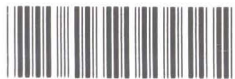


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SMALL STRAIN BEHAVIOUR OF AIR-CEMENT TREATED SOIL

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**A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF ENGINEERING (CIVIL ENGINEERING)
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A Thesis Submitted in Partial Fulfillment
of the Requirement for
the Degree of Master of Engineering (Civil Engineering)
Faculty of Engineering
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2011



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Abstract

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In this study, the small-strain behaviour of Air Cement treated Soil (ACS) was investigated by laboratory uniaxial compression tests. The small-strain stress-strain properties were evaluated by performing continuous monotonic loading (ML) and ML tests with sustained loading (SL) and cyclic loading (CL). Relatively small vertical and horizontal strains were locally measured by means of a pair of local deformation transducers (LDTs) and a set of three clip gages (CGs), respectively. Therefore, different Young's moduli and Poisson's ratios defined in this study could be accurately determined, resulting in precise evaluation of : 1) initial, tangent, and 50 percent of maximum stress Young's moduli (E_0, E_{tan}, E_{50}) and Poisson's ratios (ν_0, ν_{tan}), which were evaluated from stress-strain relations at small and conventional range of strains obtained by these ML test. 2) The equivalent Young's modulus (E_{eq}) and the Poisson's ratio (ν_{eq}), which were evaluated from the stress-strain behaviour during minute cycles of unload and reload varying with increase in the vertical stress. In addition, the parameter called "effective void ratio" was adopted to characterize these Moduli in forms of empirical equations. The effective void ratio combines the influencing factors, i.e., void ratio, cement content, and moisture content. It is shown that the effective void ratio can appropriately characterize all Moduli evaluated in this study.

Keywords : Monotonic Loading / Cyclic Loading / Air-Cement Treated Soil / Young's Moduli / Poisson's Ratio / Effective Void Ratio

หัวข้อวิทยานิพนธ์	การศึกษาพฤติกรรมการความเครียดน้อยของดินเหนียวอ่อนมวลเบาที่ปรับปรุงคุณภาพด้วยปูนซีเมนต์
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งานวิจัยนี้เป็นการศึกษาพฤติกรรมการในช่วงความเครียดน้อยของวัสดุดินเหนียวอ่อนมวลเบาผสมซีเมนต์ โดยการทดสอบแรงอัดในแนวแกน คุณสมบัติความเค้น-ความเครียดในช่วงความเครียดน้อยสามารถประเมินได้จากการทดสอบให้แรงแบบต่อเนื่องทิศทางเดียว โดยระหว่างการให้แรงแบบทิศทางเดียวมีการเพิ่มแรงคงค้างและแรงกระทำแบบวงรอบ การวัดค่าความเครียดในช่วงความเครียดน้อยในแนวตั้งและแนวราบใช้เครื่องมือวัดการเคลื่อนที่เฉพาะจุด (LDT) และเครื่องมือวัดการขยาย (clip gage) ตามลำดับ ดังนั้น การวัดค่าโมดูลัสยืดหยุ่นและอัตราส่วนปัวซองในการศึกษานี้จึงมีความแม่นยำ ทำให้สามารถประเมินค่าที่ถูกต้องของ 1) โมดูลัสเริ่มต้น โมดูลัสสัมผัส และโมดูลัสที่ 50 เปอร์เซ็นต์ของหน่วยแรงสูงสุดจากความสัมพันธ์หน่วยแรง-ความเครียดในช่วงค่าความเครียดน้อย และค่าปกติจากการทดสอบให้แรงกระทำทิศทางเดียว และอัตราส่วนปัวซองเริ่มต้น และสัมผัส 2) โมดูลัสสมมูลและอัตราส่วนปัวซองของสมมูลจากความสัมพันธ์หน่วยแรง-ความเครียดระหว่างการให้แรงกระทำแบบวงรอบ ซึ่งแปรเปลี่ยนตามการเพิ่มหน่วยแรงแนวตั้ง นอกจากนี้ งานวิจัยนี้มีการสร้างความสัมพันธ์อย่างง่ายของค่าโมดูลัสดังกล่าวกับพารามิเตอร์ “อัตราส่วนช่องว่างประสิทธิผล” ซึ่งเป็นพารามิเตอร์ที่สะท้อนถึงปัจจัยต่างๆ ได้แก่ อัตราส่วนช่องว่าง ปริมาณปูน และปริมาณความชื้น อัตราส่วนช่องว่างประสิทธิผลนี้สามารถจำแนกคุณลักษณะของโมดูลัสทั้งหมดได้อย่างเหมาะสม

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LIST OF SYMBOLS

A_w	=	Cement content (% to dry soil)
C	=	Cement content (kg/m^3)
C_w	=	Total water content
E	=	Modulus of elasticity or Young's modulus
E_{eq}	=	Equivalent Young's modulus
E_0	=	Initial Young's modulus
E_{50}	=	Secant modulus of 50% ultimate
E_{sec}	=	Secant Young's modulus
E_{tan}	=	Tangent Young's modulus
E_u	=	Undrained modulus
E_{50}	=	Secant modulus of 50% ultimate
e_{ot}	=	After curing void ratio
e_{st}	=	Effective void ratio
F_w	=	Desired foam
G	=	Shear modulus
G_s	=	Specific gravity
K	=	Bulk modulus
P_a	=	Atmospheric pressure
q_u	=	Unconfined compressive strength
S_u	=	Undrained shear strength
W_T	=	The total weight of prepared original untreated clay sample
w_0	=	Natural water content of the clay sample
w^*	=	The remolding clay water content
w/w_F	=	Water-foam material ratio
γ_t	=	After-curing unit weight
γ_w	=	Unit weight of water
λ	=	Compression index
ϵ	=	Strain
σ	=	Stress
τ	=	Shear strength
ν	=	Poisson's ratio
ν_{eq}	=	Equivalent Poisson's ratio
ν_0	=	Initial Poisson's ratio
ν_{tan}	=	Tangent Poisson's ratio
ΔW_w	=	The additional weight of water
8-100	=	Unit weight 8 kN/m^3 cement content 100 kg/m^3
8-150	=	Unit weight 8 kN/m^3 cement content 150 kg/m^3
8-200	=	Unit weight 8 kN/m^3 cement content 200 kg/m^3
10-100	=	Unit weight 10 kN/m^3 cement content 100 kg/m^3
10-150	=	Unit weight 10 kN/m^3 cement content 150 kg/m^3
10-200	=	Unit weight 10 kN/m^3 cement content 200 kg/m^3
12-100	=	Unit weight 12 kN/m^3 cement content 100 kg/m^3
12-150	=	Unit weight 12 kN/m^3 cement content 150 kg/m^3
12-200	=	Unit weight 12 kN/m^3 cement content 200 kg/m^3