

**STABILIZATION OF CLAYEY SOIL USING BAGASSE ASH
AND WASTE GLASS POWDER**

RESEARCH PAPER

Submitted by

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P ROFESSIONAL
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Transforming Education Transforming India

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DECLARATION

I hereby declare that the dissertation report titled “**STABLIZATION OF CLAYEY SOIL USING BAGASSE ASH AND WASTE GLASS POWDER**” is an authentic record of my own research work carried out as a requirement for the preparation of M.Tech dissertation for the award of Masters of Technology Degree in Geotechnical engineering from Lovely Professional University, Phagwara, Punjab, under the guidance of Mr Alok Sharma. All the information furnished in the report is based upon my intensive work and is completely genuine to the best of my knowledge. And no part of the united work in this report ever been published has ever been published before in my journal or presented for the award of my degree or honour.

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CERTIFICATE

Certify that this project report entitled '**STABLIZATION OF CLAYEY SOIL USING BAGASSE ASH AND WASTE GLASS POWDER**' submitted individually **GURMINDER SINGH** student of civil engineering, Lovely Professional University carried out then the work under my supervision for the award of degree. This report has not been submitted to any other university/institution for the award of any degree.

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ABSTRACT

Nowadays, expansive soils are the major issues when used for the construction works and engineers have to deal with all the problems with soil. In India expansive soils are present in many regions, and it offers difficulties at the time of construction. So it's necessary to stabilize on site expansive soil before any type of construction on it. There are many methods for improving the soil properties and increasing engineering performance. Stabilization is the most useable method for stabilize the onsite soil. Present study focuses on improving the shear strength, index properties, shrinkage-swelling problem and CBR value of expansive soil for construction area on expansive soil and the soil cannot be replaced due to high cost factor. For stabilize expansive soil two different solid waste are used i.e. Sugar cane bagasse ash and waste glass powder at different proportional mixes. Bagasse ash helps to improve in index properties and due to fine and high in density of glass powder increase the dry density of soil. It also unobservable to water which improves the swelling problem of expansive soil when increase in moisture content.

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CHAPTER 1

1.1 INTRODUCTION

Soil consists of air, water and solid particles which are generated by the disintegration of rocks and it is on the top of the earth layers. It is a construction material at very low cost than other materials available in most of the countries and its properties are not same and changes from place to place, especially in case of clayey soil. There are engineering problems due to low strength, low bearing capacity and water holding capacity and high compressibility in clay. Therefore, clayey soils are not good enough for construction like pavements, embankments, foundations etc. So there is big need to treat clayey soil. Stabilization is a good process for improving in properties of clay by using different type of stabilizing agents. Soil stabilization is an important for poor soil and not good enough for any construction. In soil stabilization process the poor soil is treated to stable by maintains or improves performance of the soil as a good construction material. Stabilizing agents are used to stable the soil and they improve the strengths parameters of sub grade material or soil. Improves in the California Bearing Ratio (CBR), is one of the main advantage of the stabilization. For improves the on-site material (soil) for construction, such as solid and strong sub base and base course stabilization is necessary. In most of the countries, the stabilization is used to construct the entire road. By utilizing the binding properties of clay soil, stabilizing was done. There are many technologies for soil stabilization and depend upon the type of soil and site conditions. Cost factor also affects the adopting method of stabilization.

Shear strength is main property of soil and important for every type of structure on soil. Clayey soils have low shear strength in wet condition and undesirable engineering properties. Clayey soil is subjected to change in volume when it is in contact with water or increase in water content. These problems of clayey soil can damage or harmful to civil engineering construction. So to achieved desire properties this soil should be treated first and the able to construction. Different methods for improve in engineering properties are chemical stabilization, densification, reinforcement and reduction in pore water pressure. Stabilized soils are more useful as a construction material.

The treatment of clayey soil with the use of sugarcane bagasse ash and waste glass powder is not very tough, it is economical and pollution controlling.

1.1.1 EXPANSIVE OR CLAYEY SOIL

Expansive soil is a category of soil which known as a circular structure, consisting porous inner, hard and frictional outer layer. Expansive soil is undergoes more Changes in volume (shrinkage & swelling) which occur due change in water content. There are deep cracks in expansive minerals in drier years and seasons and that type of soil also known as vertisoil. This shrink swell capacity of this soil is due to presence of montmorillonite and bentonite. Mineral sheets present in all clays are packaged into layers. These ratios give in the proportion of octahedral sheets and tetrahedral sheets.

Expansive soil has another important factor, its vulnerability to physical changes, with arability or presence of quantity of water. As, in a rainy season or wet, the clay is tends to swelling, and when dry season, it tends to shrink and generate cracks. Montmorillonite has the maximum swelling potential in clay or expensive soil.

