ASCE Concrete Canoe Competition

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Dr. Andrew Bechtel

Problem Statement

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

Competition Overview

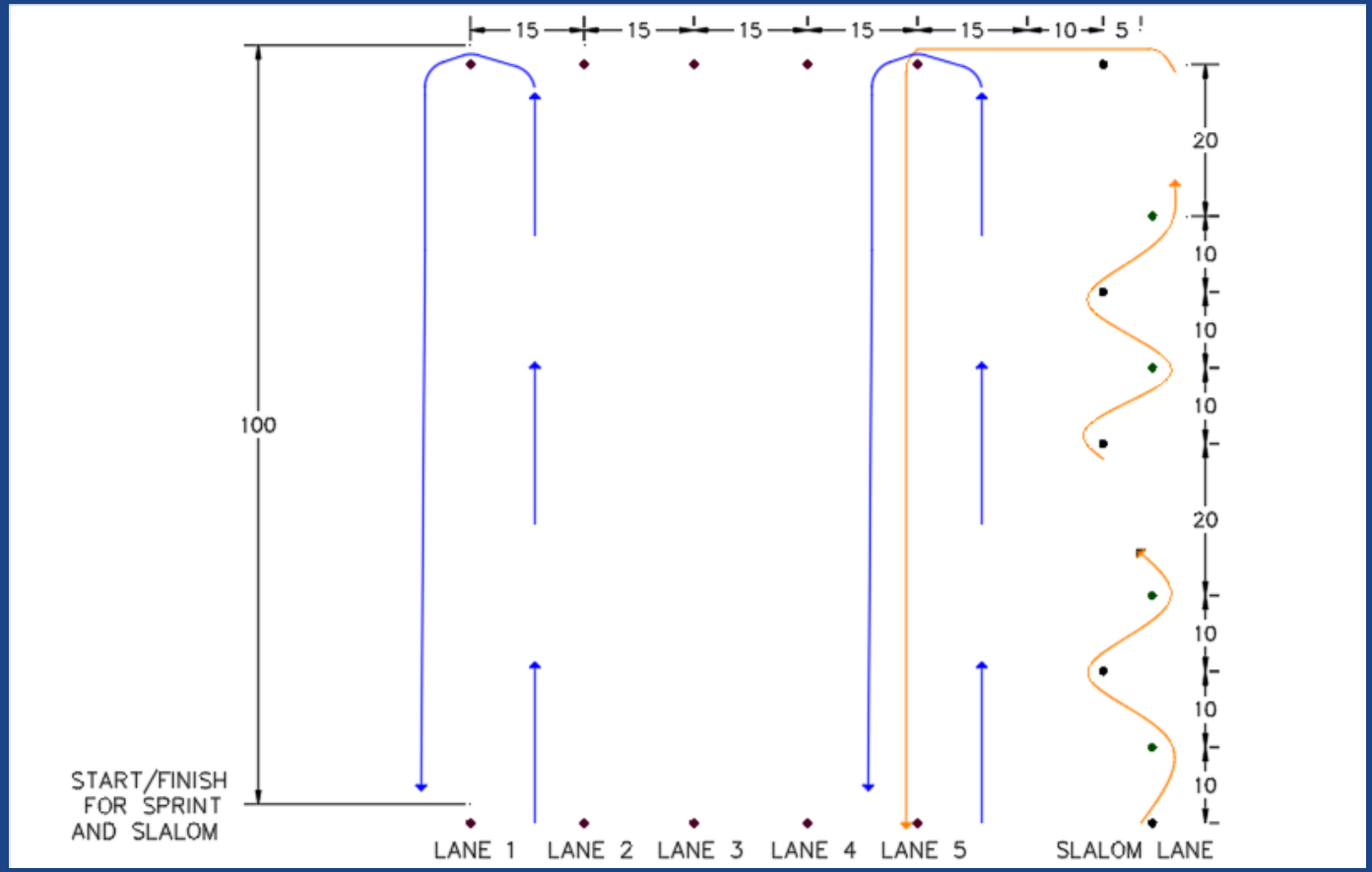
Location:

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 (cont.)

