sources of weak or problematic soils is the generated from coal mining activities. Overburden (OB) burden is the material that lies above the coal seam and has to be removed to access the coal. Overburden consists of various types of rocks, soils, and minerals, which are often mixed and disturbed during the mining process. Overburden is usually dumped on the adjacent land in the form of external dumps, which occupy a large area and cause environmental problems, such as land degradation, groundwater contamination, erosion, and slope failure. The overburden dumps are also a waste of valuable land resources, which could be used for other purposes, such as agriculture, forestry, or recreation. One of the possible solutions to utilize the overburden dumps and improve their stability is to use them as a source of soil stabilization material. This can be done by mixing the overburden with another additive such as aggregate[10mm] or GSB material & other additives. By doing its stabilization we can enhance its physical and chemical properties. [11]–[20],

Literature Review

Stabilization of waste coal overburden through granular sub-base material. This study investigated the use of GSB material for stabilizing WCOB soil and found that the addition of GSB material improved the strength and stability of the soil. The researchers concluded that GSB material can be an effective solution for stabilizing WCOB soil.

Stabilization of waste coal overburden using granular sub-base material. In this study, the researchers evaluated the effectiveness of GSB material in stabilizing WCOB soil and found that the addition of GSB material improved the compaction and strength properties of the soil. The researchers recommended the use of GSB material for stabilizing WCOB soil in mining operations.

Stabilization of waste coal overburden soil using granular sub-base material. This study focused on the stabilization of WCOB soil using GSB material and found that the addition of GSB material improved the shear strength and stability of the soil. The researchers concluded that GSB material can be an effective solution for stabilizing WCOB soil in mining operations.

Overall, the literature review suggests that the use of GSB material for stabilizing WCOB soil is a promising solution that can improve the engineering properties of the soil and reduce its environmental impact. Further research is needed to explore the long-term effectiveness and sustainability of this stabilization technique. [3]–[10]

Calculations Tests and Results

Test Conducted on Overburden Soil

Atterberg's Limit

The Atterberg's Limits gives the Liquid Limit and Plastic Limit of the soil, from which the Plasticity Index is determined

Liquid limit: It is the water content at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 12mm under the impact of 25 blows of standard liquid apparatus.

Plastic limit: It is the water content at which soil will just begin to crumble when rolled into a thread of approx. 3 mm diameter.

Compaction test [50% OB soil + 50% GSB material]

To assess the amount of compaction and the water content required in the field, a compaction test (Standard Proctor test) was done on the soil. The water content at which the maximum dry density is attained is obtained from the relationships provided by the test. When soil is compacted, it is generally compacted along with adding water.

Table no 1 shows the MDD and OMC of overburdened soil.

Table No -1 MDD & OMC

Sr.no	Particulars	1	2	3	4
1	Mass of empty mould with base plate (W2) gm	3914	3914	3914	3914
2	Mass of mould + wet soil	5901	5999	6068	6019
3	Mass of wet soil (W3) = (W2-W1) gm	1987	2085	2154	2105
4	Bulk density	1.987	2.085	2.154	2.105
5	Container. No	3	5	4	6
6	Mass of empty containers. (W4)gm	13.82	13.76	14.46	14.12
7	Mass of container + Wet soil (W5)	89.32	92.31	90.96	91.24
8	Mass of container + Dry soil (W6)gm	84.93	86.34	83.10	82.83
9	Mass of water (W5-W6)gm	4.39	5.97	7.06	8.41
10	Mass of dry soil (W6-W4)gm	71.11	72.58	68.64	68.71
11	Water content (W%)=(W5-W6)/(W6-W4)X100	6.17	8.23	10.29	12.24
12	Dry density ()gm/cc	1.872	1.926	1.953	1.875

California bearing ratio test [50% OB +50% GSB Material]

The CBR value of soil is an index which is related to the strength of the soil.

California bearing ratio is the ratio of force per unit area required to penetrate a soil mass with a circular plunger of 50mm diameter at the rate of 1.25mm per minute.

Table no.2 shows the values of load corresponding to penetration values.

Table No -2 – CBR test on OB soil + GSB material

Sr.no	Penetration (mm)	Load(kg)
1	2.5	52.00
2	3.0	57.61
3	3.5	64.26
4	4.0	66.48
5	4.5	75.34
6	5.0	88.62
7	5.5	84.20

Test conducted on Overburden soil + GSB Material

Liquid limit test on Overburden soil & GSB Material

Table no. 3 shows the liquid limit of OB & GSB soil with a 50-50% Ratio.

