

CVLE-321: Engineering Materials

Dr. Wael Zatar
Fall 2006

Credit: 3 credits

Course: Tuesday and Thursday 1.00-1.50 p.m., GH5

Laboratory: Tuesday 2.00-4.50 p.m.

Course Description:

A study of the microscopic and macroscopic structures and properties of materials used in civil engineering construction with emphasis on the relationships of their physical and mechanical properties to engineering design and application. Aggregates, cements, concrete, bituminous materials, composites, and testing of materials will be covered.

Textbook:

Materials for Civil and Construction Engineers, Michael S. Mamlouk and John P. Zaniewski, Pearson, 2nd Edition, 2006.

References:

- *Design and Control of Concrete Mixtures*, Portland Cement Association (PCA), Thirteenth Edition, ISBN 0-89312-087-1.
- *AASHTO Standard Specifications, Materials, 2004*.
- Class Handouts and Lecture Notes
- Supplied Compact Disc that includes many worthy publications from the Portland Cement Association that relate to the contents of this course.
- *Civil Engineering Materials*, Shan Somayaji, Prentice Hall, 2nd Edition (2001).
- *Materials for Civil and Highway Engineers*, Kenneth N. Derucher, George P. Korfiatis, and A. Samer Ezeldin, Prentice Hall, 4th Edition.
- *Concrete*, Sidney Mindess, J. Francis Young, and David Darwin, Prentice Hall, 2nd Edition, 2003.
- *The Science and Technology of Civil Engineering Materials*, J. Francis Young, Sidney Mindess, Robert J. Gray, and Arnon Bentur, Prentice Hall, 1998.
- *Annual Book of Standards*, American Society for Testing and Materials, various volumes, 1998.
- *Recommended Practice for Selecting Proportions for Normal Weight Concrete*, ACI Committee 211.1, American Concrete Institute.

Prerequisites:

Mechanics of Materials, equivalent, or consent of instructor

Office Hours:

Wednesday 9.00 a.m. ~ 12.00.

For those of you who will not be able to meet the instructor during the assigned office hours, the instructor has an open door policy, which means that you are welcome to come and ask him by appointment or at any appropriate time.

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Objective:

The primary objective is to enable the students to develop a thorough understanding of appropriate mechanical, physical, and chemical properties of various materials commonly used in real civil engineering applications. Materials that will be discussed include, but not limited to, aggregates, cements, concrete, timber, asphalt, metals, and fiber reinforced plastic composites. Weekly laboratory sessions complement the lectures and provide hands on experience with chemical, physical, and mechanical tests on metals, aggregates, cements, and concrete.

Outcomes:

With the successful completion of the course, the student should be able to:

- Recognize the industry standards and guidelines that are utilized in testing civil engineering and construction materials
- Distinguish between various aggregate materials based on their physical properties
- Determine appropriate aggregate gradations from sieve analysis and necessary blending proportions to meet desired specifications
- Identify the basic raw ingredients used in cement and compositions of the most common types
- Design a concrete mix in accordance with ACI and/or PCA procedures
- Distinguish the effects of various admixtures on the behavior of concrete
- Understand all important factors that affect the quality of concrete at both the fresh and hardened states
- Recognize major quality control issues and measures of ready mix concrete
- Identify the ASTM and AASHTO standards that are used to judge the properties of fresh concrete.
- Identify the ASTM and AASHTO standards that are used to judge the mechanical properties of hardened concrete.
- Recognize the importance and mechanical properties of new composite materials including fiber reinforced plastics
- Identify asphalt cements and distinguish between hot-mix asphalt, cutbacks, and emulsions

- ❑ Identify the basic requirements for HMA design and identify the primary differences between Marshall Mix Design and SuperPave design
- ❑ Develop the ability to conduct laboratory experiments, record data, and perform appropriate calculations and analysis for civil engineering materials according to the associated ASTM and AASHTO standards and reporting procedures
- ❑ Work as a team member and gain insight on its benefits toward achieving the common goal of accurately and timely project completion. Appropriate safety procedures in handling equipment and performing work in and around an equipment will be stressed during the laboratory sessions.

Assessment:

All learning outcomes will be assessed through questions in class and the evaluations of homework, Lab assignments, writing assignments, and examination problems.

Topics:

- Class Introduction
- Mineral Aggregates
- Metals
- Limes and Cement
- Concrete and Admixtures
- Concrete Mix Design
- Quality Control of Concrete
- Composites and New Technologies in Materials
- Asphaltic Cements / HMA / SuperPave
- Construction Concerns

The instructor may slightly add or change the lecture topics.