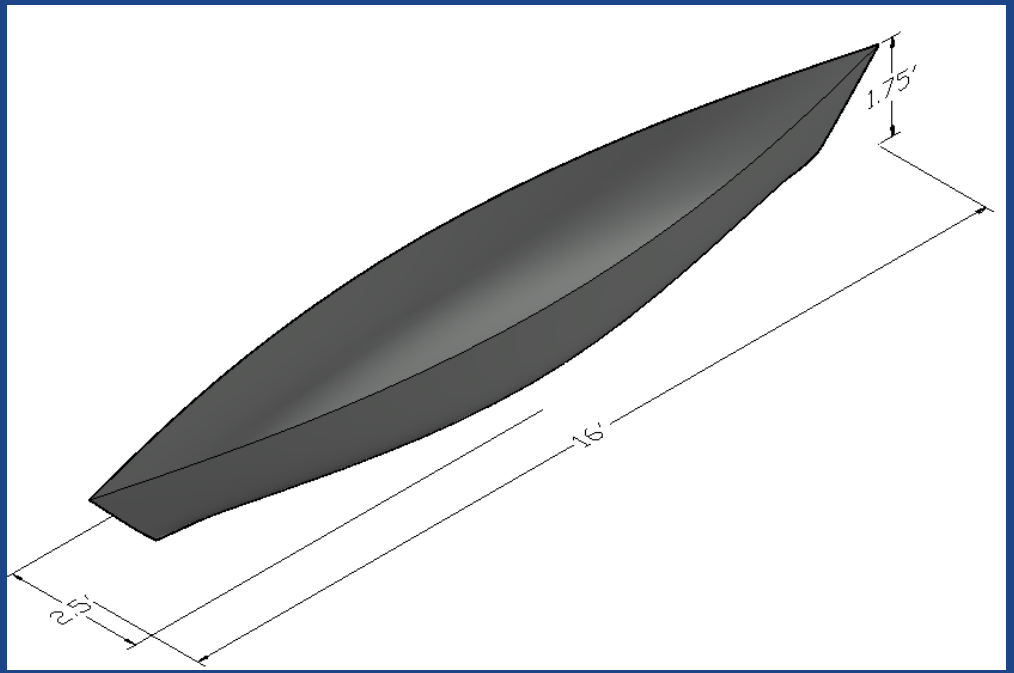
- Curing
  - 2 Layer maximum liquid membrane compound
- Prohibited Materials:
  - Bondo
  - Epoxy resins
  - Asphalt emulsions

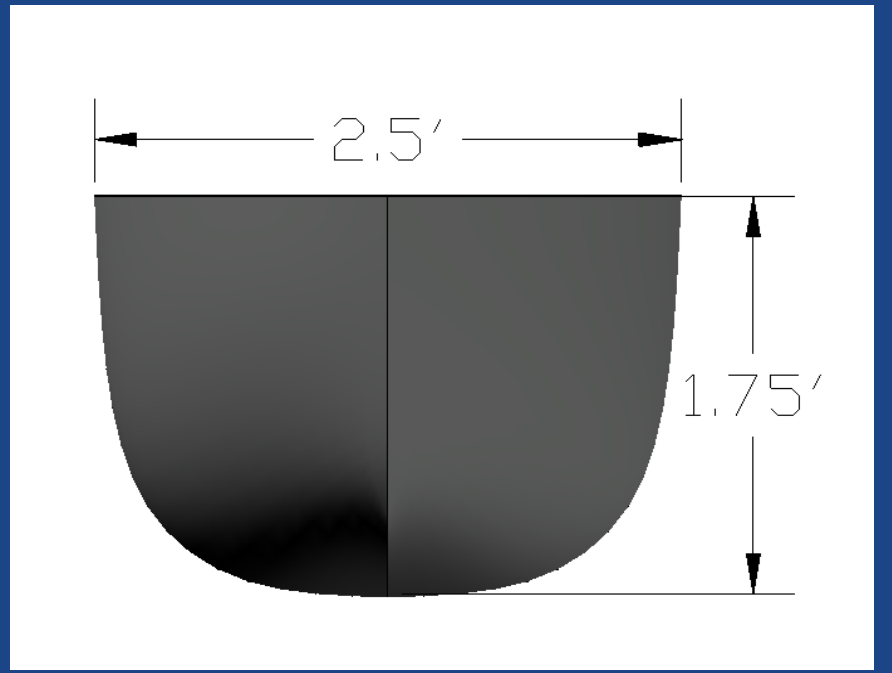
Admixtures	**ASTM**
Water Reducing & Set Control	C494
Air-Entraining	C260
Coloring Admixture/Agents & Concrete Pigments	C979
Specialty Admixtures	C494 (Type S)
Latex Emulsions	C1438

