DEPARTMENT OF TEE ARMY
Office of the Chief of Engineers
Washington, D.C. 20314

EM 1110-2-1906
Change 1

DAEN-CWE-SS

Engineer Manual
No. 1110-2-1906

1 May 1980

Engineering and Design
LABORATORY SOILS TESTING

1. This change to EM 1110-2-1906, 30 November 1970, provides the updating of the TABLE OF CONTENTS and the addition of the following four (4) APPENDICES:

a. Appendix VIII A; Swell and Swell Pressure Tests

b. Appendix XA: Cyclic Triaxial Tests

c. Appendix XB: Determination of Critical Void Ratio

d. Appendix XIII: Pinhole Erosion Test for Identification of Dispersive Clays

2. Substitute the attached pages as shown below:

Remove pages i, ii, iii, iv, v, vi, and vii	Insert new pages i, ii, iii, iv, v, vi, vii, viii, ix, x, xi, xii, and xiii

3. Add Appendices VIII A, XA, XB, and XIII.

4. File this change sheet in front of the publication for future reference purposes.

FOR THE CHIEF OF ENGINEERS:

FORREST T. GAY, III
Colonel, Corps of Engineers
Executive Director, Engineer Staff

THIS CONSTITUTES CHANGE 1 TO EM 11 10-2-1906, 30 NOV 70

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DEPARTMENT OF THE ARMY
U. S. Army Corps of Engineers
Washington, D. C. 20314-1000

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ENGINEERING AND DESIGN

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NOTATIONS †

	A	Area
	C_c	Compression index
	c	Cohesion or cohesion intercept of strength envelope based on total stresses
	c'	Cohesion intercept of strength envelope based on effective stresses
	D	Diameter
*	D_1, D_2	Dispersive soil classification--pinhole erosion test
	D_{10}	Diameter of soil particle having a size greater than 10 percent (by weight) of the particles
	D_d	Relative density
*	D_i	Initial diameter of pinhole
	e	Void ratio
*	e_c	Void ratio after consolidation
	F	Applied shear force
	G_a	Apparent specific gravity
	G_m	Bulk specific gravity
	G_s	Specific gravity of solids
	H	Henry's coefficient of solubility
	H	Height
*	H_i	Initial hydraulic head in pinhole erosion test
	ΔH	Change in height

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* † Omitted here are the symbols A, D, H, S, V, and w having the subscripts o, c, and f, and the symbol e having the subscripts o and f (for example, A_o, H_c, w_f, etc.); these subscripts indicate that the symbols refer to properties of test specimens measured or computed under the following conditions: *

o	Initial or before test
c	After consolidation or before shear
f	Final or after test

	ΔH_0	Change in height during consolidation or before shear
	h	Hydraulic head
	i	Hydraulic gradient
	k	Coefficient of permeability
	L	Length
	L_s	Linear shrinkage
	LL	Liquid limit
	N	Number of blows of liquid limit cup
*	ND_1, ND_2	Nondispersive soil classification--pinhole erosion test
*	ND_3, ND_4	Intermediate soil classification--pinhole erosion test
	n	Porosity
	P	Applied axial load
	PI	Plasticity index
	PL	Plastic limit
	p	Pressure
	p_c	Preconsolidation pressure
	p_o	Overburden pressure
	Q	Quantity of flow
	q	Rate of discharge
	q_u	Unconfined compressive strength
	R	Shrinkage ratio
	S	Degree of saturation
*	SAR	Sodium absorption ratio
	SL	Shrinkage limit
	s	Shear strength
	s_u	Undrained shear strength
	t	Time
	t_{50}	Time to 50 percent primary consolidation

	t_f	Time to failure
	U	Degree of consolidation
	u_a	Atmospheric pressure (absolute)
	u_o	Required back pressure (gage)
	V	Volume
	V_a	Volume of air
	V_s	Volume of soil solids
	V_v	Volume of voids
	V_w	Volume of water
	ΔV	Change in volume
	ΔV_w	Change in volume of water
	W	Weight of wet soil
	W_s	Weight of dry soil
	W_w	Weight of water
	w	Water content
	w_N	Water content at N blows
	β	Slope angle of flow line
	γ_d	Dry unit weight (or dry density) of soil
	γ_m	Wet unit weight (or wet density) of soil
	γ_w	Unit weight of water
	ε	Axial strain
*	ε_{da}	Double amplitude axial strain
	η	Coefficient of viscosity
	σ	Normal stress
	σ_1	Major principal stress
	σ_3	Minor principal stress
	$\sigma_1 - \sigma_3$	Deviator stress
*	σ_{dc}	Cyclic deviator stress
*	$\frac{\pm \sigma_{dc}}{2\sigma_{3c}}$	Cyclic stress ratio

*	σ_{3f}	Effective confining pressure at failure
*	σ_{fc}	Consolidation stress on the failure plane
	7	Shear stress
*	τ_{cyclic}	Cyclic shear stress
	ϕ	Angle of internal friction (or slope angle of strength envelope) based on total stresses
	ϕ'	Angle of internal friction (or slope angle of strength envelope) based on effective stresses
	ϕ'_r	Angle of friction determined from the drained repeated direct shear test