Concrete Bridge Freshman-Design Projects: Improving Communication and Belonging

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Background

CE 1025: Introduction to Civil Engineering

(1 credit)

Discussion of aspects of the civil engineering profession, campus, resources, etc.

SAIL

Swenson
Active and
Innovative
Learning

CE 1025: Introduction to Civil Engineering

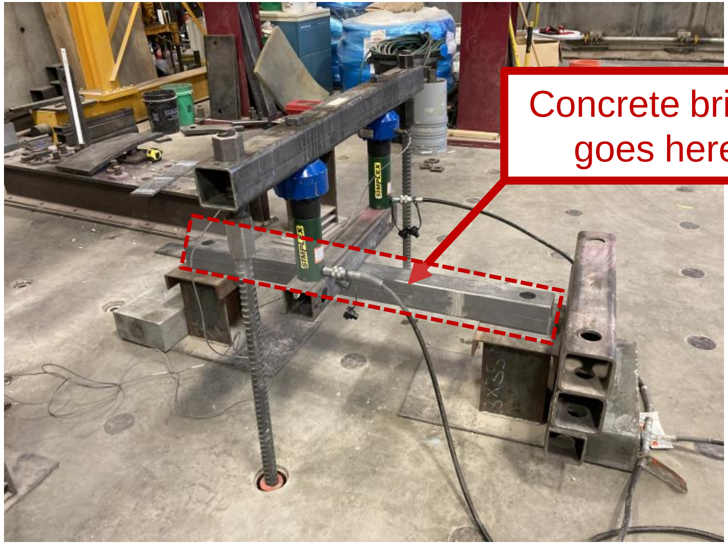
(3 credit)

Incorporate **“authentic disciplinary experience”** projects into first-year classes to increase program retention and belonging

Project Objectives

Brainstorming	Consider alternative designs and select one to satisfy requirements
Iteration	Perform testing and adapt the design as new information is found
Communication	Give oral presentations and create a set of written documents that clearly communicate the design
Fabrication	Understand and implement a plan, discussing and approving changes as necessary

Two Projects



Concrete bridge goes here!

Treat this water!

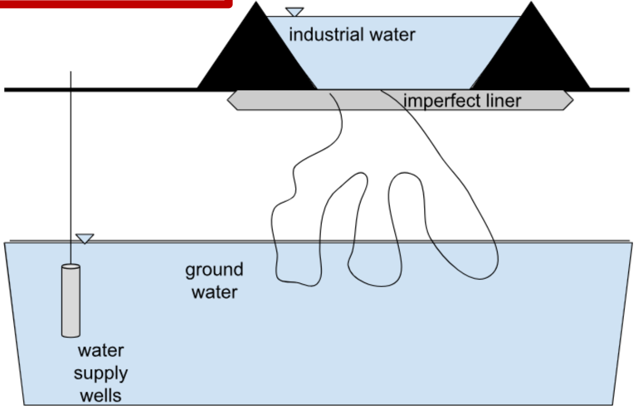
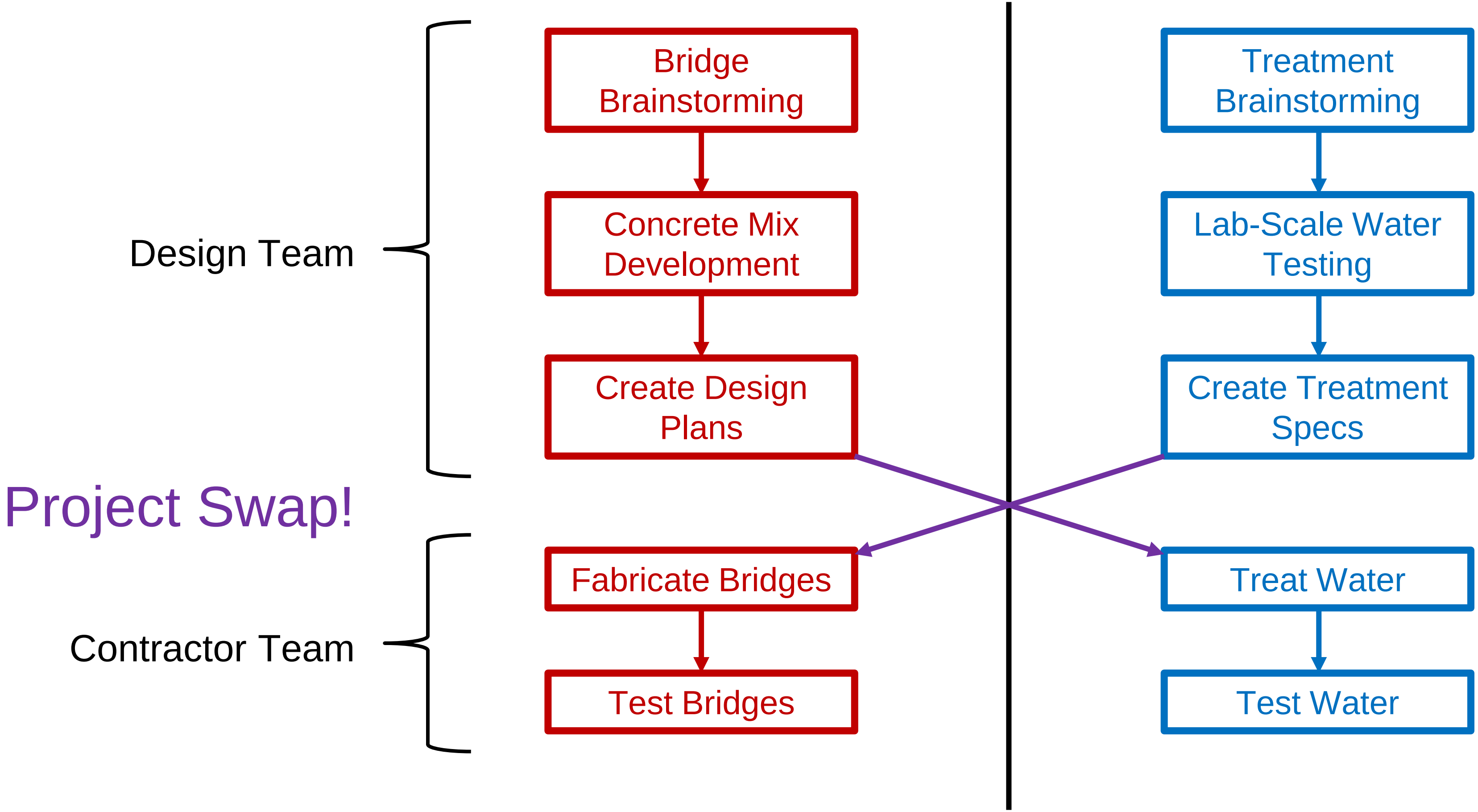