Realistic Constraints

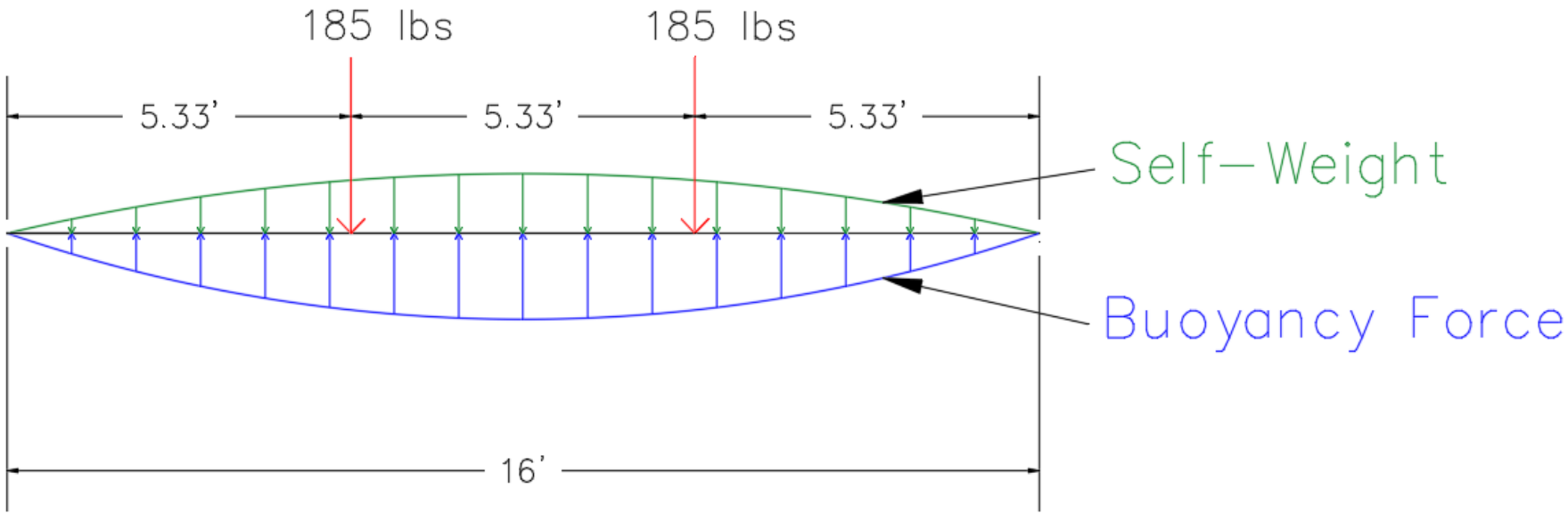
- Constructability
  - Mold
  - Workability
  - Canoe removal
  - Transportation of canoe
- Economic
  - Budget

