ASCE Concrete Canoe Competition

Rachel Alecci, Olivier Duverneau, Ethan Earley, Anthony Giorgi (Team Leader), Zach Hochheiser

Dr. Bechtel

Problem Statement

- Design and fabricate canoe out of concrete
- Improve from last year
- Focus on three aspects:
  - Materials Design
  - Constructability
  - Quality of final product

Competition Overview

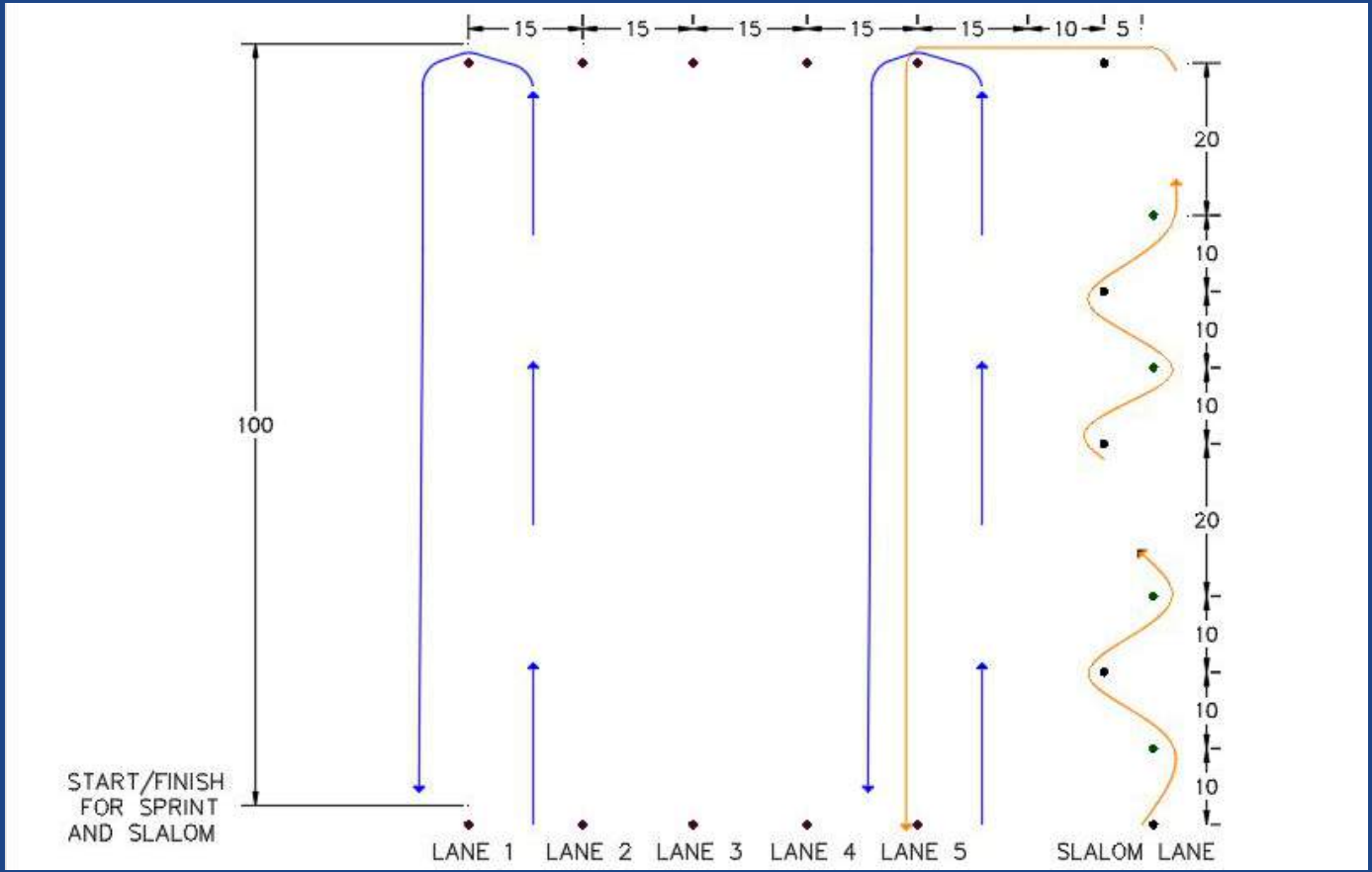
Location:

White Meadow Lake, Rockaway NJ

Four Aspects:

- Product Prototype
- Project Proposal
- Presentation
- Five Races

Course Layout



Design Constraints

- Cementitious Material:
  - Maximum 50% hydraulic cement by mass
  - Maximum 15% hydrated lime by mass
- Aggregates
  - Minimum 35% by volume

Cementitious Materials	ASTM
Hydraulic Cement (c)	C150, C595, C1157, or C845
Coal Ash	C618 (Class C or F)
Slag Cement	C989 (Grade 80 minimum)
Silica Fume	C1240
Hydrated Lime	C207 (Type S or N) or C821
Ground Pumice, Pumice, or Volcanic Ash Natural Pozzolan	C618 (Class N)

Design Constraints

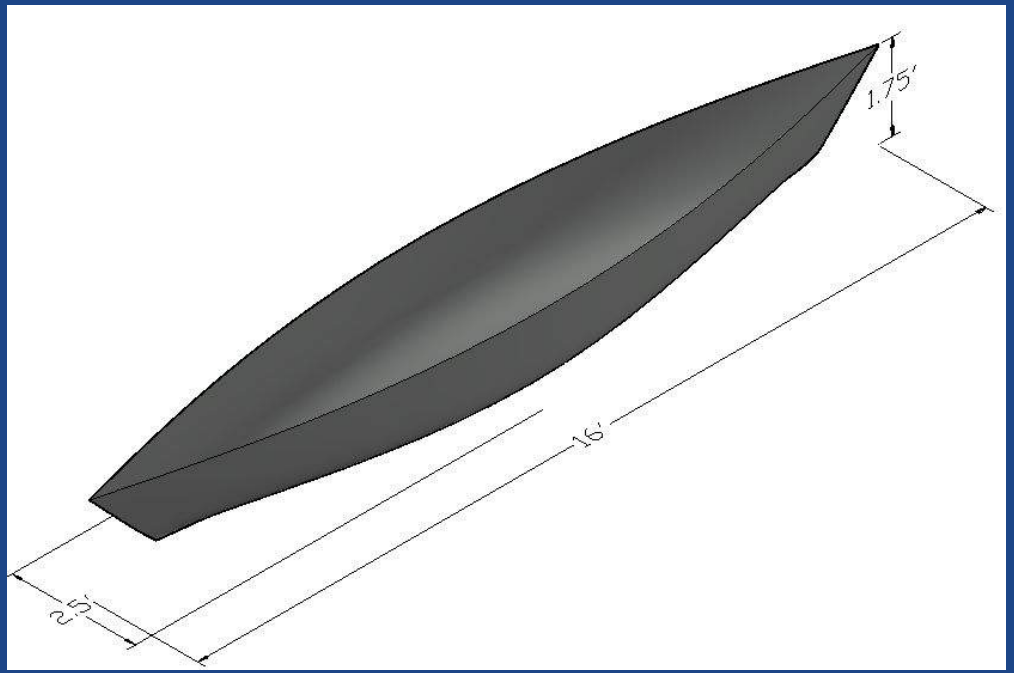
- Sealer
  - Maximum two layers
- Prohibited Materials:
  - Bondo
  - Epoxy resins
  - Asphalt emulsions

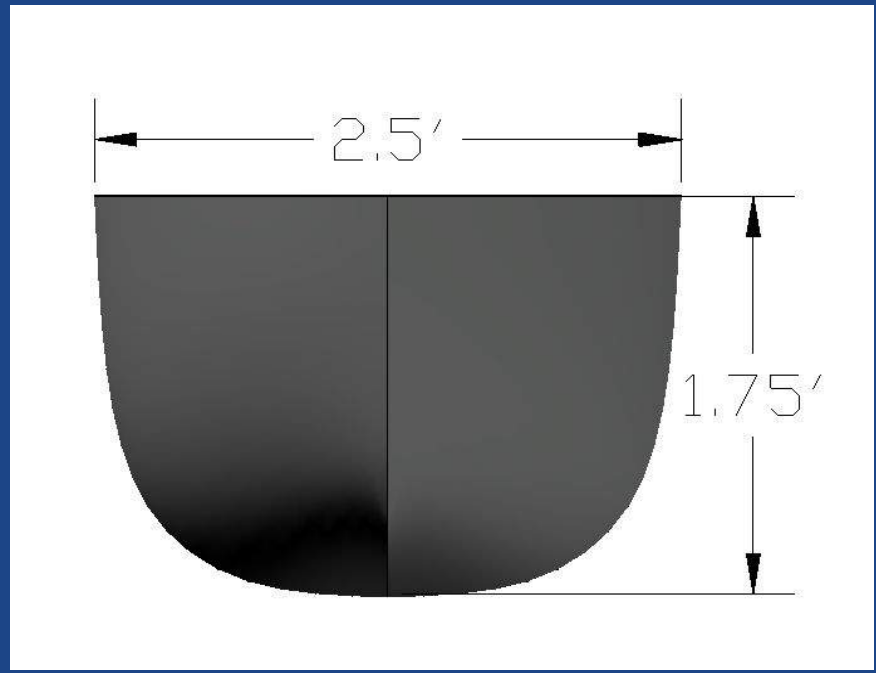
Admixtures	ASTM
Water Reducing & Set Control	C494
Air-Entraining	C260
Coloring Admixture/Agents & Concrete Pigments	C979
Specialty Admixtures	C494 (Type S)
Latex Emulsions	C1438

