

# CIVE 302 - Evaluation of Civil Engineering Materials - Fall 2007

**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*

**Class Times: Lecture:** 10:00 - 10:50 a.m. TR in 243 Physiology Building - Dr. Marvin Criswell

**Labs:**

Lab 1 – 11:00 - 1:40 p.m. Tuesday -----	CJ Riley
Lab 2 - 2:00 – 4:40 p.m. Tuesday -----	Jordan Jarrett
Lab 3 - 2:00 – 4:40 p.m. Wednesday -----	Jordan Jarrett
Lab 4 – 11:00 – 1:40 p.m. Thursday -----	Jason Steadman
Lab 5 - 2:10 - 5:00 p.m. Thursday -----	Jason Steadman

During the first half of the semester, the labs will meet in A10, the Chester Smith Structures and Materials Lab. During the last half of the semester, most of the lab work will be conducted in A11, Concrete Materials Lab

## **Instructor and Teaching Assistants:**

**Instructor:** **Marvin Criswell** A201 Engineering Building 491-6697  
e-mail: [mcriswel@engr.colostate.edu](mailto:mcriswel@engr.colostate.edu)  
Office hours: 2:10 – 3:00 p.m. Monday & Wednesday, 9:30 – 10:30 a.m. Friday

**Teaching Assistants:** **Charles “CJ” Riley, Jordan Jarrett and Jason Steadman**  
Jordan Jarrett and Jason Steadman are officed in Room A10B Engineering  
CJ Riley has his office in Room B212 Engineering Building  
They will supply their e-mail, office telephone number, and office hours in the individual labs. .

**Required Texts:** **“CE 302 – Evaluation of Civil Engineering Materials”** by M. E. Criswell  
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,  
Paperback by W. W. Norton Press, 1992.

It is expected that each CIVE 302 student can be provided (at no cost to the students) with a CD containing the 14<sup>th</sup> 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) but not yet finalized for CIVE 302 should allow students to download up to ten selected ASTM Standard for a \$10 fee.

## 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 (e.g. MECH 331 – Introduction to Engineering Materials) will be introduced; topics such as material microstructure, imperfections, alloys, heat treatment, and material failure modes.*

*The role of materials, design actions and other common causes of failures are also 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 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.

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; concepts of statistics and probability, along with their application to material properties and safety,
- \* 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 extensive 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, etc. before the lab.
2. Much of your lab work will involve teams. Rotate responsibilities among the team.
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 you 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.

<i>Laboratory exercises and laboratory reports -----</i> <i>(most individual reports, a couple of group projects and reports)</i> <i>(up to 5 of the 50% may be from short quizzes at the start of the labs)</i>	<b>50%</b>
<i>Homework (other than lab), including reviews of “Why Buildings Fall Down</i>	<b>10%</b>
<i>Two hour exams (Thursdays of Week 8 and Week 14 – tentative)</i>	<b>20%</b>
<i>Final exam (comprehensive) – 11:20 a.m. – 1:20 p.m. Tuesday, Dec 11<sup>th</sup></i>	<b>20%</b>

## Daily Class and Laboratory Schedule

The following is the tentative schedule for the Fall 2007 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*

<b>Week and Dates</b>	<b>Tuesday Lecture</b>	<b>Thursday Lecture</b>	<b>Laboratories</b>
<b><u>Week 1</u></b> 20-24 Aug 07	<b><u>21 Aug 2007</u></b> LM - 1, 2(skim) Introduction Material properties Presentation of data	<b><u>23 Aug 2007</u></b> LM – 3, start of 4 Material properties & tests Standards – ASTM, others Axial stress-strain definitions	Introduction to the labs Graphs and figures Use of EXCEL for plots Machine use demonstrated by compression tests of pop cans (full and empty)
<b><u>Week 2</u></b> 27 – 31 Aug 07	<b><u>28Aug 2007</u></b> LM – 4, part of 8 Tensile tests, $\sigma$ - $\epsilon$ curve shapes Hardness tests for metals	<b><u>30Aug 2007</u></b> LM – 5, WBFD - Preface Measurement of small strains Electrical strain gauges	Simple tensile tests of three metals in tension Hardness tests of metals
<b><u>Week 3</u></b> 3 – 7 Sept 07	<b><u>4 Sept 2007</u></b> LM 4, 5 Review/preview of mechanics Definitions of stresses, strains Flexural stress and deflection equations	<b><u>6 Sept 2007</u></b> LM – 6, WBFD – 1, 2, A 2-D and 3-D stresses Shearing stresses and strains Hooke's Law & Poisson's ratio	Cantilever beam flexural tests Strain gauges Preview of test specimens and tests of Week 4
<b><u>Week 4</u></b> 10-14 Sept 07	<b><u>11 Sept 2007</u></b> LM – 6 Elastic parameters Torsion tests Intro to inelastic behavior	<b><u>13 Sept 2007</u></b> LM – 7, WBFD – 3, 4, B,C Stress transformation – review of Mohr's circle and its use Material failure modes	Torsion test of a round steel rod Poisson's ratio determination
<b><u>Week 5</u></b> 17-21 Sept 07	<b><u>18 Sept 2007</u></b> LM – 7 Material science basics Stress concentrations Residual stresses	<b><u>20 Sept 2007</u></b> LM – 7, 9; WBFD – 5, 6 Material science basics Properties of metals, alloys	Instrumented uniaxial test of steel Notched bar tension test
<b><u>Week 6</u></b> 24-28 Sept 07	<b><u>25 Sept 2007</u></b> LM – 8, 10, 14 Fatigue behavior and modeling Impact, creep and relaxation Vibration behavior and damping	<b><u>27 Sept 2007</u></b> LM – 8, 11; WBFD – 7, 8 Fatigue behavior, modeling Basic properties of wood	Impact tests of steel Observation of creep Vibration/damping – measure damping ratio Fatigue of simulated bolted connection (tentative)
<b><u>Week 7</u></b> 1-5 Oct 07	<b><u>2 Oct 2007</u></b> LM – 11, skim 12 Properties of wood & lumber Manufactured wood products	<b><u>4 Oct 2007</u></b> LM – 11, WBFD- 9, 10 Review of basic statistics Design values for wood Buckling behavior of columns	Tests of wood: Small clear prisms Joists loaded in flexure Elastic buckling of slender columns (tentative)