Table 1 Water characteristics, treatment goals and constraints

Contaminated Water[1]	Current Concentration [mg/L hardness]	Treatment Goal Concentration[2] [mg/L hardness]	Waste Requirement[2]	Treatment Time Constraint
Industrial water	2,500	< 200	< 4 % volume	N/A
Ground water	500	< 100	N/A	< 30 mins

[1] Each pair of design/contractor teams will be assigned a water source. (SEE APPENDIX TABLE A1)
[2] Each pair of design/contractor teams may be assigned a specific objective in terms of treatment goal and waste minimization. (SEE APPENDIX TABLE A1)

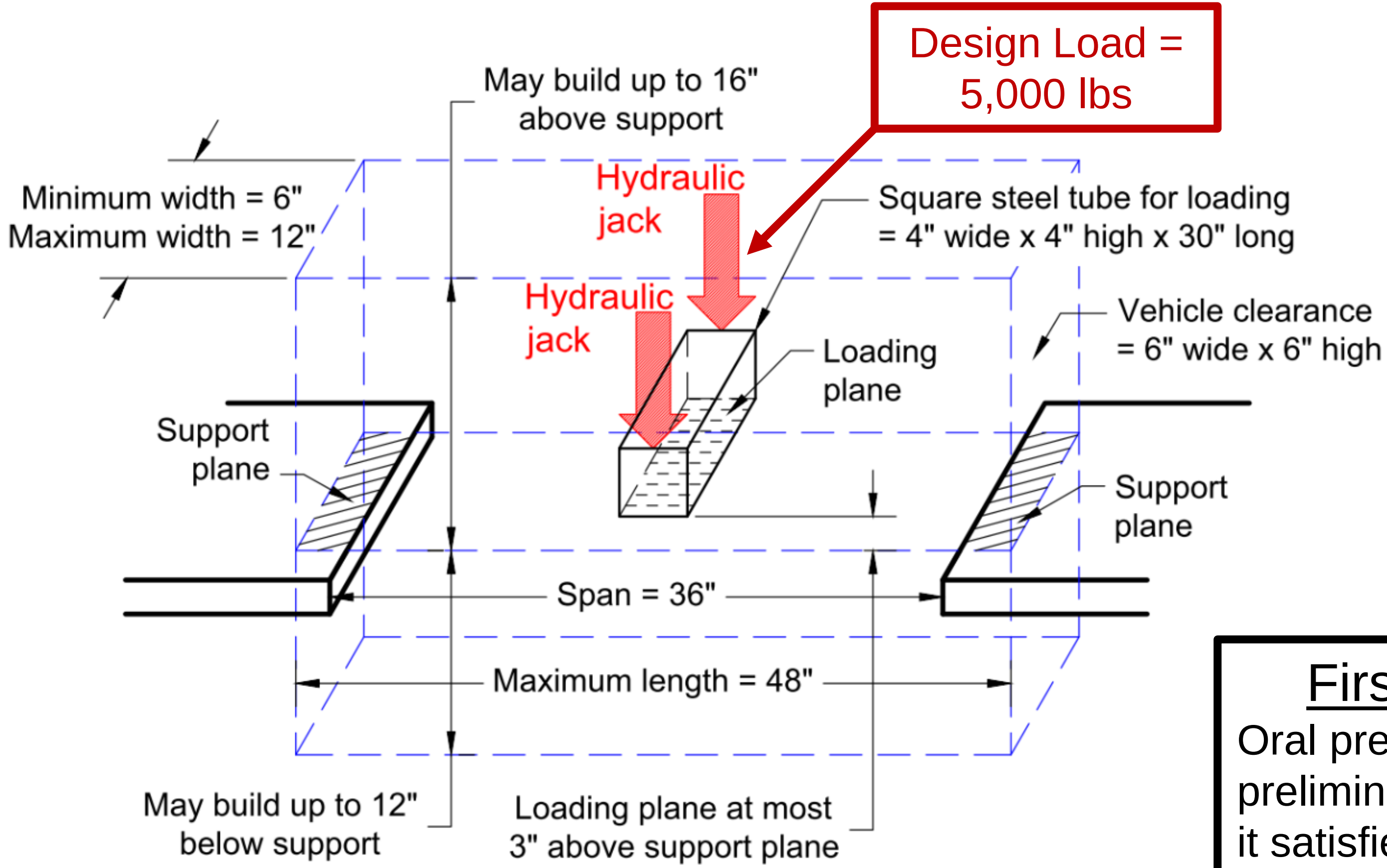
Project Structure



Team Objectives

Lightest Bridge	Minimize structural weight Ensure deflection < 1” under design load
Stiffest Bridge	Minimize the deflection under design load Ensure total bridge weight < 200 lbs
Least Cement	Minimize Portland cement usage Ensure deflection < 1” *and* weight < 200 lbs
Least Steel	Minimize reinforcing steel Ensure deflection < 1” *and* weight < 200 lbs
Shortest Profile	Minimize the total height of the bridge Ensure total bridge weight < 200 lbs

