ENES120 Design Project

Spring 2012, M. Edelen

Task: Design a railway bridge to span across a ravine.

Description:

Your engineering firm has been asked to submit a proposal for building a railway bridge across a ravine, allowing freight trains to cross safely. A number of competing firms have been presented with the same problem in the form of a RFP (Request for Proposals), issued by the railroad. In order to get the job, your firm must convince the railroad that your design is (1) safe and (2) inexpensive. The physical characteristics of the ravine are documented in the site drawing.

Requirements:

- Support the weight of the rail bed, rails, and a standard CSX freight train crossing the bridge.
- Grade must not exceed 6.5%.
- Internal forces in any member must not exceed the following:

Internal Load Specifications (in tons)	Beam Type A	Beam Type B
Max Compressive Normal Force[1]	$2.66 \times 10^5 / L^2$	$5.65 \times 10^4 / L^2$
Max Tensile Normal Force	400	275
Max Shear Force	240	165
Max Moment (inch*ton)	800	300

[1] In the formulas, use L in feet to obtain a result in tons.

Constraints:

- Due to instability of the rock face, the bridge cannot be supported by any point on the West Cliff.
- Use only steel structural beam AISI W24x104 (Type A) and/or W18x65 (Type B) with length <= 45 ft.
- The entire design must be statically determinate.

Cost:

You should attempt to minimize the cost of your design. Calculate the cost using the following data:

Cost Data (in $)	Beam Type A	Beam Type B
Beam Cost (per foot)	$182	$114
Pinned Joint, 2 members	$1000	
Pinned Joint, 3 members	$1600	
Pinned Joint, 4+ members	$2400	
Welded Joint (each)	$800	

Design Process:

Use the following process when designing your bridge. Note that the process is not linear; that is, you will not follow the steps from start to finish without backtracking. Design is an iterative process, so expect to cycle through some of the steps multiple times.

1. Define the problem
2. Identify requirements, constraints, and simplifying assumptions
3. Generate design concepts
4. Conduct structural analysis of design(s)
5. Compare concepts and select final design
6. Evaluate design with respect to requirements, constraints, and cost
7. Document and communicate the design and analysis

Deliverables: see course website for due dates

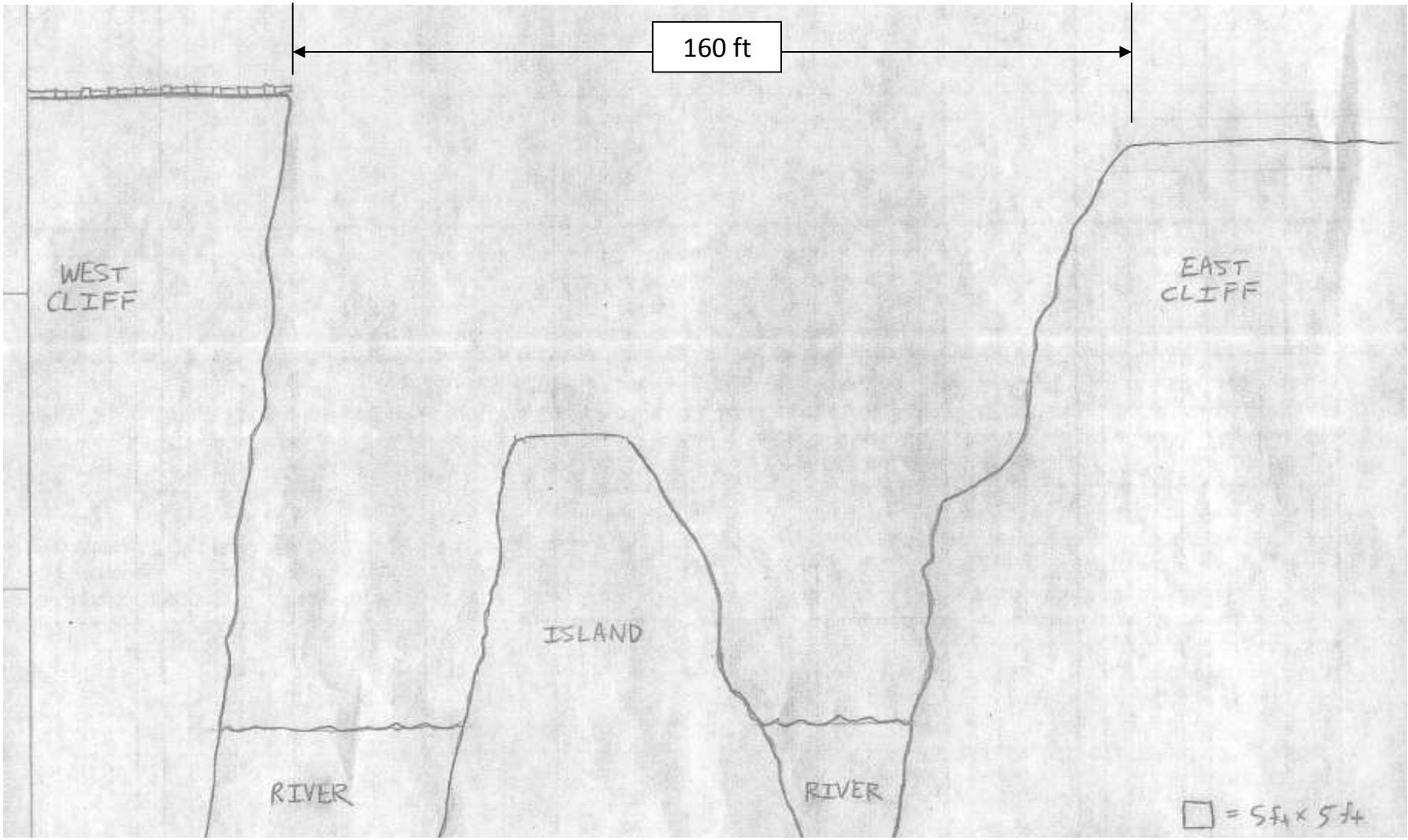
- **Preliminary Design Status Meeting** – You will schedule a meeting with your manager (the instructor) to present your progress on the design. At this meeting, you should be finished with steps 1-3 and have started steps 4 and 5 in the design process. Your boss will review your work, ask questions, and provide guidance.
- **Final Design Report –** A formal report submitted to the potential customer (the railroad), documenting all steps in the design process. See rubric for grading details.
- **Design Presentation –** A formal presentation to the customer, highlighting the strengths of your design and the process by which you created it. This is your sales pitch. See rubric for grading details.