1.1.2 PROBLEMS WITH CLAYEY SOIL

The soils have a rich content of clay minerals, behave like sponges and absorb more quantities of water when it have increase in water content, causing the clay mineral to change in volume. When the water escaped (dries) from clay mineral, and then it tends to shrinks or decrease in volume. The type of Clays that have sodium when in contact with water, expand as more as a thousand percent. Because the other soils are not having clay minerals, then the expansion in that soils typically less as compared to pure clay. However, when the volume changes occur in clay than the structures may be damaged. There can be cracks in structures and foundations when expansion in clay and also roads are affected. The main sign of expanding soil or volume change in clay beneath a structure may be displacing of doors and windows. Non-load-bearing walls, in structures heaving low weight to resist the pressure generated by expansion, typically crack earlier than load-bearing walls do. When water escape from clay (drying), expansive soil decreased in volume (shrinks), generating deep, large, cracks or "soil boil" texture in surface

exposures. Soil boil textures are the outcomes of again and again shrink/swell cycles. In more cases, cracks arises by drying clay can be good enough to copy earth fissures. However, cracks due to drying clay are not as deep or long as earth fissures. In India clay or expansive soil are present in many regions. The second disadvantage of increase in water content is reducing the shear strength of clayey soil and which is not good for structures on it. The wet clay cannot take loads properly from structures and reasons of failure of structures and pavements also.

1.1.3 STABILIZATION

Stabilization of soil is a method of improving the properties of a poor soil to modify its engineering or overall performance. In stabilization the best way of an existing soil is amplify by improving the main property of soil i.e. Shear strength of any soil corresponds to the desired needs so as to approaches the constructional standard. Stabilization of soil is used for a different type of engineering works and it is the most common method being in the road construction and air field construction pavement, wherever construction is totally depend on locally available materials. The stabilization method is adopted more where the soil present at site of construction is cannot be replaced. However, stabilization of soil is the process of improving soil properties but it can be achieved by different methods according to the demand or need. The stabilization methods of soil can be divided into two different types. These are as follows

1. Method of stabilization in which the improvement of soil can be done without adding any admixture or stabilizing agent, and
2. Method of stabilizing in which the improvement of soil is done by adding an admixture.

The methods of drainage and compaction includes in the method of improvement in which the property of the soil is changes without adding any admixture. The main stabilization methods without using admixtures are cement stabilization, mechanical stabilization, bitumen stabilization, lime stabilization, and chemical stabilization.

When the above mentioned methods are not needed or applicable, the admixtures are used for stabilization the soil. There are many admixtures used for stabilization heaving different properties which helps to improve the engineering performance of soil for example sugarcane bagasse ash, lime, silica, marble dust, glass powder etc.

1.1.4 ADMIXTURES USED

From the sugar cane plant the bagasse is generated after the extraction of juice which is the fibrous residue. Bagasse is a waste material and clutter environment. Then most of the part of sugarcane converts into bagasse after the extraction of juice, which is used as a fuel for producing steam which results in bagasse ash. This creates environment problems when it dumped outside freely. Bagasse ash has properties same as a pozzolanic material like it is rich in oxide of silica and aluminum. Due to those properties it can be used for stabilization of clayey soil. The stabilization of clayey soil with bagasse ash automatically solves the problem of disposal and it good for environment. It is used as a cheap material and very important for economy in the construction.

The disposal of waste glass is not so economical and only some are recycled. The waste glass was collected and converts into the powdered form. Waste glass powder is fine and rich in density. Then it can be used as the stabilized agent for clayey soil. The waste glass can crushed into desirable proportion for addition in clay. Some cities and town have poor solid waste management, which creates seriously environmental problems. So with using of waste glass powder for stabilizing clay, the problems arise from glass waste decreased and it became a cheap material as a stabilizing agent.

CHAPTER 2

2.1 TERMINOLOGY

Nomenclatures

Gs	Specific gravity
M1	Mass of empty container, kg
M2	Mass of container and wet sample, kg
M3	Mass of container and dry sample, kg
m1	Mass of specific gravity jar, kg
m2	Mass of specific gravity jar with 500 g of soil sample, kg
m3	Mass of specific gravity jar with water and soil sample, kg
m4	Mass of specific gravity jar filled with water, kg

Greek Symbols

γ	Density, kN/m ³
γ -max	Maximum density, kN/m ³

ABBREVIATIONS

CBR	California bearing ratio
LL	Liquid Limit
MC	Moisture content
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
PL	Plastic Limit
PI	Plasticity Index
UCS	Unconfined compressive strength
SCBA	Sugar Cane Bagasse Ash

GGBS

Ground Granulated Blast Furnace Slag

WGP

Waste Glass Powder

CHAPTER 3

3.1 REVIEW OF LITERATURE

YESILBAS, GULSAH M.S (2004):

In this research, rock powder and aggregate waste with lime used as admixture which results into reduction of swelling potential of expansive soil or clayey soil. The expansive soil used for this research is mixed of kaolinite and bentonite. The percentage of adding lime was 0-9% and aggregate waste and rock powder 0-25% by weight. From tests which done during research the size of grains distribution, Index properties or index properties and swell present were examined. Curing is done for 7 and 28 days. This method caused decrease in swelling potential and the reduction is directly proportional to percent stabilizers.

R.ALI, H.KHAN, A.A SHAH (2012)

In this research analyze the effect of sugarcane bagasse ash and marble dust on the calyey soil of plasticity index larger than 30% and liquid limit larger than 30% used. Two materials are waste on natural environment which are marble dust and bagasse ash. Those two materials can be used for stabilization of expansive soil. It improves the engineering properties of expansive soil. By the addiction of 4%, 8% and 12% sugarcane bagasse ash and marble dust are decreased the liquid limit, plastic limit, expansive index and plasticity index such as it decrease the index properties of expansive soil. The soil uplifts pressure decreased by the using 12% of bagasse ash as more effective than marble dust. At 8% addition dust of marble and sugarcane bagasse ash increased the dry density of soil but it will reduce at 12%.