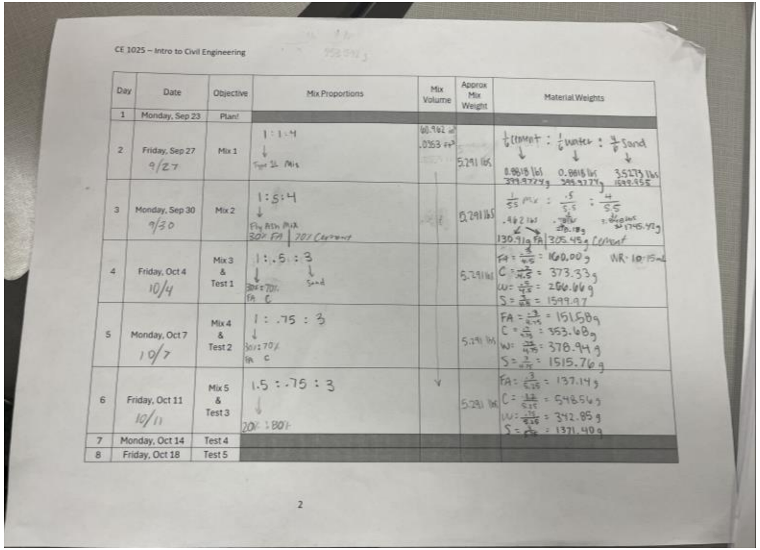
Phase 1: Concrete Project Brainstorming



<u>First Deliverable</u>

Oral presentation of preliminary design and how it satisfies requirements.

Phase 2: Mix Development



CE 1025 – Intro to Civil Engineering

Day	Date	Objective	Mix Proportions	Mix Volume	Approx Mix Weight	Material Weights
1	Monday, Sep 23	Plan!				
2	Friday, Sep 27 9/27	Mix 1	1:1:4	.0353 ft³	5.291 lbs	0.8818 lbs 399.9774 g; 0.8818 lbs 399.9774 g; 3.5273 lbs 1599.955
3	Monday, Sep 30 9/30	Mix 2	1:.5:4 Fly Ash Mix 30% FA | 70% Cement		5.291 lbs	130.91 g FA | 305.45 g Cement
4	Friday, Oct 4 10/4	Mix 3 & Test 1	1:.5:3		5.291 lbs	FA = 160.00 g; C = 373.33 g; W = 266.66 g; S = 1599.97
5	Monday, Oct 7 10/7	Mix 4 & Test 2	1 : .75 : 3		5.291 lbs	FA = 151.58 g; C = 353.68 g; W = 378.94 g; S = 1515.76 g
6	Friday, Oct 11 10/11	Mix 5 & Test 3	1.5 : .75 : 3 20% : 80%		5.291 lbs	FA = 137.14 g; C = 548.56 g; W = 342.85 g; S = 1371.40 g
7	Monday, Oct 14	Test 4				
8	Friday, Oct 18	Test 5				

