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An Experimental Study on Stabilization of Black Cotton Soil by using Bio Polymers

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ABSTRACT

In developing countries like India, due to remarkable development in road infrastructure, soil stabilization has become major issue in constructional activity, stabilization is not only a method of altering or modifying of one or more soil properties to improve the engineering . Characteristics and performance of a soil ,but also processing available materials for the production of low –cost design and construction. Black cotton soils which expand when moisture content of soils is increased the clay mineral Montomorillonite is main responsible for expansive characteristics of soil. the expansive soils called swelling of soils or black cotton soils a large part of south India is covered with expansive soil another problem with this soil is strength is decreases with increases of degree of saturation heavy damages may occur buildings roads runways pipe lines and other structures built on such soils if proper preventive measures are not method. The damages can be prevented to an large extent if characteristics of expansive soil properly assessed suitable measures taken in design construction and maintenance of structures built on soils. This presents experimental investigation to study the effect of sugarcane baggage ash on swelling and shrinkage and mechanical properties of an soil. After finding out the experimental results in lab to know the evaluation and performance of baggage ash on the black cotton soil in the laboratory

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INTRODUCTION

Soil stabilization is a general term for any physical, chemical, biological or combined method of changing of a natural soiltomeetanengineeringpurpose.Also,improvementsinclude increasingthebearingcapability,tensilestrength andoverall performance of in-situ soils, sand and other waste materials, in order to strengthened road surface. Some of the renewable technologies are enzymes, surfactants, biopolymers, synthetic polymers and more. Traditionally and widely accepted types of soil stabilization techniques use products such as bitumen emulsions which can be used as binding agents for producing a road base. Tree resin and ionic stabilizers are commonly used stabilizing agents. Other stabilization techniques include using on-site materials including sub-soils, sand, mining waste and crushed construction waste to provide stable, dust free local roads for complete dust control and soil stabilization. Many of the "green" products have essentially the same formula as soap powders, merely lubricating and realigning the soil with no effective binding property. Many of the new approaches rely on large amounts of clay with its inherent binding properties. Bitumen, tar emulsions, asphalt, cement, lime can be used as binding agents for producing a road base. While using such products, issues such as safety, health and the environmental effects must be considered. Utilizing new soil stabilization technology, a process of cross-linking within the polymeric formulation can replace traditional road/house construction methods in an environment friendly and effective way. There is another soil stabilization method called the Deep Mixing method that is non- destructive and effective at improving load bearing capacity of weak or loose soil strata. This method uses a small, penny-sized injection probe and minimizes debris. This method is ideal for re-compaction and consolidation of weak soil strata, increasing and improving load bearing capacity under structures and the remediation of shallow and deep sinkhole problems. This is particularly efficient when there is a need to support deficient public and private infrastructure.

Soil Expansivity prediction by liquid limit:

Degree of expansion	Liquid limit
Low	<30
Medium	30-40
High	40-60
Very high	>60

Degree of expansion	Holtz and Gibbs	Chen
Low	<20	0-15
Medium	12-34	10-35
High	23-45	20-55
Very high	>32	>35

Soil expansivity predictions by plasticity index:

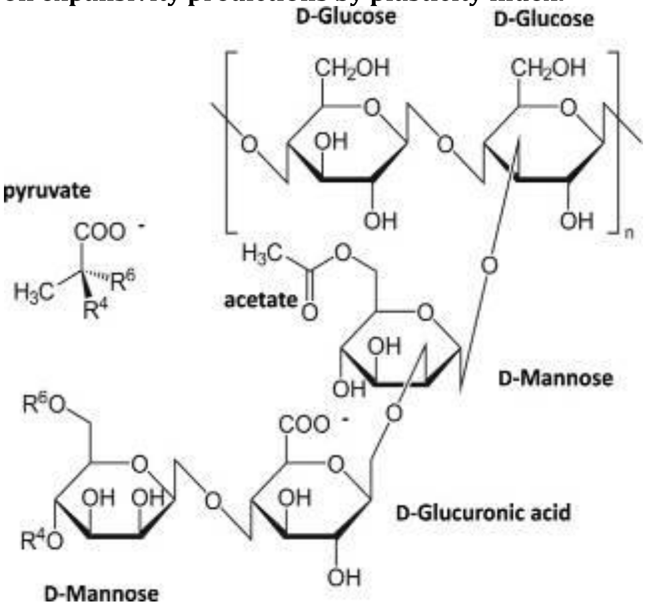


Fig 1. Chemical formula for Xanthum Gum

Uses:

- Guar Gum, 1% can produce a significant increase in the Xanthan viscosity of the liquid. It helps to prevent oil separation by stabilizing the emulsion, although it is not an emulsifier.
- Xanthan gum also helps to suspend solid particles. Xanthan gum helps to create desired texture in many ice creams.
- In oil industries, Xanthan gum is used in large quantities to thicken drilling mud. These fluids serve to carry the solids cut by the drilling and hit back the surface. The wide spread use of horizontal drilling and demand for good control of drilled solids has let to its expandeduses.

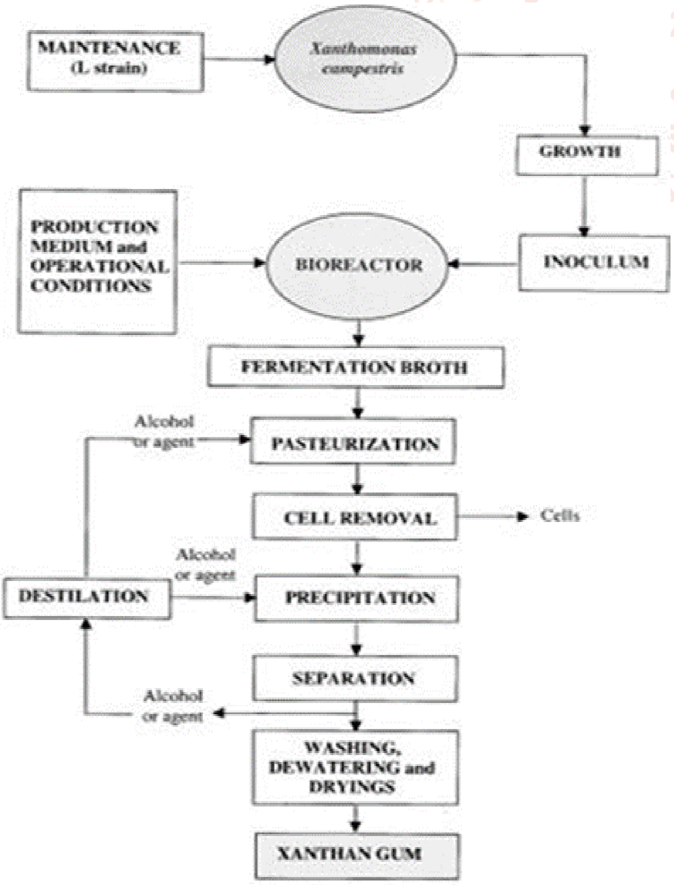
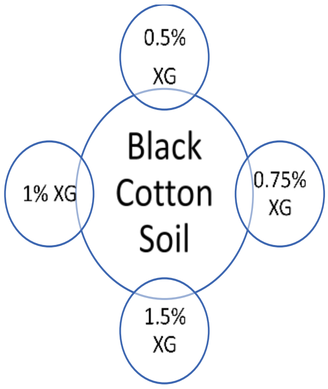


Fig-2 process of xanthum gum



Schematic Representation of Compaction Test Sample prepared with variation of XG%

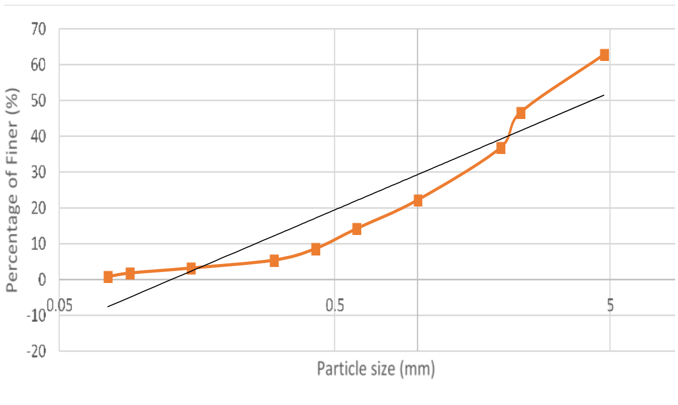
fig-3 Schematic Representation of compaction Test sample prepared with variation of XG%