M.Aly, M.S.J. Hashmi ET AL (2012)

The principle stress for characteristic fibers strengthened bond composites (NFRC) may be the personal satisfaction from claiming fibers. Clinched alongside bond grid those alkalinity will be the primary reason for those misfortune for rubbing from claiming NFRC. Those intention of this Examine might have been will Investigation the impact from claiming incomplete substitution

cost about ordinary Portland bond (OPC) Eventually Tom's perusing finely ground waste glass powder (WG) Furthermore Nano dirt particles (NC) on the mechanical execution What's more sturdiness in development of flax fiber strengthened bond composites (FRC). Those tests might have been conveyed out to study that alkali-silica response (ASR), X-beam diffraction examination (XRD), differential warm Investigation (DTA) and the mechanical execution of the composites n development meets expectations. That execution of the composites age-old under wetting Furthermore drying cycles would indicate. Those results show that consolidation of WG need a sure impact on the mechanical properties What's more execution about FRC when nc will be demonstrated. In the other hand, the DTA outcomes Furthermore XRD dissection indicate a decline in the calcium hydroxide (CH) content in mortars for two WG Also a mixture blending about WG Also NC. Those come about affirm those change of the event of the pozzolanic response and mechanical properties following 28 days about hydration.

GyanenTakhelmayum, savitha.A.L, Krishna Gudi (2013)

India is a developing country and due to that development in road infrastructure, Soil stabilization played main role in construction activity. Stabilization cannot be avoided the construction of highway and roadway, Adjustment is to change in quality what is more solidness which is expanded the execution. Adjustment will be an approach for transforming guardian materials to the era for minimal effort street plan Also construction, the control may be doubtlessly set upon the utilization for waste Eventually Tom's perusing results such as GGBS, for a see will decreasing those development cosset. In the introduce investigation is will Investigation those unconfined compressive quality What's more compaction of settled broad dirt utilizing fine and coarse ground granulated impact heater slag GGBS. Properties from claiming unreasonable dirt would convey out for grain circulation What's more soil order. A rundown from claiming compaction test were made utilizing scaled down compaction shape for separate mix about soil for two fine also coarse GGBS additions. To improve the properties of expansive soil, the unconfined compressive strength (UCS) test done at different composition of soil with GGBS mixes.

Md. Nuruzzsaman & Dr. Md. Akhtar Horssain (2014)

This study tells about to obtain any signature of improvement of expansive soil by the mixing of dust of soda lime glass with soil. In this research clayey type soil has been used. Clay soil has some problems in engineering properties and which need to stabilization. The major deficiency is that it subjected to consolidation occur due to the loading for long time. Secondary problem is when water is escaped then shrinks and swell significantly if it contact with water which apply great value of pressure on the substructure. Dust of glass is cohesionless material used as a stabilizing material. Mixing of cohesionless material to the cohesive soil and it will decrease the settlement cause from consolidation and expansiveness of soil. To analysis the effect some methods of analyzing the changes due to mixtures on soil have been taken i.e. performs many tests on virgin soil and soil treated with dust of waste glass and then tally the outcomes. The different tests were performed in this study are Atterberg test, Compaction test, Unconfined compression test, Consolidation test. First grain specific gravity tests and size analysis were performed. the optimum moisture content reduces which examine from the outcomes, maximum dry density, plastic limit increases, increases, reduction in liquid limit, plasticity index reduces, index of compression and swell reduces with the mixing of dust of waste glass with soil. Unconfined compressive strength (UCS) reduces at 0 days of curing and after putting it into water for numbers of days the UCS improves with the additive of dust of waste glass with soil.

AMIT S.KHARADE, VISHAL V. SURYAVANSHI (2014)

The base of each Structure is determined by soil and its stability to support the Structure. The major reason for un-stability of a Structure is due to the pressure of montmorillonite mineral, which is basically found in spacious soils such as black cotton soil. Soil Stabilization is the most appropriate method to improve fly ash, sodium chloride, calcium chloride etc. Disposal of agricultural waste is one of the serious problems. Some effective method of using agricultural waste in construction material are there for example Bagasse Ash is used to improve the stability of black cotton soil. Several experiments were conducted on Bagasse Ash as a substitute mixed with black cotton soil in the ratio (3%, 6%, 9%, &12%) and it was found helpful to better the existing performance of black cotton or expansive soil.

Oormila.T.R & T.V.Preethi (2014)

Expansive soils have many problems that make many challenges in construction area for civil engineers. They are assumed a hardly natural hazard, which creates harmful effects to structures if not seriously treated. Expansive soils swell when it contact to water and shrink in dry condition. There are many advantages of utilization of industrial waste materials in the improvement of soils like it is a cost efficient and pollution controlled method. Stabilization of the soil is obtained by using ground granulated blast furnace slag (GGBS) and fly ash. This research holds those change about dirt properties similar to unconfined compressive quality (UCS) test Also California bearing proportion test (CBR). The dirt example might have been taken starting with Tamil Nadu, Palur, Furthermore blending to that, different proportions from claiming fly cinder (5, 10%, 15% Furthermore 20%) What's more GGBS (15%, 20%, 25%) might have been included with discover the variety for its unique quality. Dependent upon those results cbr test might have been performed for the ideal GGBS, ideal flyash and combination of optimum flyash with changing GGBS percentages (15%, 20%, and 25%). From these outcomes, it was observed that optimum GGBS (20%) gives the large improvement in CBR value relates with another mixtures.

