The University of Iowa
Department of Civil & Environmental Engineering
SOIL MECHANICS 53:030
Fall Semester 2003
Preview of Final Examination
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The final exam is scheduled to be given on Wednesday December 17th at 2:15pm in 3505 SC. The exam period is two hours long, and will be used to administer a comprehensive exam on all material covered since the start of the semester. The exam format will include both short answer questions, and problem solving questions. The exam will be closed book, closed notes, but you are permitted to bring in up to three formula sheets containing basic relations and basic facts about soils. **You are not permitted, however, to have solved problems written down on your formula sheet.** You will be requested to hand in your formula sheet with your exam, and it will be returned with your graded exam. Since many students never pick up their final exam, and since the formula sheets are often quite useful, you might want to make a photocopy of your sheet and keep it with your course notes.

To prepare for the exam, you should become thoroughly familiar with the issues outlined below. Once you've studied for the exam by reviewing the topics listed below, you may want to test your readiness by attempting the sample final exams available on the course web-site with a self-imposed time limit of two hours.

Mass, Volume, Void Ratio, Saturation Relations

- Know such definitions as void ratio, porosity, saturation, water content, dry density, saturated density, specific gravity, etc.
- Know how given some soil information (void ratio, porosity, saturation, water content, etc) you can generate additional information using basic definitions.
- Know and be able to quickly apply expressions for various densities of soils.
- Know about relative densities of soils.

Soil Types

- Know the basic soil types (gravels, sands, silts, clays) and what the fundamental differences are between these soils.
- Be very familiar with the idea of specific surface area of soils and how this changes with the grain sizes of soils. Also be able to explain how SSA affects the permeability of soils.
- Know about grain size distributions for soils, and how you would measure them. Also know the difference between well-graded, and uniform soils.
- Know about Atterberg limits for soils, and what they measure.
- Also, know what the liquidity index is for fine-grained soils.
- Know about the potential dangers of loose soil deposits.
- Be familiar with the different soil classification systems.
- Know about capillarity effects in soils, and which soil types exhibit strongest effects.

Fluid Flow in Soils

- Know about Bernoulli head and how it measures the energy of fluid in soils.
- Understand Darcy's Law (both the one-dimensional and multi-dimensional forms), and know how to apply it.

- Know that discharge velocities represent volumetric flow rates per gross unit area.
- Understand hydraulic conductivities of soils, how they are measured, andhow they are related to fluid viscosity and the soil's so-called *absolute permeability.*
- Know the continuity equation for fluid flow in soil and how to apply it.
- Know about flows through layered soils.
- Know how to draw good flow nets for two-dimensional seepage problems, and know how to utilize all of the information that flow nets provide.
- Know how to calculate fluid pressures in soil, both when seepage is not occurring, and when seepage is occurring.
- Know about draw-down of the water table from pumping wells and how to apply appropriate formulas.

The Effective Stress Concept

- Understand the relationship between total stresses, effective stresses, and pore pressures (or neutral stresses). Know what effective stresses actually represent physically.
- Be able to calculate total stresses, effective stresses, and pore pressures when no seepage is occurring.
- Be able to do the same when seepage is occurring.
- Understand, and be able to calculate seepage forces exerted by fluid on the soil skeleton.
- Understand how and why liquefaction of soils can occur.
- Be able to calculate factors of safety against heave around hydraulic structures.

Compression/Consolidation of Soils

- Know and understand how to use void ratio versus logarithm of effective stress relations to predict changes in void ratios of soils, and to predict consolidation settlements.
- Understand such ideas as: over-consolidated soils, normally consolidated soils; swelling index; compression index; pre-consolidation stress. Also be able to use these ideas in computing settlements of soils under applied loadings. This will involve computing the initial effective stresses in the soil and the stress increases caused by specific loadings.
- Know how to apply one-dimensional consolidation theory to compute the time scale on which consolidation settlements will occur. (For the exam, you will be responsible only for primary consolidation.)
- Be able to identify the assumptions invoked in developing the one-dimensional consolidation theory used in soil mechanics.

Stresses in Soils

- For two-dimensional states of stress be able to use Mohr's Circle and the Pole method to:
  - compute the stresses on a plane of any orientation; and
  - to compute the orientation of a plane on which specific stress states (σ, τ) act.
- Given suitable formulae and/or charts, know how to compute stresses in the soil mass for the following types of loadings: concentrated point loads; line loads; strip loads; flexibly loaded rectangular areas; flexibly loaded circular areas; embankments.

Shear Strength of Soils

- Understand and be able to apply the Mohr-Coulomb shear failure criterion.
- Be able to take account of pore fluid pressures, if known.
- Understand the different methods explored for measuring shear strengths of soils (direct shear test and triaxial compression tests).
- Understand the different types of strength tests: consolidated drained (CD); consolidated undrained (CU); unconsolidated undrained (UU).
- Know when in geotechnical engineering one might use a CD, CU, or UU shear strength criterion.

Compaction of Soils

- Know and appreciate what soil compaction is and why it is generally performed on soils imported to construction sites;
- Know the general shape and tendencies of moisture-density relations in compacted soils;
- Appreciate why dry unit weights (or densities) are used to quantify degrees of soil compaction. Also appreciate the meaning and usage of the zero-air voids dry unit weight;
- Be able to compute soil masses (or weights) needed for compacted construction applications. Also be able to compute required volumes of soil to be taken from uncompacted borrow sites.
- Know good construction practices that facilitate achieving high degrees of soil compaction: small lift thicknesses; careful control of field moisture contents; and number of samples to take per lift.