CIVE 302 - Evaluation of Civil Engineering Materials - Fall 2008

Course Description: CIVE 302 - Evaluation of Civil Engineering Materials - 3 cr (2 - 3 - 0)
Behavior and properties of construction materials, instrumentation, use of statistical tools, material standards, material selection, quality control.

Prerequisites: CHEM 111, General Chemistry I
CIVE 203, Engineering Systems and Decision Analysis
CIVE 360, Mechanics of Solids – this is the most important of the prerequisites.

Class Times: Lecture: 10:00 - 10:50 a.m. TR in A108 Microbiology Building
Dr. Marvin Criswell and Dr. Rebecca Atadero

Labs: Labs will meet first in a regular classroom, then move into either the Structures and Materials Lab (A10) or the Concrete Materials Lab (A11). No Lab 4.
Lab 1 - 11:00 - 1:40 p.m. Tuesday (B2 Engrg) -------------- Jordan Jarrett
Lab 2 - 2:00 - 4:40 p.m. Tuesday (B2 Engrg) -------------- Jordan Jarrett
Lab 3 - 2:00 - 4:40 p.m. Wednesday (B101 Engrg) ------- John McWilliams
Lab 5 - 2:10 - 5:00 p.m. Thursday (B2 Engrg) ------------- John McWilliams

Instructor and Teaching Assistants:
Instructors: Marvin Criswell A201 Engineering Building 491-6697
            e-mail: marvin.criswell@colostate.edu
            Office hours: 2:00–3:00 pm T & W, 9:30–10:30 am F
Becki Atadero A218 Engineering Building 491-3584
            e-mail: rebecca.atadero@colostate.edu
            Office hours: 11:00 – noon M W F

Teaching Assistants: Jordan Jarrett and John McWilliams
Both have offices in A10B Engineering, 491-6788
e-mails: jjarrett@engr.colostate.edu johnmcw@lamar.colostate.edu
They will inform their labs of their office hours.

This is a locally reproduced set of text and lab notes and will be in the CSU Bookstore.

“Why Buildings Fall Down” by Matthys Levy & Mario Salvadori,

By Week 7, CIVE 302 students will be provided (at no cost to the students) with a CD containing the 14th edition (2002) of the Portland Cement Association’s “Design and Control of Concrete Mixtures (358 pages), along with about 25 other publications by PCA and the American Concrete Pavement Association, complements of the Rocky Mountain Cement Council.

A new program offered by ASTM (American Society for Testing and Materials) and which will be used in CIVE 302 allow students to download up to ten selected ASTM Standard for a $10 fee. More details will be given in class.
Expanded Course Description:

*CE 302 is the fifth course in the civil engineering core curriculum and is designed for primarily first semester junior students.*

*The class addresses construction materials commonly used in civil engineering applications, including their properties, tests and quality control, and basics of their uses.*

*Standards describing these materials and tests to determine their properties are covered.*

*Several topics covered in more detail in a typical introduction to materials science course (such as MECH 331 – Introduction to Engineering Materials) will be introduced; topics such as material microstructure, imperfections, alloys, heat treatment, and material failure modes.*

*Common causes of structural failures, particularly those associated with materials and with incomplete or erroneous design actions, will also be covered, along with some history of civil engineering/structural design and construction.*

*Laboratory work on the testing of materials and concrete mix design and technology is a major component of the class, as is report preparation and other aspects of technical communication.*

Course Objectives:

*Students successfully completing CE 302 will:*

1. Have gained an understanding of materials and their importance in construction.
2. Develop a basic understanding of the material science basis of material behavior.
3. Develop basic skills in testing of materials and use of test equipment and instrumentation.
4. Be able to use the appropriate basic statistical tools to help quantify material properties.
5. Be familiar with and understand materials standards and material quality control provisions, along with the purposes of standards and quality control.
6. Have improved abilities to analyze and present data and to prepare engineering reports on materials, quality control issues and engineering properties.
7. Know and appreciate the primary criteria in the selection of suitable, durable materials.
8. Better understand how material properties affect design and how to reduce failures due to either material limitations or general design philosophy and procedures.