Realistic Constraints

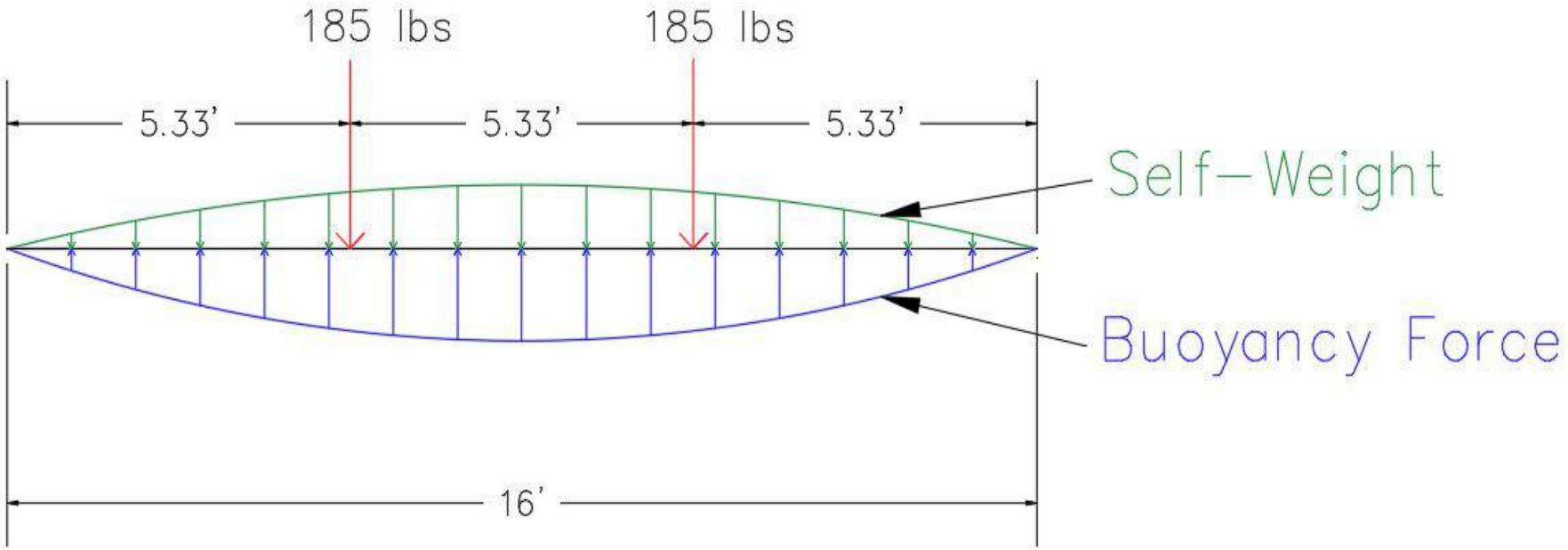
- Constructability
  - Mold
  - Workability
  - Transportation of canoe
- Economic
  - Budget