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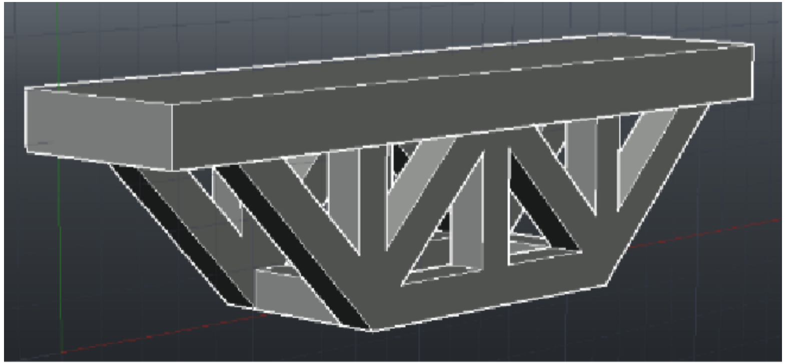
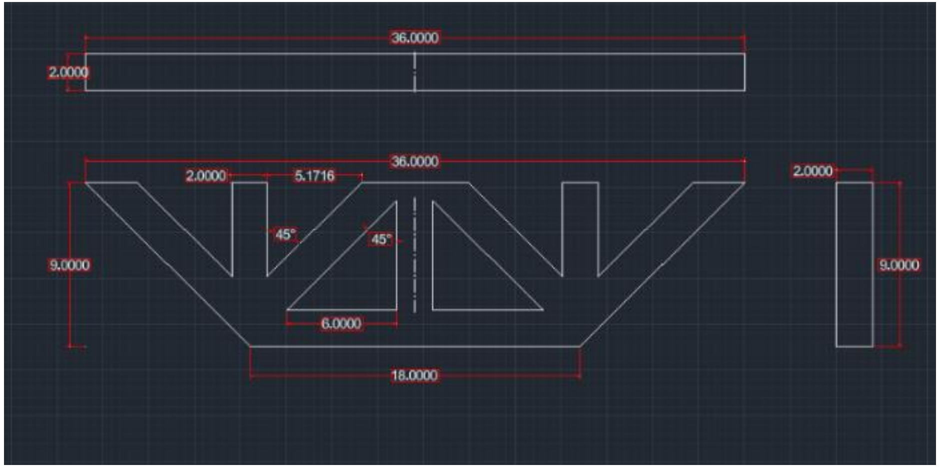
Second Deliverable

Testing data sheets and mix design to provide adequate strength and workability.

Phase 3: Design Plans





<u>Third Deliverable</u>

Design plans:

1. Introductory memo
2. Bill of materials
3. Mix design and specifications
4. Bridge plan
5. Construction sequence

<u>Meet with Contractors!</u>

Communicate design

Propose changes

Consider constructability

Phase 4: Construction

Phase 4: Construction

<u>Fourth Deliverable</u>

The completed bridge!

Phase 5: Testing

Phase 5: Testing

Phase 5: Testing

Assessing Outcomes

Pre- versus post-class surveys (n = 26 in CE, 312 across college)

% change pre to post:

		CE	All
Science Self-Efficacy	I feel confident in my ability to be successful in my science courses.	+26.9%	+9.9%
	I feel capable I can apply the skills learned in my classes to real-life situations.	+3.8%	+8.7%
	I feel confident that I can develop technical science skills.	+3.8%	+3.9%
Science Communication	I feel confident I can communicate scientific knowledge to my peers.	+36.5%	+14.1%
	I feel capable of communicating scientific knowledge to nonscientist community members.	+50.0%	+17.3%
	Discussing science with others increases my confidence as a scientist.	+26.9%	+12.0%

Assessing Outcomes

Pre- versus post-class surveys (n = 26 in CE, 312 across college)

% change pre to post: CE All

		CE	All
Science Identity	I have a place in the scientific community.	+3.9%	+19.6%
	I consider myself a scientist.	+57.7%	+25.7%
	The scientific community accepts me.	+30.8%	+25.7%
	The scientific community values my role and knowledge as a community member outside of science.	+34.6%	+28.2%
	Taking part in community engagement strengthens my identity as a scientist.	+23.1%	+13.8%

Conclusions

Freshman Projects	First-year students can deliver on complicated projects, even with minimal background knowledge!
Communication	Students learned about and valued communication in the design and fabrication processes.
Belonging	Authentic experience helped students recognize their place in the engineering community; will see if this translates to increased retention.

Questions?

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