قال تعالى:

{ وَتَرَى الْجِبَالَ تَحْسِبُهَا جَامِدَةً وَهِيَ تَمْرِرَ الْسَّحَابَ صَنَعَ الَّذِي اتقن كُلَّ شَيْءٍ اِنَّهُ خَبِيرٌ بِمَا تَفْعَلُونَ }

صدق الله العظيم

النمل - الآية 88
DEDICATION

To my Mother

To my Father’s Soul

To my husband

To my children’s

To my brothers and Sisters

To my Friends
ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my advisor, Professor Abd Elrahman Elzubair. I am greatly indebted to him for the challenges he has placed upon me as well as his invaluable guidance throughout this research.

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ABSTRACT

This study presents an evaluation of use of the cement waste as chemical stabilizers and recycling fiber glass wastes and plastic waste (PET Bottles) as soil reinforcement, for improving the strength and stability of soils. An experimental program was conducted to investigate the effect of materials waste and evaluate the efficiency of their use on clay soil as stabilizers, this was achieved based on a study of the effect of materials waste on the properties of clay soil such as optimum moisture content (OMC), maximum dry density and shear strength parameters (cohesion\(c\) and angle of friction \(\phi\)). The aim was to determine the optimum content of each of these materials waste and consequently, to reduce the pollution which results from accumulation of (plastics waste (PET: Polyethylene Teraphathalate), fiber glass and cement waste). A series of laboratory compaction, triaxial and California Bearing Capacity (CBR) tests were carried out.

Various percentages of cement waste (3, 6, 9, 12 and 15%) of dry weight of soil was added to clay soil and tested. Also soil was reinforced randomly by different percentage (0.5, 1.5, 3, 6, 9 and 12 %) of dry weight of soil by fiber glass (length 10-30mm) and Plastic (PET) bottles strips waste (length and width (5-10mm)). Soil specimens were compacted at maximum dry density.

Results of soil treated by cement waste indicate that addition of cement waste increased the shear strength (385.38 \(mPa\) at age 2hours) and CBR ()to a maximum value for up to 9% addition, when the percentage of addition of cement waste was equal to or greater than 9% soil became non plastic. The OMC decreased with an increase of more than 12% of cement
waste content. The dry density of the soil decreased from 1.56 to 1.48 $g/cm^{3}$ with an increasing of cement waste content.

Results of soil reinforced by fiber glass and PET bottle indicate that an increasing of fiber glass and plastic bottle content decreased the maximum dry density and increased the OMC. The highest increase in strength value ($386.82 \text{ mPa}$) was achieved when the soil was reinforced by 3.0% of fiber glass content and ($386 \text{ mPa}$) when the soil was reinforced by 1.5% of plastic bottle content and the highest CBR value was achieved at 3.0% of fiber glass and PET bottle content respectively.

The highest CBR value was 8.3 times the CBR of natural clay soil for soil treated by cement waste, 3.6 times the CBR of natural clay soil for soil reinforced by fiber glass and 2.1 times the CBR of natural clay soil for reinforced by PET bottle waste.

As a result of this study it is recommended to use not more than 9% of cement waste, 3% fiber glass waste and (1.5% to 3%) PET bottle waste as stabilizers to improve the shear strength and CBR of clayey soil.
المستخلص

تعرض هذه الدراسة تقييم استخدام مخلفات الأسمنت كمثبت كيميائي و مخلفات الفاير قلاس و البلاستيك (زجاجات البولي إيثيلين ترفثلات) كمادة تسليح للترة الطينية لتحسين مقاومة و استقرار التربة. تم عمل إختبارات معملية لنقيم أثر استخدام مخلفات المواد و كفاءتها كمثبت للترة الطينية و هذا اعتمادا على دراسة أثر مخلفات المواد على خواص التربة الطينية مثل المحتوى المائي الأمثل (OMC) و الكثافة الجافة القصوى (MDD) و معاملات القص (التماسك (c) و زاوية الإحتكاك (φ) . و بالتالي تقليل التلوث الناتج من تراكم مخلفات البلاستيك و الفاير قلاس و الأسمنت. تم إنجاز سلسلة من فحوصات الدمك، الضغط الثلاثي المحاور و نسبة تحميل كاليفورنيا.

