



Geotechnical Performance Evaluation of Plastic Waste - Calcium Carbonate Composite Fillers for Sustainable Soil Stabilization

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Abstract: The increasing generation of plastic waste and the need for sustainable soil stabilization materials have prompted the quest for alternative additives for the construction of pavement. This study examined the combined influence of shredded waste plastic (SWP) and calcium carbonate filler (CCF) on the properties of clay soil. Laboratory tests were conducted on natural and stabilized soil samples at replacement levels of 0%, 12%, 24%, and 36% to determine changes in the specific gravity, consistency limits, compaction properties, and California bearing ratio (CBR) respectively. The natural soil exhibited moderate plasticity, a maximum dry density (MDD) of 1.70 kg/m³, at an optimum moisture content (OMC) of 13.67%, and a CBR of 5.30%, making it inadequate for pavement applications. The addition of SWP and CCF increased the specific gravity from 2.05 to 3.10, reduced the liquid limit, and transformed the soil to a non-plastic state at all replacement levels. The additives reduced the OMC and increased the MDD, indicating improvement in compaction. Furthermore, the CBR increased from 5.30% to a maximum value of 8.45% at 24% replacement before decreasing at 36%, indicating that excessive additive contents impaired the load transfer performance. The results revealed that the blended application of SWP and CCF effectively improved the engineering performance of A-2-6 soils and offered a sustainable approach to waste valorization. A 24% SWP-CCF replacement level was identified as the optimum dosage for stabilization. However, further studies are recommended to examine the influence of uneven proportions of SWP and CCF on soils stabilization performance.

Keywords: Soils, Soil Stabilization, Shredded Waste Plastic (SWP), Calcium Carbonate Filler (CCF), Soil Properties

INTRODUCTION

Civil engineering construction utilizes various soil types, some of which are naturally suitable for engineering applications, while others require improvement or stabilization before use (Chijioke *et al.*, 2019; Archibong *et al.*, 2020; Ademila, 2022). Different countries in the world rely heavily on road networks due to its economic benefits through the movement of people, products and services between locations (Onyeka and Osegbowa, 2020). Due to the critical role of road networks in economic development, the Nigerian Government has prioritized the development of road infrastructure (Olaniyan *et al.*, 2019). However, the poor geotechnical characteristics of base and subgrade materials are among the main causes of highway failures in Nigeria (Osegbowa and Eze, 2019). Also, since the advent of construction, improving the engineering properties of soils has remained a key concern for

geotechnical and transportation engineers (Amadi, 2014). Different researchers (Syafiadi, 2020; Ayininuola and Abidoye, 2018) have identified soil stabilization as a reliable technique of improving the characteristics of soil for the purpose of construction. Soil stabilization is the application of various methods to enhance the strength, stability, physical and other engineering characteristics of soil (Archibong *et al.*, 2020; Jan and Kumar, 2022). Generally, soil stabilization practices date back to 1904, when the first recorded soil stabilization experiment was conducted in United States (US), laying the foundation for modern ground improvement methods (Sachdeva and Shrivastava, 2023).

Clay soils are made up of silicates of aluminum, iron, or magnesium, which are often relatively small particles and they take in water slowly and holds onto it for a very long time (Osegbowa and Eze, 2019). Generally, clay soils have unfavorable engineering features like high compressibility, low mechanical (strength), and notable shrinkage and swelling properties as a result of moisture content variations (Olufowobi *et al.*, 2014). Despite its heterogeneous and complex nature, it is widely utilized in construction owing to its availability and cost saving merits. However, it may not always possess the properties required for specific construction applications (Armin and Behzad, 2013), thus, bringing about the need for it to be improved upon through stabilization. Although, soil stabilization may be costly, however, it decreases the overall cost necessary for the construction of buildings and subgrades of roads (Fazal *et al.*, 2020). Soil stabilization can be done in two (2) ways; mechanically - by altering the soil's gradation and chemically - by changing the chemical makeup of the soil through inclusion of chemical additives (Bayat, 2025; Sai and Srinivas, 2019). The most frequently used chemical materials for soil stabilization are lime and cement (Syafiadi, 2020; Ugochukwu and Charles, 2023; Mallikarjuna and Mani, 2016), which different researchers (Armand *et al.*, 2021; Tavala and Tabaroei, 2025) described as traditional or conventional stabilizers in addition to waste materials (Angham *et al.*, 2020). Nevertheless, these traditional stabilizers have been effective in soil improvements, however, their cost and environmental bottle necks remain a great concern (Tavala and Tabaroei, 2025; Ridhorkar *et al.*, 2024). Other researchers (Ayininuola and Abidoye, 2018; Armand *et al.*, 2021; Olufowobi *et al.*, 2014; Safa and Hassan, 2022) have also identified other materials (fly ash, bitumen, rice husk ash – RHA, silica fume, Gypsum, powdered glass; egg shell power; rubber tyre rubber) as good stabilizing agents for soils. Plastic wastes material has been scantily used as soil stabilizer but Ujwala *et al.* (2022) identified it as one of the promising waste materials suitable for improving soil properties. This also serves as plastic wastes management strategy.