Hull Design

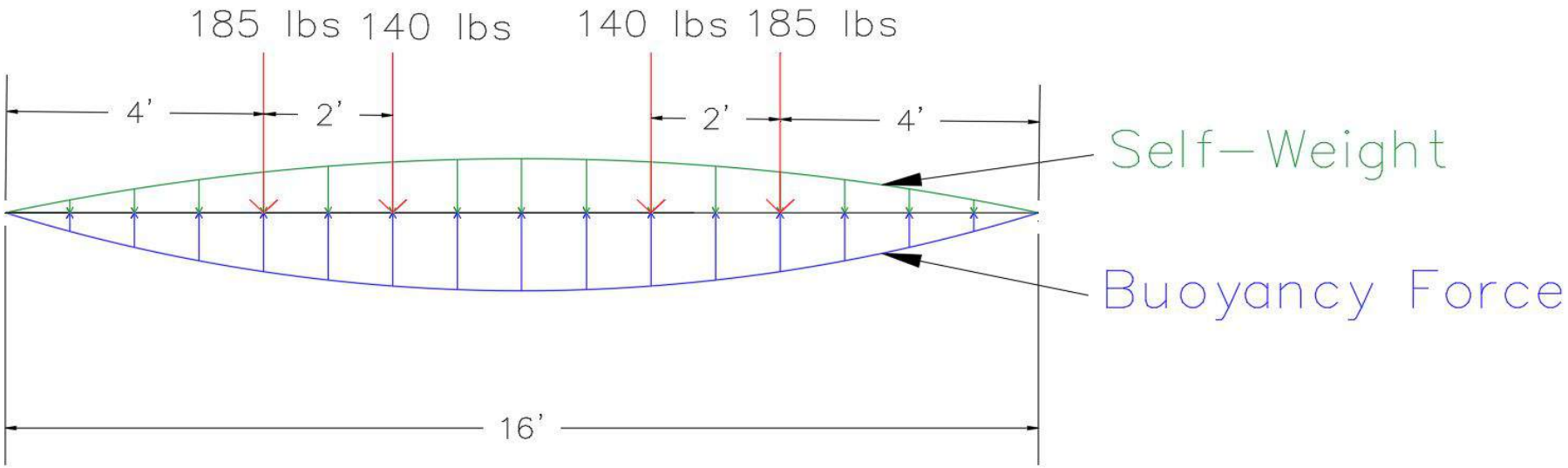




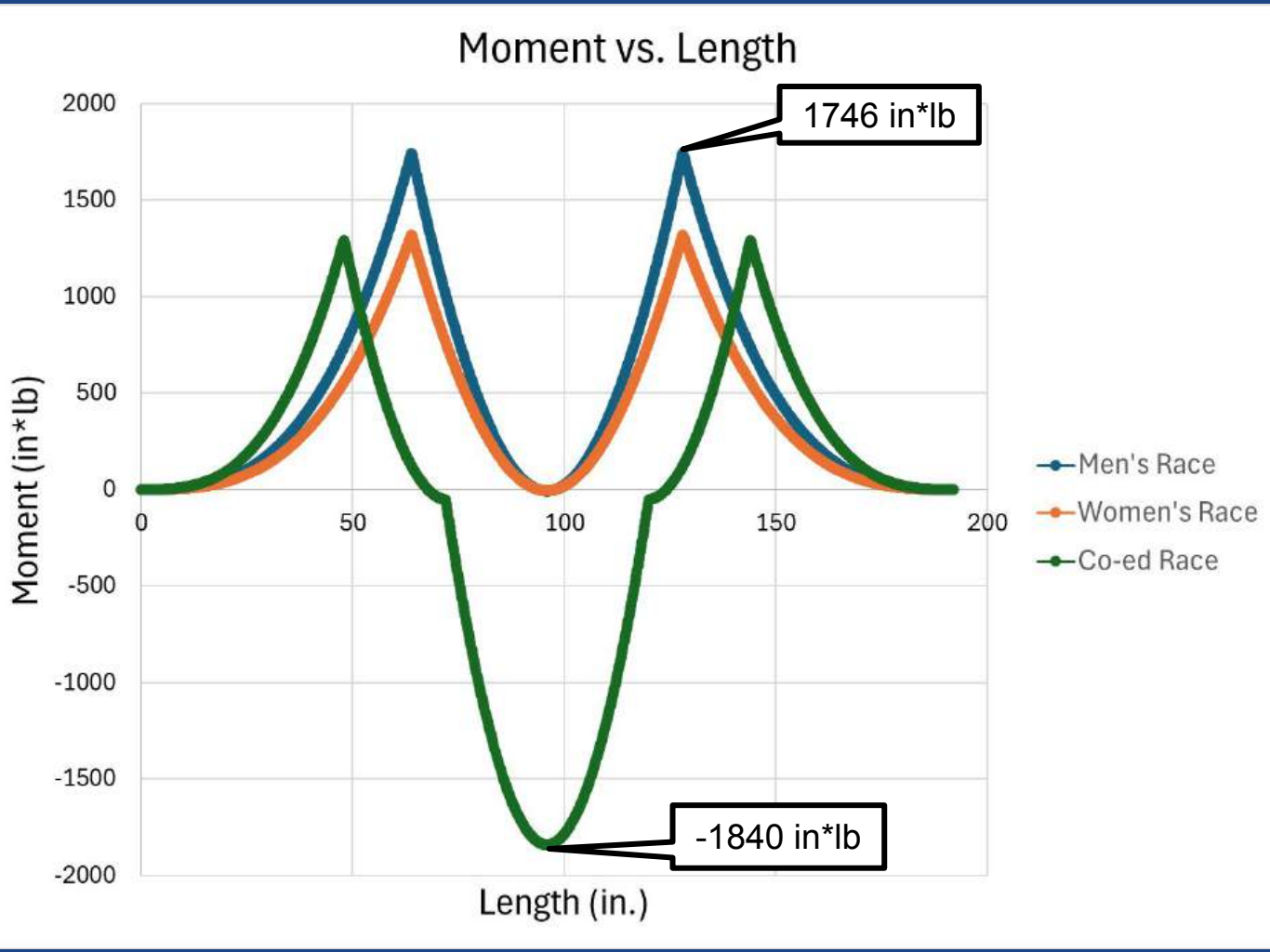
Structural Analysis



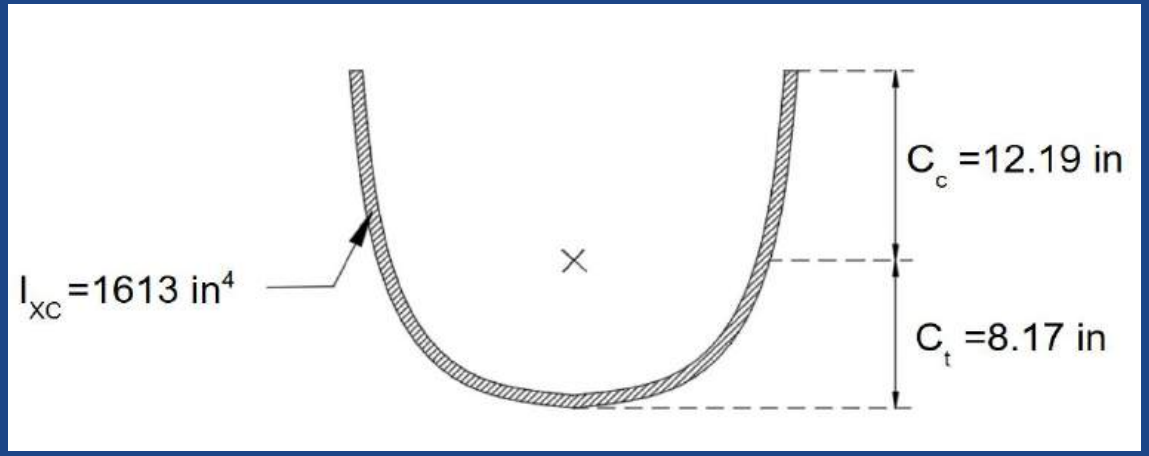
Structural Analysis

