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Department of Civil Engineering

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JOURNAL OF CIVIL ENGINEERING







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CivilTech: Journal of Civil Engineering Research and Innovation is a print research journal being published by Department of Civil Engineering, Babu Banarasi Das Institute of Technology & Management (BBDITM). The journal aims to provide a platform for students, researchers, academicians, practicing engineers and industry professionals to share original research and practical developments across the broad field of civil engineering. The journal welcomes original research papers, review articles, case studies, technical notes and practice-oriented contributions that advance knowledge, improve engineering practice, and support safe, resilient and sustainable infrastructure. Submissions should be clearly written, technically sound and relevant to civil engineering research or practice. It publishes original papers, and the research contributions made across academia and industry with a focus on the work that contributes in the prosperity of modern societies and keeping in mind the sustainable engineering goals of united nation.

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The current issue focusses on applications of advance technologies

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- Disaster risk reduction, resilient infrastructure and climate adaptation
- Solid waste management, circular economy and sustainable construction
- Innovative methods in infrastructure maintenance and rehabilitation

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INVESTIGATING THE USE OF BIOCHAR FOR CLAY SUBGRADE STABILIZATION IN HIGHWAY CONSTRUCTION

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Abstract

Clayey soils used as subgrades in highway construction often suffer from high plasticity, excessive swelling, low bearing capacity, and inadequate strength, leading to early pavement failure. To overcome these limitations in a sustainable manner, this study investigates the effectiveness of stabilizing clay with a hybrid combination of rice husk biochar, wood biochar, and lime are added in the ratio of 3:3:4. Biochar, a carbon-rich and porous by-product of biomass pyrolysis, has gained attention for its ability to improve soil structure and moisture behaviour, while lime remains a proven chemical stabilizer capable of inducing pozzolanic reactions and long-term strength gain.
In this research, natural clay was stabilized using rice husk biochar, wood biochar, and lime, selected based on their optimum performance ranges reported in literature and confirmed through preliminary assessment. A comprehensive experimental program was conducted, including Atterberg limits, California Bearing Ratio, Moisture test, and specific gravity tests.

Keywords:

Rice Husk Biochar; Wood Biochar; Lime Stabilization; Clay Subgrade; Soil Stabilization; California Bearing Ratio (CBR); Atterberg Limits; Sustainable Construction Materials; Eco-friendly Stabilizer; Soil Improvement Techniques.

INTRODUCTION

The subgrade is the natural soil or prepared foundation layer over which the pavement layers are constructed. Its primary function is to provide adequate support to withstand the stresses transmitted from the traffic loads through the pavement structure. The strength and stability of the subgrade play a critical role in determining the overall performance and life of the pavement. In many regions, especially in India, clay soils are commonly encountered as subgrade material. Clay soils are composed of very fine particles (<0.002 mm) with a large specific surface area and strong affinity for water. These properties make clay soils highly problematic for use as subgrade in highways. In this study we are mixing different combinations of wood biochar, rice husk biochar and lime to this clayey soi to enhance its physical properties and make it suitable for the use in construction work without any problems. We will examine this soil properties before and after the mixing of these admixtures to find out how much improvement has been there in the soil properties and on the basis of these findings, we will make further future studies that this soil should be used.

The main contributions of this study include:
Improvement in Soil Strength Properties
Reduction in Plasticity and Swelling Behaviour
Enhancement of Compaction Characteristics
Improvement in Durability and Moisture Resistance
Environmental and Economic Benefits.

LITERATURE REVIEW

Clayey subgrades typically suffer from high plasticity, low shear strength, low CBR, high compressibility, and moisture sensitivity—all of which reduce pavement life. Conventional stabilizers (lime/cement) work but raise cost and CO_2 footprint. In the last decade, biochar—a porous, carbon-rich material from biomass pyrolysis—has been explored as a sustainable stabilizer. Studies generally report reduced swell/shrinkage, improved CBR, altered compaction behaviour (↓MDD, ↑OMC), and microstructural changes (flocculation/aggregation, pore-structure modification). However, effects depend on feedstock, pyrolysis temperature, particle size, and dosage, and there's still a need for standardized mix design, durability under cyclic loading, resilient modulus (Mr) data, and field validation.
Previous studies in Geotechnical Engineering have extensively highlighted the challenges associated with clayey subgrade soils, particularly their high plasticity, low strength, and significant swelling–shrinkage behavior under varying moisture conditions. Traditionally, stabilizers such as cement and lime have been widely used to improve soil properties; however, their application is often limited by high costs and environmental concerns, including increased carbon emissions. Researchers have reported that the incorporation of biochar can enhance soil strength, reduce plasticity, and improve moisture retention characteristics, although the extent of improvement varies depending on soil type and biochar content.

Furthermore, biochar contributes to sustainable construction practices by promoting waste utilization and supporting Carbon Sequestration. Despite these advantages, existing literature indicates a lack of comprehensive studies focusing on its application in highway subgrade stabilization, particularly under long-term loading and field conditions. Review of Previous Studies

2008 – Lehmann & Joseph Published "Biochar for Environmental Management". This foundational work explained biochar's physical and chemical properties, highlighting its role in improving soil structure, porosity, and stability. Although primarily agricultural, it opened the door for geotechnical applications.
2011 – Downie et al. Reported that biochar produced at higher pyrolysis temperatures showed better structural stability and higher surface area, which are useful for soil stabilization.

2014 – Zhang et al. Studied the effects of rice husk biochar on expansive clay. Results showed reduction in plasticity index and swelling potential, making clay more stable for subgrade applications.

2016 – Sutar & Sahoo Investigated the use of wood biochar in clayey soil stabilization. Findings showed increased CBR (California Bearing Ratio) values and improved load-bearing capacity of the treated soil.

2017 – Ghosh et al. Compared biochar with lime stabilization on soft clay. Biochar showed better improvement in permeability and durability, though lime provided higher initial strength.
2018 – Chen et al. Conducted a detailed study on the microstructure of biochar-amended clay. Reported pore-filling and flocculation effects, which enhanced shear strength and reduced compressibility.

2020 – Saha & Ghosh Evaluated biochar from rice husk in expansive clay stabilization for pavements. Found that optimum 6–8% biochar content increased UCS (Unconfined Compressive Strength) and reduced swelling index significantly.
2021 – Rajasekaran & Kumar Studied the durability of biochar-stabilized clay subgrades under cyclic loading. Found that biochar not only improved strength but also resisted fatigue and deformation under repeated traffic loads.
2022 – Zhang & Wu Analyzed different pyrolysis temperatures of biochar on clay stabilization. Found that high-temperature biochar (600–700 °C) offered the best long-term stability due to its high fixed carbon and surface area.