The disposal of plastic wastes has become a great concern in emerging nations due to poor recycling facilities (Jadhav *et al.*, 2025). Generally plastic wastes poses a risk to the environment because they are typically not biodegradable and can generate long-term pollution in the environments (Wasiu and Osegbowa, 2023; Worku, 2022; Kumar *et al.*, 2025). One of the effects of the improper disposal of these materials is the blockage of drainage system (Rebecca *et al.*, 2020). It has been reported that about 4,000 - 5,000 tonnes of plastic wastes are generated daily, remaining unchanged in the environment for period of 4,500 years (Adunoye *et al.*, 2023). Also, the growing global population has resulted to a rise in the demand for polyethylene terephthalate (PET), which is widely used as a packaging material for liquid products, including drinking water, soft drinks, beverages, and household sauces (Davies and Olofinnade, 2021). Furthermore, the cost of sourcing, and processing conventional road construction materials, such as sand, bitumen, cement, and stone aggregates, has continued to rise, thereby increasing the overall cost of road infrastructure development (Olufowobi *et al.*, 2014; Rebecca *et al.*, 2020). Hence, the inclusion of plastic wastes in soil stabilization practices offer a reliable strategy for improving the overall performance of unsuitable soils while addressing plastic waste management challenges (Gangwar and Tiwari, 2021; Sachdeva and Shrivastava, 2023; Jadhav *et al.*, 2025). As a result, several researchers have investigated the potent of plastic wastes as soil stabilizing agent. Hassan *et al.* (2021) evaluated the influence of polyethylene (PE) and polypropylene (PP) waste fibres on the characteristics of clayey soil obtained from Hawshki, west of Duhok City, Iraq. Based on the findings, the authors recommended an optimum fibre content of 1–2% for both PE and PP fibres in clay soil

stabilization. [Ahmed and Mousa \(2021\)](#) investigated the effect of shredded plastic water bottles on high and low plasticity clay soils. The study used plastic strips measuring 1.0 cm (length) x 2.0 - 3.0 mm (width) which were added at varying contents (0.5% - 3.0%) by weight of the dry soil sample. The study obtained the optimum performance at 1.5% plastic content, which the study recommended as the ideal replacement level for both soil types. Other researchers ([Ikramul et al., 2019](#); [Rebecca et al., 2020](#); [Jiasheng et al., 2023](#); [Gangwar and Tiwari, 2021](#); [Attom et al., 2025](#); [Ali et al., 2023](#); [Zaini et al., 2025](#)), have also documented notable improvements in the various engineering characteristics of soils stabilized with plastic waste materials. Furthermore, calcium carbonate (CaCO_3) filler is a cost saving and readily available inorganic compound extensively utilized in different industries like oil, paint, plastics, and agriculture, for pH control ([Ab Manan and Ab Aziz, 20218](#)) and also as soil stabilizer ([Chen et al., 2024](#)). The cost reduction in using calcium carbonate filler (CCF) compared to traditional stabilizer aligned with the lesser energy needed for its production ([Comes et al., 2024](#)). The effectiveness of CCF in soil stabilization is attributed to its filler action, cementation potential, and compatibility with different soil types ([Chen et al., 2024](#)). [Winarsih et al. \(2024\)](#) investigated the effectiveness of calcium carbonate in stabilizing expansive soil by incorporating 3% - 9% (steps of 3%) of calcium carbonate by the soil's weight. The study found that, the addition of 3% calcium carbonate significantly improved the soil's CBR results by 46.01% (unsoaked) and 59.96% (soaked). [Phuyal et al. \(2024\)](#) used precipitated calcium carbonate (PCC) in improving soil properties. The study found that adding 5% PCC increased the strength of loess soils by an average value of 10% to 28%, compared to the untreated soil. It concluded that PCC can enhance resistance to saturation-induced collapse while reducing reliance on cement and lime, thereby lowering associated carbon emissions and promoting sustainable soil stabilization practices. Literature has revealed previous studies relating to the deployment of plastic wastes for soil stabilization, but one can rarely find any study that have utilized shredded waste plastic (SWP) and calcium carbonate filler (CCF) for the stabilization of soils. This current study tends to close the gap in literature by examining the properties of clay soil improved with shredded waste plastic (SWP) and calcium carbonate filler (CCF) through laboratory tests. This will help to promote sustainable utilization of plastic waste materials.