Hull Design

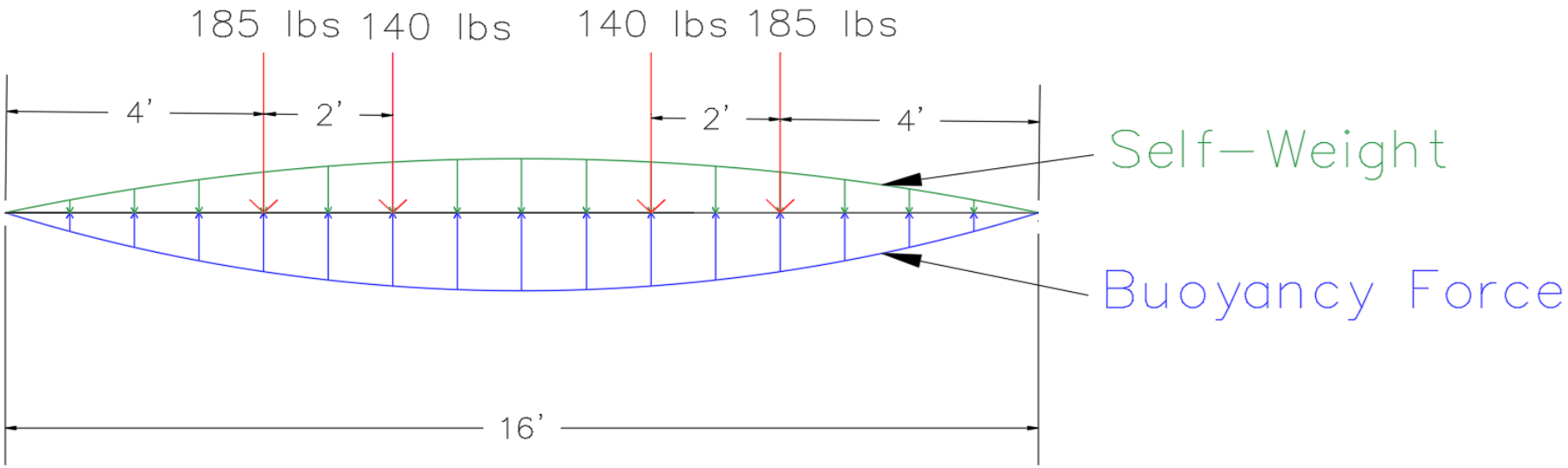


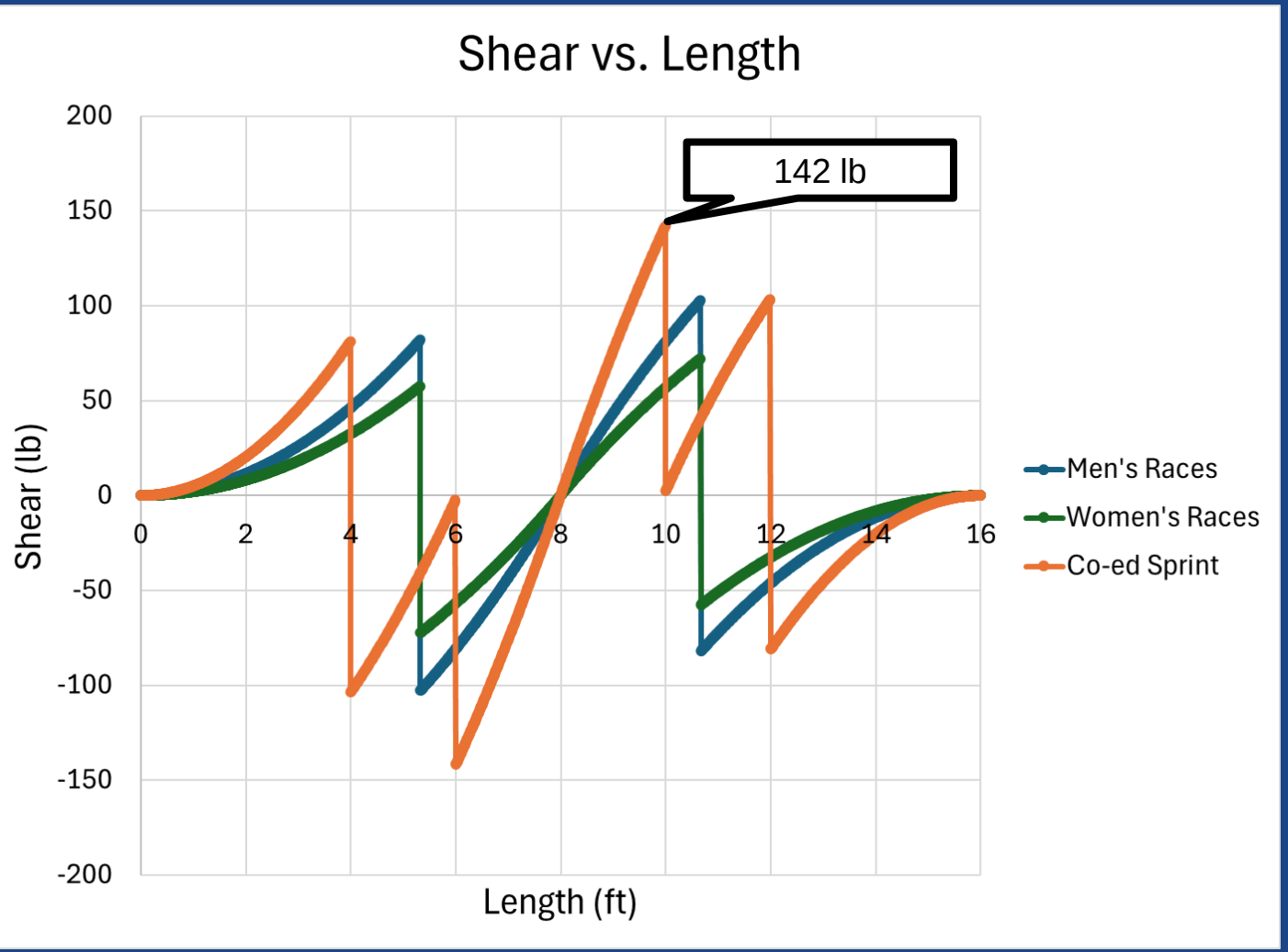