2023 – Singh et al. Conducted experimental studies on highway clay subgrades treated with rice husk and bamboo biochar. Reported that biochar addition improved CBR by 25–40% and significantly reduced plasticity.
2024 – Li et al. Recent research highlighted the use of biochar-lime blends for highway subgrades. Found that combining biochar with traditional stabilizers like lime/cement enhanced performance while reducing carbon footprint, making it highly suitable for sustainable pavement construction

METHODOLOGY

The present investigation aims to study the improvement in the engineering properties of clay subgrade soil by using a combination of rice husk biochar, wood biochar, and lime. The experimental program consists of material collection, characterization, sample preparation, and laboratory testing under controlled conditions. The methodology adopted is discussed in detail below.The materials used in this study include clay soil, rice husk biochar, wood biochar, lime, and water. The clay soil was collected from a nearby construction site where weak subgrade conditions were observed. The soil was air-dried, pulverized, and passed through a 4.75 mm sieve to obtain uniform consistency. Preliminary classification tests revealed it to be a highly plastic clay (CH) as per the Unified Soil Classification System.
Rice husk biochar (RHB) was prepared by pyrolyzing rice husk at temperatures between 400 °C and 600 °C under limited oxygen. It is a lightweight, porous, carbon-rich material with a high silica content that improves the binding and strength characteristics of clay soil. Wood biochar (WB) was obtained from hardwood waste pyrolyzed between 450 °C and 550 °C. Its rough, porous surface enhances inter-particle friction and increases the dry density and strength of stabilized clay. Lime used in this study was commercial hydrated lime conforming to IS 1514:1990. Lime was chosen for its pozzolanic reaction with clay minerals, forming cementitious compounds such as calcium-silicate-hydrate (C–S–H) and calcium-aluminate-hydrate (C–A–H), which contribute to long-term stabilization. All materials were stored in airtight containers to prevent moisture absorption before mixing. The entire procedure followed a logical sequence:

Collection and identification of natural clay soil.
Characterization of soil properties through preliminary tests.
Preparation of rice husk and wood biochar.
Mixing of biochar and lime with clay soil in different proportions.
Determination of OMC and MDD through compaction.
Preparation and curing of stabilized samples.
Conducting strength and durability tests
Analysis of results to evaluate improvements in subgrade performance

SURVEY WORK

Work Location: Gomti River Bank The survey work for this study is contextually linked to the area surrounding the Gomti River Bank, which is known for its diverse soil characteristics and ongoing urban development activities the Gomti River Bank region was selected as the environmental reference location due to its predominant

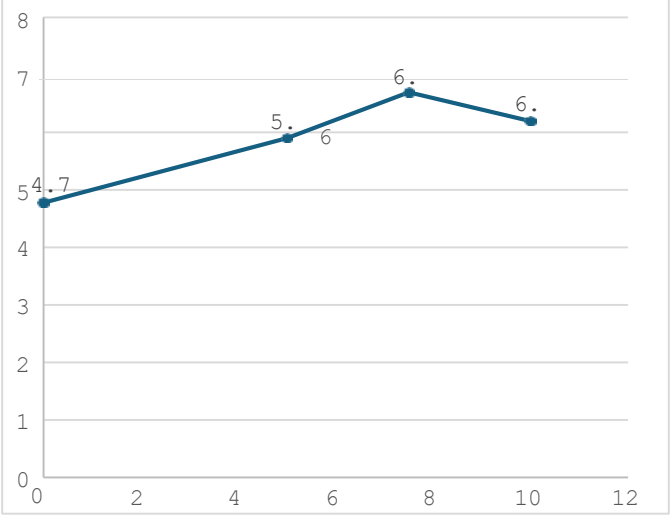
clay-rich subgrade and the pressing need for soil improvement solutions in nearby infrastructure works. The site's naturally occurring soft, wet, and highly plastic clay deposits provide a practical background for understanding stakeholder perceptions toward sustainable stabilizers such as rice husk biochar, wood biochar, and lime. This location also represents a typical scenario where weak subgrades affect road performance, making it an ideal contextual zone for evaluating the feasibility and acceptance of biochar-based stabilization techniques among engineers, students, faculty, and practitioners

EXPERIMENTAL RESULT AND ANALYSIS

The tests conducted include density test, moisture content determination, liquid limit test, and California Bearing Ratio (CBR) test. All tests were performed in accordance with relevant Indian Standard (IS) codes to ensure accuracy and reliability of results.

With these testing of the soil we get to know about the soil properties and its analysis and how well it performances without adding of the admixtures with in our case are the wood biochar, rice husk biochar and lime and how its properties get better with their addition and it becomes very more useful and far more economical. Final comparison is shown on the basis of change in CBR values with the change in percentage of soil.

Admixtures (%)	CBR Values	% Increase in CBR values
0	4.78	
5	5.9	23.43
7.5	6.7	40.17
10	6.2	29.71



CONCLUSION

The present study was carried out to evaluate the engineering properties of natural soil and to examine the effectiveness of stabilization using rice husk biochar and lime. Based on the laboratory investigations conducted, the soil was identified as a clayey-silty mixture with low plasticity characteristics. The Atterberg limits revealed a liquid limit of 38.5% and plastic limit of 23.49%, resulting in a plasticity index of 15.01%, indicating very low plastic behavior and poor cohesion. The natural moisture content was found to be relatively high, while the dry density was comparatively low, suggesting the presence of fine particles and voids within the soil structure. The strength characteristics of the soil were evaluated using the California Bearing Ratio (CBR) test, which yielded a value of 4.78% at 2.5 mm penetration. This low value indicates that the soil possesses poor load-bearing capacity and is not suitable for use as a subgrade material in highway construction without improvement. The results clearly establish that the natural soil, in its untreated state, cannot sustain traffic loads effectively and is prone to deformation. To improve the soil properties, stabilization was carried out using rice husk biochar and lime. The addition of these materials resulted in noticeable improvements in the engineering behavior of the soil. The most significant improvement was observed in the CBR value, which increased from 4.78% to a maximum of approximately 6.7% at an optimum mix of 7.5% rice husk biochar and lime. This increase in CBR indicates an improvement in load-bearing capacity and resistance to penetration

FUTURE SCOPE

The present study provides a foundation for understanding the behavior of clayey-silty soil stabilized with rice husk biochar and lime; however, there is significant scope for further research and improvement. Future studies can explore the use of higher percentages of stabilizers or different combinations of biochar and lime to achieve greater strength and durability. Long-term performance studies should be carried out to evaluate the durability of stabilized soil under varying environmental conditions, including wetting-drying cycles and repeated traffic loading. This would provide a better understanding of the behavior of stabilized soil over time and its suitability for real-world applications. Further research can also focus on microstructural analysis using advanced techniques to understand the bonding mechanism between soil particles, biochar, and lime. This would help in optimizing the mix proportions and improving the efficiency of stabilization

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investigating the use of biochar for clay subgrade stabilization in highway construction provides the technical foundation for structuring this paper.

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SUGGESTIVE METHOD FOR TREATMENT OF WASTE WATER DISCHARGE FROM BALRAMPUR SUGARMILL

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ABSTRACT: The study was designed to treat the effluent from sugarcane sector. As cane itself contain 67.5% of water out of which 13.4%goes in bagasse's ,2.6% in filter cake and 0.6%in molasses.The use of fresh water in sugarcane industry and result huge amount of waste water is not a secret to anyone. The use of chemical in large quantity has caused a great risk and damage to the ground water, soil and ultimately lead to destruction of our environment. Treatment of industrial sugarcane waste water is not an easy task. The purpose of our study is treatment and reuses it for different purpose. Coagulation with alum, ferric chloride is done in this process. The result of the study discloses that BOD and COD were in huge amount which was successfully treated.