MATERIALS AND METHODS

2.1 Materials

2.1.1 Soil: Disturbed soil sample was obtained from Aviele Community, beside the popular Dantata Firm, Etsako West Local Government Area (LGA) of Edo State. The collected soil sample was transported to the Laboratory of the Department of Civil Engineering at Edo State University, Iyamho, Edo State. The soil sample was spread on the floor in the laboratory as depicted in [Plate-1](#), and allowed to air-dry before the required laboratory experiments were conducted.



Plate-1 Collected and air dried soil sample

2.1.2 Shredded Waste Plastic (SWP): Waste plastic bottles (WPB) as shown in [Plate-2](#), were collected from Iyamho Community in Edo State. It was easy transporting the WPB to the University Laboratory, as the source (Iyamho Community) of the WPB is the same community where the University laboratory used for this study is located. The plastic waste bottles were shredded to become shredded waste plastic (SWP) as depicted in [Plate-3](#), with the help of a scissor and then washed with clean water, in order to remove contaminants. Based on sieve analysis, the SWP exhibited particle sizes ranging from 6.7 to 19

mm. The addition of the shredded waste plastic (SWP) was done in varying percentages by weight of the soil.



Plate-2 Waste plastic bottles (WPB)



Plate-3 Shredded waste plastic (SWP)

2.1.3 Calcium carbonate filler (CCF): The CCF used for the study was Sunsek brand (Plate-4) and it was purchased from Auchi environs in Edo State. The CCF is shown in Plate-5, and sieve analysis showed that its particle size ranged from 0.125 to 0.18 mm. The CCF was added in varying percentages by weight of the dry soil collected and used for this study. The shredded waste plastic (SWP) and calcium carbonate filler (CCF) were added in equal percentages as shown in Table-1, with both percentages adding up to; 0%, 12%, 24% and 36% respectively.



Plate-4 Bag of Calcium carbonate filler



Plate-5 Calcium carbonate filler

Table-1 Percentage replacement of shredded waste plastic and calcium carbonate filler

S/N	Shredded waste plastic replacement (%) = a	Calcium carbonate filler content (%) = b	Total percentage replacement by weight of soil (%) = (a + b)
1	0	0	0
2	6	6	12
3	12	12	24
4	18	18	36

2.1.4 Water: The water that was used throughout the study was potable water from Edo State University Iyamho's tap and it was colourless, odourless, and tasteless.

2.2 Methods

The various laboratory tests conducted in this study are presented and discussed below.

2.2.1 Soil Sample Preparation and Mixing with the Composite Stabilizers

The air-dried soil was passed through a 4.75 mm sieve to remove oversized particles and also to obtain a uniform sample. The stabilizing composite material was prepared by thoroughly blending the SWP and CCF in the proportions presented in Table 1 to achieve a homogeneous mixture. The composite stabilizer was then incorporated into the sieved, and pre-weighed soil with the mixture dry-mixed until a uniform distribution was achieved. Water was subsequently added to attain the required moisture content, after which the mixture was thoroughly remixed before preparing specimens for the various

laboratory tests conducted in this study in accordance with the relevant testing standards. Single, and two (2) replicate tests were conducted were necessary using the prepared samples and the following outlined methods.

