

# Designing a New Course: Construction Statics and Mechanics

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**Abstract** - Most engineering and engineering-related students in Colleges of Engineering are required to take engineering statics and engineering mechanics of materials courses as part of their curriculum. These courses are mostly taught by Mechanical Engineering Professors who use books written by colleagues in the mechanical engineering discipline. The entire course work –lecture notes, examples and other course materials are delivered and assessed in the context of mechanical engineering. All the examples in the courses are also geared towards machine parts, mechanical systems and components. Even though not all engineering/ engineering-related students are in mechanical engineering, little or no reference is made to other engineering disciplines. It is therefore not surprising that other engineering students find these courses unattractive and sometimes challenging. These disadvantaged (curriculum-wise) students are sometimes denied the attention required. Unfortunately, they end up with little or no appreciation for anything mechanical. It can not however be gainsaid that students other than those in mechanical engineering need to understand statics and mechanics as they relate to structures, components and systems in their own disciplines.

This work is geared towards the creation and delivery (together with assessment) of a new course entitled Construction Statics and Mechanics. This course will introduce students in an engineering-related/non-major discipline like construction management to the principles of statics and mechanics of materials. These principles will then be employed to solve various problems in building and other constructed structures which are directly related to the construction discipline. This approach, coupled with other considerations like the satisfaction of accreditation requirements, will impart the necessary engineering skills to engineering-related majors in the construction discipline.

*Index Terms* – Construction, Engineering, Mechanical, Statics, Structures, Systems.

## INTRODUCTION

Students in American Council of Construction Education (ACCE) accredited construction management programs  
San Juan, PR

are required to take a combined total of 120 semester hours of instruction. Fifty of these hours of instruction are required to be in construction science and construction courses [1]. To facilitate communication with design professionals, future construction managers are obligated by ACCE to take construction science courses. The traditional approach to designing construction management programs to accommodate construction science course requirements is to include Engineering Statics and Engineering Mechanics of Materials, which are entirely mechanical engineering courses. The course notes, examples and other materials are based on mechanical components and systems, with little or no reference to constructed structures. However construction management academicians and advisory boards generally concur to the need for construction management students to understand the forces acting on constructed structures. It has therefore become necessary to design and/or reconfigure construction management programs to include the requisite engineering courses which will serve the demands of the construction industry.

## RESEARCH METHODOLOGY

The course design, delivery and assessment process is both a science and an art. The methodology employed in this research involves an analysis of ACCE accreditation requirements, curriculum design procedures and challenges, and course design techniques employed in designing a new completely new course to address the engineering content of a construction management program. An evaluation or assessment plan will also be worked into the course design.

## ACCE ACCREDITATION

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The importance of accreditation to any academic program can not be over-emphasized. It is generally accepted that accreditation ensures program quality. Accreditation can be defined as the employment of processes, techniques, standards/measurements and

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professional judgment to ascertain the credibility of a particular educational program. Even though accreditation criteria vary with the purpose and type of accrediting organization, they are all meant to ensure academic organizations and programs meet a minimum set of standard measures of quality defined by the accrediting organization. The ACCE accreditation criteria [1]+[2] for a typical baccalaureate degree program (for instance North Dakota State University's B.S in Construction Management) have been divided into 6 broad subject categories (together with their minimum academic requirements). These are:

1. General Education (15 semester or 22 quarter hours):- This category encompasses such courses as communications, ethics, social sciences and humanities.
2. Mathematics and Science (15 semester or 22 quarter hours) :- This consists of mathematics and/or statistics and analytical physical sciences.
3. Business and Management (18 semester or 22 quarter hours):- courses in this category are economics, business law, principles of management and accounting
4. Construction Science (20 semester or 30 quarter hours):- Construction science has been subdivided into the following:
  - (a) Construction Materials:- Courses in this category are equipment selection, construction materials, etc.
  - (b) Fundamentals of Design Theory:- The various course options within this sub-division are electricity, statics, strength of materials, hydraulics, thermodynamics, soil mechanics, and hydrology.
  - (c) Analysis and Design of Construction Systems:- examples of courses within this unit are structural, HVAC, plumbing, mechanical, etc.
  - (d) Construction Design:- Courses that make up the design aspect of construction management are construction surveying, construction graphics, foundations, rigging, etc.
  - (e) Other:- Courses which fall into this category are project/land development, value analysis, architectural and engineering alternatives, etc.
5. Construction (20 semester or 30 quarter hours):- Some of the courses under the construction section are estimating, planning and scheduling, construction accounting and finance, construction law, safety, etc.
6. Others (22 semester or 34 quarter hours):- These are additional courses required by the various programs to satisfy the 120 instructional hours stipulated by ACCE.

