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A Study on Stabilization of Soil Using Corn Cob Granules and Glass Powder

K. Divya[1], K. Ramani[2], K. Lense[3], J. Rani[4], M. Yogiswara Rao[5]

[1]Assistant Professor, Department of Civil Engineering, VSM College of Engineering, Ramachandrapuram – 533255
[2,3,4,5] UG Students, Department of Civil Engineering, VSM College of Engineering, Ramachandrapuram - 533255

ABSTRACT
The stabilizing soil using corn cob granules and glass powder innovative, sustainable materials. Corn cob granules by product of agricultural processes, offer eco-friendly properties such as biodegradability and improved water drainage, while glass powder, produced from recycled waste glass, provides enhanced strength and reduce the plasticity of soil. The study focuses on the combined effect of these materials on improving soil properties like compressive strength, shear strength and moisture retention. Laboratory experiments, including compressive demonstrate that the inclusion of both materials significantly enhances the mechanical behaviour of the soil. The finding indicates that using corn cob granules and glass powder is a viable, cost-effective solution for environmentally friendly soil stabilization with potential applications in road construction, foundation strengthening and sustainable infrastructure. Further research is suggested to refine the mixture ratios and evaluate long-term performance in field.

INTRODUCTION

SOIL STABILIZATION

It is a general term for any physical, chemical, biological or combined method of changing a natural soil to meet an engineering purpose. Improvements include increasing the weight bearing capabilities and performance of in-situ subsoil, sands and other waste materials in order to strengthen the soil.
The prime objective of soil stabilization is to improve the California bearing ratio of in-situ soils by 4 to 6 times. The other prime objective of soil stabilization is to improve on-site materials to create a solid and strong sub-base course. In certain regions of the world, typically developing countries and now more frequently in developed countries, soil stabilization is being used to construct the entire road. Originally, soil stabilization was done by utilizing the binding properties of clay soils, cement based products such as soil cement, and/or utilizing the “rammed earth” technique (compaction) and lime. Some of the renewable technologies are: enzymes, surfactant , bio-polymers, synthetic polymers, co- polymer-based products, cross-linking polystyrene acrylic polymers, tree resins,calcite, sodium chloride, magnesium chloride and more. Some of these new stabilizing techniques create hydrophobic surfaces and mass that prevent road failure from water penetration or heavy frosts by inhibiting the ingress of water into the treated layer.

MATERIAL USED

Black Cotton Soil

In India deposition of Black cotton soil is very good and prosperous for farmers. All the basic amenities

of life i.e. food, clothes and house have been fulfilled by the soil, without soil.it is just next to impossible to think about life on the earth. But on the other side in Civil Engineering Aspects Black cotton soil is very troublesome and problematic and hazardous due to its characteristics. Because of its high swelling and shrinkage characteristics, the black cotton soil has been a challenge to the Engineers. The black cotton soil is very hard when dry but loses its strength completely when in wet condition. Soil deposits in nature exist in a extremely erratic manner producing there by a infinite variety of possible combination which will affect the strength of the soil and the procedure to make it purposeful. So, in the particular case of black cotton soil with wide range of challenges associated with the construction All the black cotton soils are not expensive soils and all the expensive soil are not black in colour. These soils possessed high strength in summer and decreased rapidly in winter. Swelling and shrinkage of expansive soil cause deferential settlement resulting in severe damage to the foundation, buildings, roads, retaining structures and canal linings. This study deals with the formation of black cotton soil, characteristics of black cotton soil, obstacles to construct structures in black cotton soil, causes of structures failed in soil, remedial measures to construct the structures in black cotton soil.