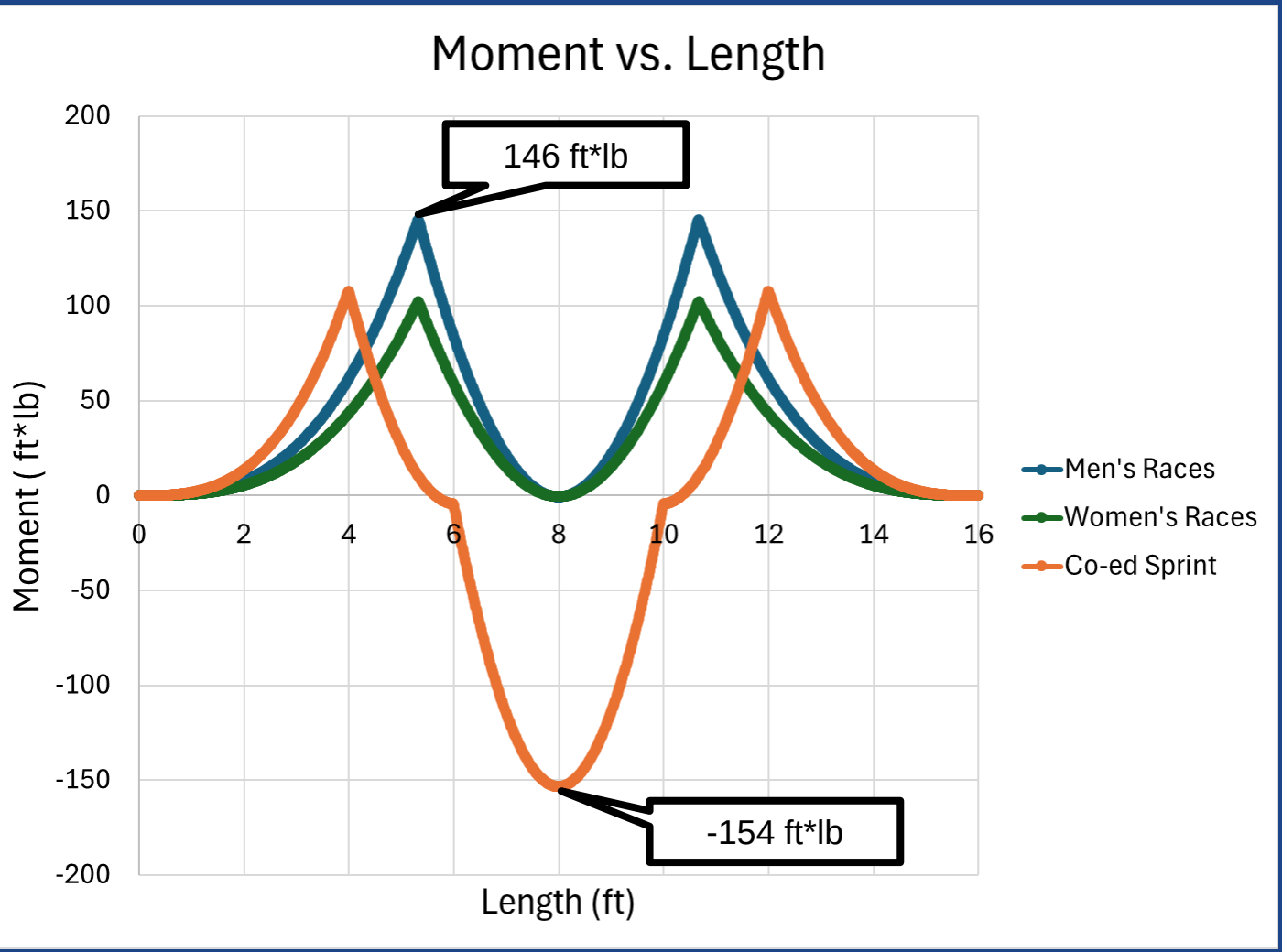
Structural Analysis



