SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE TITLE: Soil Mechanics

CODE NO.: ARC 217

PROGRAM: Civil Engineering Technology

SEMESTER: III

AUTHOR: S. Ienco

DATE: August 1990

NEW: _____ REVISION: x

APPROVED: L. Chiarotta 90/08/29

CHAIRPERSON DATE

SOIL MECHANICS & HIGHWAY ENGINEERING — ARC 231-3

Course Name — Course Number

PHILOSOPHY/GOALS:

To introduce the student to basic soil mechanics. The topics covered will include: soil formation, identification and classification, engineering properties of soil, movement of water through soil and subgrade pavement materials.

The student will reinforce his/her understanding of soil mechanics by undertaking a research project to collect, record and review selected soil reports for various streets in the Sault Ste. Marie area.

METHOD OF EVALUATION:

Field exploration	15%
Laboratory	15%
Assignments	10%
Mid Term Examination	25%
Final examination	35%
	100%

The grading system used will be as follows:

A+	90% - 100%
A	80% - 89%
B	70% - 79%
C	55% - 69%
R	Repeat

1) Minimum acceptable grade is 55%

2) Each lab assignment will carry equal weight.

3) Each research assignment will carry equal weight.

4) If, at the end of the semester, your overall average of the combined laboratory, assignments, mid semester examination and final semester examination is below 55%, then it will be up to the instructor whether you receive an "R" grade or a rewrite. The criteria employed for arriving at that decision is class attendance, class participation and overall grade.

5) If a re-write is granted it will be given for the examination portion of the course work and the maximum obtainable mark on the rewrite is 60%

TEXTBOOK(S):

Highway Materials, Soils & Concretes
Harold N. Atkins

TOPIC NO.	TOPIC DESCRIPTION
1.	Site Investigation - sample recovery - bore hole logs - record keeping of field observations
2.	Laboratory Soils - soil classification - mass volume measurements - grain size by sieve analysis - grain size by hydrometer analysis - Atterburg limits test - constant head permeability test - falling head permeability test - unconfined compression test - compaction test - determination of in-place soil density - California bearing ratio
3.	Movement of Water Through Soil - permeability - Darcy's law of flow - drainage - flow nets
4.	Highway Construction - sub-grade treatment - frost protection - aggregate and sub-grade preparation - earthwork operations - compaction equipment
5.	Research Project - Collect, record and review existing soil reports

ARC 231-3

COURSE OBJECTIVES

Site Investigation

1. Identify those topographical features of a site that indicate its subsoil properties.

2. Prepare a schedule of equipment for a typical subsoil investigation.

3. Schedule a procedure for carrying out such an investigation.

4. List the steps necessary to ensure satisfactory sample recovery.

5. Participate in a field crew investigating party.

6. Recover at least three bored samples in an "undisturbed" form, and three "disturbed samples.

7. Submit a written report on the site exercise together with site plan and logs.

Soil Mechanics

1. Using the disturbed samples determine the water content.

2. From an undisturbed sample determine the Mass - volume measurement.

3. Using the disturbed samples determine the soil classification.

4. Perform a grain size analysis by sieve.

5. Perform a hydrometer test for fines passing the 200 sieve.

6. Classify the in situ soils.

7. Determine the Atterburg limits for the sample soil.

8. Perform a constant head permeability test on at least two samples.

9. Perform an unconfined compression test on at least two undisturbed samples.

10. Solve basic soil problems using all of the above experimental findings.

ARC 231-3

COURSE OBJECTIVES

Movement of Water Through Soil

1. Define permeability and identify factors affecting water flow through soil.

2. Solve problems using Darcy's law for flow.

3. State, define and illustrate by example laminar and turbulent flow.

4. Relate the effect of soil type on permeability.

5. State, define and illustrate by example capillary rise in soils.

6. Identify systems dewatering excavations.

Highway Layout

1. Identify the sub-grade materials, treatment of unsuitable material and compaction requirements.

2. State the conditions that must be present for frost damage to occur.

3. Identify the major components of a sub-grade structure.

4. Identify different types of earthmoving equipment.

Research Project

This project will be performed in cooperation with the City of Sault Ste. Marie and ReadyMix Marketing Committee. Additional information to follow.

Sault Ste.Marie ReadyMix Marketing Committee June 25, 1990

Minutes of Meeting at Sault College, June 13, 1990

Topic: Data Gathering of Concrete Streets at City Hall by Sault College Students.

In Attendance: Jim Reid - Director of Engineering & Construction (City of Sault Ste.Marie)
Sal Ienco - Professor-Civil Dep't., Sault College
Dick Beaumont - Lyons Readymix Company Ltd.
Gary Slater - Permanent Concrete
Rick Sawyer - Reiss Lime Company of Canada Ltd.