***Index Terms*: Waste water minimization, BOD, COD, Alum.**

INTRODUCTION

Water is most vital and more valuable source for all living organism because of rapid urbanization and industrialization. Sugar is produced in 120 countries and global production is around 180million tones a year.In developing countries like India sugar is one of the significant agriculture product and sugar industry is one of the agro based industry in India. India is the largest producer of sugar unseating Brazil .Brazil alone account for 25%of world production .And in India U.P is consider the largest producer of sugar which is directly propotional to the amount of waste it generate especially waste water .And in UP one of the biggest sugarmill is BCML (Balrampur chini mill limited) which has a crushing capacity of 14000 tonne per day so the amount of waste water generated can easily be known.It is reported in the literature that by different coagulant alum ,ferric chloride and ferric sulphate can get a better result on 6-8ph.Coagulation is an essential and effective step of different industries and sugar industries effluent are mostly deposit in agriculture land or in fresh water canal.In general the waste water of sugar industry contain high BOD, nearly natural ph,nutrient defficency and sulphate .Physiochemical treatment will be adequate but can be used as rough unit In contrast ,modern approach to waste water management aims at optimizing production process and at minimizing generation of wastewater then managing the unavoidable waste in an environmentally acceptable and economical manner. In most of the environmental problems, the cheapest and most effective way is to reduce the pollution and if possible avoid the production of the waste. Industries can modify the production processes so that lesser quantities of wastes are generated or the waste generation .

AIMS AND OBJECTIVE

To reduce the water consumption.
To achieve the sustainable reduction in power bills.
To reduce the waste water generation.

LITERATURE REVIEW

J.Prabhakaran(2016)- The sugar industry effluent which is untreated highly contains COD, BOD, TSS, TDS, TS and low contents of DO which is toxic, to plants. So it is not permissible for irrigation. * The treated effluent of sugar industry which is well balanced of chemicals will be suitable for irrigation purpose. Effluent Type Greengram Paddy Control 100%, 96.60% , Treated Effluent , 100% ,98.40%.Untreated Effluent 67.90% 61.90% International Jour Technology, Treated Effluent released from sugar industry may be utilized for industrial processing again and it is economically profitable for sugar industry.

Nitin P Sonaje(2017)- The sugar factory is one of the most popular and second largest agro based industries and there are about 600 plus sugar industries in India playing a vital role in economic development of the country. These industries are using huge quantities of water and raw material in their production process. The raw water requirement for sugar industry is 200- 400 lit/tonne and wastewater produced is about 200-300 lit/tonne of sugarcane crushed. In the production of sugar bye-products such as, Press mud (3.5-4%), Bagasse (28-32%) and Molasses (3-4%) are produced. The darker side of growth of the sugar industries in the country is environmental deterioration i.e. water, soil and air pollution. These environmental problems are affecting the future prospects for sugar industry development in the country.

Satoto Endar Nayono (1989)- From the results of this study, it can be concluded that there is the possibility to use granular sludge from one UASB reactor as an inoculum for another UASB reactor, although the sludge can be categorized as relatively inactive and due to a long storage period without feeding. It supports the report that

granular sludge can be stored for many months without loosing its activity (Lettinga et al., 1980 in Polprasert et al. 2001). Granular sludge has the ability to increase its activity by applying a proper organic loading rate, considering the "readiness" of methanogenic bacteria to utilize the products of fermentive and/or acetogenic.

CASE STUDY

The name of the industry under study is "BALRAMPUR CHINNI MILL" it is situated in Balrampur district , Uttar Pradesh The industry work from month of October to june .It is the time when sugarcane is available in field .The industry runs in 3 shift for 24 hours .there are about 1000 workers working in the industry .It has high capacity utilization rate, good recovery of sugar and well diversified business model .Over the year balrampur has increased the scale of operation through capacity expansion and acquisition. It is a 0%waste producing industry as it reuses all it waste in different person .The enivorment is very excellent and the people are very cooperative over there. Industry uses 3 lakh of water per day .The industry has develop greenry also .The treatment of waste water is done in completely different section using ETP. Lab are also present for testing of untreated and treated waste water.RO facility is also present in the industry.

FROM THIS CASE STUDY FOLLOWING POINTS TO CONCLUDED:

1:Sugar waste water is an area that has adequetly explored but the characterstic of sugar waste water is lot more fluctuating depending upon the size.

2: In sugar industry there is the large scope of recirculation and reuse of water. 3 :The waste water is highly organic in nature.

4: Physiochemical are also getting popularity nowdays and the most important problem in biological treatment is seasonal nature of industry.

METHODOLOGY

Treatment of sugar industry require a process that combine mechanical, chemical and biological treatment measure. Screening ,grit removal,equalization and sedimentation are used to remove suspended solid load .

The methodology is divided into two was – 1 .Biological treatment method

2. Physio chemical treatment method

MANUFACTURING OF SUGAR

The sugarcane are cut into pieces and cut in the series of roller to extract the juice in the mill house.The milk of is then added to juice and heated when all the colloidal and suspended impurities are also coagulated.The coagulated juice is then clarified to remove the sludge.The sludge is further filtered through filtered press.The clarified juice is then preheated and then concerated in evaporator and vaccum pan .The partially crystalissed syrup is then transfer to crystallizer ,where complete crystallization of sugar cane occur .The sugar is then dried and packed for transport.

SOURCES OF WASTE WATER:

Waste water from the mill include the water used as splashes to extract maximum amount of juice and those use to cool the roller bearing .As such the mill house contain waste water with high BOD .The filter cloth used to filter need cleaning for which also need cleaning .The periodical washing of floor also contribute agreat lot of pollution load.

EFFECT OF WASTE WATER

The fresh effluent from sugar industry decomposes rapidly after few hours of stagnation .It has been found that it causes considerable difficulty when their effluent get access to the water course.The rapid depletion of oxygen due to biological oxygen followed by anaerobic stabilization of the waste causes the secondary pollution of waste and odour.

WATER CONSUMPTION

The sugar industry consume large quantity of water in manufacturing process and resulting in huge waste water generation.The water used in sugar industry is of two type one is cold and other is hot water.The cold water is used as makeup water ,consumption water and hot water are used in boiler feed water,juice dilution ,lime and sulphate preparation . 1- **MILLING SECTION COLD WATER-**

For mill bearing cooling-30m3/hr

For shredder bearing cooling-20m3/hr For gearing cooling-76m3/hr **HOT WATER-**

For mill ambition-85.8m3/hr

CLARIFICATION OF JUICE COLD WATER

For sulphate station-11m3/hr Air compressor-20m3/hr Pump glant cooling-8m3/hr **HOT WATER**:

For milk and lime preparation- 10.4m3/hr Filter washing-13m3/hr

EVAPORATION :

HOT WATER

For molasses conditioning; 5.2m3/hr Melter-13m3/hr **COLD WATER**:Injection water for vaccum pan-4640m3/hr 4-**BOILER FEED**:Hot water as a boiler feed water:170m3/hr

Cold water as boiler makeup water:13.9m3/hr RO plant reject-4.17 m3/ hr.