2.2.2 Moisture Content

The moisture content experiment aims to quantify the quantities of water available in the collected soil sample. The moisture content test was conducted in compliance with [ASTM D2216-19 \(2019\)](#).

2.2.3 Specific Gravity

The specific gravity test was carried out in the laboratory in compliance with [ASTM D854-14 \(2014\)](#).

2.2.4 Sieve Analysis or Gradation Test

The sieve analysis was conducted to ascertain the different particle sizes of the soil sample, and it was carried out in compliance with [BS 812 - 103 \(1985\)](#).

2.2.5 Consistency Limits

The liquid limit (LL) and plastic limit (PL) tests were carried out in compliance with [ASTM D4318-17 \(2017\)](#).

2.2.6 Compaction Test

The compaction properties of the soil sample with and without both additives (SWP and CCF) were determined through compaction test in accordance with [BS 1377-4 \(1990\)](#).

2.2.7 California Bearing Ratio Test

The California bearing ratio (CBR) values obtain from CBR test of a given soil mass is generally utilized to ascertain soil's strength ([Singha et al. 2025](#)) and bearing capacity for highway constructions ([Kassa et al., 2020](#)). The CBR test in this study was done in compliance with the procedures stipulated in [ASTM D1883-16 \(2016\)](#). In the study, the test was performed on both natural and stabilized soil sample.

RESULTS AND DISCUSSION

3.1 Characteristics of the natural or untreated soil sample

The soil exhibited a natural moisture content of 23%, with standard deviation (SD) of 0.20%. The natural moisture content was found to be higher than the range (5 – 15%) as stipulated by the Federal Ministry of Works and Housing ([FMWH, 1997](#)), as reported by [Emmanuel et al. \(2021\)](#) for highway construction. This natural moisture content result revealed that the soil has water absorption ability which negatively impacted its strength. These aligned with the findings of [Emmanuel et al. \(2021\)](#). The low SD of the natural moisture content indicates minimal variability and high repeatability among the replicate measurements. The soil's average specific gravity (2.35) met the criteria (2.30 – 2.50) of specific gravity for organic soils as documented by [Rajebhosale et al. \(2024\)](#). The SD value of 0.01 was low showing minimal variability. Also, the soil exhibited 16.12% passing the sieve No. 200 and 24.61% passing the sieve No. 40. This showed that the soil predominantly contained granular material with moderate amounts of clayey and fine fractions. The soil's coefficient of uniformity (Cu) and coefficient of curvature (Cc) aligned with the documented criteria (Cu ≥ 6, Cc range between 1 to 3) for a poorly graded soil as reported by different researchers ([Kalore and Babu, 2023](#); [Kayode-Ojo and Odemerho, 2023](#)). The soil's Atterberg limit values (liquid limit of 30.72% with SD of 0.03% and plastic limit of 15.59% with SD of 0.01%) revealed that, the soil possessed medium plasticity, suggesting moderate compressibility and volume change potential. The plasticity index (15.13%) of the soil was above 12% recommended in [FMWH \(1997\)](#) as reported by different researchers ([Ubani et al., 2025](#); [Ademila, 2022](#)). This made the soil inadequate for road construction, thus aligning with the findings of [Ademila \(2022\)](#). The soil was classified as A-2-6 with the AASHTO system of soil classification. This also showed that the soil contained granular soils with significant clayey fines. Generally, A-2-6 class of soils exhibit; good to fair performance as a pavement subgrade material, aligning with the group index result of zero (0). This also aligned with the findings of [Vordoagu \(2024\)](#) on A-2-6, AASHTO classified soils. The soil

attained a MDD value of 1.68 Mg/m³ at OMC value of 13.67%. The OMC and MDD results of the natural soil sample did not meet the combined criteria (less than 18% for OMC and minimum of 1.70Mg/m³ for MDD) stipulated in the FMWH (1997) as document by Oyelami *et al.* (2022). Also, the untreated soil recorded an unsoaked CBR of 5.30%, indicating poor load-bearing capacity and rendered it not appropriate as pavement materials. The CBR value fall below the minimum CBR requirements of approximately 10% for subgrade, 30% for sub-base, and 80% for base materials as specified by FMWH (1997) and reported by Oyelami *et al.* (2022). The characteristics of the natural soil shows that stabilization is required to improve its engineering characteristics.

