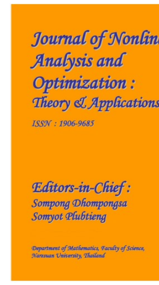
Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 1, No.10 : 2024
ISSN :**1906-9685**



SOILSTABLIZATIONUSINGBIO-POLYMER(WITHXANTHANGUM)

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ABSTRACT - Chemical stabilization is one of the most widely used techniques forimprovingweaksoilsandpermittingitsuseingeo-technicalprojects.Althoughalternative binders can also be used, Portland cement is still the most commonly usedbindertostabilizesoils.ButsincetheusageofPortlandcementisassociatedwithahostof environmental problems, microbiological- based methods have been looked into asviable substitutes for conventional soil stabilizing methods. Here, one of the practical,sustainable,andecologicallyfriendlymaterialoptionsforsoilstabilizationistheuseofbio-polymers made from living organisms. Bio-polymers, however ,can have a widerange of physicalpropertiesbasedontheir typesandcompositions.The primaryobjectiveofthisworkistoexaminetheeffectsofsmallconcentrationsofbio-polymers,xanthan gum in particular, on the physical properties of red soil at (0%, 10%, and20%).This study's characteristics include specific gravity, sieve analysis, shrinkagelimit, plastic limit, and liquid limit. The shear strengths of both treated and untreatedsoilwereexperimentallyevaluatedatvariouscuringtimesusinganunconfinedcompressivestrength test

KEYWORDS-

Soil Stabilization, Foundation ,CBR Test , Proctor Test , UCS Test, Engineering Properties, SoilStrength

1. INTRODUCTION

Soilimprovementtechniqueshavebeenafocus of geo technical engineering for alongtime,withhistoricalexamplesincluding surface compaction, drainagemethods, vibration methods, and more[1].Ancientcivilizationsusednaturalmaterialslikemudandbitumenforvariousconstructionneeds,whileinancientRome,Romanconcretewasmadefromvolcaniccash,aggregates,anda binder[2]. After the Industrial Revolution,ordinaryPortlandcementbecame popularforsoil stabilization, but its Excessiveusehashadnegativeenvironmental consequences,particularly in terms of carbon dioxideemissions[3]. As a response, geotechnicalengineershavestartedexploringbio-mediated soil improvement technologiesasamoreenvironmentallyfriendlyalternative[4].Thesetechniquesinvolveusingbiopolymersandmethodslikemicrobial-inducedcalciteprecipitation.Biopolymers,whicharebiodegradablepolymers,haveshownpromiseinImprovingsoil.Thispaperreviewsrecentstudieson theapplication.

Bio-polymer, rising technical engineering,including experimentalresults theoreticalexplanations,andcasestudies[5].Italsosummarizesthestrengtheningmechanismsbetween common bio-polymers an soils based onmicrosco pici nteractions.Soilstabilizationisacrucialaspectofcivilengineeringandconstruction,aimingtoenhance the engineering properties of soiltomeettherequirementsofvariousconstructionprojects.[6]

Traditionalmethods often involve chemical additivesor mechanical processes, which may poseenvironmental concerns and sustainabilitychallenges. In recent years, there has beena growing interest in exploring sustainableandeco-friendlyalternativesforsoilstabilization, with biopolymers emergingas promising candidates. Biopolymers arenaturally occurring polymers derived fromrenewableresourcessuchasplants,animals,andmicroorganisms,offeringadvantagesoverconventionalstabilizerssuch as biodegradability, non-toxicity, andcompatibilitywith the environment.

