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Oct-17th, 2017

Truss Bridge Design, Request for Proposals (RFPs)

As discussed in CIV102, the Truss Bridge Design assignment has multiple deliverables that span the learning objectives of both CIV102 and ESC101. This document describes the relationship between the different deliverables that make up the project.

Overview

The Truss Bridge Design assignment has three components: a poster and presentation (a.k.a.: Design Critique, Crit., Design Pitch, Pitch), a Report, and a set of Calculations. The Calculations are submitted as an appendix to the Report.

Each team will present their design of a pedestrian truss bridge, highlighting key design decisions and features. This Crit. is a short presentation and teams will need to exercise significant judgment in their selection of which information to include.

The second deliverable is the Report, which includes the Calculations. The Report will describe the team's bridge concept in more detail than was provided in the Presentation, and will include a set of truss Calculations as an Appendix. The report and presentation will also include a discussion of a site inspection for a bridge in the GTA which will be replaced by your design.

Objectives

1. Conduct a site visit to be able to assess existing conditions for a pedestrian bridge in the GTA.
2. Demonstrate an ability to carry out safe truss analysis and design procedures.
3. Demonstrate an ability to clearly articulate the feasibility of the design through calculations.
4. Develop a design that adheres to the constraints.
5. Pitch the design proposal in a Crit. environment and Report that explains your design concept.
   a. the Design Pitch should convince the audience (CIV102 teaching staff, as well as ESC101 teaching staff), that your design proposal should be selected (i.e. why should we pick your bridge instead of all the other bids?).
   b. the Design Pitch should describe key design decisions and features.
   c. the Design Pitch should not describe detailed calculations.
6. Argue and defend why your bid should be selected amongst the other bidders in the context of the constraints and criteria of this RFP.
   a. this involves following the Toulmin Model for argument both in the written report and the Design Crit.
   b. The written report should focus on design decisions and justifying those decisions using the requirements model from Praxis.

Background

Recent political interest has sparked an interest amongst the community in revitalizing the municipal infrastructure of the Greater Toronto Area. One of the areas of interest are in replacing the various pedestrian bridges in the city with updated and visually appealing designs.

Sponsors interested in funding various bridge upgrades are now soliciting proposals identifying bridges in need of replacement, and conceptual designs of bridges which will replace the existing structures. Types of bridges which can be considered include, but are not limited to, pedestrian bridges crossing valleys or other natural features and bridges connecting adjacent buildings. Bridges located on University of Toronto campuses are not to be considered.

In teams of 3 or 4 engineering students (as assigned by your TA), you are to respond to this request for proposal by submitting a bid for the project. The bid will include a site inspection of an existing bridge and your updated design. As a part of the package you are required to submit a report summarizing your design and detailed calculations demonstrating the structural feasibility of your design. Furthermore, your team must participate in a Design Critique arguing why your bid should be considered for further investment.

The minimum clear span must be at least 10 m. The width of the deck should not be less than 3 m, but may be made larger to meet the needs of the specific site. The weight of the deck and other non-structural components should be estimated while designing, though the self-weight of these parts should not be less than 1.0 kN/m^2 and they will likely not exceed 2.0 kN/m^2 of deck area (should verify this assumption). The topping of these pedestrian bridges is often wood but your design may include other design features including glass enclosures, hand rails, etc. The main steel truss structure is to be designed to support a live load of 5.0 kN/m^2 in addition to the weight of the deck and the self-weight of the structure. You may initially assume that the self-weight of the supporting structure, neglecting non-structural components, is 0.7 kN/m^2. The design loading due to wind on this structure will be 2.0 kN/m^2 of frontal area. The self-weight of the structure should be checked against the initial load estimates to ensure a safe design.

One possibility is to span the valley with two large single-span trusses (one on each side of the deck). Other solutions involve intermediate supports which will divide the span into smaller spans requiring smaller trusses. The intermediate supports could be provided by columns (vertical and/or inclined) under the bridge or cables and towers above the bridge (cable stayed bridge). Other concepts are acceptable provided they involve the use of structural steel. Your bridges should be designed using hollow structural sections.