3.2 Effect of shredded waste plastic and calcium carbonate filler on the soil's specific gravity

The results revealed that, increase in the percentages of shredded waste plastic (SWP) and calcium carbonate filler (CCF) resulted to an increase and then decrease in the specific gravity of the soil as depicted in Fig. 1. The specific gravity rose from 2.35 for the untreated soil to 2.90, 3.10 and then decreased to 3.02 at 12%, 24%, and 36% SWP and CCF, replacement levels respectively as shown in Fig. 6. The increase was mainly linked to the CCF, which enhanced the particle packing and reduced the void spaces, resulting in a denser soil matrix. The subsequent reduction at higher replacement content was due to the increasing influence of the low-density of SWP within the composite mixture. However, the significant improvement in the specific gravity revealed enhancement in the soil's mechanical property (strength). This aligned with the findings of different researchers (Akinwamide *et al.*, 2026; Guner and Ozgan, 2025).

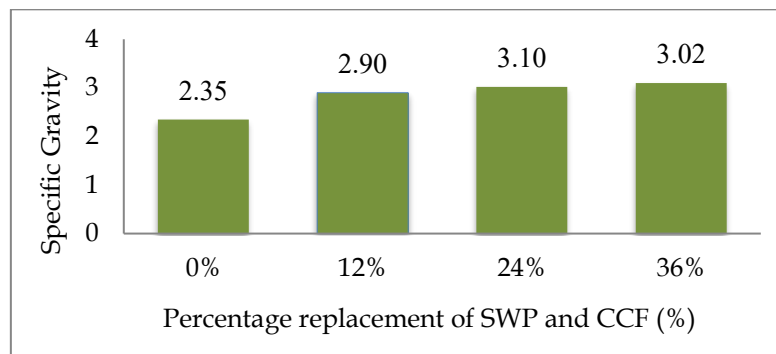


Fig. 1 Variation of SWP and CCF with the soil's specific gravity

3.3 Impact of shredded waste plastic and calcium carbonate filler on the soil's Atterberg limits

The results of the influence of shredded waste plastic (SWP) and calcium carbonate filler (CCF) on the soil's liquid limits are shown in Fig. 2. The results demonstrated that the liquid limit (LL) reduced with increasing percentages of SWP and CCF. The LL decreased from 30.72% for the untreated soil to 22.0%, 18.5%, and 17.0% at 12%, 24%, and 36%, SWP and CCF replacement levels, respectively. The LL values for all the percentage addition of SWP-CCF met the $LL \leq 30\%$ standard for sub-base/subgrade as stipulated in the FMWH (1997) and documented by Nwa (2025). The reduction in the LL is attributed to the CCF, which enhanced the particle flocculation and reduced the water required for the soil to reach the liquid state, and also, the hydrophobic, non-plastic attribute of the SWP, which reduced the water – holding potential of the soil. The combined effect of SWP-CCF, improved the stabilized soil's particle packing, reduced the soil – water interaction and plasticity thereby enhancing the soil stability while reducing its shrink – swell potential. Also, the results showed that the soil's plastic limit decreased from 15.59% for the untreated soil to a non-plastic (NP) state at all replacement levels (12%, 24% and 36%) of SWP and CCF, representing a complete loss of plastic behaviour. The NP state of the stabilized soil was due to the hydrophobic and non-plastic attribute of the SWP which reduced the soil – water interaction and the clay activity within the soil matrix. Thus, the results showed that the stabilized soil is more stable than the untreated soil.

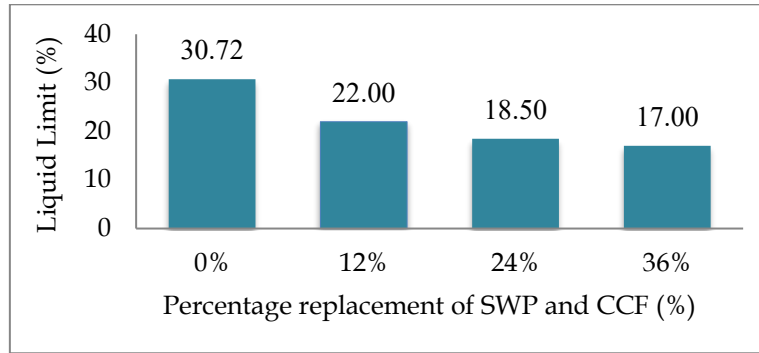


Fig. 2 Variation of SWP and CCF with the liquid limit of the soil

3. 4 Effect of shredded waste plastic and calcium carbonate filler on the soil's compaction