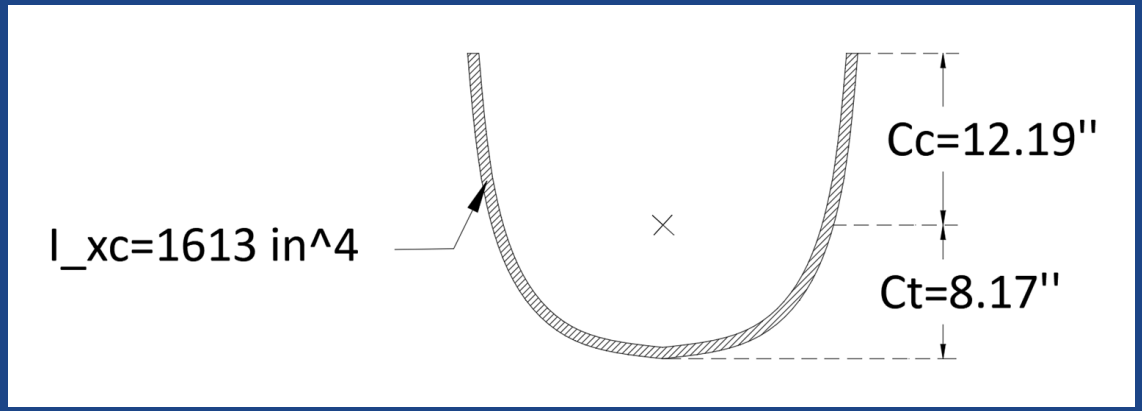
Structural Analysis (cont.)