Biopolymer-basedsoilstabilizationinvolves the use of natural polymers toimprovetheengineeringpropertiesofsoil[9].Thesepolymerscanbeclassifiedintovariouscategoriesbasedontheiroriginandchemicalcomposition,including polysaccharides, proteins, andmicrobial polymers. The mechanism ofsoil stabilization with biopolymers ofteninvolvesphysicalandchemicalinteractionsbetweenthepolymermoleculesandsoilparticles.Theycanactasbinders,creatinganetworkthatstrengthensthesoilstructureandenhances itsload-bearingcapacity[10].Biopolymer-based soil stabilization hasdiverseapplicationsacrossvarioussectors,includingroadconstruction,slope stabilization, erosion control, andland reclamation.In road construction,biopolymerscanimprove thestrength anddurabilityofroadbasesandsubgrades, reducing maintenance costs andextendingtheservicelifeofroads.Inslopestabilizationanderosioncontrol,biopolymerscanstabilizesoilslopes,preventsoilerosion,andrevegetatedegradedland,promotingsustainable solutionsthatminimizeenvironmentalimpact and promote ecosystem Despitethenumerousbenefitsofbiopolymer-basedsoilstabilization,several challengesremaintobeaddressed,suchascost-effectivenesssandscalabilityofbio-polymerproduction and application[7]. Advances inbiotechnology and materials science areexpected to drive innovation in this field,leadingtonovelbio-polymerformulations with enhanced performanceandversatility[8].

1.1 SoilStabilization

Traditionalsoilstabilizationmethodshave several drawbacks and limitationscompared to biopolymers. Firstly, thesemethodsofteninvolvetheuseofchemicaladditivesthatcanhavenegativeenvironmentalconsequences.Theseadditivesmaycontaminatethesoilandground water, leading toeco system degradation[11]. Moreover, manytraditionalstabilizersurelyonnon-renewableresources,contributingtosustainabilitychallenges.Additionally,theproductionandtransportationoftraditional stabilizers result insignificantenergy consumption and greenhouse gasemissions, exacerbating climate change.Unlikebiopolymers,traditionalstabilizers are not biodegradable and canpersist in the environment for extendedperiods,potentially harming wildlife.[12] Furthermore,somechemicaladditivesusedintraditionalmethodscanposehealthriskstoworkersandnearbycommunities.Costinefficiencyisanotherdrawback,withhighmaterial,labor,andequipmentexpenses,aswell asongoingmaintenanceandrepaircosts.Traditionalstabilizersalsohavelimited versatility, as they may not besuitableforallsoiltypesorenvironmentalconditions[13].Therefore,exploringalternativeapproacheslikebiopolymer-based stabilization is crucialforpromotingsustainablesoilmanagementpracticesandminimizingenvironmental[14].

2. METHODOLOGY

2.1 MaterialUsed

Xanthan gum, also known as XG, is apolysaccharidesderivedfromthefermentation of glucose. [15]The proportionsto use the bio-polymer in soil (0%,10%and 20%).XG has the unique property ofbeing soluble in both hot and cold water,anditenhancestheviscosityofthesubstances it is mixed with.[16] It is widelyusedinvariousindustriessuchascosmetics, food, agriculture, oil drilling,andcivilengineering.SolutionscontainingXGexhibitnon-Newtonianbehavior, with their viscosity decreasingasshear stress increases.

2.2 SpecimenPreparation

In the process of specimen preparation,anelectronicbalancewasusedtomeasure and batch all mixing quantities.[17]Themixingprocessinvolvedtwo approaches.

Fig.1(preparationofsoilsample)

In the first approach, the dry components(base soil and biopolymers) were mixedtogether slowly for a few minutes.[18] Fourtypesofbiopolymers(XG,GG,CHI,andBG)weremixedintothesoilatconcentrationsof0%,10%,and20%relativetothemassofthebasesoil.Aftermixing a biopolymer with the soil, waterwassprayedintothemixtureuntilitreached 16.5% of the mass of the basesoil.[19]Thewatercontentof16.5%waschosenastheoptimumlevelforspecimenpreparation,aslowerwatercontentsresulted in non-uniform soil samples andhigherwatercontentsmadethespecimenstoosoft.[20]Throughouttheprocessofaddingwater,thesoil-biopolymer mixture wascontinuouslymixedtoensureevendistribution.