RAMDHAN W. SALIM, ET AL (2014)

The use of concrete and Cement for constructions has given special importance (has been underemphasized) in developing countries .Earth Bricks have gained special importance as construction material in addition they boost the bearing of construction . Researches indicate the Ash of Sugarcane Bagasse has given positive result to improve the soil capacity. Moreover, only few of researches show the effect of Sugarcane Bagasse on the mechanical property of Compressed Earth Brick. The recent research inquiry the effect of adding (3%, 5%, 8%, and 10%) Ash of Sugarcane Bagasse the material of compressed Earth Brick with the addition of 10% Ash of Sugarcane Bagasse improves the compressive strength of Earth Brick by 65% positive result shown by research.

PRAKASH CHAVAN AND DR.M.S.NAGAKUMAR (2014)

Soil is the base material .It supports burden from beneath structure .It is material, which is mostly used in highway system, in both forms natural and processed .Eventually, the structure of road rest on soil foundation if the local materials include local soils for construction of lower layer of road structure such as the sub –base course can be used, the cost of construction is decreased. The shaping from claiming undulations, corrugations, up hurling Also rutting need aid by attributed of the poor sub evaluation states. In the late investigation those soil testing might have been done. This dirt might have been sorted similarly as CH concerning illustration for every Indian standard arrangement framework (ISCS). The assortment about dosage about impact heater slag i. E. 3%, 6%, 9% and 12% were used to settle that broad (costly) soil. Hint at handling from claiming bagasse powder unchangeable soil might have been judge utilizing physical and quality execution tests namely; plasticity index, particular gravity, compaction, California bearing proportion (CBR) Furthermore unconfined compressive quality test (UCS). On the tested are used to upgrade the strength quality of the subgrade soil. However the material which is used road construction can improve, systematically proliferating the strength of soil and in addition reduces the project cost. According to the result, it was vividly seen that basic researches carried out proved notable after the mixing of sugarcane Bagasse Ash. And California bearing ratio (CBR) value enhance from 1.18% to 6.9 % and the unconfined compressive strength of specimens proliferating from 94KN/m² to 430 KN/m².

ASHISH MURARI, ISTUTI SINGH (2014)

A huge number of basic physical and organization of structure projects are being successfully installed in overall parts of our country .The useless of industries and farming affect the environment. As high ground area will be needed for their disposal and when they did not domain constrains found in the production of harmful gases reason, soil contamination, land fill space and many other hazardous effects. In India, the average of generation of solid litter found to be proliferating at a very high rate in last few years. Stabilization of soil means that develop

the characteristics of soil such as strength, unchangeable of volume and durability. Whose soil which changes value significantly when it comes in contact with water and are therefore, problematic to structures is known as spacious .Soil Sugar Cane Bagasse Ash (S.C.B.A.), the useless material from the sugar industry is used for developed un-changeability for proliferating characteristics of the soil. The materials can be utilized in various civil engineering works. According to researches check out the development characteristics of soil after the addition of bagasse ash in different percentages (2, 5, 7 & 10%). According to the results that standard proctor test was observed by tests result such as wet limit, plastic limit and other found from different proportions of bagasse ash needs reduce the liquid limit and plastic limit.

KHUSHBU S. GANDHI ET AL (2014)

In India large space deposits protected by expensive soil which have productivity undergo volume change due to changing water content with seasonal variation. The problem with spacious soil has been recorded all over the world because of these soil can occur heavy economically, as well as being a source of risk to the population. Civil engineering structure constructed on such soils experience harm due to add motion caused by swelling and shrinkage process of soil .The moistening and rough process of subgrade layer composed of black cotton soil occur with failure of Substructure in from of settlement and cracking. Therefore it is compulsory to reduce the problem posed by spacious soils and save from cracking structures. Highly spacious soil situated in Surat. According to experiment study unchangeable ability of spacious soil in Surat considering of changes of its different characteristics by the addition of unusable material industrial origin such as Bagasse Ash and Wood Ash .Its comparative study also for stabilize various useless material. Eventually, we can bring that in which useless material unchanged the Surat region soil effectively based on its selling properties. This may achieve the twice objective of decrease the problems of this type of soil, and also of providing a use for the useless product, thus eliminating the economic and environmental custom involved in managing

them. The empirical correlation of original soil characteristics with swelling characteristics improved using regression analysis for the quick result for stabilized soil.

I.A.IKARA, A.M.KUNDIRI AND A.MOHAMMAD (2015)

The research inquiry the quality of using Waste Glass (WG) and mixed to cement unchangeable black cotton soil (BCS) for roads, fills and embankment. The soil was categorized as A-7-5 and on the behalf of American Association and the Unified Soil Classification System (USCS) Classifications. Chemical analysis revealed that WG is rich in main oxides such as Silicon Oxide (69.2), Aluminum Oxide (2.29), Iron Oxide (1.57), Calcium Oxide (15.1) and Sodium Oxide (8.75). The soil was stabilized with 0, 2, 4, 6 and 8% cement and 0, 5 10, 15 and 20% WG by weight of the dry soil. Laboratory recent were follow out using the Standard Proctor (SP) compactive efforts, California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS), and compaction characteristics tests to evaluate the effectiveness of WG on Ordinary Portland cement (OPC) stabilized BCS. The outcomes got demonstrate An tumble down in the plasticity list (PI), LL, plastic limit (PL) and expand greatest MDD for proliferating over WG substance On the whole bond proportions utilized and Concerning illustration contrasted with those qualities got for the common dirt. The top 7 days UCS qualities about 1152kN/m² might have been gotten In 8% OPC Also 20% WG. In same manner, highest CBR value of 53.8% was obtained at an perfect blend of 8% OPC/20%WG. The results show that there is a big benefit in the use of WG as mixed to strengthen expansive soils.

