

MICHIGAN TECHNOLOGICAL UNIVERSITY

Department of Civil and Environmental Engineering

CE 4990 –TRACK DESIGN AND CONSTRUCTION

Spring semester, Jan. 14 – May 3, 2008

Interactive lectures: Tue, Thu, 1:05-1:55 p.m., Dillman 202 (Dillman 213 for MicroStation and Geopak sessions)

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Text: No required books. Selected texts from various sources, handouts and other additional material will be provided by the instructor during the course and through course site at WebCT. Students are encouraged to look for additional information from the internet. Some of the publications used during the course include *Practical Guide for Railroad Engineering* and *Manual for Railway Engineering* by AREMA, *Manual of Uniform Traffic Control devices* and selected material provided by the Department of Engineering Professional Development during the seminar visit to the University of Wisconsin Madison. Tutorials and help files for MicroStation and Geopak will also be useful sources to assist in the course project, which utilizes both software.

Course description

This 3 credit course introduces students to the design and development of construction documents for railroad projects. The course takes a hands-on approach where assigned readings, interactive lectures, homework assignments and other instructional materials will be applied by participants to complete a real-life rail project. In Spring 2008, the project will be related to highway-rail grade crossing. The students will work in 2-3 person teams throughout the course and perform assignments needed to complete a highway-rail grade crossing project from the beginning of the design to the delivery of construction documents. The course will require students to use teamwork and creative thinking to solve an open ended design challenge. By the end of the program, students will have a basic understanding in the fundamentals of the track and roadway components, track design principles and criteria and estimating the basic project costs. They have also gained experience in how to use MicroStation and Geopak software in the design part of the project.

Course goals

Course has two key goals: 1) Learning the railroad track and highway design principles. This goal includes developing an understanding of interrelationships between design, document production and construction, internalization of design principles and criteria and identification of key process steps in rail related projects. Specific attention will be paid to the similarities and differences in track versus roadway design. 2) Applying the principles. Students will learn to take the guidance, instructions and references and apply them toward developing a real solution while working in a team where they have to depend on each other's individual expertise to get the product done.

Course topics and development

Course will provide participants with sufficient understanding of track and highway components and design criteria. Specific topics include horizontal and vertical geometry and cross-section components. While the concentration will be on learning track design principles, roadway design will also be reviewed as it pertains to the course project. The project steps will include taking an existing track layout and topography in a design software, creating a design for modified layout and developing construction documents which will include plan sheets, cross-sections and general cost/quantity estimates.

Instructional methods

The necessary background information on highway-rail grade crossings will be provided at the *Highway-Rail Grade Crossing Safety Course*, in January 17-18, 2008 in Madison, Wisconsin. Information regarding the basic steps of design process of railroad track / roadway will be provided during the interactive lectures, offered twice a week throughout the semester. Course books and materials offer excellent source for references and guidance during the project work. The objective is to review topics in the similar order they are faced in the project work.

Significant portion of the course are hands-on activities, exercises / homework assignment, or preparing designs and documents in MicroStation and Geopak or preparing presentations of the product. Students are expected to handle majority of the cad work within their teams and regular review sessions with instructor are used to verify the progress and to allow for student questions, The objective is to encourage students to take responsibility of their projects, while feeling comfortable to ask questions when they run into potential roadblocks.

Regular teamwork is a necessity and interactions between different teams are encouraged. Presentations and reports after Madison conference and after project completion are geared toward improvements in oral and written output.

Course requirements

In addition to the material covered in Madison seminar, the course has two weekly hours of interactive lectures to deliver necessary information to participants. Due to step-by-step approach of the course, it is extremely important that all participants are present during sessions and the deadlines in the assignment and project work are honored, unless agreement for extension has been negotiated in advance. The submittal of all documents

(with an exception of final design documents) will be in electronic format via WebCT. The course requires each participant to take the responsibility of their individual learning and each team to take responsibility for successful completion of project tasks.

The grading of the class will incorporate following methods.

- There will be no tests during the course, but written quizzes and individual homework assignments may be used to test the knowledge on instructional material covered during interactive lectures. These tests and homework assignments will affect the participation portion of the overall grade (25%).
- There will be two team presentations and written reports during the course. First will be in topics learned during the Madison seminar and second in the final design product. If written report is considered insufficient, a re-submittal will be required until it is considered satisfactory. These presentations and reports will form the majority of the grade (75%). The grades will be based on the quality of the presentations and reports and are determined by course instructor and the evaluations by the fellow students and invited guests. The grade for the presentations and project will be the same for each team member and improvement from previous submittal will be considered an elevating factor for the overall grade. A draft of each report will be graded and commented prior to the final submittal. 50% of the points lost in the draft report evaluation will be rewarded to those teams, who sufficiently address the reviewer comments in the final report.
- Active participation and proper preparation to team activities and to interactive lectures are absolutely essential to the success. Each student will provide feedback on the performance of themselves and their team members in open format twice – in mid-semester and in the end and these will be compared with the instructor’s evaluation. Any absence from the class must be discussed in advance and absence without permission will affect negatively to the participation portion of the grade. The evaluations and absences together with quizzes and homework assignments will form 25% of the grade. The teams are expected to solve potential conflicts internally and are advised to approach the instructor for conflict resolution only when internal efforts haven’t been effective.