3. EXPERIMENTS:

3.1 UCSTest

unconfined compression test, also knownasacylindercompressiontest,istheappropriate method for determining thecompressive strength of a cohesive soil,regardlessofthepresenceofbiopolymers.[21] The test involves applyinganaxialloadwithastrainrateof1.5%/min,followingtheAmericanSocietyforTestingandMaterialsStandard (ASTM) ASTMD2166/D2166M36.[22]Thecompressivestrengthiscalculatedbydividingthemaximumloadattainedduringthetestbythe cross-sectional area of the specimen.Additionally,Young'smodulus,E,canbeobtained from this test by recording theappliedloadandlongitudinaldeformationandextractingitfromtheslope of a straight line passing throughtheorigin.

3.2 CBRTest

To use a CBR testing machine, obtain arepresentativeundisturbedorremoldedsoilsample.[23]Conduct amoisturecontent testandadjustthemoisturecontenttothedesiredvalue.[24]Assemblethemouldassembly by attaching the base plate tothemouldandsecuringtheextensioncollar on top of the mould. [25]If the soilsampleis cohesive,linethemouldwithathinlayeroffilterpaperorasuitablereleaseagent.[26]Compacteach layerinlayersandavoidovercompaction.Measure and record the height (H0) anddiameter(D0)ofthecompactedsoil sampleusingvernier calipersoraruler.

3.3 PROCTORTest

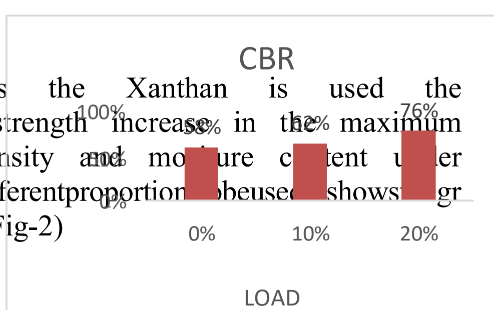
Totestsoilforcompaction,obtainarepresentative soil sample, remove anyorganic materials or large particles, andplaceitinaProctormould.[27]Fillthemould inthreeequallayers,compacteachlayer, trimexcesssoil,anddeterminetheweight of the compacted soil. Repeat thecompactionprocessforadditionalmoisturecontentlevels,usually2-3moretimes.[28]Drythesamplesinanovenordryingapparatusat230-250°Fforatleast 24 hours until the samples reach aconstant weight. [29]Calculate the moisturecontent for each sample using the formula: Moisture Content (%) = [(WetWeight-DryWeight)/DryWeight]x 100.Plotmoisturecontentversusdrydensity curve using the obtained values.Determine optimal moisture content andmaximumdrydensityfromthecurveandrepeattheprocessto obtain arange

ofcompactedsampleswithdifferentmoisture contents.[30] Remove soil samplescarefully and place them in a moisturecontentcan orcontainer.

4 RESULTS:

4.1 UCS

Shows the Xanthan is used the shearstrength increase in the maximum drydensity and moisture content under thedifferentproportiontobeused shows graph (Fig-2)



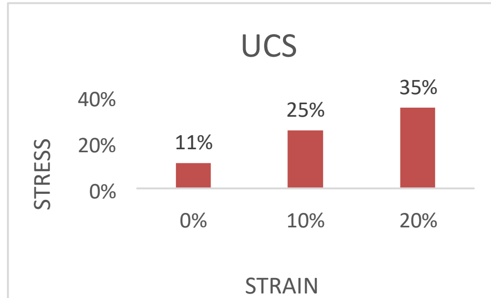


FIG-2

4.2PROCTOR

Youmayfindthemaximumdryunitweightandideal weightandidealwaterweightononeaxiscontentforthisweightbyandthewaterusingagraphthatplotscontentonanotherthedryunit[3 1] using

(0%,10%,20%)

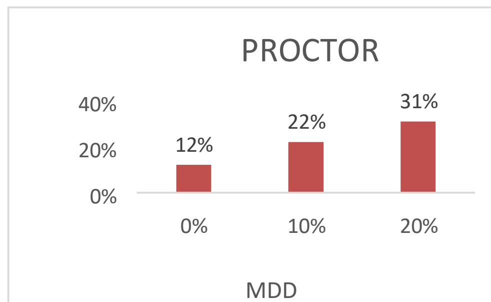


FIG-3

4.3CBR

DIALGAGUE

Fig–4

5. WITHOUTBIO-POLYMER:

Compared to with bio polymer shows themoreXanthangumimprovessoilstrengthhandstiffness.[3 2 , 3 3] Xanthan gumd e c r e a s e s . s o i l h y d r a u l i cconductivity.Reducesoil loss andinfiltration.Incomparisontounstabilizeds oil,thechemical reaction.