TABLE:NORMS FOR SUGAR INDUSTRY:

SR.NO.	PARAMETERS	STANDARD PRESCRIBED BY BOARD
		Limiting concentration inmg/l
1	pH	5.5-9
2	OIL AND GREASE	10
3	BOD(3 days 27C)	100
4	SULPHATE	1000
5	SUSPENDED SOLID	100
6	TOTAL DISSOLVED SOLID	2100

WATER CONSERVATION TECHNIQUE ADOPTED:

Recirculated the cooling waters.

Sulphur Burner Water used is recirculated and connected to spray pond.

Oliver Filter Instead of using fresh water, spray pond water is used to create vacuum at vacuum pump and barometric condensers

Hot water condensate is used for filter cake.Water required to wash sugar mascuitte in centrifugal machine is condensate from evaporator bodies.

Hot water is used instead of fresh water. Cooling water Mill drive, mill bearing, power house turbines,compressor, cooling and vertical crystallizers is also cooled condensate instead of fresh cold water.

PROCESS MODIFICATIONS

Now-a-days it is a necessary to establish co-generation unit along with sugar industry from economic sustainability point of view and also raw material required for this is available in the form of bagasse, which is byproduct of sugar industry. In this co-generation plant either condensing or back pressure turbines can be used. From the water minimization point of view, back pressure turbine shall be preferred instead of condensing turbine as a process modification. Also cooling towers in condensing turbines requires huge amount of fresh cooling water which can be minimised to zero by installing air cooled condensers for these turbines. The Excess condensate is get contaminated to certain extent after repetitive recycling as it catches some of the sugar traces. This condensate water shall be treated by installing condensate polishing unit so that instead of taking the fresh water from the nature this treated water can become a by-product of sugar industry.

TREATMENT OF WASTE WATER IN BALRAMPUR SUGAR MILL-EFFLUENT TREATMENT PLANT:(ETP)

The consumption of large volumne of water and the generation of organic compound as liquid effluent are major environmental problem in sugarcane industry.The inadequate and indiscriminate disposal of this effluent in soil and water bodies have received much attention .Like any other industry the pollution load in sugar mill can also be reduced with better water and material economy.The operation of ETP is such that it will give and effluent of such standard prescribe by the MPCB (Maharastrian pollution control board).

THE MILL HAS PROVIDED ETP AND THE UNITS OF ETP ARE:-

1)Screening chamber cum oil &grease tank.
2)Equalisation tank
Mixing tank
Aeration tank with aerator 5)Clarifier

A.SCREENING CHAMBER CUM OIL &GREASE TANK-

The screen~~ chamber~~ or bar screen used to remove the large floating object .The untreated effluent contain large floating solid paper etc.The screening chamber prevent these material from choking pipe system and other equipment of the chamber.All these material are remove by bar screen which are 10 mm wide and 50 mm deep,arranged with spacing of 20 mm between two adjacent bar .Then the material reach the oil and grease chamber which are used for the removal of oil and grease from the effluent which may cause damage to the pumping unit.

B.EQUALIZATION TANK-

Equalization basin may be used for temporary storage.Basins provide aplace to temporarily hold incoming sewage during plant maintaince and a means of diluting and distributing batch discharge of toxic or high strength waste which might otherwise inhibit biological secondary treatment.

C.MIXING TANK- Mixing tank are generally provided for thorough mixing of the effluent which is present in the equalization tank.The mixing carried out with the help of mechanical stirrer.

D.AERATION TANK WITH AERATOR:Aeration is the process by which air is circulated through ,mixed with or dissolved in a liquid .Hence aeration tank are provided to aerate the waste water by the biological treatment.

E.CLARIFIER Clarifier are the settling tank built with mechanical means for countinous removal of solid being deposited by sedimentation.A clarifier is generally used to remove solid particle or suspended solid from liquid for clarification and thickening.concentrated impurities discharge from bottom of the tank ,while the particle that float to the surface.

RESULT

The treatment of waste water purely depends upon how we decrease its BOD and COD.COD TEST- COD of untreated water ranges from 2000 to 3000.So we take a sample of 20ml of untreated water and add 1to 2 gm of sulphuric sulphate then we add 10ml of potassium dicromate , 30 ml of conc.H2SO4 slowly slowly and some quantity of silver sulphatewhich will break the particle .Then we heat the soluation for upto 2hr at the temperature of 90 to 120 C.Then we cool the soluation at room temperature and aad ferrious indicator and start titration and stop it when it turn yellow and measure the COD.

FORMULA USED-

B=BLANK (NORMAL CONSTANT VALUE)=24

A=SAMPLE VALUE WHICH WE WILL GET FROM TITRATION

COD constant=8000 Normailty=0.1

The COD of untreated water was 3200mg/l And the value of a came after testing =18 Now putting the value in formula =

$$(24 - 18)$$
$$(8000) * 0.1 = 240$$
$$20$$

after treatment which is suitable for drinking.

BOD TEST-This test take 5 days for result when the sample is kept at 22.5C for 5 days or 27C for 3 days. The BOD came out after the treatment was=79mg**/l**

TECHNIQUE ADOPTED FOR WASTE WATER MINIMIZATION:

MILLING SECTION-

A-Oil and grease can be sold as alow grade lubricant or burnt in boiler after mixing with bagasse or may be used directlyon open gearing.

B-Collect leakage in the pit and recycle into process.

C-Recycle the cooling water.

VACCUM PUMP- Recycle the cooling water.

BOILER HOUSE-Wter used for cooling can be used for different irrigation purpose.

-Design of the industry in such a way that it reduce the pollutants .

Use material scraping system for cleaning rather then solvent.

Allocate waste treatment and disposal cost directly to the department which produce maximum amount of waste.

Chemical precipitation,Nano filtration,Algae treatment mechanism,reverse osmosis treatment method should be used.

Waste water treatment usin MFC (Microbial Fuel Cell) This technique has a unique advantage of utilizing microorganismin waste water to generate power to drive indusrial process and to decontaminate the waste water.

CONCLUSION: Water is the most costly and instantly affecting natural resource .Scarcity of water is the major problem throughout the world,so the conservation of water is essential for every junction.Conservation of water is significant aspect of enviromental and economical sustainability. Sugar industry demand large quantity of water .There is the considerable amount of water generated which has large potential of being reused back in the industry for various purpose ,which reduces the demand of raw water..The process like milk of lime preparation ,mill ambition,washing etc require large amount of water.So to make the industry as zero water intake industry treatment is required.This reduction in raw water intake also reduce the water bill.it also reduce the quantity of waste water generated.Thus process like use of back pressure turbine instead of condensing turbine ,efficient operation and maintenance of industry with optimum use of water will lead to achieve water minimization in sugar industry.

FUTURE SCOPE

Water which is recycled in the treatment can be used for electricity generation.

Waste water treatment will reduce the water need,with UN reports warning of water stress faced due to increasing global population so water treatment is very much required.

Ethanol production will also inhance due to this treatment.