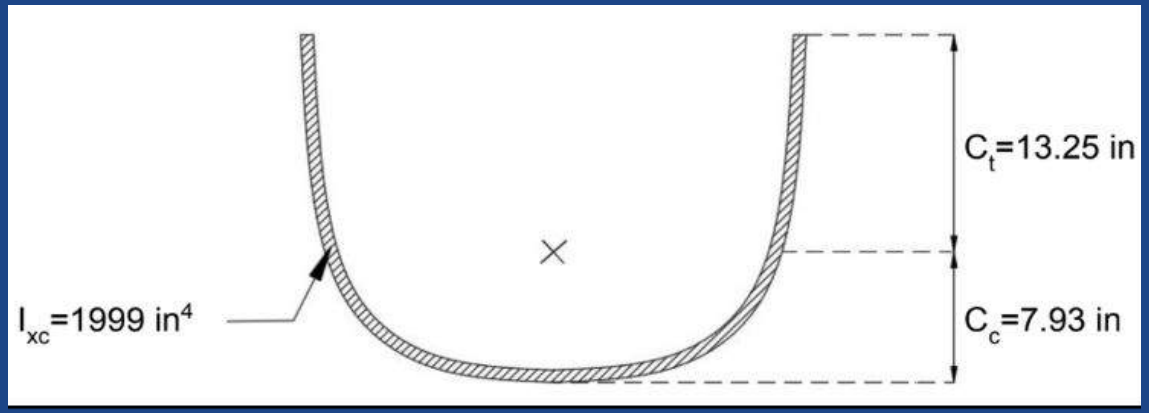



Shear vs. Length
142 lb
150
100
50
0
-50
-100
-150
Shear (lb)
0
40
80
120
160
200
Length (in.)
Men's Race
Women's Race
Co-ed Race