Contribution to Program Outcomes:

1. an ability to apply knowledge of mathematics, science, and engineering
- 2b. an ability to conduct experiments
- 2c. an ability to analyze and interpret data
3. an ability to design civil engineering projects or components of projects to meet desired needs
7. an ability to effectively communicate in oral, written and electronic formats
- 9a. a recognition of the need to engage in life-long learning
- 9b. an ability to engage in life-long learning
11. an ability to use techniques, skills, and modern engineering tools necessary for engineering practice
12. an ability to apply sound safety practices in laboratory and design work

Computer Usage:

Utilizing the contents of the Supplied Compact Disc from the Portland Cement Association
 Word Processing Software (Microsoft Word or Word Perfect)
 Excel Spreadsheets
 The World Wide Web
 Research in library resources for references
 Electronic mail for effective communication between the professor and students
 Power Point Software

Accreditation Category Content:

Engineering Science:	2.5 credits	(83.3%)
Engineering Design :	0.5 credits	(16.7%)

Homework, Lab Assignments, Reports, and Presentation:

- Homework, laboratory assignments, and writing assignments/reports will be regularly assigned either during the class/lab time or by e-mail.
- Checking your e-mail is required on a daily-basis for information regarding the assignment of homework, laboratory assignments, and writing assignments/reports.
- The students are required to submit the writing assignments on a regular basis. The writing assignments will be combined in a final report, to be re-submitted before the end of the semester.
- Homework, laboratory assignments, and writing assignments/reports must be submitted before the starting time of class on the assignment date.
- Late homework is not acceptable except for unusual circumstances, e.g., an excused absence.
- Lab reports and writing assignments/report must be prepared with the available software packages, e.g., Microsoft Word or Word Perfect, Excel Spreadsheets, Power Point, etc. They have to be prepared in accordance with the report and lab report guidelines that will be provided by the instructor.
- You are expected to provide your homework in engineering papers - not a Xerox copy.
- Homework must be neat, readable, and must conform to acceptable Standards of Engineering Computation.
- The instructor will assign a presentation topic to each student. The presentation has to be prepared and given before the final exam.

Exams:

Two exams and a final exam will be given during the course of the semester. Exams will be closed book and closed notes, with the exception that a portion of the 2nd exam will be open book. No makeup exams will be given with the exception of unusual circumstances (severe injuries, family emergencies, etc.).

Grading Policy:

Homework and presentation	10%
Lab Assignments	10%
Writing Assignments and Report	10%
Exam 1	20%
Exam 2	20%
Final Exam	30%

Letter Grade Scale:

90-100	A
80- 89	B
70-79	C
60-69	D
0-59	F

The instructor does reserve the right to slightly curve or scale the grades based on class groupings.

Engineering Ethics and Academic Honesty:

It will be assumed that each student subscribes to a professional code of ethics that is the basis for his behavior in class. Any and every case where the professional code of ethics and academic honesty are violated will be dealt with in accordance with the student handbook and the governing provisions of Marshall University.

Additional Information:

- [1] Arrangements for inviting a guest speaker from the industry will be made. The specialty of the speakers will be in the area of concrete.
- [2] The instructor will give presentations on the application of enhanced material properties on advancing the civil and bridge engineering practice and on the applications of new composite materials on advancing the CE practice.
- [3] A field trip to the WVDOH Materials Testing Laboratory will be arranged.
- [4] The purpose of the writing assignments is to stimulate interest in the subject matter. Therefore, the instructor expects that you will study the subject thoroughly and prepare your questions. You may ask the instructor during the office hours for any question or clarification. This should, in no way, inhibit your asking questions at the end of the class.
- [5] You are expected to attend all classes and labs. However, the instructor accepts your absence for one session provided that an advance notice will be given, unless this is unavoidable. Non-excused absence for few lecture/lab sessions will result in a lower overall grade of the course. Frequent absence from either the classes or labs may result in a failing grade.
- [6] The instructor will not discuss the grades in e-mails or phone calls.

Laboratory Exercises:

SESSION	TOPIC
1	Introduction to lab safety and description of lab report format
2	Introduction to statistical methods and measuring devices
3	Sieve analysis of coarse aggregates
4	Sieve analysis of fine aggregates
5	Specific gravity and absorption of fine aggregates
6	Specific gravity and absorption of coarse aggregates
7	Tension tests of steel
8	Tension tests of aluminum, copper, and other metals
9	Making of fresh concrete and tests of fresh concrete (i.e. slump test)
10	Curing of concrete cylinders and preparing specimens for the flexural tests
11	Compressive strength of cylinders (7-days)
12	Flexural tests of hardened concrete members
13	Compressive strength of standard cylinders (14-days)
14	Compressive strength of standard cylinders (28-days)
15	Asphalt labs (will be carried out at WVDOH Materials Testing Lab)

The instructor reserves the right to slightly add or change the laboratory topics in order to achieve the maximum benefit of the course learning outcomes.