Type Compaction Test Samples with XG% variation:

Samples Prepared for Compaction Test	
1	Black Cotton Soil
2	BC + 0.5% XG
3	BC + 0.75% XG
4	BC + 1% XG
5	BC +1.5% XG

Sieve Analysis

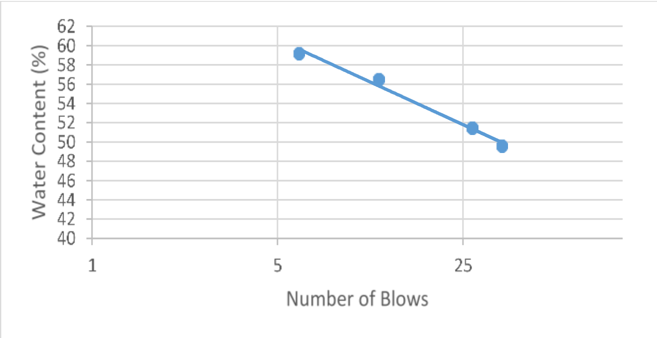
IS Sieve	Weight Retained	Percentage Retained	Cumulative Percentage	Percentage of Finer
	(g)	(%)	(%)	(%)
4.75	372	37.2	37.2	62.8
2.36	162	16.2	53.4	46.6
2	98	9.8	63.2	36.8
1	146	14.6	77.8	22.2
0.6	80	8	85.8	14.2
0.425	56	5.6	91.4	8.6
0.3	32	3.2	94.6	5.4
0.15	22	2.2	96.8	3.2
0.09	14	1.4	98.2	1.8
0.075	10	1	99.2	0.8
PAN	4	0.4	99.6	0.4



Sieve Analysis Graph

Liquid Limit Calculations:

S. no	Observations & Calculations	Test 1	Test 2	Test 3	Test 4
1	Number of Blows	32	25	18	12
2	Mass of Empty Container (M_1)g	24	32	28	21
3	Mass of Container + Wet Soil (M_2)g	62	78	69	72
4	Mass of Container + Dry Soil (M_3)g	45	41	34	37
5	Water Content W = (M_w/M_d)x100 %	49.62	54.17	56.50	59.23



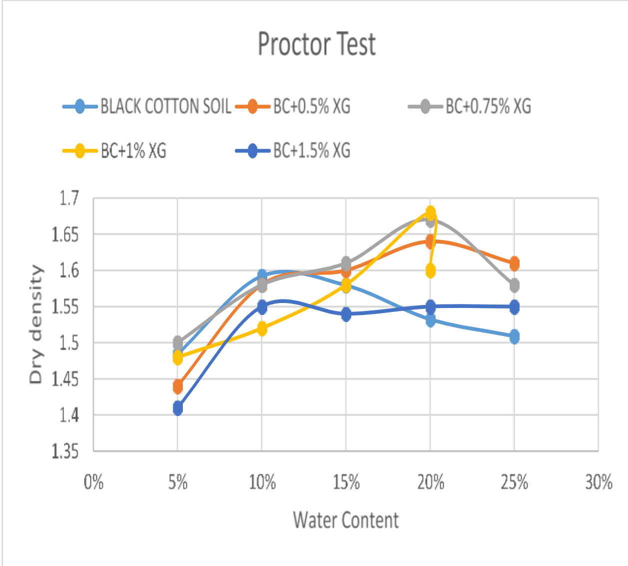
Liquid limit determination Graph

Observation table on Black cotton soil:

Characteristics	Value
Color	Black
Specific Gravity	2.67
Liquid Limit (%)	52
Plastic Limit (%)	26.7
Plasticity Index (%)	25.3
Classification	CH
Optimum Moisture Content (%)	20
Maximum Dry Density (g/cc)	1.58
Unsoaked CBR	2.2
Soaked CBR	1.4
Unconfined Compressive Strength (kg/cm²)	0.9
Differential Free Swell (%)	50