تمت إضافة نسبة مختلفة من مخلفات الأسمنت (3،6،9 و 15)% من الوزن الجاف للتربة للترة الطينية و تم اختبارها في عمر ساينتين و ثلاثة أيام. أيضا تم تسليح التربة على شكل مختلفة الأسمنت (0.5،1،5،3،6 و 9)% من الوزن الجاف للتربة) بالفاير قلاس (الطول من 10 إلى 30) مم و مخلفات البلاستيك (زجاجات البولي إيثيلين ترفثلات) (الطول و العرض (5-10) مم). عينات التربة تم دمكها عند الكثافة الجافة القصوى.

تشير نتائج التربة المحملة بالأسمنت إلى أن إضافة مخلفات الأسمنت تزيد من مقاومة التربة للقص و نسبة تحميل كاليفورنيا حتى قيمة مضافة تساوي 9%، وعندما نسبة المضاف من مخلفات الأسمنت تساوي أو أكبر من 9% تصبح التربة غير قادرة. المحتوى المائي الأمثل يقل مع زيادة مضافة أكثر من 12% من مخلفات الأسمنت. الكثافة الجافة القصوى تقل من 1.56 إلى 1.48 جم/سم³ مع زيادة مخلفات الأسمنت.

تشير نتائج التربة المسلحة بمخلفات ألياف الفاير قلاس و زجاجات البولي إيثيلين ترفثلات إلى أن زيادة ألياف الفاير قلاس و زجاجات البولي إيثيلين ترفثلات تقلل من الكثافة الجافة القصوى و تزيد المحتوى المائي الأمثل. أقصى قيمة في زيادة المقاومة يتحصل عليها عندما يتم تسليح التربة ب 3% من مخلفات الفاير.
قياس و 1.5% من مخلفات زجاجات البولي إيثيلين ترفثلات و أقصى قيمة في نسبة تحميل كاليفورنيا تتحصل عليها عند نسبة 3% من مخلفات الفايبر قلاس و زجاجات البولي إيثيلين ترفثلات على التوالي.

أقصى قيمة بنسبة تحميل كاليفورنيا تساوي 8.3 أضعاف نسبة تحميل كاليفورنيا للتربة الطينية الطبيعية للتربة المحشونة بمخلفات الأسمنت، 3.6 أضعاف نسبة تحميل كاليفورنيا للتربة الطينية الطبيعية للتربة المسلحة بمخلفات الفايبر قلاس و 2.1 أضعاف نسبة تحميل كاليفورنيا للتربة الطينية الطبيعية للتربة المسلحة بمخلفات زجاجات البولي إيثيلين ترفثلات.

نتائج هذه الدراسة توصي بعدم استخدام أكثر من 9% من مخلفات الأسمنت و 3% من مخلفات الفايبر قلاس و 1.5% إلى 3% من مخلفات زجاجات البولي إيثيلين ترفثلات كمثبت للتربة لتحسين مقاومة القص و نسبة تحميل كاليفورنيا للتربة الطينية.
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Symbol and abbreviation

ASTM: American Society of Testing Material

AASHTO: American association society of highway and transportation organization

C: Cohesion

CKD: cement kiln dust

CBR: California Bearing Ratio

ECC: Engineered Cementitious Composites

HDPE: high density polyethylene

LKD: Lime kiln dust

LOI: low loss on ignition

LDPE: low density polyethylene

MSW: municipal solid waste

OMC: optimum moisture content

OPC: ordinary Portland cement

PC: Percentage of cement waste

PET: polyethylene terephthalate

PI: plasticity index

PP: polypropylene

PP: Percentage of PET waste

PF: Percentage of fiber glass waste

PS: Polystyrene

PVA: poly (vinyl) alcohol
PVC: poly (vinyl) chloride
RDFS: randomly distributed reinforced fibre soil
RHA: Rice Husk Ash
USCS: united soil classification system
UCS: unconfined compressive strength
USEPA: U.S. Environmental Protection Agency
WBC: waste-based cement
ϕ: Angle of friction