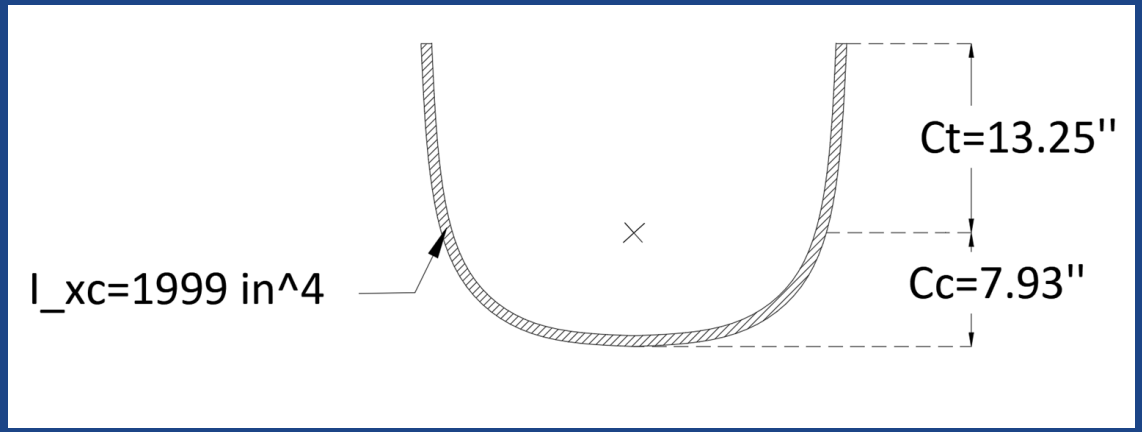



Shear vs. Length
142 lb
200
150
100
50
0
-50
-100
-150
-200
0
2
4
6
8
10
12
14
16
Shear (lb)
Length (ft)
Men's Races
Women's Races
Co-ed Sprint


Moment vs. Length
200
150
100
50
0
-50
-100
-150
-200
0
2
4
6
8
10
12
14
16
Moment (ft*lb)
Length (ft)
146 ft*lb
-154 ft*lb
Men's Races
Women's Races
Co-ed Sprint

Structural Analysis (cont.)





5 ⅓ feet:

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

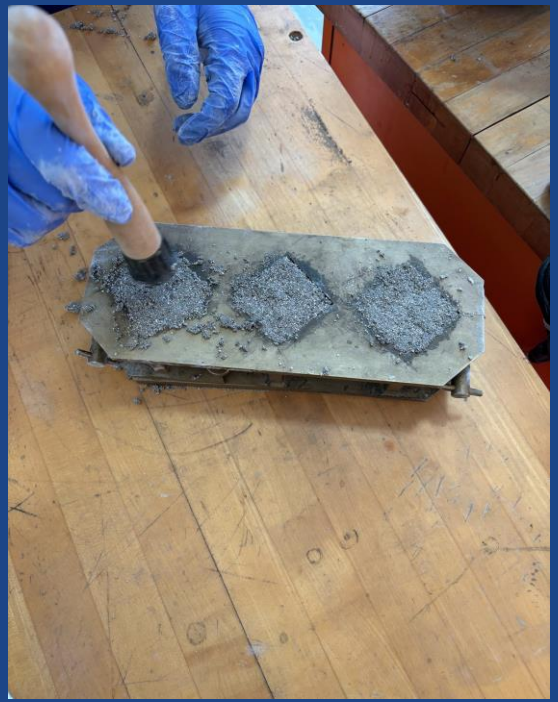
8 feet:

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

Mix Design

2024 TCNJ Mix Vs. University of Florida (Winner)

- Florida’s Mix:
  - More workable
  - Less compressive strength
  - Use of hydrated lime



Mix Design (cont.)

	Mix #3	Mix #4	Mix #5
Difference	Pumice	Finer Poraver	Less Materials
Unit Weight (pcf)	75	73	57
Compressive Strength (psi)	2324	1927	1007
Workability	**LOW**	**LOW**	**LOW**

Constructability

Sprayer:

Advantages

- Workability
- Construction Time

Disadvantages

- Unit Weight

Mix Design (cont.)

Admixtures:

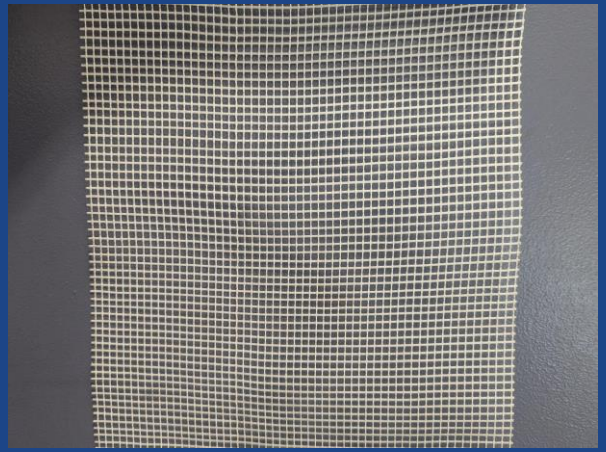
- Super Plasticizer
  - Increase Workability
- Air Entrainer
  - Reduces Strength
- Water Retarder
  - Slows curing process

Mix Design (cont.)