Compaction Test Observation table for black Cotton soil +1.5% XG:

content	% of water				
	5%	10%	15%	20%	25%
Empty Weight of Mould	4980	4980	4980	4980	4980
Weight of Mould + compacted soil	8780	8920	9060	9225	9264
Weight of compacted soil	3800	3940	4080	4245	484
Weight of cup	36	36	36	36	36
Weight of cup + wet soil	43	64	56	58	51
Weight of cup + dry soil	42	61	53	51	48
Weight of soil	6	25	17	15	12
mass of water	1	3	3	4	3
water content , W	16.7	12	17.6	26.7	25
Bulk density	1.65	1.74	1.8	1.88	1.85
dry density	1.41	1.55	1.54	1.55	1.49

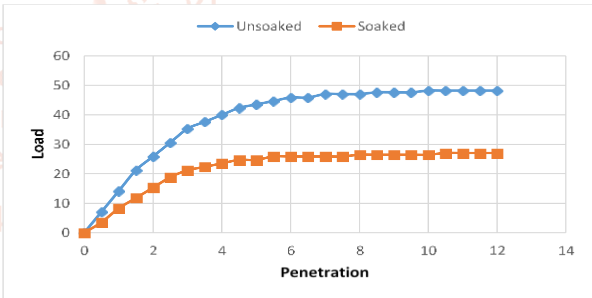


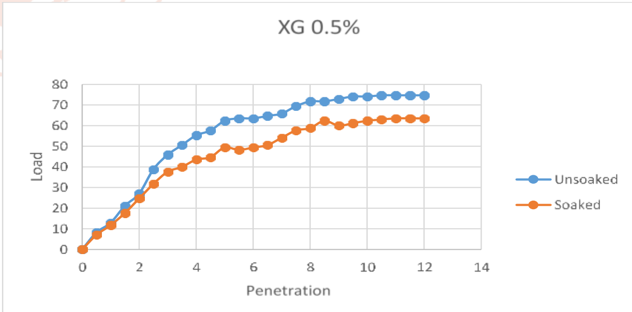
Compaction curves for soil samples with 0%, 0.5%, 0.75%, 1%and 1.5% XG

S. no	Sample	OMC (%)	MDD (g/cc)
1	Black Cotton Soil	20	1.59
2	BC+0.5%XG	20	1.67
3	BC +0.75% XG	20	1.52
4	BC + 1%XG	20	1.64
5	BC +1.5% XG	20	1.55