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COST ANALYSIS AND COMPARISON OF RCC RETAINING WALL WITH GEOGRID RETAINING WALL

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Abstract: The issue of soil retention has existed for years. Man has explored numerous methods to retain information in his quest for better outcomes. Enormous piles of earth made up of random stonework, bamboo, wood, and alternative materials. RCC retaining walls are now the most frequently requested solution as time goes on. New ideas and materials have made it possible for technology to find more effective ways to hold heavy quantities of soil. However, India's application of this innovative soil retaining technique, RE walls employing Geogrid, falls short of international standards. The study of RCC walls and retaining walls using Geogrid for the comparison of costs is the main emphasis of this work. The systems are proved to be of significant cost benefit when compared to other types of structures and are capable of adapting specific local conditions such as terrain geometry and aesthetic preferences irrespective formal design limitations. The analysis and estimation of retaining walls using geogrid are the main topics of this study. In the realm of geotechnical engineering, attention has been drawn to the use of geogrids as reinforcement to increase the pull-out strength of retaining structures. Due to their availability, affordability, strength, durability, and safety, reinforced retaining walls are significant in the creation of many retaining structures. This article also summarizes many studies that are currently being done on geogrid reinforced structures, including their strengths, sturdiness, and economic benefits. The study of RCC walls and retaining walls using Geogrid for the comparison of costs is the main emphasis of this work.

Index Terms **- Cantilever Retaining Wall, Designing, Geogrid, Construction Cost.**

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Index Terms **- Cantilever Retaining Wall, Designing, Geogrid, Construction Cost.**

INTRODUCTION

In our built environment, retaining wall systems primarily consist of a retaining wall and backfill soil which are frequently used for things like basement walls, bridge abutments, residential elevations, highway walls, and more. The purpose of a retaining wall is to either keep the retained soil in certain shape and prevent it from falling (stability), or to restrain the deformation of the wall and the backfill to maintain its service function (serviceability).
Currently, due to an increased competition in the field of construction worldwide. Quality and cost are the biggest priorities of construction industry, and these can only be met if modern construction techniques are used. Earlier everyone used RCC retaining wall for soil retention. Presently Retaining wall using geogrid technology used in Europe and North America. In India, RCC retaining walls are frequently built, but the adoption of Geogrid reinforced soil retaining walls is not up to pace with other Asian nations due to a lack of understanding of the construction process, its costs, and how long it takes.

Therefore, in order to compare the two types of retaining walls on the basis of cost, this research has done a complete analysis of the construction method, types, construction costs, quality, uses, advantages, and disadvantages of RCC retaining walls and geogrid reinforced soil retaining walls.

OBJECTIVES

The main goals of this study are as follows:
To evaluate the cost of construction by comparing R.C.C. retaining walls with Geogrid reinforced soil retaining walls.
To put forward a suggestion for an environmentally friendly technology that might benefit society

LITERATURE REVIEW

1988, R. L. Curtis, V.E. Chouer Curtis and D. A. Miller, analysed geogrid reinforced soil retaining wall on compressible soils. A concrete facing was constructed as it reduces the settlement. As a result, it was found that, the geogrid reinforced wall tolerates the settlement and providing a temporary vertical face.

2007, Jorge G. Zornberg had an objective which advances in reinforced soil design for conventional loading, advances in design for unconventional loading and advances in reinforcement materials. In the result it was found that the addition of fibres can significantly increase the peak shear strength and limit the post peak strength loss of both cohesive and granular soil.

2014, Xinye HAN and Tomoharu MERA, study and focus

on Square-shaped geocell (diamond-shaped geocell) and ordinary geogrid and found that the geocell-RS RW exhibited higher seismic performance than geogrid-RS RW and gravity-type RW from the evaluation of residual displacements and response acceleration of the wall.

2014, C.R. Lawson & T.W. Yee, studied segmental block retaining walls with combination geogrid and anchor reinforcement and found that residual tensions in the geogrid reinforcements within the reinforced fill zone are transferred into the rigid zone by means of anchors or nails.

2015, Harangad Singh and Dr. Saleem Akhtar made an economic analysis of reinforced earth wall with different types of reinforcing materials**.** In the result, Cost analysis proves that if the quantities are not changed and only the material is changed, then the price of a reinforced earth wall with synthetic geo grid is the least expensive when combined with local earth as a backfill material for the reinforced earth wall if only the material is altered.

2018, Izzaldin Almohd, Rami El-Sherbiny and Dimiter, Dr.Alexiew, made a study over very high reinforced geogrid retaining wall and as a result it was found that the measured surveys during construction and after completion showed small deformation and were lower than calculated numerical simulations.

2020, Anjali Diwalkar, made an analysis of retaining wall stability against overturning & sliding of the retaining wall. As a result, it was found that the retaining wall with relieving platform is safer against overturning and sliding as compared to cantilever retaining wall.

G.Q. Yang, P. Lv, B.J. Zhang and Q.Y. Zhou, examined the field test of moulding concrete rigid panel faced geogrids reinforced soil retaining wall and found that the magnitude along the length of geogrid reinforcement is nonlinear distribution, the maximum is near the middle of reinforcement, to the wall face and the end of reinforcement direction, it is gradually decreasing

Rameesha K., Aloshious Kannanayakkal, Chithira P. U., Naima Shamsudheen and Vibitha P. K., worked on finding the stability analysis of retaining wall using GEO5. The use of crusher dust or quarry dust, a waste product derived from the quarry, increases the stability of the backfill.

From the above-mentioned different research papers, we hereby going to make a detailed cost analysis of traditional RCC retaining wall and geogrid retaining wall and determine the total cost effectiveness of geogrid usage over steel reinforced retaining walls by making a detailed comparison between both types of retaining walls.

SITE INVESTIGATION AND METHODOLOGY

Site Selection:

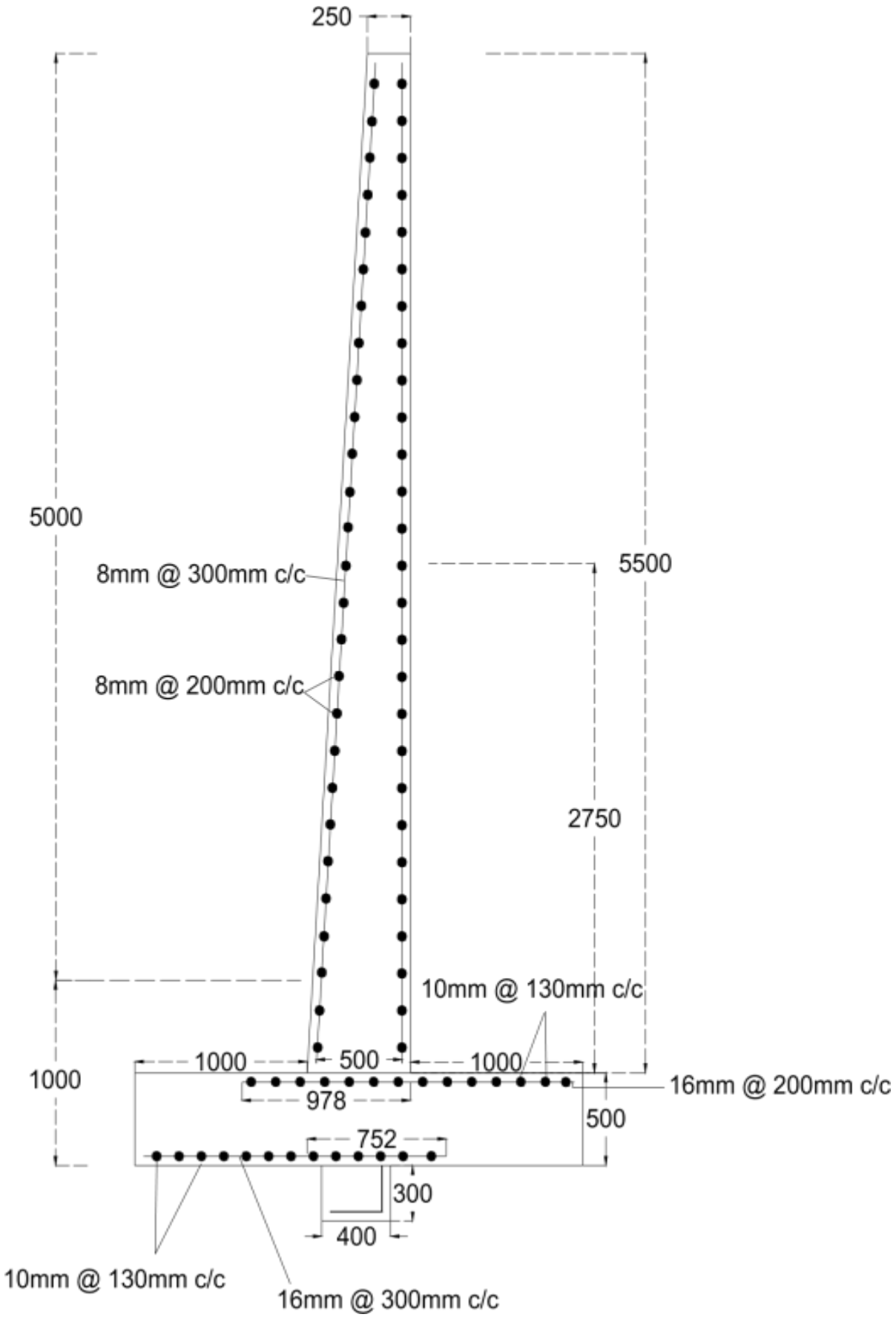
In this study, building cost analysis is carried out near Malhaur Railway Station, Viraj Khand, Gomti Nagar, Lucknow 226010, Uttar Pradesh. The retaining wall is to be constructed to protect the railway track from the road which is at higher elevation, hence to prevent collapsing of road to the railway track a RCC retaining wall of total height 6m is to be constructed over a length of 850m along the railway track. Data related to construction of geogrid reinforced soil retaining wall in terms of cost was identified. Comparison between these walls were done based on cost and quality parameters.

Flowchart of Methodology:

The given below is the flowchart representing the necessary steps to be followed in order to conduct the study:



Designing of cantilever retaining wall:



(Figure 1 Detailed view of Cantilever Retaining Wall with Design Dimensions)

Cost Analysis of Cantilever Retaining Wall of 6m height:
(Table 1 Cost Analysis of Cantilever Retaining Wall of 6m height)

Description	Unit	Rate (Rs. / Unit)	Quantity	Amount (Rs)
Earth Work Excavation	cum.	152.5	9	1372.5
Levelling Pad (M20 Grade Concrete)	cum.	8364.20	0.0656	548.69
RE wall with Facia Panel	Sq m.	1299	5	6495
Back Filling (murum) in Reinforced Zone	cum	200	33	6600
Steel Reinforcement	kg	70.97	255.08	18103
Total				**33115.02**

Total Cost per Running Meter for Cantilever Retaining wall of 6m height= Rs. 33,115.02 **Total cost for 850m long wall= 33,115.02 × 850 = Rs. 2,81,47,767**

Cost Analysis of Geogrid Retaining Wall of 6m height:
(Table 2 Cost Analysis of Geogrid Retaining Wall of 6m height)

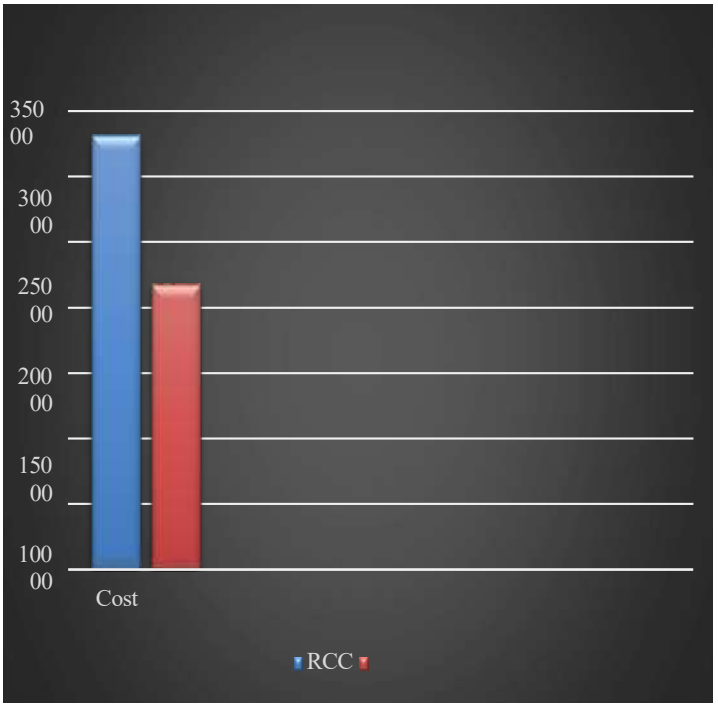
Description	Unit	Rate (Rs. / Unit)	Quantity	Amount (Rs)
Earth Work Excavation	cum.	152.5	9	1372.5
Levelling Pad (M20 Grade Concrete)	cum.	8364.20	0.0656	548.69
RE wall with Facia Panel	Sq m.	1299	5	6495
Back Filling (murum) in Reinforced Zone	cum	200	33	6600
Geogrid	Sq m.	140	48	6720
Total				**21736.19**

The average market price of Biaxial Geogrid in India is Rs 140 per Square Meter.
Total Cost per Running Meter for Cantilever Retaining wall of 6m height= Rs. 21736.19 **Total cost for 850m long wall= 21736.19 × 850 = Rs. 1,84,75,761.5**

RESULT AND DISCUSSION

When compared to R.C.C. retaining walls, geogrid reinforced soil retaining walls have many advantages. The main points are as follows:

Use quick and straightforward construction techniques; do not use heavy machinery.
Do not require skilled craftspeople with experience or specialised knowledge for construction.
Need less site preparation than different options.
Reduce the amount of space needed for construction activities in front of the building (facia panels).
Less time was needed for construction.
Cost study data shows that the reinforced earth wall with synthetic geo grid is the most affordable option if only the



(Graph 1 Cost Comparison between RCC and geogrid retaining wall per running meter length)

CONCLUSION

The following points can be concluded from the study:

RCC retaining walls cost an average of Rs. 33,115 whereas Geo-grid reinforced soil retaining walls cost an average of Rs. 21,736 for a 6m height. For a 6m height, the cost savings as a percentage is therefore about 35%.
Therefore, a geogrid reinforced soil retaining walls may have 50% cost savings when higher walls are to be constructed.
Due to the simultaneous nature of all the construction operations, the geo-grid retaining wall takes less time to complete. RCC retaining walls take a long time to construct since every step is done in order. Hence Geo-grid retaining wall uses less material.
Quality control is better in Geo-grid retaining wall as compared to RCC retaining wall.