Grade determination

Table below presents the basis for grade determination.

Grade division	Percent of total grade
Madison presentation and report	30%
Track design project presentation and report	45%
Attendance and Participation (includes potential morning quizzes and homework assignments)	25%

The overall grade depends on the percentage of overall points collected during the course:

Percentage of overall points	Grade
>93%	A
89-93%	AB
85-88%	B
80-84%	BC

Both categories may be adjusted during the course. The instructor will inform students in advance, if such adjustments become necessary.

In addition to the official instructor evaluation, students are encouraged to provide informally both oral and written feedback about instructor's performance. An informal feedback session will be held at the mid-semester point, but feedback can also be provided anonymously to instructor's mailbox in DOW.

Tentative content: Approx. 26hrs of lectures + seminar at Univ. of Wisc. – Madison (lecture topics may be reorganized as deemed necessary)

Week	Date	Activity
Week1	1/15	Welcome to track design course Review of the syllabus and confirmation of Madison trip plans. Introduction to MicroStation
	1/17-18	Highway-Rail Grade Crossing Safety Course, Pyle Center, University of Wisconsin, Madison (14 hrs) (separate syllabus to be provided)
Week 2	1/22	Components and design process Introduction to the critical track components and their relationship to the design process. Steps involved in the rail design project.
	1/24	Railroad surveying Critical considerations when performing railroad and topo surveys. Importing survey to MicroStation. Development of existing layout as a base for design.
Week 3	1/29	Track and road design principles – horizontal. alignments 1 Limits of curvature and reasons behind them. No curve areas. Chord definition in curve design. Transition and reverse curves. Benefits and drawbacks of curves. Drawing horizontal elements in MicroStation and Geopak.
	1/31	Track and road design principles – horizontal alignments 2 Railroad vs. highway curves comparison. Horizontal clearance considerations.
Week 4	2/5	Madison Seminar presentations Each group will make 10-12 minute presentation and deliver a written report on selected topics discussed at Madison seminar.
	2/7	Winter Carnival – Stay on the right track!

Week 5	2/12	Track and roadway design principles – vertical alignments 1 Limits of grades and vertical curves and reasons behind them. No vertical curve areas. Drawing vertical elements in MicroStation and Geopak.
	2/14	Track and roadway design principles – vertical alignments 2 Railroad vs. highway vertical curve comparison. Vertical track clearances. Madison reports due.
Week 6	2/19	Track and roadway design principles – Cross section components 1 Happy Valentine's Day!!! Introduction to cross section components and critical issues in developing cross sections for construction documents. Development of existing cross sections in MicroStation and Geopak.
	2/21	Track and roadway design principles – Cross section components 2 Introduction to cross section components and critical issues in developing cross sections for construction documents. Developing proposed cross-sections in MicroStation and Geopak.
Week 7	2/26	Highway-rail grade crossing project 1 Introduction to design project. Base information and objectives of design. How to use basic features of MicroStation and Geopak to advance rail related projects.
	2/28	Highway-rail grade crossing project 2 Producing a design project in MicroStation and Geopak.
Week 8	3/4	Subgrade and drainage design 1 The water will always flow downhill. How to guide it to the preferred locations. How to design ditch profiles and determine, if closed drainage system is necessary.
	3/6	Drainage design 2 Basic sewer calculations and sizing of the pipes under the tracks. Other considerations for track design.
Week 8.5		Spring Break, Don't get derailed!!
Week 9	3/18	Specific design considerations at highway-rail grade crossings Pavements markings. Special cross sections at grade crossings. Crossing designs and materials. Other MUTCD issues.
	3/20	Basics of plan production 1 Stationing and basic rules and information represented in the plans and cross sections.
Week 10	3/25	Basics of plan production 2 Introduction to developing general, plan, profile and cross section sheets for rail project.
	3/27	Quantity estimates for rail projects Quantity takeoffs from design documents and cross sections.
Week 11	4/1	Cost estimates for rail projects Unit costs and their application in the process. Different types of

		work items necessary at the unit cost estimate.
	4/3	Project guidance session Individual guidance for teams in their design projects.
Week 12	4/8	Project guidance session Individual guidance for teams in their design projects.
	4/10	Construction stakeout How to prepare information for construction stakeout in the field. Development of stakeout information and guidance for surveyors.
Week 13	4/15	Final project presentations 15-20 minute presentations of completed plans and cost estimates for the evaluation committee via Marratech-conferencing.
	4/17	Construction documents - Discussion of basic construction documents and specifications and project element neglected in the course project. Draft final design report due.
Week 14	4/22	Feedback session on design reports Instructor feedback on design reports to be incorporated in the final reports.
	4/24	Final reports due –review and course feedback session