The combined total of construction and construction science courses should amount to 50 semester (75 quarter) hours of instruction. These 2 categories constitute the bulk of the discipline-specific course requirements for construction management majors.

The core subject areas which constitute the construction science category within the ACCE accreditation criteria are fundamentals of design theory, analysis and design of construction systems, construction design, construction materials and other [1].

#### **COURSE DESIGN, DELIVERY AND ASSESSMENT**

Construction Managers are required to understand design processes and expected to communicate effectively with engineers, architects and other design personnel. Besides the understanding of code and regulations which are driven by the engineering aspects of construction, Construction Management Professionals are also expected to comprehend the forces on construction structures and how these forces are supported in a structure [3]. This is the basis of the construction science category in the ACCE criteria. In order to satisfy the construction science course requirements, Construction Management programs incorporate Statics and Engineering Mechanics of Materials courses in their curricula. These two courses are strictly mechanical engineering courses and follow a structured mechanical engineering-based approach to instruction. These 2 courses serve as pre-requisites for upper-level mechanical engineering courses and design projects. It has therefore become necessary to design courses which are based on the engineering statics and mechanics of materials but are geared towards constructed structures. Under this design paradigm, students will be introduced to the fundamental theories underlying engineering statics and mechanics of materials. This will then be followed by the use of construction processes and constructed structures as examples, instead of mechanical processes and components. This approach will not only enhance the abilities of CM students in engineering principles, it will also enable them to directly relate their understanding of these principles to constructed structures. A complete course outline is depicted below. The author has had considerable experience in teaching engineering fluid mechanics and engineering mechanics of materials to purely engineering students. A course textbook is normally recommended for all undergraduate courses and is an important part of all undergraduate studies. A number of text books were analyzed but it soon became apparent that there is no single text book in the market

today which truly satisfies the new course requirements. Two books have been tentatively chosen as the course textbooks. The Schaum series book was chosen because of its straight forward approach and the abundance of sample problems[4]. The other textbook by Onouye [5] relates engineering principles to constructed structures and processes. Materials from a number of other sources will be used to supplement the textbooks.

*I. Course Number and Name*

CME 250 - Construction Statics and Mechanics (3 hrs)  
 Dates/Times/Location TBD

*II. Text (Tentative)*

1. Statics and Strength of Materials for Architecture and Building Construction.  
 Author: Barry Onouye & Kevin Kane, Prentice Hall, 1999.
2. Schaum’s Outline of Statics and Strength of Materials.  
 Author: John J. Jackson & Harold G. Writz, McGraw-Hill, 1983.

*III. Catalog Description*

This course provides a non-engineering overview of the principles of statics and strength of materials and applications in the construction industry. Emphasis is placed on understanding the behavior of structural components associated with buildings, bridges, construction/building processes.

*VI. Pre-requisite(s)*

The only prerequisite for the course is Math 165 (calculus I).

*VII. Course Objectives*

Upon completion of this course, construction management students will be able to;

1. write and solve principles of forces, vector addition, equilibrium and free-body diagrams of residential and commercial buildings and structures
2. apply the principles of strength of materials to solve shear and bending moments with particular reference to constructed structures,
3. perform beam and column analysis of buildings and other constructed structures
4. understand the behavior of structural

components associated with construction processes

5. improve the integrity of constructed structures by applying sound construction practices