Material
Poraver (0.5mm-1mm)
Poraver (0.25mm-0.5mm)
Portland Cement
Slag Cement
Hydrated Lime
Water
Superplasticizer
PVA Fibers

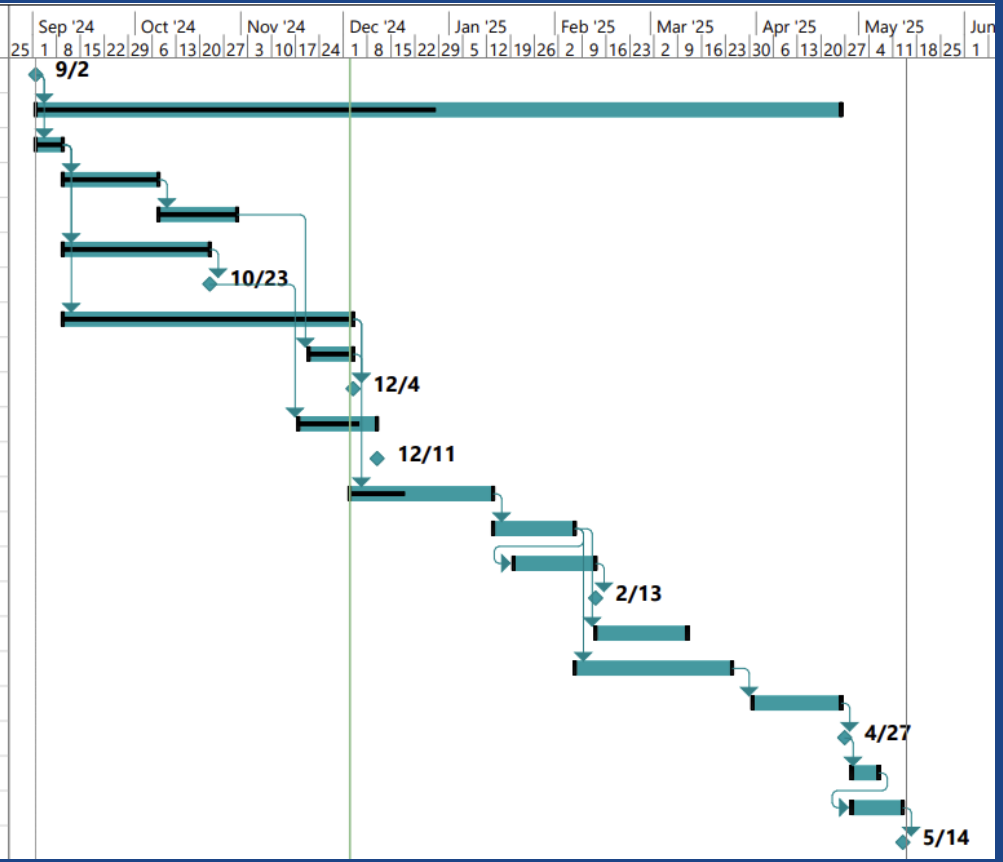
Compressive Strength (psi)	1599
Unit Weight (pcf)	61

Constructability (cont.)



Schedule

Task Name	% Complete
Project Start	100%
Fundraising	50%
Research	100%
Hull Design	100%
Structural Analysis	100%
Fall Quarterly Report	100%
Fall Quarterly Report	100%
Mix Design	100%
Engineering Services Presentation	90%
Engineering Services Presentation	90%
Engineering Services Proposal	80%
Engineering Services Proposal	80%
Order Materials	40%
Canoe Construction	0%
Competition Proposal	0%
Competition Proposal	0%
Spring Quarterly Report	0%
Canoe Cure and Removal	0%
Competition Preparation	0%
Competition	0%
Final Presentation	0%
Final Report	0%
Project Finish	0%



Engineering Costs

	Supervisor	Engineer II	Engineer I
Employees	1	1	4
Rate (per hour)	$80.00	$35.00	$33.00
Hours	10	51	204
Total Salary	$800	$1,790	$6,730
Combined Salaries		$9,320	
Overhead (150%)		$13,980	
Fixed Fee (10%)		$2,330	
Fall Total Cost		**$25,600**	
Expected Spring Cost		**$21,400**	
Total Cost		**$47,000**	

Questions?