The incorporation of SWP and CCF, modified the soil compaction characteristics as shown Fig. 3. The optimum moisture content (OMC) reduced from 13.67% to 12.20% at 12% replacement, then after increased to 14.74% at 24%, and then decreased to 12.50% at 36%. The reduction in OMC is as a result of the hydrophobic attribute of the SWP, which reduced the water absorption, while the temporary increase at 24% was due to the finer calcium carbonate particles increasing water demand during the compaction. The reduction in the OMC also aligned with the findings of Kassa *et al.* (2020), which involved the stabilization of soil with sole plastic waste as stabilizer. Conversely, the maximum dry density (MDD) increased from 1.70 Mg/m³ (natural soil) to 1.78 Mg/m³ at 12% (SWP - CCF replacement level) and attained a constant value of 1.82 Mg/m³ at both 24% and 36%, SWP and CCF replacement levels. The improvement in the MDD values for the stabilized soil was a result of the void-filling effect of the CCF, which improved the particle packing and the soil densification. The enhanced MDD value of the treated soil met the MDD criteria of 1.8 – 2.1 Mg/m³ for Nigerian laterites as reported by Nwa (2025). Also, the increase in the MDD value aligned with the findings from existing studies (Mallikarjuna and Mani, 2016; Sai and Srinivas, 2019), which applied different proportion of plastic waste material as sole soil stabilizer. However, this trend contrasts the reductions in CBR value reported in studies where CCF was used as the sole stabilizing agent (Jadhav *et al.*, 2025). Nevertheless, the combined effect of the SWP and CCF enhanced the compaction characteristics of the soil, as evidenced in the improvement of the OMC and MDD values.

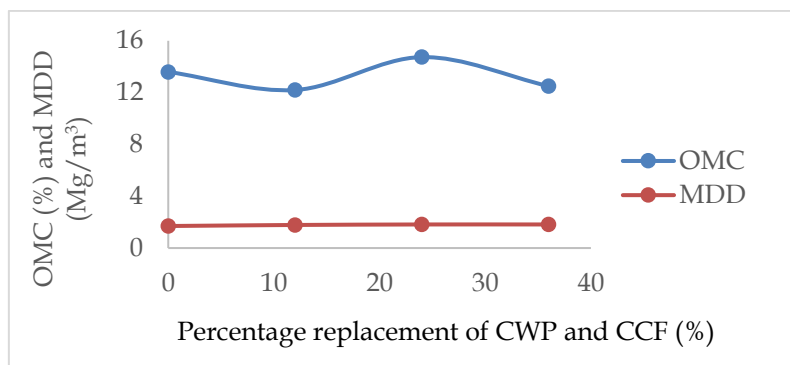


Fig. 3 Variation of SWP and CCF with OMC and MDD

3.5 Influence of shredded waste plastic and calcium carbonate filler on the soil's strength

The combined effect of the SWP and CCF on the soil strength is depicted in Fig. 4. The incorporation of both SWP and CCF, improved the CBR of the soil at all replacement levels. The CBR increased from 5.30% for the natural soil to 7.06% and 8.45% at 12% and 24% replacement levels, representing improvements of 33.21% and 59.43%, respectively. The enhancement in the CBR values is as a result of the reinforcing influence of the SWP as well as the void-filling and cementitious properties of CCF, which improved particle interlocking, reduced pore spaces, and consequently increased the stiffness of the soil. However, the CBR decreased to 7.00% at 36% replacement, but remained higher than that of the untreated soil. The increase in the CBR value aligned with increased CBR values (but in different proportion) obtained from different studies (Jadhav *et al.*, 2025; Kassa *et al.*, 2020; Mallikarjuna and

