DEDICATION

To my family…………

ACKNOWLEDGEMENTS

Praise be to Allah, and peace be upon his messengers

First I acknowledge profusely and all the thanks are due to my god who enabled me to achieve this work.

Then I acknowledge with profound gratitude and sincerity the supervision and guidance I received from my supervisor Dr.Omer E. M.FADOL, for his interest, advice, help, constructive criticism and encouragement throughout the preparation of this research.

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Abstract

The behavior of pile-cap in expansive soils layers under axial loading was investigated using axi-symmetric state , finite element model, these consists of soil continuum elements, with material non-linearties for the soil, and the pile-cap is simulated as linear elastic material. The simulation of soil swelling is based on the softening model to determine swelling potential and hence upheaval deformation in pile-cap-soil system.

The literature review was undertaken in order to provide a framework of available information regarding expansive soils and pile foundation on them.

The behavior of pile-cap has been studied extensively using different load, pile diameter, cap diameter and thickness of cap. It is found out from the results of simulation analysis that the addition of a cap to a pile and taking advantage of the axial load resistance of pile cap have been found to increase the axial load carrying capacity of pile-cap system.

The increase in size of pile cap has been found to increase the axial load carrying capacity of pile significantly.

Axial behavior of a pile-cap system is directly related to the axial capacity of the piles. Also, the results obtained using the softening model confirm the fact that the cap on expansive soils increases upheaval deformations in Pile-Cap-Expansive soils systems and induces high tensile stresses in piles.

Key words: expansive soil, swelling potential, softening model, upheaval deformation, pile-cap through expansive soil.

الخلاصة

في هذه الدراسة تم التعرف علي سلوك نظام الخازوق -الوسادة في التربة المنتفخة تحت تأثير الحمل المحوري وذلك باستخدام نموذج محوري متماثل بطريقة العنصر المحدد. تم تمثيل عناصر التربة بعناصر مرنة لا خطي وعناصر الخازوق - الوسادة مثلت بعناصر مرنة خطي. لإيجاد جهد الانتفاخ وتشوهات الانتفاخية في الخازوق والكاب تم ذلك بطريقة أنموذج الليونة الميكانيكي لحساب تشوهات التربة الطينية الانتفاخية.

تم استعراض المعلومات المتوفرة بخصوص التربة المنتفخة وتأسيس الخوازيق في هذا النوع من التربة.

تمت دراسة سلوك الخازوق- الوسادة ذلك بتغير الأحمال وأقطار خوازيق والوسادة وسمك الوسادة .

من النتائج التي تم التحصل عليها من هذه المحاكاة وجد انه من محاسن إضافة الوسادة للخازوق إن الوسادة تعمل علي زيادة المقاومة التحميلية وبالتالي زيادة الحمل المحوري لنظام كذلك الزيادة في حجم الوسادة تنتج عنها زيادة في الحمل المحوري المحمول بواسطة النظام. أيضا وجد أن السلوك المحوري للنظام مرتبط بالزيادة او النقصان في قيمة الحمل.

وأيضا وجد في هذه الدراسة المبنية علي أنموذج الليونة و التي تؤكد علي حقيقة أن نظام الخازوق-الوسادة في التربة المنتفخة يعمل علي تفاقم مشكلة التشوهات الناتجة من الانتفاخ وزيادة الاجهادات المحورية في الخازوق وذلك إذا كان الكاب يستند علي سطح التربة مباشرة.

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Symbols	Definition
LL	Liquid limit
PI	Plasticity index
SL	Shrinkage limit
Ac	Activity of soil
C	Colloids (or clay) content
ΔV	Change in initial volume of the specimen
V	Initial volume of the specimen
Vs	Final volume of the specimen
$COLE_{ws}$	Coefficient of linear extensibility on a whole-soil
$\gamma_{d\,33<2mm}$	Dry density at 33 kPa water retention on a <2 mm
$\gamma_{d\,<2mm}$	Dry density, oven-dry or air-dry, on a <2 mm
C_m	Coarse fragment (moist) conversion factor
e_0	Voids ratio
e_f	Final voids ratio
Δe	Change in voids ratio during heave
ρ	Total heave
N	Number of layers
z_i	Initial thickness of layer *i*
C_{mi}	Matric suction index for layer *i*
C_{ti}	Effective stress index for layer *i*
σ	Total stress
u_a	pore air pressure
u_w	pore water pressure

α	Compressibility factor (slope of specific volume versus water content curve)
B	slope of suction versus water content curve
G_s	Specific gravity of solids
F_i	a reduction factor for layer i
PE_i	potential expansiveness for layer i
ε_{ve}	Swelling strain
σ_{v0}	Vertical stress
ε_{veo}	Swelling strains under free load
ε_{ve}	Swelling strains under load
$\Delta\varepsilon_{vc}$	additional compression strain induced by softening
P_{ev}	Swelling pressure
$\overline{E}_c$	additional compression modulus
$\overline{E}_{cP}$	additional compression modulus according to swelling pressure
$\overline{E}_{ci}$	additional compression modulus of layer i derived from the softening model.
$\overline{E}_{cp}$	additional compression modulus according to the swelling pressure
Su	upheaval deformations on ground of site with expansive soil layers
σ_{z0i}	Vertical stress of central point of soil layer i
D	diameter of the pile
K	ratio between the horizontal and vertical pressure
Z	depth of the active zone
C	cohesion of the soil

ϕ	angle of internal friction
γ	total unit weight of the soil
ϕ_{ps}	Effective angle of shaft-soil friction
α_1	coefficient of uplift between the pile and the soil
$\overline{\sigma}_s$	Swelling pressure in terms of effective stresses
W	withholding forces
q_{dl}	unit dead load pressure
f_s	skin friction below active zone.
L	length of the pile
R	radial body forces
Z	Vertical body forces
M	Poisson's ratio
G	Tangent shear modulus
θ	Rotational angle
u	Radial displacements
w	Vertical displacements
P_{ev}	Swelling pressure
σ_{vo}	Initial stresses
$\overline{E}_c$	Additional compression modulus induced by softening
$\overline{E}_{cp}$	Additional compression modulus according to swelling pressure,
ε_{ve0}	Swell strain under free load and
τ_{rzp}	Shear stress induced by swelling
A	Area of element
σ_1	Major principal stresses
σ_3	Minor principal stresses

σ_z	Vertical stress
σ_r	Lateral stress
R_f	failure ratio
P_a	Atmospheric pressure
$K_{\max}$	Shear stiffness coefficient
D_r	Reference shear displacement