B. AHMED, A. RAHMAN, J. DAS (2015)

In that conditions, the virgin soils in natural said do not present sufficient characteristics to be used as road service coarse. For development geotechnical parameters to meet the need of technical specifications of construction industry, unchangeable soil techniques are ordinary emphasized. Aims of research is to enhance subgrade CBR quality Toward utilizing sugarcoat bagasse powder Furthermore eggshell powder during fluctuating rates individually and will figure out the impeccable rate of both blended Past which CBR worth tumble down for dirt.

Increments the CBR quality about dirt dealt with sugarcoat bagasse powder what is more eggshell powder around rates with proliferating CBR quality of dirt with expansion from claiming bagasse powder toward weight (1%, 3%, 5%, 7%, 9%, Furthermore 11%). Those outcomes from claiming led demonstrate that at first to immaculate dampness substance about soil will be 13.8% and to expansion for bagasse powder up to 11% it need turned proliferating up to 15.20%. Further of eggshell powder up to 13% in starting optimum wet content of soil has become grow up with 15.25%. Firstly the CBR value of soil is 6.47%. Much more adding of bagasse ash up to 9% the CBR value of sand has become grow up 13.85% and then with adding of 11% bagasse ash it has become in grow down 13.28%. When eggshell powder adding in sand up to 11% the CBR value of soil has become proliferating up to 9.52% and then entrance of 13% eggshell powder it has become in DE proliferating 9.38%.

J. A. SADEEQ, J. OCHEPO ET AL (2015)

According to study was following out to examine the effect on the California bearing ratio of expansive soil with sugarcane bagasse ash. Laboratory research were implement on the natural soil in accordance with BS 1377 (1990) and implement bagasse ash treated soil in accordance with BS 1924 (1990). Treated specimens were prepared by made by combination bagasse ash with soil in manner of 0, 2, 4, 6 and 8 % proportions of dry soil and imputing with used oil in steps of 0, 2, 4, and 6 % by weight of dry soil. Those preliminary lab request conveyed crazy on the characteristic lateritic soil demonstrates that it diminish under Silt-Clay material about assembly A-6 utilizing AASHTO classification What's more inorganic mud material from claiming low will medium plasticity cl as stated by bound together soil classification framework (USCS). The particular gravity of the soil tests develop down from 2.61 to that regular dirt should 2.48 at 8 % bagasse powder substance and should 2.16 What's more 2.11 toward 6 %oil / 0 %BA what is more 6 %oil / 8 %BA substance separately. Those fluid and plastic breaking points develop dependent upon from 36.32 What's more 21.30 % individually on the crest values, from claiming 38.00. Furthermore 21.54 % during 2% bagasse powder content for at oil substance. The most extreme dry thickness (MDD) of the soil develop dependent upon from 1.

48 Mg/m³ to those common dirt on crest worth for 1. 49 Mg/m³ during 8 % bagasse powder substance for every one oil substance. Those ideal dampness content (OMC) develop dependent upon from a worth for 18.5 % to the common soil should 19.0 % during 2 and 4 % bagasse powder substance et cetera after develops down. The uncooked CBR values from 5 % BA content and above met the less CBR value of 35% specified for base course material which is mostly used when determined at MDD and OMC. However, the highest CBR value of 63 % recoded at 9% BA content not passed to meet 85 % CBR value Oil contamination resulted in reduced CBR values in expansive soils.

Tanmay Jain, Gulshan Yadav ET AL (2015)

In India Expansive soil is available in most of the states, which have properties of volume change with change in water content due to seasonal variation. All over the world faces these problems with expansive soils. These soils are dangerous to structures on it and can create major economic losses, as well as makes risk to the population. Soil is a main part of structure (base) and supports the structure from beneath and distributes the entire load from structure effectively. If the stability of the soil (base) is not sure, then damage or failure to the structure occurs in the form of cracks, settlement, etc. This research shows different stabilizing materials such as cement, industrial wastes, lime, fly-ash, and Geo-synthetics etc., and gives to be useful in stabilization of black expansive soils. There is highly expansive soil in Surat region, so in this region Civil Engineers have many challenges for construction. In Surat, Stabilization of an expansive soil contains the variation of its different properties by the mixing of different waste materials of industrial origin such as fly ash, bagasse ash, rice husk, wood ash and polyester fiber. In this research shows the effect of waste material on black cotton soils by mixing or addition in Surat region. Based on the whole study, the total effect of waste material on black expansive soil is analyzed in Surat region. This research also used for stabilization using several waste materials. So that we can decide which waste material stabilize the Surat region soil by changing its engineering properties. The main objective of this study is to reducing the problems of this type of soil, and also by gives a use for the waste product, thus emitting the environmental and economic cost involved in managing them.