Mani, 2016; Sai and Srinivas, 2019; Singh *et al.*, 2024), which incorporated different percentages of plastic waste materials in achieving soil stabilization. Also, the increase in the CBR value aligned with the 46.01% increase in unsoaked CBR value obtained by Winarsih *et al.* (2024), for 3% calcium carbonate soil stabilization. However, the SWP and CCF combination gave better improvement. Also, the reduction beyond the optimum content was due to the excessive plastic waste particles disrupting soil-to-soil contact and reducing load transfer efficiency. The results revealed 24% SWP-CCF replacement as the optimum content for maximizing CBR performance. This met the standard CBR value ($\text{CBR} \geq 5$) for sub-grade pavement construction documented by Ugwuanyi and Onyelowe (2019).

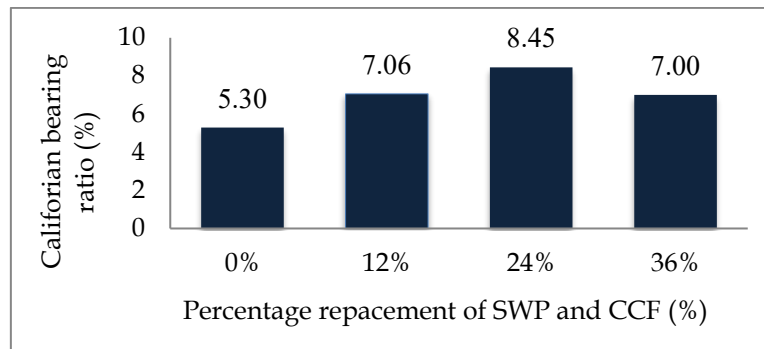


Fig. 4 Variation of SWP and CCF with the soil's CBR

CONTRIBUTION TO KNOWLEDGE

The study demonstrated the successful incorporation of shredded waste plastic (SWP) and calcium carbonate filler (CCF) in soil stabilization. The findings represent a sustainable stabilization approach that reduces reliance on conventional materials, enhances plastic waste management, and promotes environmentally friendly infrastructure development. These contributions align with the objectives of Sustainable Development Goal (SDG) 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action).

CONCLUSION

The experimental findings led to the underlisted conclusions;

- i. The natural soil was classified with AASHTO classification system as A-2-6 soil with predominantly granular characteristics, moderate plasticity and fair subgrade performance. Generally, A-2-6 class of soils exhibit; good to fair performance as a pavement subgrade material. However, the CBR value obtained in this study was below the required standard, indicating the need for stabilization.
- ii. The incorporation of shredded waste plastic (SWP) and calcium carbonate filler (CCF) increased the specific gravity of the soil from 2.35 (0% replacement) to 3.10 at 24% replacement levels of SWP - CCF, indicating improved soil densification.
- iii. The incorporation of SWP and CCF significantly reduced the soil's liquid limit and eliminated its plasticity property. The SWP- CCF transformed the soil to a non-plastic state at all SWP - CCF replacement levels.
- iv. The incorporation of SWP and CCF favorably modified the compaction properties of the soil by generally reducing the OMC and increasing the MDD of stabilized soil samples.
- v. The incorporation of SWP and CCF significantly enhanced the soil's bearing capacity, with the CBR increasing from 5.30% to a maximum value of 8.45% at 24% replacement with a decrease at 36% level. Thus, the 24% SWP-CCF was identified as the optimum replacement level due to its potential as a sustainable soil stabilizer, although it did not meet the minimum CBR

requirement for pavement material as specified by the FMWH (1997). But it met the standard for sub-grade material documented in other existing studies (Ugwuanyi and Onyelowe, 2019).

The incorporation of SWP-CCF into soil stabilization represents a sustainable stabilization approach that reduces reliance on conventional materials, enhances plastic waste management, and promotes environmentally friendly infrastructure, thereby contributing to the achievement of the United Nations Sustainable Development Goals (SDGs). Based on the findings, a 24% shredded waste plastic (SWP) - calcium carbonate filler (CCF) replacement level demonstrated potential for improving the engineering characteristics of A-2-6 soils. However, further studies are required to examine the influence of uneven proportions of SWP and CCF on the stabilization performance of different types of soils.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest associated with this research project titled “geotechnical performance evaluation of plastic waste - calcium carbonate composite fillers for sustainable soil stabilization”.

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