



## Soil Mechanics: Stress Distribution

**Course Number:** CE-02-116

**PDH:** 4

**Approved for:** AK, AL, AR, FL, GA, IA, IL, IN, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, VT, WI, WV, and WY

### State Board Approvals

Florida Provider # 0009553 License #868

Indiana Continuing Education Provider #CE21800088

Maryland Approved Provider of Continuing Professional Competency

New Jersey Professional Competency Approval #24GP00025600

North Carolina Approved Sponsor #S-0695

NYSED Sponsor #274

**Course Author:** Mathew Holstrom

### How Our Written Courses Work

This document is the course text. You may review this material at your leisure before or after you purchase the course.

After the course has been purchased, review the technical material and then complete the quiz at your convenience.

A Certificate of Completion is available once you pass the exam (70% or greater).

If a passing grade is not obtained, you may take the quiz as many times as necessary until a passing grade is obtained).

If you have any questions or technical difficulties, please call (508) 298-4787 or email us at admin@PDH Pro.com.



## TABLE OF CONTENTS

FOREWORD .....	i
TABLE OF CONTENTS .....	i
LIST OF FIGURES.....	x
LIST OF TABLES.....	xxi
CHAPTER 1 IDENTIFICATION AND CLASSIFICATION OF SOIL AND ROCK.....	1
1-1 INTRODUCTION .....	1
1-1.1 Scope. ....	1
1-2 SOIL DEPOSITS.....	1
1-2.1 Geologic Origin and Mode of Occurrence. ....	1
1-3 SOIL VISUAL DESCRIPTION, IDENTIFICATION, AND CLASSIFICATION.....	5
1-3.1 Definitions.....	5
1-3.2 Visual Description and Identification (ASTM D2488) .....	6
1-3.3 Unified Soil Classification System (ASTM D2487).....	11
1-3.4 Soil Classification for Highways (AASHTO).....	15
1-3.5 Other Classification Systems .....	16
1-3.6 Common Soil and Rock Names .....	17
1-4 ROCK VISUAL DESCRIPTION, AND CLASSIFICATION.....	23
1-4.1 Definitions.....	23
1-4.2 Visual Classification .....	24
1-4.3 Classification by Field and Laboratory Measurements.....	29
1-4.4 Rock Mass Classification Systems.....	31
1-5 SPECIAL MATERIALS.....	35
1-5.1 Expansive Soils .....	35
1-5.2 Collapsing Soils .....	39
1-5.3 Frost Susceptibility and Permafrost.....	41
1-5.4 Limestone and Related Materials .....	44
1-5.5 Coral and Coral Formation.....	46
1-5.6 Quick Clays .....	47
1-5.7 Other Materials and Considerations .....	47
1-6 SUGGESTED READING .....	51
1-7 NOTATION. ....	51
CHAPTER 2 FIELD EXPLORATION, TESTING, AND INSTRUMENTATION .....	53
2-1 INTRODUCTION .....	53

2-1.1	Scope .....	53
2-1.2	Planning for Field Investigations .....	53
2-2	PUBLISHED REFERENCE MATERIALS.....	55
2-2.1	Previous Investigations .....	55
2-2.2	Published Geologic and Hydrogeologic Maps .....	56
2-3	REMOTE SENSING DATA METHODS .....	56
2-3.1	Sources .....	56
2-3.2	Utilization .....	56
2-4	GEOPHYSICAL METHODS.....	60
2-4.1	Utilization and Applications .....	60
2-4.2	Advantages and Limitations .....	61
2-5	SOIL AND ROCK EXPLORATION METHODS .....	61
2-5.1	Drilling and Boring Methods .....	61
2-5.2	Test Pits and Test Trenches .....	67
2-5.3	Other Exploratory Techniques .....	67
2-6	SAMPLING .....	68
2-6.1	Soil Sampling.....	69
2-6.2	Rock Sampling.....	73
2-6.3	Offshore Sampling .....	75
2-6.4	Field Logging and Boring Logs .....	76
2-7	PENETRATION RESISTANCE TESTS.....	79
2-7.1	Standard Penetration Test (SPT).....	79
2-7.2	Cone Penetrometer Tests (CPT).....	81
2-7.3	Flat Plate Dilatometer .....	84
2-7.4	Dynamic Cone Penetrometer .....	87
2-8	GROUNDWATER MEASUREMENTS .....	89
2-8.1	Types of Standpipe Piezometer .....	89
2-8.2	Multiple or Nested Installations .....	92
2-8.3	Measurement of Groundwater Levels .....	92
2-8.4	Detection of Combustible Gases.....	93
2-9	MEASUREMENT OF SOIL AND ROCK PROPERTIES <i>IN SITU</i> .....	94
2-9.1	Strength and Deformation Properties of Soil .....	94
2-9.2	Hydraulic Conductivity of Soil.....	101
2-9.3	Engineered Fill and Earthworks .....	103
2-9.4	Rock Properties .....	110