Aluko, O.G, Oke, O.L, Awolusi, T.F (2015)

This research indicates the effect of addition of waste glass powder in the block on the compressive strength of compressed stabilized earth block (CSEB) as cement adding or used as admixture. For examine the characteristics the soil sample the consistency limits and water content was tested. There would two sorts about waste glass powders expected were the individuals death through sifter 150 μm with substitution cost levels shifted In 0%, 20%, 40%, 60% and the another death through sifter 75 μm with supplanting levels shifted toward 0%, 5%, 10%, 15%, 20%, 25% Also 30% individually. 1st 65 squares were produced for size 225 x 225 x 112. 5 mm. Also curing is accomplished for 7, 14 Furthermore 28 times. For admiration to WGP molecule sizes utilized within this research, it might have been watched to the rates from claiming bond displacements utilized (up on 60%) that the compressive qualities recorded were greatest over 3N/mm², those least prescribed quality for CSEB during 28 days.As no changes was observed for the mixing of WGP to CSEB in this study, the result suggests that 20% replacement of cement with WGP whether at 150 μm or 75 μm could be used.

Hanifi Kanakci, Aram-Al kaki (2016)

This research was complete with an motive to examine any clue of modification of clayey soil due to mixtures of waste soda lime glass powder (WSLGP). Waste soda lime glasses were converted into powder form and then sieved through #200 (75 μm) sieves and addition in proportion of 3, 6, 9, and 12% in dry weight of the clay. The main test performed are Strength and consistency test on mixed samples after curing. The test outcomes indicated that the mixture of WSLGP into clay has a important strength effects and overall performance of the clay.

AMRUTA P. KULKARNT, ET AL (2016)

It is difficult task for the engineers to construction on black cotton or expansive soil as a structures and it can crack without any warning Soil mixing depending upon constituents of soil, i.e. bulk density, water content, density, shear strength, angle of friction, etc. With the stabilization of soil the properties of black cotton soil can be modified with the use of stabilizing agents or by mechanical means. As bagasse ash is problem for environment when it disposal freely. This problem can remove by using bagasse ash as a stabilizing agent and it is cheaper than cement or lime stabilization. In this paper the stabilizing of black cotton soil done by using addition of lime and bagasse ash. Bagasse is that remains after extraction of sugar and it is a fibrous residue of sugarcane stalks and when uses as a fuel makes bagasse ash. The chemical analysis on bagasse ash placed to contain mainly silica, and potassium, iron, etc. exhibit pozzolanic properties. The research found the performance of expansive soil when stabilized by lime, ash and both of lime and ash. The main objective is to economically improve the engineering properties of the black cotton soil such that the structures on this soil are safe.

CHAPTER 4

4.1 RATIONALE AND SCOPE OF THE STUDY

- ▣ Much research has been done using bagasse ash as a stabilizer in different clays.
- ▣ Very Few studies are found on waste glass powder in clay.
- ▣ But no study has been done using both bagasse ash and waste glass powder as stabilizers in clay.
- ▣ By using this combination of both sugarcane bagasse ash and waste glass powder in clay, positive results are expected.
- ▣ This study gives huge advantage to waste management system of state or country where it carried out and solves the problem of disposal of those two materials.

CHAPTER 5

5.1 OBJECTIVES OF STUDY

- ▣ To improve the liquid limit, plastic limit, plasticity index, such as improves the index properties of clayey soil. By improve that values the problems of shrinkage and swelling of clay when it contact with water or increase in moisture content can be solved.
- ▣ To improvement in sub grade characteristics of CBR of clay. It helps to improve in bearing capacity of clay soil under the application of loads from structure on it.
- ▣ To overcome uneven volume changes of clay without any warning.
- ▣ To improve in dry density at different water content and obtain the maximum or improved dry density at optimum moisture content (OMC)
- ▣ To Improvement in Unconfined compressive strength (UCS) clay.
- ▣ The main objective of this study is to improve the overall performance of clay by using two waste materials i.e. sugar cane bagasse ash and waste glass powder as stabilizers.

CHAPTER 6

6.1 MATERIALS

The materials used in carrying out this study were clay soil, waste glass powder and sugarcane bagasse ash. The soil sample was provided from the Amritsar (Punjab) district in the city of Bias, in north India. All properties of waste glass powder are mentioned in table no6.1.

Table 6.1. Summarizes of various properties of soda lime glass

Properties	Values
Silica (SiO ₂)	74%
Sodium oxide (Na ₂ O)	13%
Lime (CaO)	10.5%
Alumina (Al ₂ O ₃)	1.3%
extra Components present	1.2%
Density	2.52 g/cm ³
Young's modulus at	72 GPa

Table 6.2. Chemical properties of bagasse ash

Chemical element	Percent by weight
SiO ₂	63.45
Al ₂ O ₃	10.34
Fe ₂ O ₃	7.68
K ₂ O	2.63
CaO	8.65
So ₃	1.25
Mn	0.3
Cu	0.21
Zn	0.29
Na ₂ o	1.77
P ₂ O ₅	2.23

Water used for the tests was clean and free from impurities so that was able to drink and, water temperature was normal about 20 to 22 degrees.

From the sugar cane plant the bagasse is generated after the extraction of juice which is the fibrous residue. Bagasse is a waste material and clutter environment. Then most of the part of sugarcane converts into bagasse after the extraction of juice, which is used as a fuel for producing steam which results in bagasse ash. This creates environment problems when it dumped outside freely. Bagasse ash has properties same as a pozzolanic material like it is rich in oxide of silica and aluminum. Due to those properties it can be used for stabilization of clayey soil. The stabilization of clayey soil with bagasse ash automatically solves the problem of disposal and it good for environment. It is used as a cheap material and very important for economy in the construction.