Topics covered:

1. Engineering material standards and their use.
2. Mechanical properties of steel, wood, polymers, other materials.
3. Testing of materials to determine strength, stiffness, ductility, etc.
4. Use of strain gauges and other testing instrumentation and equipment.
5. Material failure modes, including fatigue and impact.
6. Properties and tests of aggregates and cements.
7. Concrete mix design and tests of fresh and hardened concrete.
8. Properties of asphalt and basic characteristics of asphalt pavements.
9. Use of statistical concepts to help analyze test results and the procedures used to set design values to characterize materials.
10. Preparation of engineering reports, including preparation of graphical content.
11. Readings and discussion on the development of structural design and construction materials, with emphasis on conditions which have resulted in notable distress or failures.
Conduct of the Class – Lecture Component:

Each week, the Tuesday lecture session will emphasize the type of material, material behavior, material tests to be conducted during that week in the laboratory, and reports to be prepared; or when appropriate, to preview other activities planned for that week’s laboratory. Chapters in the Laboratory Manual will be assigned beforehand and should be read before the class period. In several of the Tuesday lectures, a few minutes will be devoted to general professional topics and/or large-scale design challenges.

The Thursday lecture session will be used to complete topics and to present related topics often not directly addressing the lab work, with the specific selection of type of topic(s) depending upon the week. The type of topics to be addressed on Thursdays include:

* brief discussion and elaboration on reading assignments from the “Why Buildings Fall Down” book - to be done most weeks,
* material science topics,
* properties of construction materials not the subject of laboratory tests,
* topics on report writing and data processing/presentation; applications of statistics and probability to the quantification and control of material properties and to safety considerations,
* guest lectures (likely 2 or 3) on material-related topics,
* a preview of the class topics and laboratory work for the week to follow, and
* the two hour examinations.

Laboratory Component:

You will be given additional information, instructions, and assignments in the lab sessions. Some general comments and observations:

1. Be prepared to do the labs though studying about the lab topic, test procedures, etc. before the lab.
   
   If you are in Lab Section L01, which immediately follows the lecture, you have a special task.

2. Much of your lab work will involve teams. Rotate responsibilities among the team. Do your share.

3. Although you will usually have shared “team” data, individual reports will be required except if/when you are given very specific instructions to submit group reports.

4. Do your lab work in a professional manner, and pay attention to SAFETY concerns.

5. If you are not sure of the proper laboratory procedure(s), including testing machine operation, ask your laboratory instructor for more instructions.

6. If you or your group break or have trouble operating equipment or instrumentation, please tell your laboratory instructor so that appropriate additional instruction, repairs, or replacement can be made before the planned next use of the equipment or instrumentation.

Course Evaluation ——— Note: plus/minus grading will be used.

(although grades of C-, D+ and D- are no longer being used)

Laboratory exercises and laboratory reports - - - - - - - - - - - - - - - - - - - - - - - - - - 50%

(most individual reports, a couple of group projects and reports)

(up to 5 of the 50% may be from short quizzes at the start of the labs)

Homework (other than lab), including reviews of “Why Buildings Fall Down 10%

Two hour exams (Thursdays of Week 8 and Week 14 – tentative) 20%
Daily Class and Laboratory Schedule

The following is the tentative schedule for the Fall 2008 CIVE 302 class and labs. This schedule almost certainly will be modified in some detail as the semester progresses. Thus, each week, you should refer primarily to the weekly schedule that you will receive on Tuesday for schedule details, as well as for individual assignments.

The Monday lab section goes with the previous week’s lecture (except the last few weeks).

