UF ACI – Concrete Canoe Competition Project

David Orense

University of Florida

About the Concrete Canoe Competition

- The ASCE (American Society of Civil Engineers) National Concrete Canoe Competition (NCCC) provides students with a practical application of the engineering principles they learn in the classroom, along with important team and project management skills they will need in their careers. The event challenges the students' knowledge, creativity and stamina, while showcasing the versatility and durability of concrete as a building material.

Excerpt from article on Concrete Canoe on Wikipedia
https://en.wikipedia.org/wiki/Concrete_canoe

The 2019 UF Concrete Canoe Team

Each year, a team of undergraduate student design leads and volunteers work at the University of Florida to design and construct a concrete canoe for the ASCE regional and national competitions.


RESEARCH AND
DEVELOPMENT

Research and Development

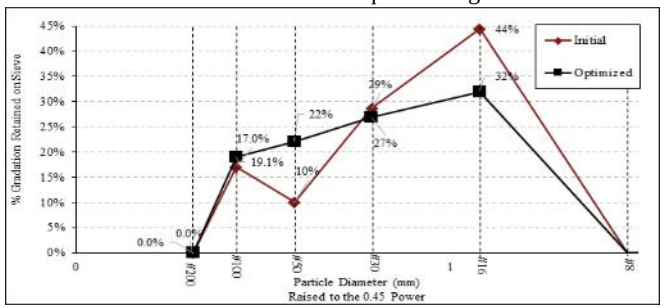
- Development of rule-compliant mortar designs
  - ASTM C330 Aggregate Requirement
  - Specified documentation of ingredients
- Design parameters
  - Workable for hand placement
  - Lightweight for buoyancy
  - Structural at 7 days
- Over 40 trial batches conducted over a 6-month testing program

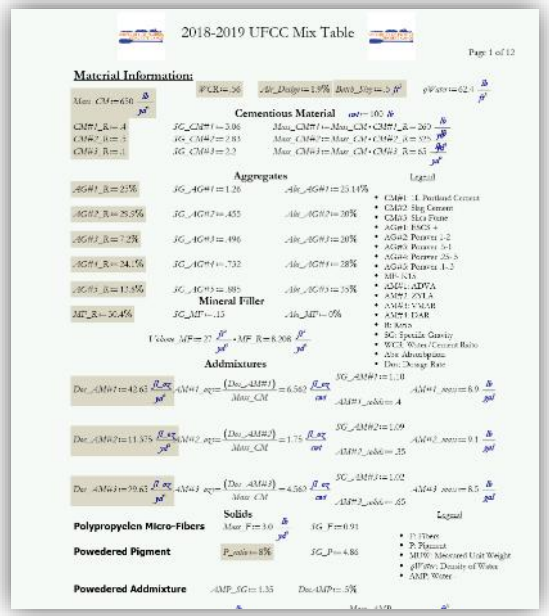

DESIGN

The Design Process

$$P(D) = \frac{D^q - D^q_{min}}{D^q_{max} - D^q_{min}}$$

P = Optimized % Volume
D = Particle Diameter
q = Packing Coefficient





- Preliminary Research
  - Academic knowledge and faculty
  - Industry contacts
- Focus on *aggregate optimization*
  - Reduce concrete unit weight
  - Improve strengths to reduce required cement content
- MathCAD integration for QC on mix designs

CEMENTITIOUS MATERIALS

Component	Specific Gravity	Volume (ft³)	Amount of CM (mass/volume) (lb/yd³)	
Portland Cement Type 1L	3.06	1.414	270	Total Amount of cementitious materials 540 lb/yd³ c/cm ratio 0.5
Slag Cement	2.83	1.529	270	

FIBERS

Component	Specific Gravity	Volume (ft³)	Amount of Fibers (mass/volume) (lb/yd³)	
Polypropylene Micro-Fibers	.91	0.05	3.0	Total Amount of Fibers 3 lb/yd³