The disposal of waste glass is not so economical and only some are recycled. The waste glass was collected and converts into the powdered form. Waste glass powder is fine and rich in density. Then it can be used as the stabilized agent for clayey soil. The waste glass can crushed into desirable proportion for addition in clay. Some cities and town have poor solid waste management, which creates seriously environmental problems. So with using of waste glass powder for stabilizing clay, the problems arise from glass waste decreased and it became a cheap material as a stabilizing agent.

6.2 RESEARCH METHODOLOGY

6.2.1 Laboratory tests and analysis

Different tests and readings were taken out to determine the effects of the powder of waste glass and sugarcane bagasse ash on the expansive soil i.e. grain size distribution analysis, specific gravity test, Atterberg limits test, and compaction test and CBR test were attempt to the determination the effect of mixture. With the help of these tests, the required proportions of glass powder and SCBA, to effective stabilization of the expansive soil was examined.

The different no of tests used are

- ▣ Particle size distribution analysis
- ▣ Natural moisture content
- ▣ Specific gravity test
- ▣ Atterberg limits tests
- ▣ Compaction test
- ▣ CBR

CHAPTER 7

7.1 LABORATORY INVESTIGATION

7.1.1 Particle size distribution analysis

Table.7.1 shows proportions of the grain size distribution analysis with retained soil in each sieve.

Table 7.1 Particle Size Distribution Analysis

Sr.no	Sieve diameter (mm)	Mass retained (kg)	% retained	% passing
1	4.75	0.056	5.6	94.4
2	2.36	0.102	10.2	84.2
3	2	0.052	5.2	79
4	1	0.214	21.4	57.6
5	0.600	0.064	6.4	51.2
6	0.300	0.074	7.4	43.8
7	0.150	0.278	27.8	16
8	0.075	0.102	10.2	5.8
9	PAN	0.058	5.8	0

In Fig.7.1 is graph plot between the sieve size analysis and finer percentage from which the Cu and Cc obtained as 0.197 and 11.72 respectively.

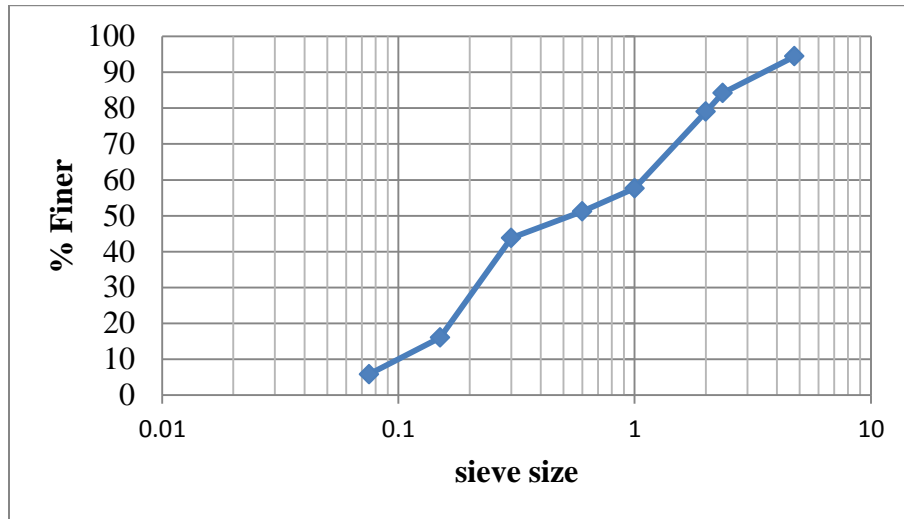


Fig.7.1 Particle Size Distribution Chart

7.1.2 Natural moisture content

The clay soil used for this research work had natural water content sample 4.67% as given in Table 7.2.

Table.7.2 Moisture content results

Test sample	Mass of empty cont. (g) M1	Mass of cont. + wet soil (g) M2	Mass of cont. + dry soil (g) M3	Moisture (g)	MC %
1	45.82	96.38	94.14	2.24	4.63
2	46.01	97.8	95.51	2.29	4.62
3	47.50	98.2	95.89	2.31	4.77
Average					4.67

The equation used for determine the moisture content is

$$MC = \frac{M3 - M2}{M2 - M1} \times 100\%$$

7.1.3 Atterberg limits tests

The water content values of soil sample are examined by the Atterberg limits test (LL, PL and SL) are as shown in Tables 7.3 and 7.4. The LL is 37.5, PL is 20.53% and plasticity index is 16.97 of the natural soil sample.

Table.7.3 liquid limit results

Sample	No. of blows	Mass of wet sample (g)	Mass of dry sample (g)	Moisture (g)	MC %
1	52	6.52	4.97	1.55	31.18
2	39	8.1	6.05	2.05	33.80
3	27	11.03	8.07	2.96	36.6
4	19	8.65	6.24	2.41	38.6
5	11	9.56	6.50	2.75	42.31

The Liquid limit from graph correspond to 25 blows is 37.5.