In the reading assignments listed for each lecture period,

- **LM** = Laboratory Manual (Evaluation of Civil Engineering Materials – Criswell)
- **WBFD** = “When Buildings Fall Down”, by Levy and Salvadori
- **PCA** = “Design and Control of Concrete Mixtures”, by Portland Cement Association

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<thead>
<tr>
<th>Week and Dates</th>
<th>Tuesday Lecture</th>
<th>Thursday Lecture</th>
<th>Laboratories</th>
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<tr>
<td><strong>Week 1</strong></td>
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<td>25-29 Aug 08</td>
<td><strong>26 Aug 2008</strong>&lt;br&gt;LM - 1, 2 (skim)&lt;br&gt;Introduction&lt;br&gt;Material properties&lt;br&gt;Presentation of data</td>
<td><strong>28 Aug 2008</strong>&lt;br&gt;LM – 3, start of 4&lt;br&gt;Material properties &amp; tests&lt;br&gt;Standards – ASTM, others&lt;br&gt;Axial stress-strain definitions</td>
<td>Introduction to the labs&lt;br&gt;Graphs and figures&lt;br&gt;Use of EXCEL for plots&lt;br&gt;Machine use - demonstrated by compression tests of pop cans (full and empty) ??</td>
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<td><strong>Week 2</strong></td>
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<td>1 – 5 Sept 08</td>
<td><strong>2 Sept 2008</strong>&lt;br&gt;LM – 4, part of 8&lt;br&gt;Tensile tests, σ-ε curve shapes&lt;br&gt;Hardness tests for metals</td>
<td><strong>4 Sept 2008</strong>&lt;br&gt;LM – 5, WBFD - Preface&lt;br&gt;Measurement of small strains&lt;br&gt;Electrical strain gauges</td>
<td>Simple tensile tests of three metals in tension&lt;br&gt;Hardness tests of metals</td>
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<td><strong>Week 3</strong></td>
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<td>8 -12 Sept 08</td>
<td><strong>9 Sept 2008</strong>&lt;br&gt;LM 4, 5&lt;br&gt;Review/preview of mechanics&lt;br&gt;Definitions of stresses, strains&lt;br&gt;Flexural stress and deflection equations</td>
<td><strong>11 Sept 2008</strong>&lt;br&gt;LM – 6, WBFD – 1, 2, A&lt;br&gt;2-D and 3-D stresses&lt;br&gt;Shearing stresses and strains&lt;br&gt;Hooke’s Law &amp; Poisson’s ratio</td>
<td>Cantilever beam flexural tests&lt;br&gt;Strain gauges&lt;br&gt;Preview of test specimens and tests of Week 4</td>
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<td><strong>Week 4</strong></td>
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<td>15-19 Sept 08</td>
<td><strong>16 Sept 2008</strong>&lt;br&gt;LM – 7&lt;br&gt;Elastic parameters&lt;br&gt;Torsion tests&lt;br&gt;Intro to inelastic behavior</td>
<td><strong>18 Sept 2008</strong>&lt;br&gt;LM – 7, WBFD – 3, 4, B, C&lt;br&gt;Stress transformation – review of Mohr’s circle and its use&lt;br&gt;Material failure modes</td>
<td>Torsion test of a round steel rod&lt;br&gt;Poisson’s ratio determination</td>
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<td><strong>Week 5</strong></td>
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<td>22-26 Sept 08</td>
<td><strong>23 Sept 2008</strong>&lt;br&gt;LM – 8&lt;br&gt;Material science basics&lt;br&gt;Stress concentrations&lt;br&gt;Residual stresses</td>
<td><strong>25 Sept 2008</strong>&lt;br&gt;LM – 7, 9; WBFD – 5, 6&lt;br&gt;Material science basics&lt;br&gt;Properties of metals, alloys</td>
<td>Instrumented uniaxial test of steel&lt;br&gt;Notched bar tension test&lt;br&gt;Grain structure of steel alloys (tentative)</td>
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<td><strong>Week 6</strong></td>
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<td>29 Sept – 3 Oct 08</td>
<td><strong>30 Sept 2008</strong>&lt;br&gt;LM – 8, 10, 14&lt;br&gt;Fatigue behavior and modeling&lt;br&gt;Impact, creep and relaxation&lt;br&gt;Vibration behavior and damping</td>