Moment vs. Length
1746 in*lb
-1840 in*lb
Moment (in*lb)
Length (in.)
2000
1500
1000
500
0
-500
-1000
-1500
-2000
0
50
100
150
200
Men's Race
Women's Race
Co-ed Race

Structural Analysis





5 ⅓ feet:

$\sigma_{c,min}$ = 14 psi

8 feet:

$\sigma_{t,min}$ = 13 psi

Mix Design

2024 TCNJ Mix Vs. University of Florida (Winner)

- 2024 TCNJ Mix
  - Low workability
- Florida’s Mix
  - More workable
  - Use of hydrated lime

Mix Design

- Main Objectives:
  - Workability
  - Unit Weight
- Adjustments:
  - Types of cement
  - Amount of aggregate
  - Different admixtures

Mix Design

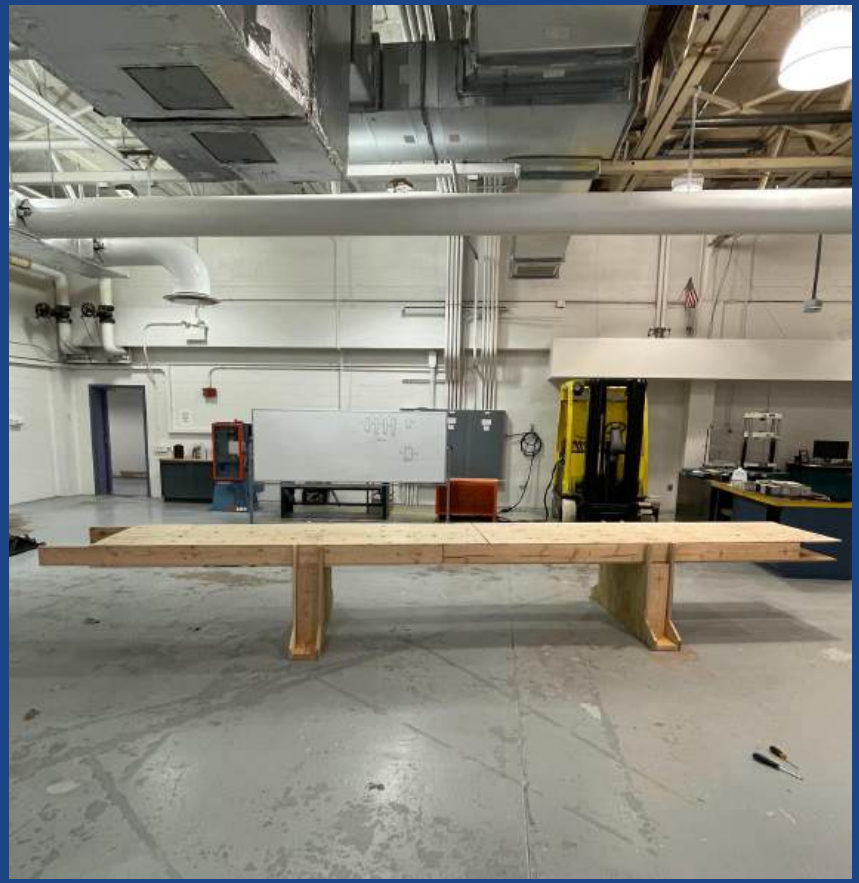
	Mix #3	Mix #5	Mix #7
Difference	Pumice	No Fly Ash	Admixture
Unit Weight (pcf)	73	59	64
Compressive Strength (psi)	1930	1080	1240
Workability	**Low**	**Low**	**Medium**

Mix Design

Material	% (mass)
Poraver (0.5mm-1mm)	21
Poraver (0.25mm-0.5mm)	12
Portland Cement	24
Slag Cement	14
Hydrated Lime	5
Water	22
Superplasticizer	3
PVA Fibers	0.15