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Analysis Of Sugarcane Bagasse Ash for the Improvement in the Properties of Black Cotton Soil

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***Abstract*:** The purpose of this research is to lookinto the feasibility of using sugarcane bagasse ash to improve the geotechnical properties of soil. Clayey soil is mixed with varying amounts of bagasse ash (0%, 5%, 10%, 15%, 20%, 25% and30%). Several tests (Atterberg's limits, Standard Proctor Test, and CBR Test) were conducted to determine its effect on strength parameters. Standard Proctor Tes tresults showthat the Optimum Moisture Content increases as the percentage of sugarcane bagasse ash increases ,while the Maximum Dry Density decreases as the percentage of sugarcane bagasse ash increases .California According to the Bearing Ratio results, the CBR value increases up to a 20% replacement of sugarcane bagasse ash. With an increase in the proportion of sugarcane bagasse ash. According to the California Bearing Ratio results, the CBR value increases upto a 20% replacement of sugarcane bagasse ash. The CBR value decreases as the percentage of sugarcane bagasse ash increases. These findings indicate that sugarcane bagasse ash, at its optimum percentage of 20%,can be used as a stabilizer to increase the CBR values of sub grade soil.

Keywords: Sugar Cane, Bagasse-ash, (SCBA), Maximum Dry Density (MDD), Optimum Moisture Content (OMC), California Bearing Ratio (CBR).

INTRODUCTION

According to the California Bearing Ratio results, the CBR value increases by up to 20%when sugarcane bagasse ash is replaced. As the percentage of sugarcane bagasse ash increases, so does the CBR value. These findings suggest that sugarcane bagasse ash can be used as a stabilizer to increase the CBR values of sub grade soil at its optimum percentage of 20%.Tomake them useful and meet the requirements of geotechnical engineering design, researchers have focused more on the use of low-cost materials derived locally from industrial and agricultural wastes in order to improve the properties of deficient soils while also lowering construction costs. The large production of agricultural wastes has the potential to harm the environment by causing air pollution water Pollution, and ultimately affecting local ecosystems. The study's main goal is to look into the use of rice husk ash and sugarcane bagasse ash, both of which are agricultural waste, to stabilize the weak sub grade soil. This has previously hampered the poor and under developed nations of the world from providing accessible roads to the rural in habitants, who make up the majority of the ir population and are primarily agriculturally dependent. Thus, by utilizing agricultural waste, construction costs will be significantly reduced while also reducing environmental hazards. It has been discovered that Portland cement, due to its chemistry, emits a large amount of CO2per ton of finished product.

LITERATUREREVIEW

Many ancient societies, including the Chinese, Romans, and Indians, used various tactics to increase soil suitability, some of which were so effective that many of the buildings and streets they built still exist and are in use today. Separately, the Mesopotamians and Romans realized that by mixing poor soils with a stabilizing material such as pulverized limestone or calcium, they could improve the ability of routes to transport traffic. This was the first time that weak soils were chemically stabilized in order to improve their load carrying capacity

KiranR.G.KiranL.(2017)conducted research on' The investigation of strength properties of Black Cotton soil utilizing Bagasse ash and additions as stabilizer'? The black cotton soil used in this study was collected at Harihara ,Davanagere district, Karnataka. In this study, laboratory experiments are conducted out for various percentages of Bagasse ash (5%,10%,and15%) and additive mix proportions.The strength metrics, such as CBR, are determined by danditis It was discovered that the blend results of Bagasse ash with varying percentages of cement for black cotton soil generated a change in density and CBR value. When 8% Bagasse ash was added to 8% cement, the density values increased from 15.16kN per m2 to16.5kN per

m2,and the CBR values increased from2.12 to 5.43. The addition of 4% Bagasse ash with 8% cement enhanced the tensile strength to174.91kN/m2 from 84.92kN/m2 with the addition of 8% Bagasse ash with 8% cement. The MDD value increases up to 8% replacement and the CBR value increases up to 8% above which it declines.

Sumair Razvi, Syed(2018) the CBR of the lime treated black cotton soil increased when compared to the untreated black cottons oil ,according to the research report "soil stabilizing by lime. "For black cotton soil, CBR value improves with lime content ranging from 2% to 3% .Soil stabilization is the process of increasing the various engineering qualities of black cotton soil and resulting in stables oil**.**

Gupta Chayan(2016) the author wrote the study article "The black cotton soil modification by application of waste materials,"andthe conclusion is as follows:

The standard compaction criterion, maximum dry density of black cotton soil, increases from1.53g/cm3 to 1.76g/cm3 for the final optimum composite, whereas the optimum water content of black cotton soil drops from 22.8% to 19%.The results of the UCS test demonstrate that after soil
stabilization, the unconfined compressive strength values of black cotton soil increase from 138.01kPa to286.13kPa, a107.32% increase.

K. Shreyas (2017) the author's study article is titled "stabilization of black cotton soil by admixtures," and the conclusion is as follows: By replacing some of the cement with fly ash, the engineering qualities of black cotton soil improve, as does its stability. The conduct of CBR tests by adjusting the quantity of additives such as cement, M-Sand, and fly ash in the soil mix results in an increase in CBR values when the percentage of stabilizer is increased.

MATERIALANDMETHODS

Black Cotton Soil

Black Cotton soil as the name speaks for itself looks Gray to black in color. This type of soil has excessive expansive and sink age characteristics which make it undesirable for use as sub grade in highway construction .Normally, it has very high dry strength and very low wet strength .so it is important to improve the geotechnical properties of the black cotton soil before using it sub grade. Soil sample for this study was available locally. Bank of GOMTI **RIVER, LUCKNOW, UTTAR PRADESH** Various test were conducted and results are summarized in the following table:

Table1: Properties of Soil Sample

Specific Gravity	2.2
Maximum Dry Density	1.53g/cc
Water Content	26.8%
California Bearing Ratio	1.9%
Liquid Limit	30%
Plastic Limit	22%
Plasticity Index	8%
Color	Grayish Black

Bagasse Ash

The fibrous residue that remains after the sugar juice is extracted from cane mills is known as bagasse. The byproduct of burning bagasse is known as bagasse ash. This substance typically causes sugar factories disposal issues. For both financial and environmental concerns, research has been focused on using waste materials from industry and agriculture to build road ways. Bagasse ash was purchased from **RAUZAGAON CHINI MILL, AYODHYA , UTTAR PRADESH**

The following table summarizes the findings of lab studies undertaken to determine the engineering qualities of bagasse ash:

Table2: Properties of bagasse Ash Sample

Specific Gravity	1.40
Maximum Dry Density	1.2gm/cc
Optimum Moisture Content	30
Color	Black

BagasseAshStabilization

In this study, numerous features of the soil and bagasse ash mixture (0% to 14%) were investigated for evaluation, including:

A. Maximum Dry Density
B. (MDD)

C. Optimum Moisture Content (OMC)

D. California Bearing Ratio (CBR)

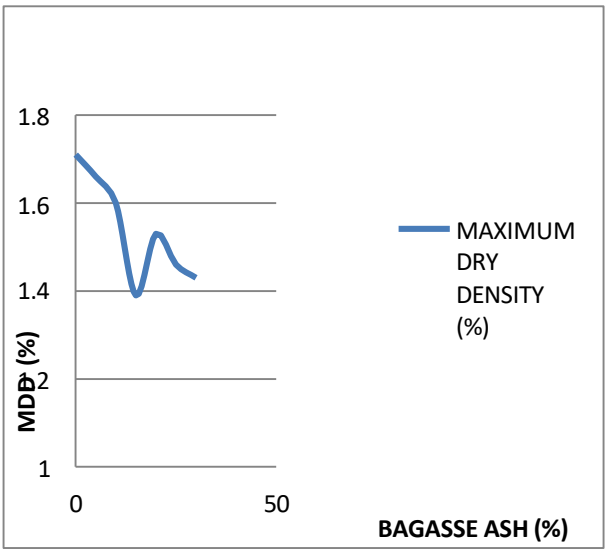


Figure 1: Maximum Dry Density vs. SCBA (%)

RESULTSANDDISCUSSIONS

OMC and CBR are summarized. These data have been analyzed under the constructions category.