*VIII. Course Outline*

Week 1	Administrative Trivia, Syllabus, Introduction, etc.	
	Definition of a structure, Loads on structures, etc.	
Week 2	Forces, Theory of vectors,	Assignment #1
	Vector analysis, Force systems, Free body diagrams	
Week 3	Equilibrium, Analysis of selected structural systems	Assignment #2
	Plane trusses, Pinned frames(multi-force members)	
Week 4	Loading, Load tracing	Assignment #3
Week 5	Indeterminate structures, simple stress and strain	Assignment #4
Week 6	Elasticity, Simple stress, Strain, Deformation	Assignment #5
Week 7	Other material properties	Assignment #6
Week 8	Center of gravity, moment of inertia, etc.	Assignment #7
Week 9 + 10	Classification of beams and loads, timber beams, shear and bending moments, load, shear and moment diagrams, etc.	Assignment #8
Week 11	Bending stress and strain, shear stress, development of equations, deflection in beams, applications to wood frames/structures. Analysis of residential and commercial buildings. Construction considerations for structural integrity.	Assignment #9 + 10
Week 12	Column analysis and design – modes of failure of short and long columns, end (end plate) support conditions and lateral bracing of wooden	Assignment # 11 + 12

	structures. Analysis of residential and commercial buildings. Construction considerations for structural integrity.	
Week 13 & 14	Other design/construction considerations	
Week 15+	Final Exams/Other	

IX. Evaluation Plan

Assignments	40%
Exams	40%
Quizzes, PRS Sessions	10%
Final Project	10%
<b>TOTAL</b>	<b>100%</b>

- Homework Assignments must be turned in immediately after class on the day that they are due. Assignments will be accepted up to one week after the due, however, late assignments will receive a maximum grade of 50% of the original point value. There will be no credit for assignments handed more than one week late.
- There will be a number of in-class work sessions, quizzes, and PRS sessions during the semester. There will be no credit or make-ups for: 1) missed in-class work sessions, quizzes, or PRS sessions. No excuses for missed in-class work sessions (quizzes & PRS) although you may drop the lowest two grades.
- Every effort should be made to contact the instructor in the event of medical or personal problems, as soon as possible.

X. Grade Distribution

90 – 100	A
80 - 89.9	B
70 - 79.9	C
60 - 69.9	D
< 60	F

XII. Additional Information

- **Students with Disabilities:** Any student requiring accommodations or services due to a disability must share their concerns with the course instructor and immediately contact:

North Dakota State University, Counseling Center-Disability Services, 212 Ceres Hall P.O. Box 5226, Fargo, ND 58105-5226 Phone: (701) 231-7671 TTY: (800) 366-6888. Fax: (701) 231-6318. And/or <http://www.ndsu.edu/counseling/disability.shtml>

- **Assistance from the Professor:** You should always feel free to contact the professor outside of class, either during office hours or by special appointment. It is acceptable to call at the office or home in the evenings (at a reasonable hour). Please do not hesitate to seek any appropriate out-of-class assistance from the professor in your efforts to master the subject matter of this course.
- **Academic Dishonesty and Misconduct:** Work in this course must adhere to the Code of academic and Conduct as cited in “SECTION 601: **Right and Responsibilities of Community: A Code of Student Behavior [August 2005]**” <http://www.ndsu.nodak.edu/ndsu/vpsa/code/>

As outlined above, the course work range from forces/vectors through the theory of bending to column analysis and design. The course will delivered via lectures, discussions, tutorials, in-class work sessions, group work, and reading assignments. A set of lecture notes based on the textbooks and other materials will placed on Blackboard [6]. Other materials will also be placed on Blackboard.

Examination, quizzes, homework and Personal Response System, PRS [6] will be employed to assess the progress of students in the course. The PRS is an electronic tool designed to capture the responses from students to questions asked or displayed in classroom. It is believed to capture and engage the attention and participation of students in a learning environment.

CONCLUSIONS

Construction Management students are required to comprehend the engineering and design issues related to constructed structures and construction processes. A Construction Manager must be able to interpret

engineering-based code and specification in order to construct a structure to meet inspection and quality requirements. Industry personnel concur that an understanding of construction codes and specifications is central to the successful construction of structures. Students in Construction Management programs must therefore be taught engineering principles underlying the engineering and design of constructed structures. Over the years CM students have learnt Engineering Statics and Mechanics of Materials from Mechanical Engineering programs. But these courses are not directly meant to serve the needs of students outside the Mechanical (and sometimes Civil) Engineering discipline. From the author's own experience, all course materials and examples are geared towards purely engineering design disciplines. These courses serve as prerequisites for upper level mechanical engineering and design courses. Course professors are not expected to address issues pertaining to constructed structures and construction processes. The courses are not therefore supposed to serve engineering related programs like construction management. Students who take these courses will not be able to relate engineering principles to constructed structures and construction processes.

