

## الآية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قال تعالى:

{وَتَرَى الْجِبَالَ تَحْسِبُهَا جَامِدَةً وَهِيَ تَمْرٌ مَرُّ السَّحَابِ صَنَّ اللَّهُ الَّذِي آتَقَنَ كُلَّ

شَيْءٍ إِنَّهُ 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*

*I would also like to thank my parent's, brothers and sisters for their support and care provided to me throughout my education. Their support has been invaluable and the reason I have succeeded to be where I am today as a person and scholar.*

*I am grateful to my lovely husband Dr. Ibrahim Younis, Plastic Engineering Department, for his valuable suggestions, encouragement, kind help and support for carrying out this work.*

*I finally would like to thank my friends in Sudan University of Science and Technology*

## 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 Teraphthalate), 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  $mPa$ ) was achieved when the soil was reinforced by 3.0 % of fiber glass content and (386  $mPa$ ) 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 إستخدام مخلفات الأسمت كمثبت كيميائي و مخلفات الفاير قلاس و البلاستيك (زجاجات البولي إثلين ترفثلات) كمادة تسليح للتربة الطينية لتحسين مقاومة و استقرارية التربة.

تم عمل إختبارات معملية لتقييم أثر إستخدام مخلفات المواد و كفاءتها كمثبت للتربة 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 ( $\phi$ )). و بالتالي تقليل التلوث الناتج من تراكم مخلفات البلاستيك و الفاير قلاس و الأسمت. تم إنجاز سلسلة من فحوصات الدمك , الضغط الثلاثي المحاور و نسبة تحميل كليفورنيا.

تمت إضافة نسب مختلفة من مخلفات الأسمت (3, 6, 9, 12 و 15)% من الوزن الجاف للتربة) للتربة الطينية و تم إختبارها في عمر ساعتين و ثلاثة أيام. أيضا تم تسليح التربة عشوائيا بنسب مختلفة الأسمت (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 إثلين ترفثلات) (الطول و العرض (5-10) مم). عينات التربة تم دمكها عند الكثافة الجافة القصوى.

تشير نتائج التربة المحسنة بالأسمت إلى أن إضافة مخلفات الأسمت تزيد من مقاومة التربة للقص و نسبة تحميل كليفورنيا حتى قيمة مضاف تساوي 9% , وعندما نسبة المضاف من مخلفات الأسمت تساوي أو أكبر من 9% تصبح التربة غير لدنة. المحتوى المائي الأمثل يقل مع زيادة مضاف أكثر من 12% من مخلفات الأسمت. الكثافة الجافة القصوى تقل من 1.56 إلى 1.48 جم/سم<sup>3</sup> مع زيادة مخلفات الأسمت.

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

فلاس و 1.5% من مخلفات زجاجات البولي إيثيلين ترفتلات و أقصى قيمة في نسبة تحميل كليفورنيا يتحصل عليها عند نسبة 3% من مخلفات الفاير فلاس و زجاجات البولي إيثيلين ترفتلات على التوالي.

أقصى قيمة لنسبة تحميل كلفورنيا تساوي 8.3 أضعاف نسبة تحميل كلفورنيا للتربة الطينية الطبيعية للتربة المحسنة بمخلفات الأسمت, 3.6 أضعاف نسبة تحميل كلفورنيا للتربة الطينية الطبيعية للتربة المسلحة بمخلفات الفاير فلاس و 2.1 أضعاف نسبة تحميل كلفورنيا للتربة الطينية الطبيعية للتربة المسلحة بمخلفات زجاجات البولي إيثيلين ترفتلات.

نتائج هذه الدراسة توصي بعدم إستخدام أكثر من 9% من مخلفات الأسمت و 3% من مخلفات الفاير فلاس و 1.5% إلى 3% من مخلفات زجاجات البولي إيثيلين ترفتلات كمثبت للتربة لتحسين مقاومة القص و نسبة تحميل كليفورنيا 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

$\phi$ : Angle of friction