Compressive Strength (psi)	1599
Unit Weight (pcf)	59
W/C Ratio	0.51

Mold Construction



Mold Construction

Mold Construction

Pour Day

Curing/Mold Removal

Curing/Mold Removal

Transportation

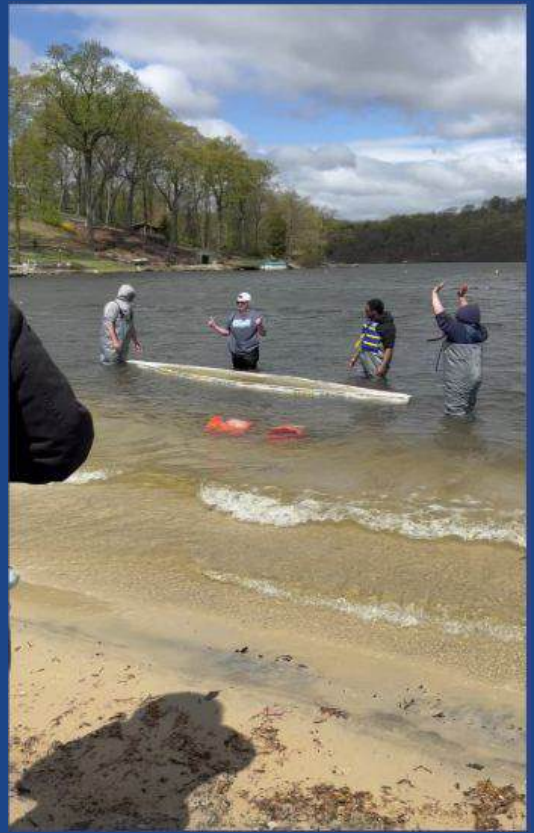
Competition

Overall: 5th

- Proposal: 6th
- Presentation: 4th
- Prototype: 3rd
- Races: Would’ve Dominated

Competition

Swamp Test



Construction Costs

Construction		
	Budgeted	Spent
Mold/Curing	$450	$760
Concrete Materials	$750	$770
Construction Materials	$200	$75
Transportation	$550	$670
Competition	$1400	$675
Total	**$3,350**	**$2,950**

Fundraising	
HNTB	$500
CivilTec	$250
Whiting Turner	$500
Heidelberg Materials	Slag Cement
JDM Materials	Admixtures Portland Cement