Using other methods to incorporate engineering content into CM programs has been a challenge for quite some time. In this work, a new course has been designed to fill in the gap between a purely engineering design approach and an engineering-based interpretation of constructed structures. The course content covers the engineering principles like forces/vectors, bending

moments, column analysis, among other things as well as their relationship to constructed structures and construction processes. A number of course delivery approaches including lectures, assignments, group work, quizzes, tutorials and PRS will be employed to teach and assess learning in the course.

### REFERENCES

- [1] American Council for Construction Education (ACCE), *Document 103*.
- [2] Hauck, Allan, J., "Towards a Taxonomy of Learning Outcomes for Construction Management Education", *Journal of Construction Education*, Vol. 3, No. 3, Fall 1988, pp. 150-163.
- [3] Senior, Bolivar, A. and Hauck, Allan, J., "Designing Engineering Content for Construction Management Program", *Journal of Construction Education*, Vol. 6, No. 2, Summer 2001, pp. 65-74.
- [4] Jackson, Jon, J. and Writz, Harold G., *Schaum's Outline of Statics and Strength of Materials*, McGraw-Hill, 1983.
- [5] Onouye, Barry & Kane, Kevin, *Statics and Strength of Materials for Architecture and Building Construction*, Prentice Hall, 1999.
- [6] GTCO CalComp Interactive Technology Solutions/InterWrite Interactive Products, Personal Response Systems, 2006.

Construction engineering focuses on planning, design and management for the construction of infrastructure projects such as highways, bridges, pipelines, airports, railroads, industrial plants, buildings, dams and reservoirs. The construction engineering degree prepares students intending to gain a professional engineer license, while working at the interface of design activities and field construction. ASU's degree program is the third in the Southwestern U.S. and one of about 20 worldwide. CEE 210 Engineering Mechanics: Statics or equivalent. CEE 212 Engineering Mechanics: Dynamics or equivalent. CEE 213 Introduction to Deformable Solids or equivalent. CEE 321 Structural Analysis & Design or equivalent. AC 2011-317: a design project for a mechanics & statics. COURSE Robert A. Marlor, Northern Michigan University Robert Marlor is an Associate Professor in the Engineering Technology Department at Northern Michigan University. He received a Ph.D. in Civil Engineering (Structural Engineering) from Michigan Technological University in 2003. The best teams are those that combine good design with good construction, so it can be beneficial to build teams based upon a combination of academic ability and construction skills. Quiz and test scores garnered in the first seven weeks can be used to identify the students with the strongest academic abilities and simple questionnaire is used to determine construction and fabrication abilities. The review-and-analytical and scientific-and-technical Journal «Structural Mechanics of Engineering Constructions and Buildings» acquaints the readers with the recent achievements of scientists, researchers, and engineers of the Russia and other countries. «Analysis and design of building structures», «Dynamics of structures and buildings», «Analytical and numerical methods of analysis of structures», «Shell theory», «Problems of theory of elasticity», «Buckling analysis», «Geometrical investigations of middle surfaces of shells», «Experimental researches», «Theory of plasticity», «Mechanics

Learn about statics through real life engineering examples. Engage with the theory to grasp the full understanding of simple machines and complex mathematical models. Learners should know secondary school mathematics, as well as the "Mechanics" section from Physics. They should have a developed spatial awareness and be able to use a scientific calculator. About this course. Skip About this course. Are you interested in improving your mechanics or introducing yourself to the subject all together? Join our unique course, devised by the Ural Federal University. Through our innovative approach, you will receive the basic traditional material by engaging in practically-oriented tasks and learn the strictly theoretical mathematical analysis of basic concepts. Download free Construction Pdf Books and training materials. You will find here all are free download and in various formats: (PDF, DOC, PPT, ZIP, RAR). Engineering Books Pdf have 57 Construction Pdf for Free Download. Offshore Structures Design, Construction and Maintenance by Mohamed A. El-Reedy. 2473. 3,801.