Grading: The total grade for this project will be calculated according to the following.

Preliminary Design Report	20 pts
Final Design Report	60 pts
Design Presentation	40 pts
Total	120 pts possible

SITE DRAWING

Each group will receive an electronic copy of this drawing, and multiple hard copies.



Note: Bridge supports cannot be placed anywhere on the West Cliff, but can be placed in reasonable locations on the Island or the East Cliff.

Final Design Report

Assignment Description:

This is a formal (typed) report, presenting your design to the customer for their evaluation. The report should clearly explain every step taken in the design process. It must include appropriate technical justification for why your bridge design meets all of the requirements, within the constraints, and at minimal cost to the customer. Use illustrations, pictures, diagrams, and calculations as much as possible.

Calculations can be hand-written, but they must be extremely neat and organized, and they must be integrated into the report (i.e., don't throw all calculation into an Appendix). It is also possible to do calculations electronically, which should be attempted for simple calculations.

Diagrams of your design should be done as professionally as possible. Hand-drawn pictures should be a last resort. If you use any design tools (e.g. online truss applets), I would recommend including **annotated** screen shots to illustrate your process of generating, and comparing concepts.

Scoring Rubric:

Report Component/Characteristic	Point Value
1. Define the problem	2
2. Identify requirements, constraints, and simplifying assumptions	4
3. Generate design concepts	8
4. Conduct structural analysis of design(s)	8
5. Compare concepts and select final design	8
6. Evaluate design with respect to requirements, constraints, and cost	6
Correct application of statics principles; clear, valid calculations	10
Effective use of drawings, diagrams, pictures	8
Clarity of writing; grammar, spelling, etc.	6
TOTAL:	**60 pts**
EXTRA CREDIT: Design that meets all requirements with lowest cost.	**5**
EXTRA CREDIT: Design that is not exclusively two-force members.	**5**

Design Presentation

Assignment Description:

This is a group presentation to the customer. Your goal is to convince the customer that your design is the best solution to their problem. Therefore, you should focus on highlighting the strengths of your design, the thoroughness of your design process, and the rigor of your structural analysis. Above all, you must clearly evaluate your design with respect to all requirements. **If your design does not meet a requirement, be honest and admit it!** Integrity and professional ethics are also important to the customer.

Your presentation should last **a maximum of 15 minutes**, so you will need to be concise. You will not have time to explain detailed calculations; save those for the report. Also, do not spend time discussing the problem, requirements, and constraints, as these are common to every group. During the 15 minute presentation, every group member must talk.

Scoring Rubric:

Presentation Component/Characteristic	Point Value
A. Explanation of simplifying assumptions	4
B. Presentation of design concepts	6
C. Justification for selected final design	6
D. Summary of structural analysis performed	6
E. Evaluation of design with respect to requirements and cost	6
Presentation within time constraints (<= 15 minutes)	4
Effective use of visual aids	4
Public-speaking ability (eye contact, enunciation, etc)	4
TOTAL:	**40 pts**