Bridge Design Requirements

Constraints

1. Work only in your **assigned** group of 3 or 4 engineers. Work independently of other groups but it is not required that each team replaces a unique existing bridge.
2. The bridge you inspect must be located in the GTA, must be a PEDESTRIAN BRIDGE, must have a minimum clear span of 10 m, the width of the deck should not be less than 3 m, and may not be located on the University of Toronto Campuses.
3. **SAFELY**, identify an existing pedestrian bridge and conduct a site inspection to assess the span of the bridge and other details. You must summarize your visit with a drawing of the existing site including the span, elevation, plan, cross-section and significant terrain or support condition details. The detailed structural components of the existing bridge need not be audited unless you use these details for arguments in your Crit. or Report.
4. **!!! DO NOT CLIMB ON BRIDGES, GO BENEATH BRIDGES THAT ARE NOT MEANT FOR PUBLIC PEDESTRIAN ACCESS, GET IN THE WAY OF MOVING VEHICLES TO CONDUCT YOUR INSPECTION OR ANY OTHER ACTIVITY THAT MAY ENDANGER YOU OR ANYONE ELSE.** The inspection should be done as a pedestrian following all the conventions, legislation and regulations of a pedestrian. If you think something is dangerous, don't do it. The purpose of this inspection is not to get EXACT values on the site rather, it is meant for you to provide reasonable estimates for the purposes of developing a design proposal. Any unsafe activity will result in grade deductions. If it is not publically accessible don't go there. At a distance visual estimates are sufficient.
5. **ALL INSPECTION MUST BE NON-DESTRUCTIVE AND NON-DAMAGING.**
6. After conducting the bridge inspection you are required to replace the bridge with a new pedestrian truss bridge. If the existing bridge is a truss bridge your design needs to be substantially different from the existing design and in your Crit. and report will need to justify your choices.
7. Design the steel trusses, the columns, and the towers using hollow structural sections with a yield stress of 350 MPa.
8. Must provide an estimate of the mid span deflection of the longest span of the structure due to live load.
9. Must design the structure against vibrational effects, as discussed in CIV102.
10. The bridge must meet all the safety standards outlined in CIV102 lectures.
11. Must provide an estimate of the total cost of the bridge and supports using the assumptions given below. These prices include both material and erection costs. Note that you need to include the cost of the cables, foundations, and anchors in your estimate.

12. If you use columns in your design, assume each column will be supported on a concrete footing which can resist vertical and horizontal loads.
13. Use a statically determinate steel structure. If you use intermediate supports, provide appropriate pin connections between the support and the trusses on each side of the support.

Assumed Costs:

14. Hollow structural steel sections with 350 MPa yield stress:
    a. Standard sections given in your tables - $3 000/tonne erected cost.
    b. Custom sections - $4 000/tonne erected cost.
15. High strength steel cables with yield stress of 1650 MPa - $5 000/tonne erected cost.
16. Concrete footings capable of resisting vertical and horizontal loads:
    a. In river - $25 000 per footing.
    b. On valley wall - $18 000 per footing.
    c. End abutments - $12 000 per footing.
    d. Tower support - $12 000 per footing.
    e. Cable anchorage - $12 000 per footing.

Design Critique (Crit.)

1. Must employ visual aids. Should be in the form of poster board (tri-fold poster or similar size hanging poster visit GB117/217 to assess how you will present, we will not provide any other equipment or adhesives). Must adhere to conventions taught in Praxis for presentation, communication and argument.
2. Each member of the team must present, with approximately equal amounts of time for each presenter.
3. Design pitch length must be under 3 minutes, allowing 2-4 minutes for questions (from both CIV102 and ESC101 staff).

Design Criteria

(criteria not in order of preference)