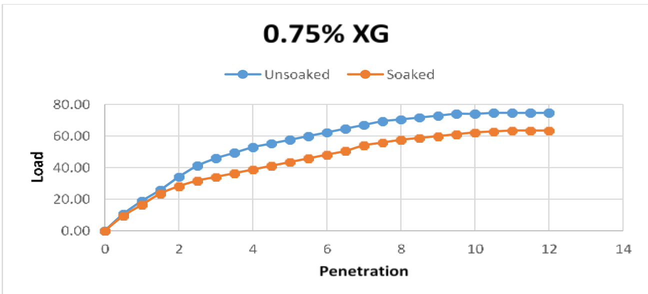
OMC and MDD values of BC + XG%

Load Vs Penetration graph for Black Cotton Soil (Unsoaked & Soaked

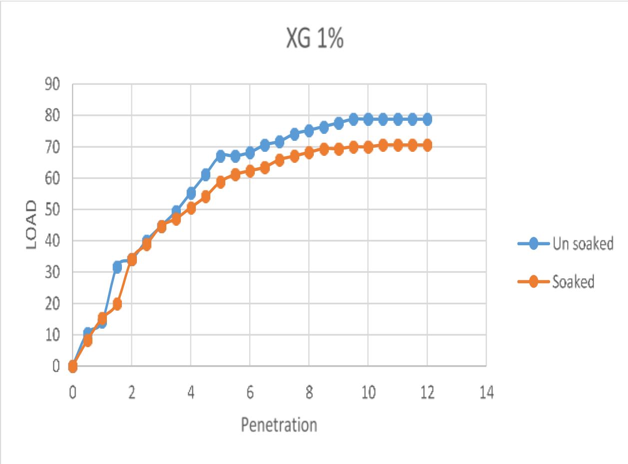




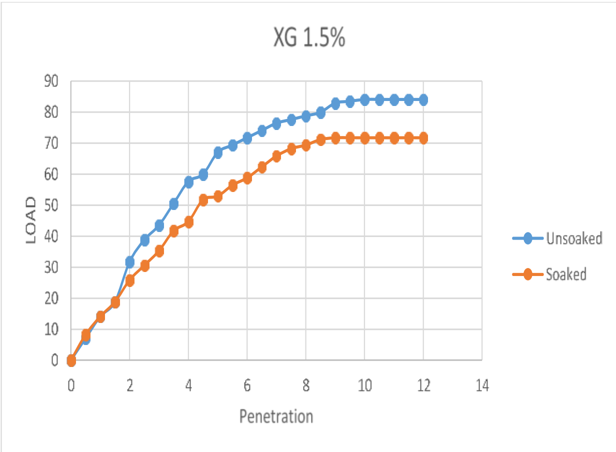
Load Vs Penetration graph for Black Cotton Soil+0.5%XG (Unsoaked & Soaked)



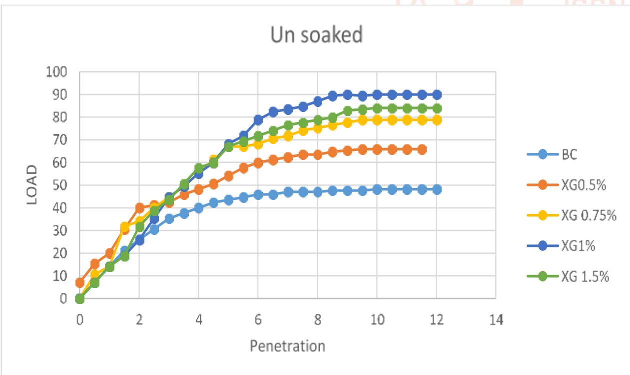
Load Vs Penetration graph for Black Cotton Soil+0.75%XG (Unsoaked & Soaked)



Load Vs Penetration graph for Black Cotton Soil +1% XG (Unsoaked & Soaked)



Load Vs Penetration graph for Black Cotton Soil +1.5%XG (Unsoaked & Soaked)



Load Vs Penetration graphs of Unsoaked CBR at different percentages of XG

UCS values for different % of XG

Sample	Curing periods				
	0	3	7	14	28
BC	0.97	1.11	1.29	1.36	1.41
XG (0.5%)	3.8	4.1	4.8	5.1	5.4
XG (0.75%)	4.2	4.5	5.6	5.8	6.1
XG (1%)	5.4	5.6	7.1	7.8	8.2
XG (1.5)	5.1	5.3	7.6	8.4	8.8

CONCLUSIONS

In this study, the major properties studied are OMC, MDD, CBR, UCS, and Consolidation. Based on the all investigations on all samples and when compared with normal soil, following conclusions were made

Compaction Test and CBR Test:

- In Standard Procter Test, the increase in XG percentage the dry density increases upto 0.75% and after the MDD value has been decreasing trend. Though, a decrease in OMC has been observed with increase in XG %
- Maximum dry density was increased with the addition XG
- When 0.5%,0.75%,1%,1.5% XG added, higher MDD observed for 0.75% of XG
- Both the Unsoaked and soaked condition of CBR were studied and Peak value was obtained at 0.75% XG in both conditions.

Unconfined compressive strength:

- In UCS, Due to increase in XG percentage the UCS value having increasing trend with respect to the parent soil.
- In UCS, Due to increase in XG percentage the UCS value has been observed increasing trend up to1.5 %
- XG specimen fails by formation of Vertical cracks.
- The Curing period of mix is a governing parameter as the chemical reaction of stabilizers is depends on it.so it can be concluded that the strength will increase with increase in curing period.
- UCS of treated soils was higher than that of untreated soils.
- UCS value of sample is Increased from 0.97 to 8.8 kg/cm^2

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