To find the type of clay we use the equation: $0.73(LL-20) \Rightarrow 0.73(37.5-20) = 12.8$

To find plasticity index used equation $PI = LL - PL$

And $L.L - P.L = 37.5 - 20.53 = 16.97$

The value of plasticity index (16.97) is greater than 12.8 ($16.97 > 12.8$) so the type of soil is clay.

Graph is plotted between the No. of blows and water content to find the value of liquid limit which is 37.5.

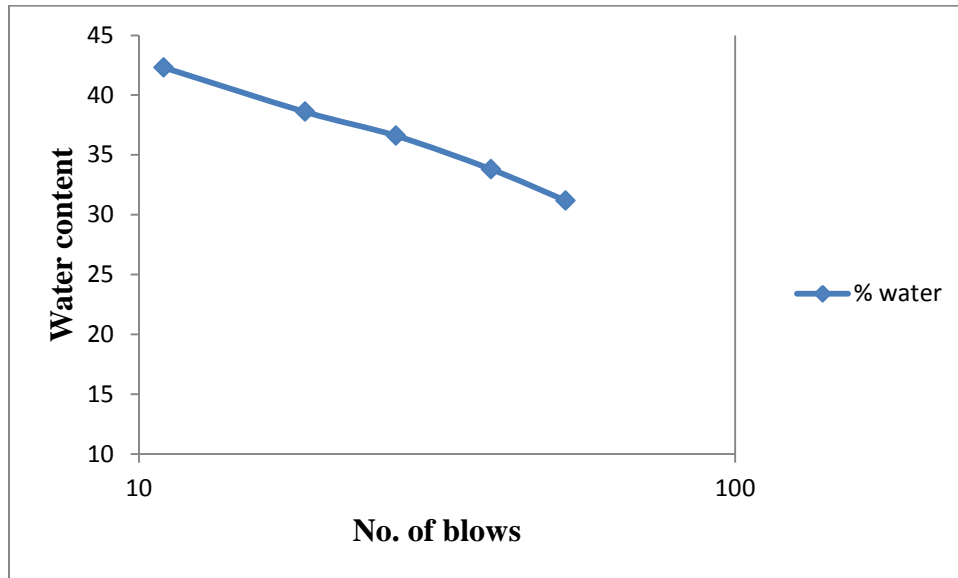


Fig.7.2 Graph between no. of blows and water content

From the plastic limit test the results are obtain from the readings which are given in table no. 7.4

Table.7.4 Plastic limit results

sample	Mass of wet sample (g)	Mass of dry sample (g)	Moisture (g)	MC
1	6	1.02	4.98	20.52
2	6.07	1.03	5.04	20.76
3	5.33	0.9	4.43	20.31
Average MC				20.53

7.1.4 COMPACTION TEST

Table 7.5. contain the compaction test outcomes for the expansive soil, from the outcomes the maximum dry (γ -max) density is 17.5 kN/m^3 and the OMC is 17.5%.

Table 7.5. Summary of MDD and OMC Values

MDD (kN/m^3)	OMC (%)
16.63	10.76
16.98	14.48
17.33	16.96
17.14	19.2
16.81	20.04
16.48	21.31

Fig.7.3 shows the graph between the water content and dry density of soil and from which the maximum dry density obtained at optimum moisture content

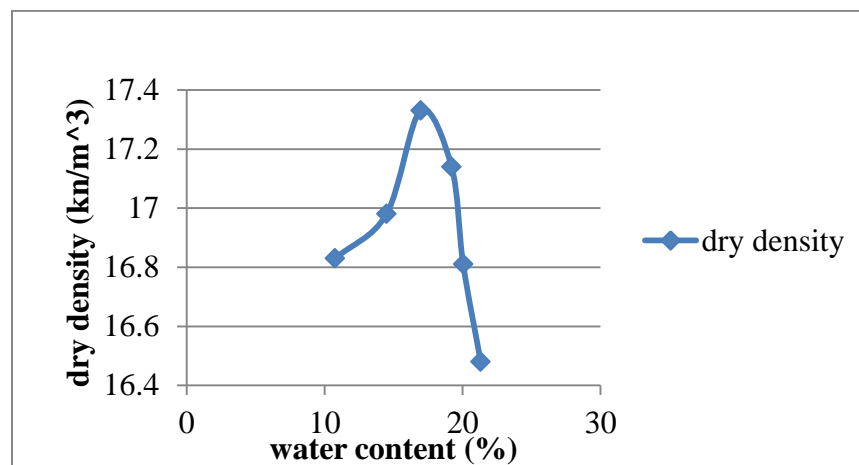


Fig.7.3 Graph of Maximum Dry Density at optimum moisture content

7.1.5 Specific gravity

The specific gravity of the clay soil was examined as 2.64 as shown in Table 7.6.

Table 7.6 Specific gravity

Sr. No.	Masses (Kg)	Test 1	Test 2	Test 3
1	Mass of density jar + Water (Full) = m_4	1.515	1.515	1.515
2	Mass of density jar + Soil + Water = m_3	1.829	1.831	1.830
3	Mass of density jar + Soil = m_2	1.128	1.128	1.128
4	Mass of density jar = m_1	0.628	0.628	0.628
5	Specific gravity	2.68	2.71	2.70
	Average specific gravity (G_s)	2.69		

The equation used to find out the specific gravity is given by

$$G_s = \frac{m_2 - m_1}{(m_2 - m_1) - (m_3 - m_4)}$$

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