AGGREGATES

Aggregates	ASTM C330	Abs (%)	SG_{OD}	SG_{SSD}	Base Quantity (lb/yd³) OD	Base Quantity (lb/yd³) SSD	Volume (ft³)
Riverlite ESC	Yes	25.14	1.01	1.26	134.644	168.494	2.143
Poraver® 1.0-2.0mm	No	20.00	0.38	0.46	66.118	79.342	2.795
Poraver® 0.5-1.0mm	No	20.00	0.41	0.50	21.446	25.735	0.831
Poraver® 0.25-0.5mm	No	28.00	0.57	0.73	68.215	87.315	1.912
Poraver® 0.1-0.3mm	No	35.00	0.66	0.89	36.468	49.232	0.892

ADMIXTURES

Admixture	lb/gal	Dosage (fl. oz / cwt)	% Solids	Amount of Water in Admixture (lb/yd³)	
ADVA® 600	8.9	10.00	40.00	2.25	Total Water from Admixtures, $\sum_{Wadmx}$ 5.12 lb/yd³
ZYLA® 310	9.1	1.45	35.00	0.362	
V-MAR® 3	8.5	4.56	65.00	0.572	
DAREX® AEA	8.5	5.72	5.80	1.933	

SOLIDS (LATEX, DYES, POWDERED ADMIXTURES, AND MINERAL FILLERS)

Component	Specific Gravity	Volume (ft³)	Amount (mass/volume) (lb/yd³)	
S38 Glass Microspheres	0.38	9.45	224.08	Total Solids from Admixtures 267.28 lb/yd³
Increte® Pigment	4.86	0.14	43.2	

WATER

	Amount (mass/volume) (lb/yd³)		Volume (ft³)
Water, lb/yd³		w: 297.00	4.76
Total Free Water from All Aggregates, lb/yd³		$\sum_{Wfree}$: -82.265	
Total Water from All Admixtures, lb/yd³		$\sum_{Wadmx}$: 5.119	
Batch Water, lb/yd³		W_{batch}: 374.146	

DENSITIES, AIR CONTENT, RATIOS AND SLUMP

	cm	fibers	aggregates	solids	water	Total
Mass of Concrete, M, (lb)	540	3	410.118	267.28	297.00	$\sum M$: 1517.4
Absolute Volume of Concrete, V, (ft³)	2.943	0.053	8.572	9.592	4.76	$\sum V$: 25.92
Theoretical Density, T, ($=\sum M / \sum V$)	58.542 lb/ft³		Air Content [= (T − D)/T x 100%]			4.1%
Measured Density, D	56.2 lb/ft³		Slump, Slump flow			4.5 in.
water/cement ratio, w/c:	1.1		water/cementitious material ratio, w/cm:			.55


CONSTRUCTION

Pour Day

- Concrete production / placement
- High student volunteer involvement (30+)
- Management and teamwork skills
- Mortar – carbon fiber composite

