



# Northern Arizona University

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# "Fear Nothing" Motto

- Goal: Improve across the board
  - Paddling
  - Fundraising
  - Concrete Mixture
  - Post-Tensioning Application
  - Aesthetics



**Figure 1:** 2015 Canoe Team



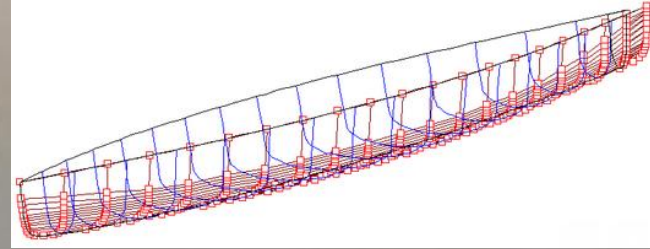
**Figure 2:** Practice Races



**Figure 3:** Paddle Practice

# Hull Design

- Shallow Arch Bottom
- 5-in rocker
- 21-ft long, 27-in wide
- Prolines
  - Optimum Speed 5.4 knots (6.2mph)



**Figure 4:** Prolines Hull Model

# Structural Analysis

- Max moment of 4-lbin/in
  - Two person loading analysis
  - Transverse direction
- Capacity of 30-lbin/in
  - Based on one layer reinforcement
  - Does not include ribs

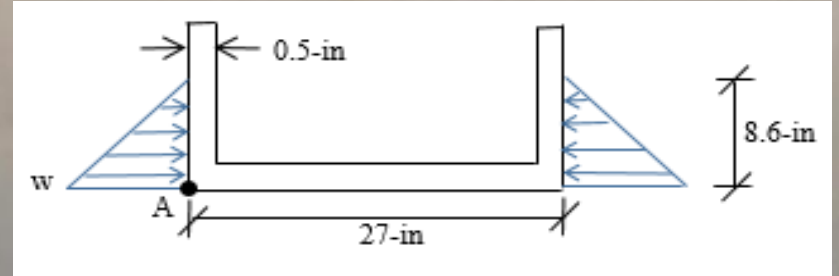


Figure 5: Transverse Free-Body Diagram

# Concrete Mix

- Final Constituents:
  - EkkoMAXX
  - Poraver (0.5mm-1mm)
  - 3M Glass Bubbles (S32)
  - MasterFiber M 100
  - MB-AE 90 Air Entraining Admixture
  
- What is EkkoMAXX?
  - Sustainable alternative to Portland
  - 100% fly ash based
  - Resistant to chemical attack
  - Reduced shrinkage
  - First time used for concrete canoes

Table 1: Final Mix Properties

Final Concrete Structural Mix:	
Wet/Dry Unit Weight	65.5/57.4 pcf
28 Day Compressive Strength	2150 psi
28 Day Tensile Strength	225 psi
28 Day Flexural Strength	725 psi

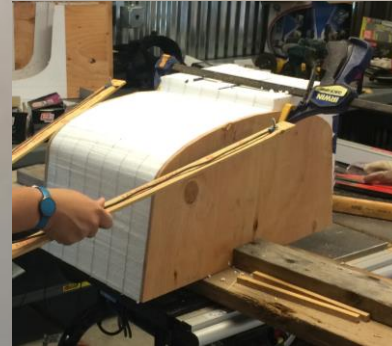


Figure 6: Concrete Mix

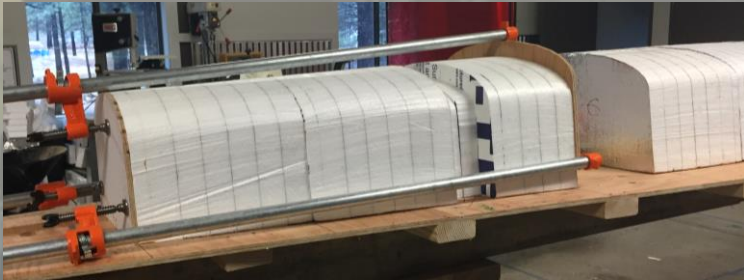
# Mold Construction



**Figure 7:** Cross-Section Cutout



**Figure 8:** Hot-Wire Cutting Foam



**Figure 9:** Gluing Cross-Sections



**Figure 10:** Finished Foam Mold

# Pour Day



**Figure 11:** Spraying Concrete Layers



**Figure 12:** Troweling Concrete Layers



**Figure 13:** Placing Post-Tensioning



**Figure 14:** Placing Reinforcement Mesh

# Post-Tensioning

- Provides 690-lbs of axial compression to increase flexural cracking load
- Six-7x7 galvanized steel tendons were placed symmetrically about the centroid
- Designed for 115-lbs of tension after calculated losses



Figure 16: Anchorage System



Figure 15: Tensioning System



Figure 17: Post-Tensioning Net



# Curing and Finishing



*Figure 18:* Curing Frame



*Figure 19:* Curing Tent



*Figure 20:* Sanding



*Figure 21:* Staining

# Aesthetics



**Figure 22:** Silicone Rib Mold



**Figure 23:** Rib in Canoe



**Figure 24:** 3D Elements in Bulkhead



**Figure 25:** Arizona Flag Stain



**Figure 26:** Flagstaff Night Sky Stain

**Presenting...**

# **Dreadnoughtus**



**Dreadnoughtus**

# Questions?