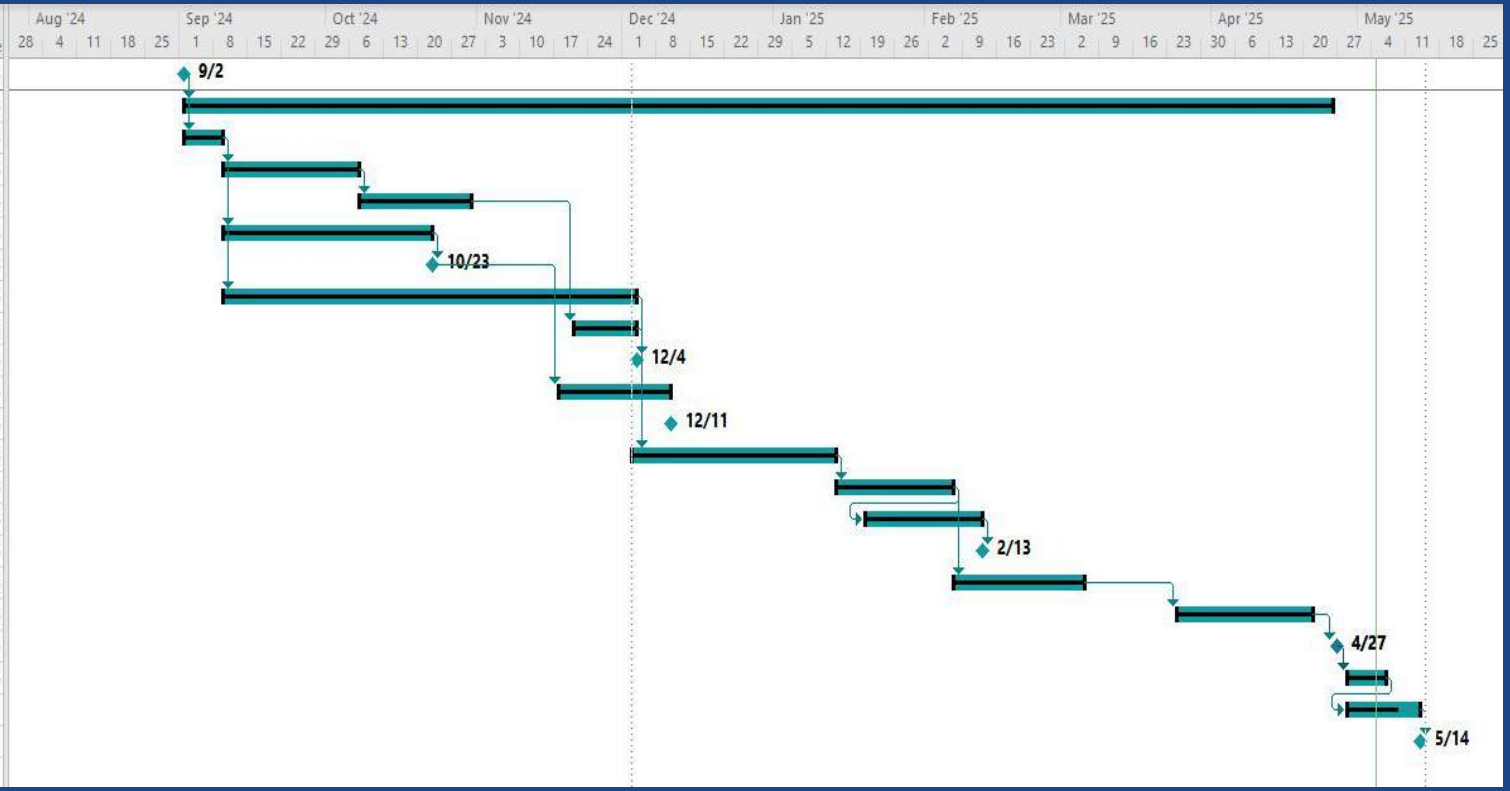
Engineering Costs

	Supervisor	Lab Technician	ENG II	ENG I	ENG I	ENG I	ENG I
	Dr. Bechtel	Mike Steeil	Anthony	Zach	Ethan	Rachel	Olivier
	$80	$50	$35	$33	$33	$33	$33
Fall Tasks							
Competition Research	1	0	8	7	7	7	7
Problem Statement Presentation	1	0	5	4	4	4	4
Hull Design	1	0	2	6	0	0	8
Structural Analysis	2	0	4	4	0	0	0
Mix Design	5	0	9	8	12	10	10
Alternative Designs Presentation	0	0	5	4	5	5	5
Website	0	0	1	1	6	6	0
Quarterly Report	0	0	5	5	5	6	6
Engineering Services Presentation	0	0	4	4	4	5	3
Final Report	0	0	8	8	8	8	8
Total Fall Hours	**10**	**0**	**51**	**51**	**51**	**51**	**51**
Spring Tasks							
ASCE Report	0	0	6	5	5	10	6
Mold Construction	10	11	39	32	31	18	21
Canoe Casting	3	1	8	9	9	9	14
Spring Presentation	0	0	1	4	4	4	4
Website	0	0	1	0	2	2	1
Spring Quarterly Report	0	0	5	3	2	5	3
Competition	0	0	8	7	7	7	7
Engineering Services Presentation	0	0	3	4	4	2	4
Final Report	0	0	2	3	3	5	3
Total Spring Hours	**13**	**12**	**73**	**67**	**67**	**62**	**63**
Total Hours on Project	**23**	**12**	**124**	**118**	**118**	**113**	**114**

Engineering Costs	
Fall Combined Salaries	$9,320
Fall Overhead (150%)	$13,980
Fall Fixed Fee (10%)	$2,330
Fall Total	**$25,600**
Spring Combined Salaries	$12,740
Spring Overhead (150%)	$19,110
Spring Fixed Fee (10%)	$3,190
Spring Total	**$35,000**
Total Cost	**$60,600**

Schedule

Task Name	% Complete
Project Start	100%
Fundraising	100%
Research	100%
Hull Design	100%
Structural Analysis	100%
Fall Quarterly Report	100%
Fall Quarterly Report	100%
Mix Design	100%
Fall Engineering Services Presentation	100%
Fall Engineering Services Presentation	100%
Fall Engineering Services Proposal	100%
Fall Engineering Services Proposal	100%
Order Materials	100%
Canoe Construction	100%
Competition Proposal	100%
Competition Proposal	100%
Spring Quarterly Report	100%
Competition Preparation	100%
Competition	100%
Final Presentation	100%
Final Report	75%
Project Finish	98%



Acknowledgements

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Questions?

Banana Split