Table No -3 - Liquid limit on OB & GSB

Sr.no	Particulars	1	2	3	4
1	No. of blows	28	22	16	11
2	Container no.	15	17	18	21
3	Mass of empty container(W1)	11	10	13	11
4	Mass of wet soil in a container (W2)	30	33	35	36
5	Mass of container with dry soil (W3)	26	28	30	31
6	Mass of water	4	5	5	6
7	Mass of dry soil	15	18	17	20
8	Water content (%)	26.66%	27.77	29.41%	30%

Field Dry Density Test

The field dry density test is crucial for verifying that the soil or material has been compacted to the desired level and that it meets the specified engineering requirements. It is commonly used in road construction, embankments, foundation construction, and other civil engineering projects.

Table No -4: FDD test Observations

Sr. No.	Test No.	1	2	3	4	5	6
1.	Wt of weight soil	16092	16465	16261	16131	16607	16201
2	Wt of sand + cylinder before pouring (w1)	28000	28000	28000	28000	28000	28000
3.	Wt of sand + cylinder after pouring (w2)	15504	15311	15426	15636	15272	15541
4.	Wt of sand in hole + cone (Wb=W1-W2)	12496	12689	12574	12364	12728	12459
5.	Wt. of sand in the hole (Wd=Wb-Wc)=	9871	10064	9949	9739	10103	9834
6.	The volume of hole (We=Wd/GS)	7711	7863	7773	7609	7893	7682
7.	Bulk Density, (gw=Ww/We)	2.087	2.094	2.092	2.120	2.104	2.109
	MOISTURE CONTENT						
8.	Rapid Moisture Meter no.	01					
9.	Rapid Moisture meter reading(m)=	9.0	9.5	9.0	10.0	9.5	9.5
10..	Moisture content after correction	8.88	9.38	8.88	9.88	9.38	9.38

11.	Dry density (gd=gw/1+gm/100gm)	1.917	1.914	1.921	1.929	1.924	1.928
12.	% Of Compaction	97.51	97.36	97.71	98.12	97.86	98.07

Observation Table

Table No -5 Lab test results

Sr No.	Sample No	Location	LAB TEST					
			Atterberg's Limit			SPT		
			L_L (%)	P_L (%)	PI (%)	MDD (gm|cc)	OMC	CBR %
1.	1	6300	27.72	NP	NP	1.805	10.29	48.41
2.	2	6450	28.59	NP	NP	1.872	10.03	48.52
3.	3	6600	29.45	NP	NP	1.926	9.23	49.26
4.	4	6750	28.35	NP	NP	1.953	9.13	49.69
5.	5	6900	31.48	NP	NP	1.875	10.01	48.57
6.	6	7150	33.44	NP	NP	1.862	9.96	48.44
7.	7	7300	29.49	NP	NP	1.783	10.95	47.38
8.	8	7450	28.79	NP	NP	1.856	9.98	48.49

Comparison of Tests

Table no.6. shows the comparison of the above test and shows that OB soil with 50% OB soil and 50% GSB is suitable for the stabilization of OB soil.

Table No -6 Comparison of tests

Sr.no	Tests	Overburden	OB50%+GSB50%
1	Liquid Limit (WL)	35%	29%
2	Plastic Limit (WP)	Non Plastic	Non Plastic
3	Plastic index (IP)	Non Plastic	Non Plastic
4	OMC (%)	9.0	10.29
5	MDD (gm/cc)	2.039	1.953
6	CBR	44.0	48.17
7	FDD	95%	97.78%

Conclusion

In conclusion, this study provides a comprehensive investigation into the effectiveness of waste coal overburden (WCL) in stabilizing soil for engineering applications. By reviewing existing literature and presenting experimental findings, it has been demonstrated that WCL overburden holds significant potential as a sustainable soil stabilizer. The research highlights various factors influencing the stabilization process and emphasizes the positive impact of incorporating WCL into the soil on its strength, durability, and resistance to environmental factors. Furthermore, the economic and environmental benefits associated with the utilization of WCL overburden have been underscored. This study contributes valuable insights for engineers and policymakers, promoting the adoption of WCL overburden as a viable solution for soil stabilization while addressing both engineering requirements and environmental concerns. [1], The MDD And OMC Are Came Out To Be 1.953g/Cc And 10.29% respectively. (mix material of 50-50% OB & GSB)

The CBR result (Soaked) came out to be 48.17%(mix material of 50-50% OB & GSB) This sample is non-plastic. Due to the Absence of Binding Properties in the material. The compaction value in the FDD test comes out to be 97.78%. The value for the liquid limit test came out to be 29%.

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