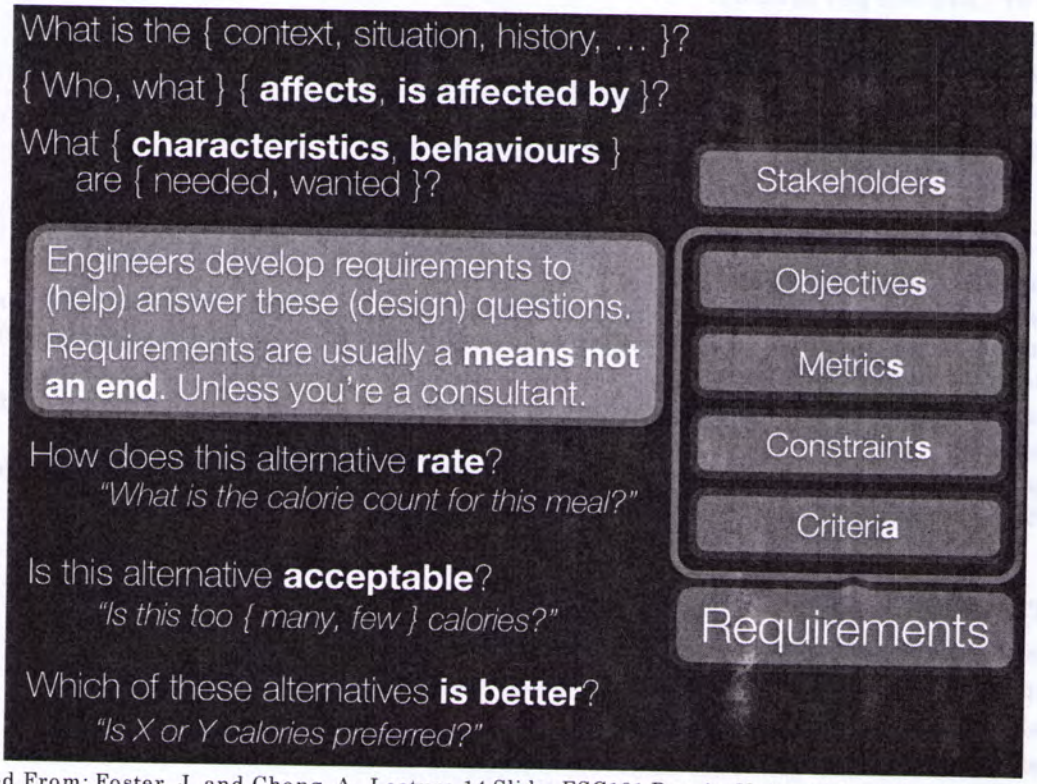
1. Correctness of engineering calculations.
2. Proposals with a larger breadth of safety considerations will be preferred (metric: minimal risk).
3. Proposals with clearer design calculations will be preferred.
4. Proposals with lower cost will be preferred.
5. Proposals with a better understanding and communication of existing site conditions (drawings) will be preferred.

Deliverables

0. One week from distribution in tutorial provide evidence of a site visit (photos, sketches showing plan and profile views) should be provided alongside a conceptual design showing a high-level concept of the replacement bridge. This includes a draft of the 11"x17" inspection drawing and a draft design layout for the new truss geometry. Research and use engineering drawing conventions for the engineering drawing including, but not limited to, using a boarder, scale, and information box in the lower right corner.
1. Three weeks from distribution in tutorial:
    a. submit a clear, detailed engineering drawing on a single 11"x17" piece of paper which **adequately** describes the existing bridge and site visit (plans, elevations, sections). Research and use engineering drawing conventions for the engineering drawing including, but not

limited to, using a boarder, scale, and information box in the lower right corner. All aspects of the drawing must be to scale. (do not fold this drawing).

b. For your report, submit a one to two page written statement describing your bridge design and highlighting key design decisions and features in the context of the requirements. This report should also justify why your proposal should be selected amongst the other bids presented. You must follow the Toulmin Model of argument, the claims you make must be clear and concise. You must also describe your design decisions in the context of the requirements model (See ESC101 Lecture 14 – reproduced below). You should clearly describe several alternatives and justify how you arrived at those alternatives using the requirements model from Praxis. You should also use the techniques presented in Praxis to arrive at your design decisions and summarize your approach in your report. Note: do not provide a narrative of what you did rather provide a summary.



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c. Submit a clear, detailed engineering drawing on a single 11"x17" piece of paper which **completely** describes your design (do not fold this drawing). Research and use engineering drawing conventions for the engineering drawing including, but not limited to, using a boarder, scale, and information box in the lower right corner. All aspects of the drawing must be to scale. (do not fold this drawing).

d. Prepare a neat, well organized set of design Calculations (no more than 10 pages), which must be submitted as an Appendix to your report. These calculations must be on engineering computational paper. These calculations should include a detailed cost estimate of your structure. Neat hand calculations are preferred.

e. Each group **must** maintain a time log for all work on this project. The tasks and time spent on these tasks should be clearly recorded for each group member. Indicate the date and times that each task was performed. This time log is not included in the 10 page limit for calculations. Each group member is to sign this time log. Use quarter hour precision.