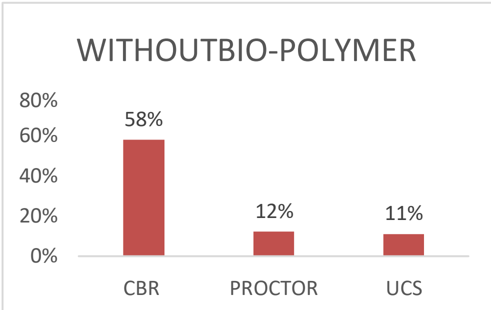


FIG-5

5.1 WITHBIO-POLYMER:

Anidealsolutionforexpansivesubgradestabilization,xanthangumat20%concentrationgreatlyincreasedtheunconfined compressive strength, elasticmodulus,andCBRvaluesofthesoil.[34,35] Becauseofitshigheradhesivestrengthandabilitytocrosslinkwithsoilparticles,xanthangumdramaticallyincreasedsoilstrengthuptoa10%dosage. This also improved unconfinedcompressivestrength(UCS)andconsolidationcharacteristics.TheCBRvalueoffinesandsoilcontaminatedwithUCO is increased by xanthan gum. Incomparison to natural sand soil, optimalof 0.4% boosts CBR by 30%, helping tostabilizethe soilforpavementprojects.

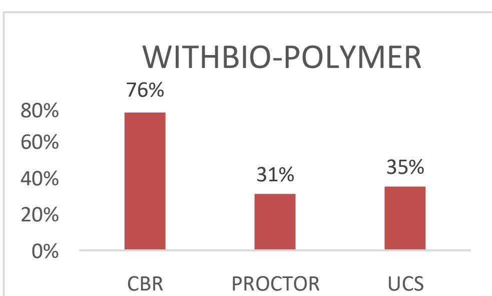


Fig-6

6. CONCLUSIONS:

Because of its capacity to enhance soilstructure, augment water retention, andlessenerosion,thisxanthangumhasdemonstratedpotentialinsoilstabilizationapplications .Its attractivenessasasustainablesolutionforsoilstabilizationprojectsisfurtherenhancedbyitsbiodegradabilityandnon-toxiccharacteristics.Thisstudyinvestigatesthe potentialofxanthangum,anenvironmentallybeneficialbiopolymer derived from microbial sources,to stabilize leftover soil .The stability ofxanthangumisasignificantfactorinimproving the mechanical properties offine-grained collapsible soil, leading to asustainable and environmentally friendlyalternativetoconventionalsoiladditives .[36] According to the results of theUCStest,stabilizingthepeatwithxanthan gum increased its shear strengthunder natural settings; after 28 days, thestabilized peat's strength was six timesgreater than the original. The results forthemaximumdrydensityandtheoptimalmoisturecontent showed anotablebutlittledecline,respectively.

7. RECOMMENDATION:

One useful soil stabilization technique toincreasesoilcohesionandstabilityisxanthan gum.[37,38]Usuallycombinedwithwater, it is applied to the soil or mixeddirectlyintothesoiltoimproveitsqualities,especiallyinbuildinganderosionmanagementprojects.Toincreasesoilcohesionandstability,especiallyinconstructionanderosioncontrol operations,xanthangumissprayedasasoilstabilizer.Consultaspecialist in soil stabilization since thedosage varies based on the type of soilandtheprojectrequirements.Asoilstabilizer called xanthan gum is appliedtoimprovesoilcohesivenessandstability, particularly in construction anderosioncontrolprojects.[39,40]Seeasoilstabilizationspecialistasthedosagevaries depending on the kind of soil andtheneeds of theproject

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