Glass Powder

In now a day it is being very much common to use waste materials and different kind of fibers in the strengthening of soil and soil stabilization. To improve the engineering properties of soil we are going for mixing of broken glass powder in the soil as we know that it has the various properties like it is a totally non- biodegradable material and it is also a totally inert material and can be useful to enhance the various road building elements strength and it also cannot get degraded in a very simple manner it has it's degradation phenomenon which is very much similar to the degradation of natural rocks. It is a non-crystalline material which is also amorphous, and it is also very much hard& brittle and transparent as well. The glass which are generally used and are familiar to everyone are windows and drinking vessels, and the glass material which is available readily is sodalime glass having 75% of CaO, silica and nitrogen oxides as well. The glass powder which is going to be used as a prime material has been collected through the various sources like various soft drink bottles which are generally being used by the people mostly in summers in the stores and shops and after collection of these glass bottle. These bottles are being properly washed and then dried after that these were broken down manually with the help of hammer into very much smaller sizes and after that process it has been passed through 400 number sieves to attain glass in the form of powder and the second useful material which are going to be used in this process was the clayey soil which has been collected at the ground.

Corncob Granules

Corn cob granules are a by-product of corn processing. They are lightweight, porous, and have a high surface area. Corn cob granules can help improve soil structure by increasing the pore space, reducing soil density, and enhancing water infiltration. The high surface area and porosity of corn cob granules allow them to retain water, reducing soil erosion and runoff. The granules can help hold soil particles together, reducing soil erosion and sedimentation. Corn cob granules can provide a favorable environment for plant growth by improving soil aeration, water availability, and nutrient cycling. Corn cob granules are a renewable, biodegradable, and non-toxic material. Soil stabilization is a crucial aspect of geotechnical engineering and environmental management, as it helps to enhance the physical and mechanical properties of soils, thereby preventing erosion, landslides, and infrastructure damage. Conventional soil stabilization methods often rely on synthetic materials, chemical additives, or energy-intensive processes, which can be costly, environmentally detrimental, and unsustainable. In recent years, there has been a growing

interest in exploring eco-friendly, cost-effective, and sustainable alternatives for soil stabilization. One such innovative approach is the use of corn cob granules, a readily available, renewable, and biodegradable biomass material. This paper investigates the potential of corn cob granules as a soil stabilization agent, examining their effects on soil properties, erosion resistance, and environmental sustainability. Chemical properties of corn cob granules Oxide compounds (mass%) Corn cob granules

EXPERIMENTAL STUDY

Table 1 - Physical Properties of Black Cotton Soil

S. No	Physical Property	Value / Description
1	Colour	Dark black to dark brown
2	Texture	Clayey, sticky when wet
3	Bulk Density	1300-1600kg/m^3
4	Specific Gravity	2.6 - 2.9
5	Liquid limit	50 – 100 % (High)
6	Plastic limit	30 – 60% (High)
7	Swelling potential	Very high
8	Shrinkage cracks	Deep and wide
9	Permeability	Very low
10	CBR value	2 – 5% (Low strength)

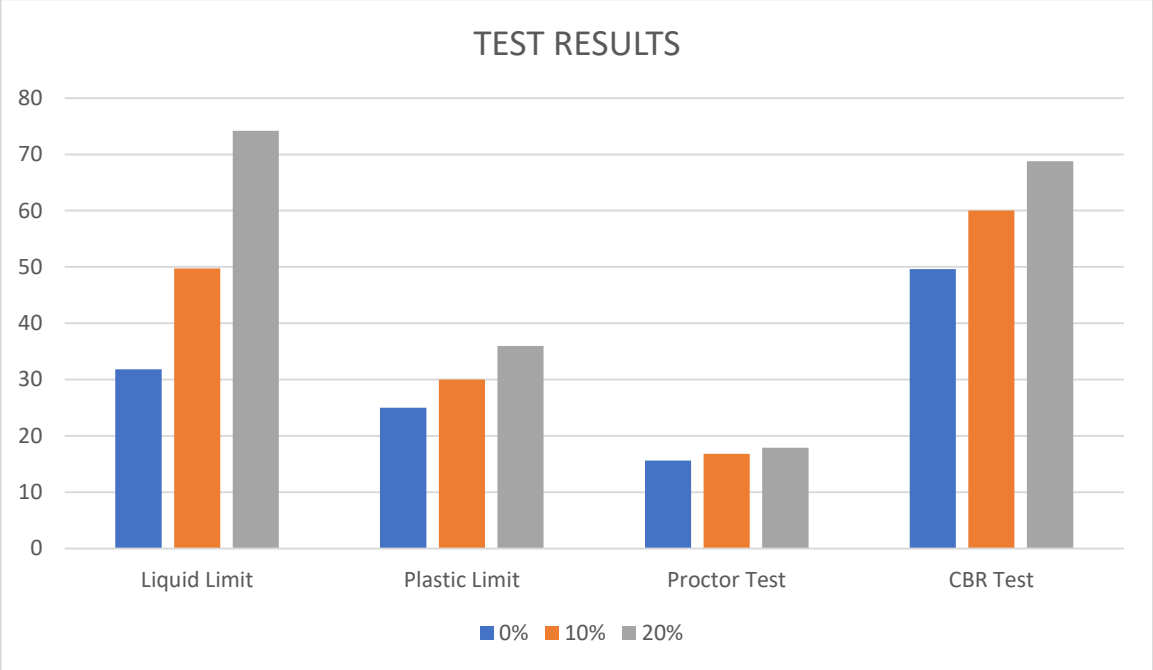
Table 2 - Physical Properties of Corncob Granules and Glass Powder