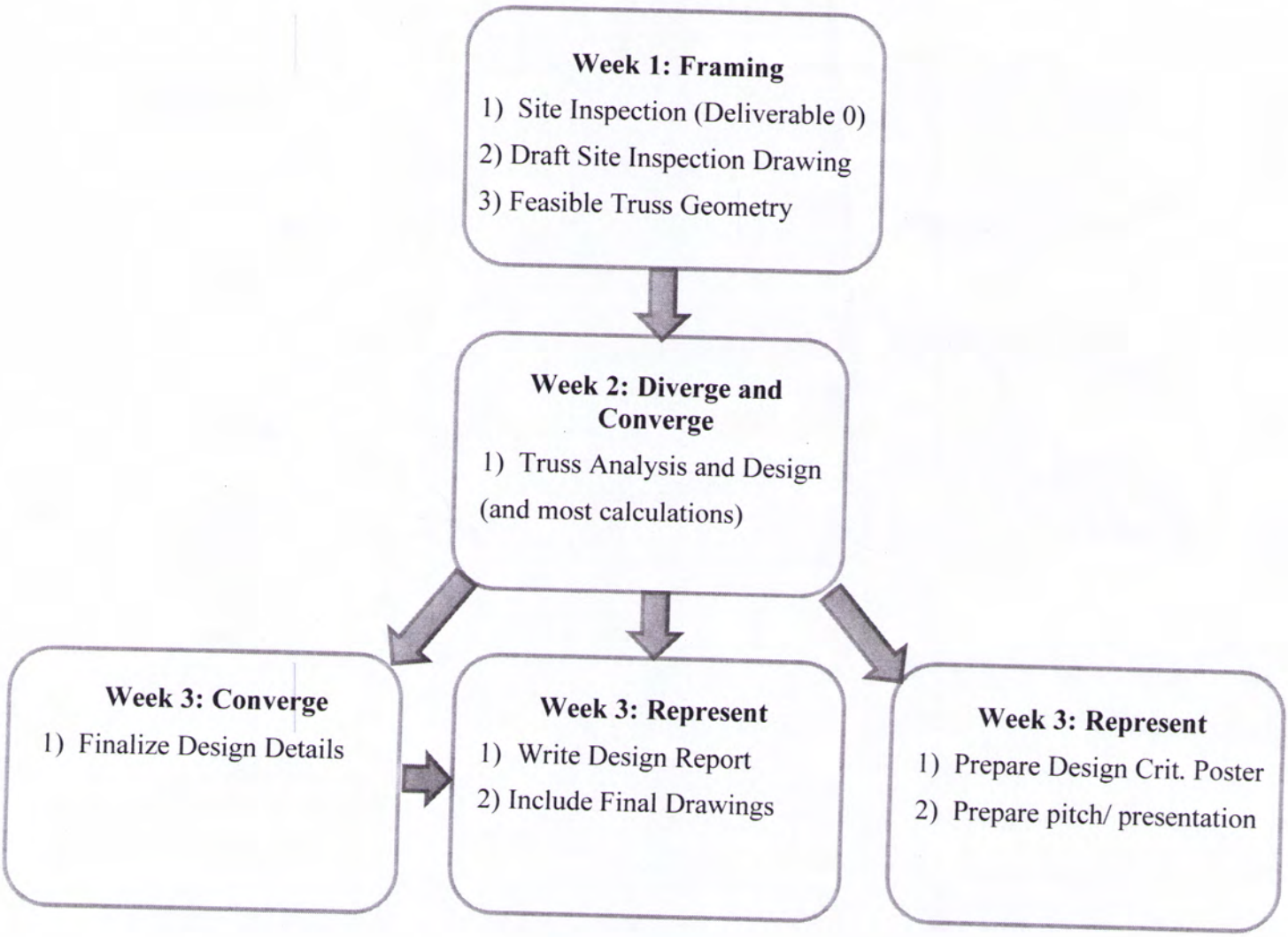
f. Prepare a design pitch with a tri-fold poster that will be presented at the design Critique which will take place in your tutorial. This pitch will be 3 minutes, allowing 2-4 minutes for questions

(from both CIV102 and ESC101 staff). This presentation should summarize why your proposal should be selected amongst the other bidders, summarize key design decisions and features, *etc.*

Due: 3 weeks from distribution* ***Type:*** Team ***Weight:*** 2.5 times a problem set

* Deliverable "0" is due 1 week from distribution
* Due at the beginning of your assigned CIV102 studio (GB117/217)

Possible Work Plan



Due Next Week

→ site construction + drawing
→ sketch of proposed new geometry

Oct. 31

→ Bring 11x17 draft poster plan