G.S.- Purpose of meeting to set up project for students to gather data on concrete and asphalt streets(soil, spec's, costs, and maintenance).

S.I.- College is very receptive to this type of project, will fit in with soils course this fall, concrete course next winter.

J.R.- Problem with this is that his dep't. does not have records on maintenance, major task to get this.

G.S.- We would need only major repairs of a half dozen streets, as well as soils and construction records.

J.R.- Problem with concrete streets is that they crack, even with saw-cuts, due to differential heaving. Feels you need the same base as for an asphalt street.

D.B.- Robin Street has been a success.

J.R.- Yes, due to subgrade material being sand with low water table. Trouble in just building these streets, especially in west end with high water table and in east end with silty sands. Major problem is with sewer laterals backfilled with different material than subgrade, this results in differential heaving. Asphalt flexes. Summary of concrete streets in the Sault;

Robin Street - Best in city.
Salsbury Ave.- from Bruce easterly.
Upton Road - Ontario Ave.southerly.
Brown Street - not in bad condition.
Chambers Ave.- Ross to Dacey overlayed, Kerr to Ross rebuild next year.
Carol Court
Danby

Major Corrective and Rebuilt Streets;
Sussex- overlay Korah to Prentice
Walnut - reconstruct Railroad to St.Georges
VanDale - rebuild this year Wawanosh to north limit.

J.R.- Street reconstruction very expensive, $800,000. to rebuild Goulais Ave.(Wallace Terr. to Second Line), using air-cooled slag aggregate as ballast material.

G.S.-Winnepeg uses concrete paving in a similar climate, though soil conditions may not be the same. Last report showed concrete lasts three times longer than asphalt.

J.R.-Heard they have a problem with aggregate in asphalt.

S.I.- Are there any reference situations in the U.S. with similar soil and frost conditions? No, not like the Sault.

J.R.- At the time they built Chambers, Carol Court and Robin, reps. from the PCA were on site and recommended only a 6 inch gran'A' base. They did not recognize sewer laterals or climate difference between Sault and Southern Ontario.

D.B.- Project purpose is to find out facts as to why some of these streets failed, we are being judged on these old roads.

J.R.- Until PCA shows evidence and examples from other cities, he will not recommend building concrete streets.

G.S.- Technology in road base has changed in recent years, we want to get data from half dozen streets, asphalt and concrete.

J.R.- Problems with St.Micheals and New Castle asphalt streets due to high water table.

How many streets would we want to look at?

S.I.- need to establish parameters on what records we want. Will assign a couple of students for 2-3 hours at a time maybe once or twice a week for the semester.

J.R.- Soils data, easy to gather, in file, photocopy and return.
- Follow-up on effect of subgrades, go out and look at streets. Repair costs, won't be able to get.

G.S.- We want just major repairs.

S.I.- Soils data could be part of soils mechanics course.

D.B.- Suggests Sal write Jim Reid to request time and date for visits.

J.R.- Will sit down with students himself and explain their records system.

G.S.- First semester, gather as much soil data (15 to 20 streets), second semester zero in on specific streets.

J.R.- Suggests we list streets we want beforehand, as this data can be ready from street plans and as-constructed plans.

J.R.- mentioned I-75 highway showing signs of distress and spalling requiring joint repairs now. This is on sand which is better than most soils in the Sault.

S.I.- Would it be worthwhile to measure frost movement, cast test slabs, seeing the airport slabs held out O.K.?

J.R.- The airport is built entirely on sand.

D.B.- There are some concrete parking lots in town, performance has to do with design specifications.

J.R.- Most consultants who do soils investigations report just the data and do not make recommendations. Wright and Barker is one that will recommend, city will usually up the spec.

S.I.- Would like to involve some students next meeting(Oct.'90) and arrange orientation at city hall.

J.R.- Will be contact person at city hall for students.

S.I.- Asked about costs incurred by students for film and processing, phototcopying and vehicle fuel?

D.B.- Prepare a small operating budget.
- Asked if there is a city map showing soil conditions.

J.R.- There is a map prepared by MNR though it is very broad. There is a report(Pavement Management System) in a computerized system showing riding comfort, surface distress and structural adequacy of all streets, this may be useful for students.

S.I.- For this project the Dean is in agreement as long as it does not create problems for students or creates a new course. May have to involve 10-13 students and rotate 3 at a time.

J.R.- Has to be impartial, could create tension with asphalt producers

D.B.- Our goal is to eventually get alternate bid for road projects and allow more competition.

S.I.- Suggests a final report could be prepared.

Next Meeting: Thursday, September 13, 1990 , 4:30 pm at Sault College.

Minutes prepared by: Rick Sawyer

Distribution: Jim Reid
Sal Ienco
Dick Beaumont
Gary Slater
Jack Hollingsworth
Rick Sawyer
Jeff Gray
Brad Knight