2-10	FIELD INSTRUMENTATION AND MONITORING .....	114
2-10.1	Operating Concepts for Geotechnical Monitoring Instruments.....	115
2-10.2	Linear Deformation Measurements .....	116
2-10.3	Angular Displacement Measurements .....	121
2-10.4	Pore Pressure and Water Pressure Measurements .....	121
2-10.5	Earth Pressure Measurements .....	125
2-10.6	Load Measurements .....	125
2-10.7	Temperature Measurements.....	126
2-10.8	Vibration Measurements .....	126
2-10.9	Field Applications for Instrumentation.....	127
2-11	SUGGESTED READING .....	129
2-12	NOTATION.....	129
CHAPTER 3	LABORATORY TESTING .....	131
3-1	INTRODUCTION .....	131
3-1.1	Scope.....	131
3-1.2	Evolution of Laboratory Test Procedures .....	131
3-1.3	Laboratory Certification.....	132
3-2	LABORATORY TESTS ON SOILS .....	133
3-2.1	Sample Selection.....	133
3-2.2	Index Property Tests.....	136
3-2.3	Compaction Tests.....	142
3-2.4	Strength Tests .....	143
3-2.5	Dynamic Tests .....	159
3-2.6	Compressibility Tests.....	163
3-2.7	Hydraulic Conductivity (Permeability) Tests .....	170
3-3	LABORATORY TESTS ON ROCK.....	172
3-3.1	Unconfined Compression Test (ASTM D7012) .....	172
3-3.2	Split Cylinder Test (ASTM D3967) .....	173
3-3.3	Rock Direct Shear Test (ASTM D5607) .....	173
3-3.4	Point Load Test (ASTM D5731) .....	174
3-4	OTHER SOIL AND ROCK TESTS.....	175
3-5	SUGGESTED READING .....	176
3-6	NOTATION.....	176
CHAPTER 4	DISTRIBUTION OF STRESSES .....	180
4-1	INTRODUCTION .....	180

4-1.1	Scope .....	180
4-1.2	State of Stress .....	180
4-2	STRESS CONDITIONS AT A POINT.....	180
4-2.1	Stress Conditions in Soil .....	180
4-2.2	Mohr Circle of Stress .....	185
4-3	ELASTIC SOLUTIONS FOR STRESSES DUE TO APPLIED LOADS. ....	185
4-3.1	Use and Applicability.....	185
4-3.2	Semi-Infinite Elastic Conditions.....	185
4-3.3	Layered or Anisotropic Foundations.....	196
4-4	SHALLOW PIPES AND CONDUITS .....	198
4-4.1	General.....	198
4-4.2	Vertical Loads on Rigid Pipe. ....	198
4-4.3	Vertical Loads on Flexible Pipe.....	199
4-4.4	Long Span Metal Culverts.....	201
4-5	DEEP UNDERGROUND OPENINGS .....	201
4-5.1	General Factors .....	201
4-5.2	Openings in Rock .....	202
4-5.3	Loads on Underground Openings in Rock .....	203
4-5.4	Openings in Soft Ground (Soil) .....	206
4-5.5	Pressure on Vertical Shafts.....	210
4-6	NUMERICAL SOLUTIONS FOR STRESSES IN SOIL.....	213
4-6.1	Numerical Analysis Types.....	213
4-6.2	Linear Elastic Stress Analysis .....	214
4-6.3	Nonlinear Elastic Stress Analysis.....	214
4-6.4	Numerical Modeling Best Practice. ....	216
4-6.5	Evaluation of Stress Due to Applied Loads .....	217
4-6.6	Evaluation of Stress within Embankments and Slopes.....	217
4-7	SUGGESTED READING .....	218
4-8	NOTATION .....	218
CHAPTER 5	ANALYSIS OF SETTLEMENT AND VOLUME EXPANSION .....	222
5-1	INTRODUCTION .....	222
5-1.1	Scope. ....	222
5-1.2	Occurrence of Settlement .....	222
5-1.3	Occurrence of Heave. ....	223
5-1.4	Applicability.....	223



Purchase this course to  
see the remainder of  
the technical materials.