FACULTY OF ENGINEERING

DEPARTMENT OF POLYMER, TEXTILE AND INDUSTRIAL ENGINEERING

PROJECT REPORT 2022

ROAD DUST MITIGATION USING SOYA BEAN UREASE ENZYME INDUCED CALCITE PRECIPITATION TECHNIQUE

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Declaration

We hereby declare present the presented content in this final year report titled "**ROAD DUST MITIGATION USING SOYA BEAN UREASE ENZYME INDUCED CALCITE PRECIPITATION TECHNIQUE**" was uniquely prepared by us after completion of executing all activities and consulting our project supervisors. This report is only prepared for our academic requirement not for any other purpose. It might not be used with the interest of opposite party of the corporation.

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Approval

Dear sir/madam, with due respect, we are proactive students pursuing the degree of Bachelors of Science in Polymer, Textile and Industrial engineering at Busitema university. We have successfully conducted a research and consultation on **"ROAD DUST MITIGATION USING SOYA BEAN UREASE ENZYME INDUCED CALCITE PRECIPITATION TECHNIQUE"** research topic from Busitema University, Tororo, Uganda.

This is to certify that **KISAKA HILLARY SADIA REG.NO BU/UG/2018/4110** and **WEPUKHULU JOHN ROGERS REG.NO BU/UP/2018/3594** did their research under supervision.

Ag. Director, Directorate of Graduate Studies, Research and Innovations, Busitema University

Professor Samson Rwahwire

Signature:..... 12/01/2023

Mr. Muwulya Vincent

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Mr. Sendawula Charles

Signature:.....

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Abstract

Uganda as a developing country roads play a role of transporting cargo and passengers from one geographical region to another. However, only 18 % of the total network is paved and the remaining 82% is unpaved, dusty and impassable when wet. Mechanical and chemical methods have been employed to mitigate dust. Biotechnology technique for stabilisation of earth soils, however, provides a sustainable dust mitigation method. Enzyme induces calcite precipitate (EICP) and microbial induced calcite precipitate (MICP) techniques are the two most studied bio-technical processes. EICP is a bio-inspired process employing enzymes and MICP is a bio-mediated process involving use of micro-organisms which secrete enzymes to catalyze urea hydrolysis to ammonium ions and carbonate ions. Carbonate ions combine with soils combine with soluble calcium ions to form a precipitate which acts as a natural binder.

The purpose of this report is to give an overview of the various activities conducted in the study of road dust mitigation using soya bean urease, urea and steel blast furnace sludge.120g of concentrated soya bean urease were extracted from crude extraction using 500g ammonium sulphate salting at 40% of the crude urease solution. 2M nitric acid leaching BSF activated soluble calcium ions using a ratio of 10ml: 1g 120 minutes. 2M urea solution was obtained by dissolving directly 120g into tap water. Minitab17 was employed in the design of experiment and optimisation process.UCS load and water absorption was the DEO response surfaces. Urease concentration molar concentrations of urea and soluble calcium were the input factors.

FTIR qualitative analysis was identified functional groups present BFS, urease and soils us the KBr mid range wavelength. Ph 0f 6.8 and a 7.17% value of dust were obtained from sieve and ph analysis of the soils. The maximum UCS load and minimum absorption values were 2376.6n from run 20 and 6.5% from run 18 respectively (table 10).ANOVA determined the significance of factors statistically. The model predicted optimal biocementing formulation responses were verified by applying the model; hence, the model was applicable.

Comparative studies revealed EICP process using soya bean urease and activated BFS improved soil properties of road soils. Formation of calcite at the surfaces formed a coating which implied soil fines where binder together. Hence, dust mitigation.

However, more research is needed to attain targets of less than 2% for water absorption, 4 MPa the unconfined compressive strength and sustainable sources with high enzymatic activity.

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List of Acronyms

EICP	Enzyme induced calcite precipitate
MICP	Microbial induced calcite precipitate
UTS	Universal tensile testing machine
UCS	Unconfined Compressive Strength
FTIR	Fourier Transformation Infra ray
ANOVA	Analysis of Variance
SDG	Sustainable Development Goals
BFS	Blast Furnace Sludge
UNRA	Uganda National Revenue Authority
NEMA	National Environmental Authority
UN	United nation
WHO	World Heath Organisation
DEO	Design of experiment
RSM	Response surface methodology
M	Molarity
CCD	Central composite design

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1. INTRODUCTION

1.1 Background

According to reports of the Ugandan ministry of works and transport, the total paved stock of the national road network by the end of the financial year 2020/2021 stood at approximately 18% and the unpaved at 82%(WEBMASTER, 2022) (Muhwezi et al., 2021). Unpaved roads in Uganda form the main accesses to villages, towns ,municipalities and cities in Uganda (Muhwezi et al., 2021) connecting people to jobs, education, health centers and income-generating markets. Thereby boosting regional integration, economic growth and hence decrease poverty though they are in fair to good states(BENEDICT L.J & TONY, 2020).

Research carried out in Kabarole district south-western Uganda showed 82% of the unpaved road network were in fair to poor state due to heavy rains, poor soils ,lack of maintenance and deliberate blockage of drainage system (Muhwezi et al., 2021). The road network was motorable but had started to loss or lost their engineering features such as road shape, drainage system and clearance view (Muhwezi et al., 2021). However, there is a disjuncture between transportation Sand pollution in Ugandan municipalities (Gershom, 2018) as a growing evidence of distinct sets of freshly emitted air pollutants (Vittorio et al., 2021) down winded from major rural roads containing elevated levels of ultrafine particulates, black carbon and carbon monoxide, oxides of nitrogen and local soil dust (Brugge et al., 2007). These pollutants impact both the human nature and road infrastructure.

For long, the road infrastructure has received inadequate attention in municipalities due to limited funding, which resulted into stagnation and dilapidation(MBW Consulting Ltd in association with PEC, 2016).emission of fugitive dust on unpaved community roads most especially during the dry seasons has led to particulate matter concentrations in these communities. Fugitive dust is considered as a nuisance and unhealthy as dust allergies and some diseases are dust bone prevailed.(Bruckman & Wriessnig, 2013)(Kiran et al., 2021).to local governments however, fugitive dust signifies a huge expense because it ultimately leads to potholes and rotting which in turn require constant maintenance. Municipalities utilise up to 70% of their annual budget on road maintenance and still dust persists((BMAU) & Ministry of Finance, 2019)

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