<b>Week 8</b> 8 – 12 Oct 07	<b>9 Oct 2007</b> LM 15, 16, PCA 1,5 Aggregates – properties, tests Intro to PC concrete	<b>11 Oct 2007</b>  <b>EXAMINATION #1</b>	Aggregate tests: Unit weight Gradation & void ratio Moisture content
<b>Week 9</b> 15 – 19 Oct 07	<b>16 Oct 2007</b> LM 18, PCA – parts of 8, 9 Concrete mix design Air entrainment	<b>18 Oct 2007</b> LM 17, 19; WBFD – App. D; PCA – parts of 6 Properties of Portland cement Tests of fresh concrete	Concrete mix design (problem lab) Demonstration – buckling of slender columns
<b>Week 10</b> 22 – 26 Oct 07	<b>23 Oct 2007</b> LM – 20, 22; PCA 3, 6, 11 Admixtures – including fly ash, silica fume Placing & curing concrete	<b>25 Oct 2007</b> LM 24, WBFD – 11, 12 Statistics – review, correlation and regression Material costs Superpasticized concrete	Mix concrete Tests of fresh concrete Cast cylinders & beams
<b>Week 11</b> 29 Oct – 2 Nov 2007	<b>30 Oct 2007</b> Handouts Asphalt – basic properties Asphalt concrete/pavements (Guest speaker)	<b>1 Nov 2007</b> Handouts, WBFD – 15, 16 Asphalt pavement - industry And construction practices (Guest speaker)	Asphalt materials and asphalt concrete – demonstrations & industry practices (Guest speakers)
<b>Week 12</b> 5 – 9 Nov 07	<b>6 Nov 2007</b> LM – 13, 23; PCA - 16 Compression and other tests of hardened concrete Polymers and elastomers	<b>8 Nov 2007</b> Handouts, WBFD – 13, 14 LM - 24 Statistics ACI concrete quality control	Concrete cylinder testing and 14—day tests Tests of polymers and elastomers
<b>Week 13</b> 12 – 16 Nov 07	<b>13 Nov 2007</b> LM – 21, 23; handout, PCA - 15, 16 Properties of hardened concrete Nondestructive tests Special aggregates	<b>15 Nov 2007</b> Statistics text, WBFD – 17,18 Statistics – curve fitting, empirical equations Selection of design values Machine stress grading – wood	21-day concrete breaks Measure E of concrete Preview tests to be done next week and reports due on concrete
<b>***** Nov 19 – 23, 2007 Thanksgiving Break *****</b>			
<b>Week 14</b> 26 - 30 Nov 07	<b>27 Nov 2007</b> LM – 25; handout; PCA 10, 11,12 Concrete – construction practices and formwork Geotextiles Fiber reinforced composites	<b>29 Nov 2007</b>  <b>EXAMINATION #2</b>	28-concrete breaks - compression cylinders - modulus of rupture - split cylinder
<b>Week 15</b> 3 – 7 Dec 07	<b>4 Dec 2007</b> LM – 26 Masonry, bricks and mortar Glass Selected other construction Materials	<b>6 Dec 2007</b> WBFD – 19 Summary – “Why Buildings Fall Down”, failure modes Introduction – structural safety Review for final exam	Final lab report due Report presentations by student teams

**Final Examination, CIV 302 -- Tuesday, December 11<sup>th</sup>, 11:20 a.m. – 1:20 p.m.**  
(Scheduled time for 10 T R classes)

*Prepared by M. Criswell - 20 August 2007*