Maximum Dry Density

Proportion of Bagasse ash (%)	**MDD(g/cc)**
0	1.71
5	1.66
10	1.60
15	1.39
20	1.53
25	1.46
30	1.43

Optimum Moisture Content

Proportion of Bagasse Ash (%)	**OMC (%)**
0	22.50
5	24.10
10	24.54
15	22.48
20	26.50
25	27.88
30	18.79

CONCLUSIONS

According to the results of the laboratory examination conducted for this study, the following conclusion has been reached:

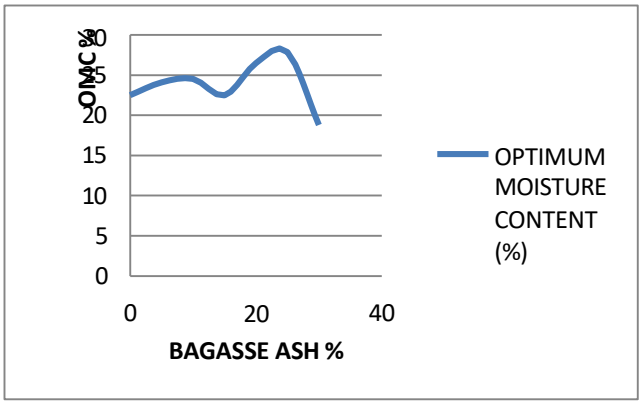


Figure 2: Optimum Moisture Content vs SCBA (%)

The optimal moisture content (OMC) and maximum dry density (MDD) of the black cotton soil increase to the maximum value and then decline.

The project's outcome and conclusion will be determined by the final findings from the experiment that must be conducted using admixtures ,along with an analysis of the readings that are collected.

CBR values have also demonstrated a comparable character. When ash was added to the mixture, these values rose up to 8% before falling if the ash percentage was raised further.

This mix's CBR values are attribute able to the cementitious nature of bagasse ash, which allows ash particles to become stronger when exposed to moisture.

3. California Bearing Ratio

Proportion of Bagasse Ash(%)	CBR(%)
0	2.55
5	3.51
10	4.78
15	5.42
20	9.25
25	7.98
30	6.70

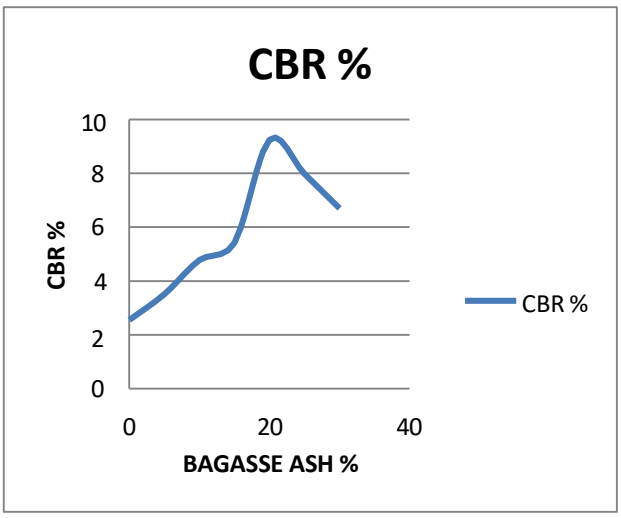


Figure 3: CBR vs SCBA (%)

SCOPE FOR FUTURE INVESTIGATION

Flexible Pavement Design for without Stabilization of Black Cotton Soil.

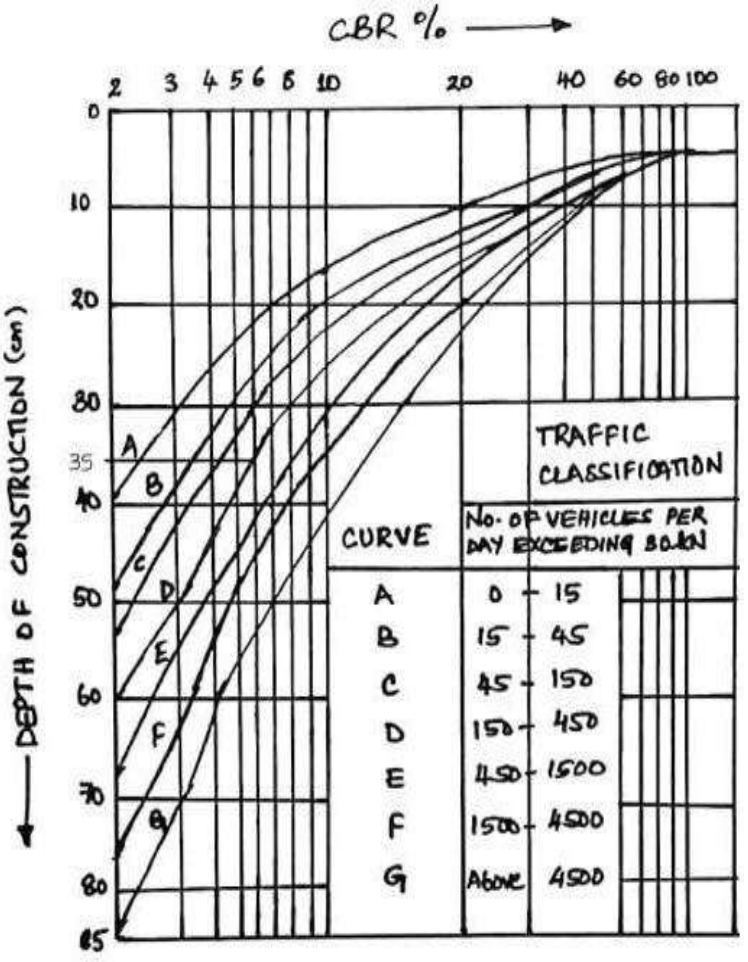
Number of commercial vehicles per day.=400

CBR applicable design curve = **D.**

Sub grade soil design CBR (wet) = 1.86%

.Hence, the pavement thickness is **600 mm**

(As per Pavement Thickness Design graph).



Number of commercial vehicles per day=**40**
Design curve for applicable of sub grade soil=11.46%.
CBR design curve=D.

Hence, the pavement thickness is 250 mm (as per Pavement Thickness Design graph). Total pavement thickness was reduced by **600- 250=350mm.**
Pavement thickness reductions as a percentage=**58.33%**

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