<td><strong>2 Oct 2008</strong>&lt;br&gt;LM – 8, 11; WBFD – 7, 8&lt;br&gt;Fatigue behavior, modeling&lt;br&gt;Basic properties of wood</td>
<td>Impact tests of steel&lt;br&gt;Observation of creep&lt;br&gt;Vibration/damping – measure damping ratio&lt;br&gt;Fatigue of simulated bolted connection (tentative)</td>
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<td>LM – 11, skim 12 Properties of wood &amp; lumber Manufactured wood products</td>
<td>LM – 11, WBFD- 9, 10 Review of basic statistics Design values for wood Buckling behavior of columns</td>
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<td>Week 8</td>
<td>14 Oct 2008</td>
<td>16 Oct 2008</td>
<td>Aggregate tests: Unit weight Gradation &amp; void ratio Moisture content</td>
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<td>LM 15, 16, PCA 1,5 Aggregates – properties, tests Intro to PC concrete</td>
<td>EXAMINATION #1</td>
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<td>Week 9</td>
<td>21 Oct 2008</td>
<td>23 Oct 2008</td>
<td>Concrete mix design (problem lab) Elastic buckling of slender columns (tentative)</td>
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<td>LM 18, PCA – parts of 8, 9 Concrete mix design Air entrainment</td>
<td>LM 17, 19; WBFD – App. D; PCA – parts of 6 Properties of Portland cement Tests of fresh concrete</td>
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<td>Week 10</td>
<td>28 Oct 2008</td>
<td>30 Oct 2008</td>
<td>Asphalt materials and asphalt concrete – demonstrations &amp; industry practices (Guest speakers)</td>
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<td>Handouts Asphalt – basic properties Asphalt concrete/pavements (Guest speaker)</td>
<td>Handouts, WBFD – 15, 16 Asphalt pavement - industry And construction practices (Guest speaker)</td>
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<td>Week 11</td>
<td>4 Nov 2008</td>
<td>6 Nov 2008</td>
<td>Mix concrete Tests of fresh concrete Cast cylinders &amp; beams</td>
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<td>LM – 20, 22; PCA 3, 6, 11 Admixtures – including fly ash, silica fume Placing &amp; curing concrete</td>
<td>LM 24, WBFD – 11, 12 Statistics – review, correlation and regression Material costs Superplasticized concrete</td>
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<td>Week 12</td>
<td>11 Nov 2008</td>
<td>13 Nov 2008</td>
<td>Concrete cylinder testing and 7-day tests Tests of polymers and elastomers, including tensile test of rubber band</td>
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<td>LM – 13, 23; PCA - 16 Compression and other tests of hardened concrete Polymers and elastomers</td>
<td>Handouts, WBFD – 13, 14 LM - 24 Statistics ACI concrete quality control</td>
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<td>Week 13</td>
<td>18 Nov 2008</td>
<td>20 Nov 2008</td>
<td>14-day concrete breaks Measure E of concrete Preview tests to be done in Week 14 and remaining reports due on concrete</td>
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******** Nov 24 – 28, 2008 Thanksgiving Break ***************

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<tr>
<th>Week 14</th>
<th>2 Dec 2008</th>
<th>4 Dec 2008</th>
<th>28-concrete breaks - compression cylinders - modulus of rupture - split cylinder</th>
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<td>LM – 25; handout; PCA 10, 11,12 Concrete – construction practices and formwork Geotextiles Fiber reinforced composites</td>
<td>EXAMINATION #2</td>
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<tr>
<td>Week 15</td>
<td>9 Dec 2008</td>
<td>11 Dec 2008</td>
<td>Final lab report due Report presentations by student teams</td>
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Final Examination, CIV 302 – Thursday, December 18th, 11:20 a.m. – 1:20 p.m. (Scheduled time for 10 T R classes)