S. No	Physical Property	Corncob granules	Glass powder
1	Density (g/cm^3)	0.4 – 0.6	2.4 – 2.6
2	Specific Gravity	1.2 – 1.5	2.5 – 2.7
3	Porosity	High	Low
4	Water Absorption	High (100% - 200%)	Very low
5	Hardness	Soft	Hard (Mohs 5-7)
6	Particle Size	Variable	Fine (<75 microns)
7	Surface Area	Moderate	High
8	Decomposition	Biodegradable	Non-biodegradable
9	Chemical Reactivity	Low	High
10	Effect On Soil	Improves aeration & moisture retention	Increase strength& reduces plasticity

TESTS AND RESULTS

Table 3 – Tests result for soil with addition of corncob granules and glass powder

Percentage (%)	Liquid limit	Plastic limit	Proctor Test	California Bearing Ratio Test (kg)
0 %	**31.82**	**25**	**1.56**	**49.61**
10%	49.76	30	1.68	60
20%	74.20	36	1.79	68.79



CONCLUSION

The study shows that adding corncob granules and glass powder improves soil strength and stability.

1. Strength Improvement: Glass powder increases bonding, while corncob granules improve drainage.
2. Reduced Plasticity: The soil becomes less prone to swelling and shrinking. Best Mix:
3. 10% mix (5% corncob + 5% glass powder) – Good for general use. 20% mix (10% corncob + 10% glass powder) – Best for strong foundations and roads.
4. Eco-Friendly: Using waste materials makes construction more sustainable.

Stabilizing clay soil using 10% and 20% corn cob granules and glass powder significantly improves soil properties.

1. 10% Mix : Suitable for moderate applications.
2. 20% Mix : Ideal for high-load and heavy-traffic applications.
3. Promotes sustainable construction by reusing waste materials.
4. Further research needed for long-term durability studies.

REFERENCES

1. **Alaa, et.al (2019):** Corn cob granules, derived from agricultural waste, have been studied for their potential in soil stabilization. Corncobs improves soil moisture retention, porosity and aeration, making them suitable for controlling swelling in expensive soils.
2. **Benson et al (2021**): Raised concerns about their bio degradability, suggesting that their long-term effectiveness might decrease as they decompose over time. Jones et al (2020): Found that corn cob granules help reduce the shrink-swell behaviour of clay soil.
3. **Rahman et al (2021):** Highlighted that glass powder remains chemically stable over time, offering long-lasting stabilization benefits
4. **Singh and Kumar (2018):** Glass powder, made from recycled glass, has proven effective in stabilizing soil due to its pozzolanic properties. They found that glass powder reacts with calcium hydroxide in the soil to form calcium silicate hydrates ,which increase soil strength and reduce permeability. It also helps in filling the voids in the soil, enhancing its compaction.