FINAL PRODUCT

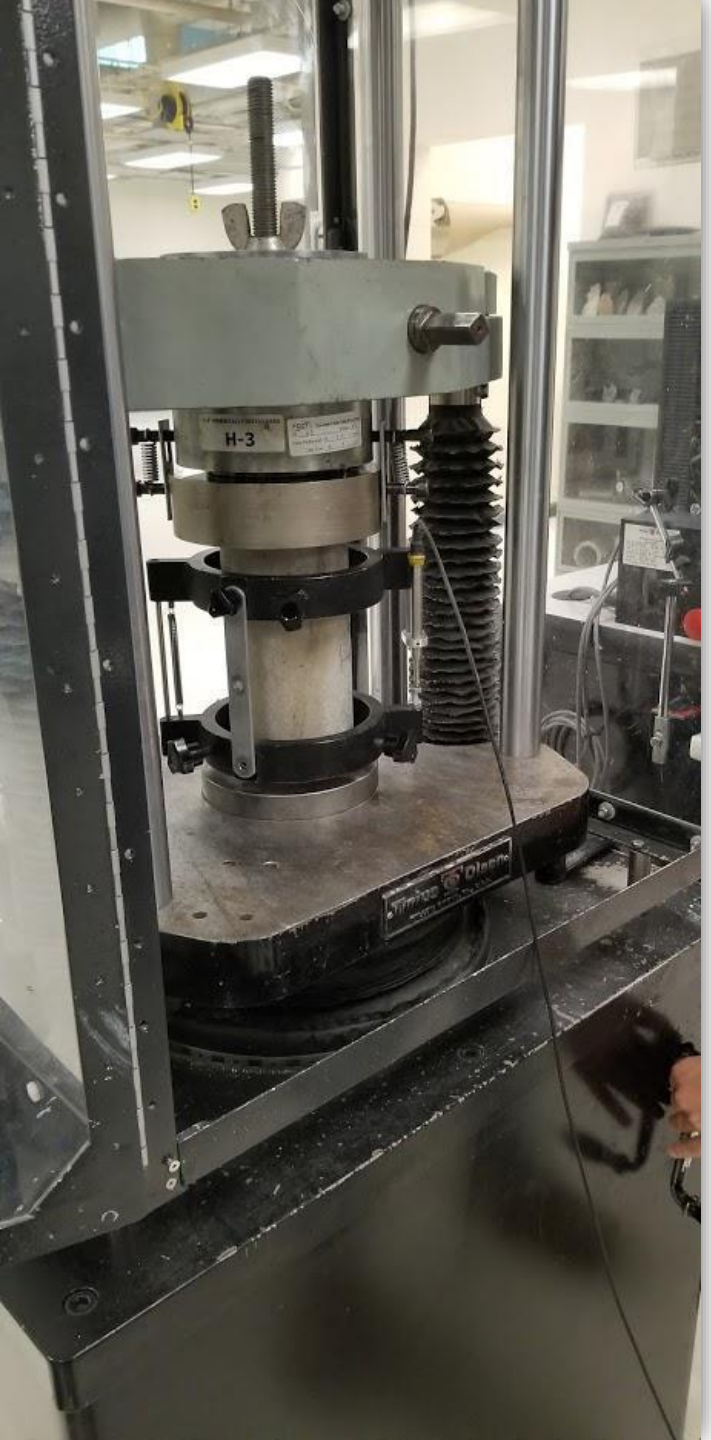


Table 2: Free Floatin' Mixture Properties			
Property	**Core**	**External**	**Aesthetic**
Wet Unit Weight (pcf)	56.3	56.2	58.0
Oven-Dry (OD) Unit Weight (pcf)	45	43	51
7-day Compressive Strength (psi)	2400	2050	1500
7-day Tensile Strength (psi)	143	92	102
7-day Composite Flexural Strength (psi)	722.5		N/A
Air Content (%)	4.1	4.1	1.9

FREE FLOATIN'

Table 1: *Free Floatin' Specifications*	
Name	*Free Floatin'*
Weight	160 lbs.
Primary Colors	Maroon, Gray, Black, White
Primary Reinforcement	Kevlar® woven carbon fiber
Secondary Reinforcement	Polypropylene Micro-Fibers
Maximum Length	21.8 ft.
Maximum Width	2.10 ft.
Average Thickness	½ in.
Maximum Depth	1.15 ft.

CONFERENCES

ASCE Southeast Regional Conference

Concrete Canoe Southeast Regional Competition

Knoxville, TN March 28th-31st, 2019

25 schools competed in Concrete Canoe.

Each school was judged in 4 categories:

- Design Paper
- Presentation
- Final Product Display
- Race

UF won 1st in all 4 categories and moved forward towards Nationals in Melbourne, FL in June 2019!

National Concrete Canoe Competition

Concrete Canoe National Competition

Melbourne, FL June 6th-8th, 2019

- 20+ schools worldwide

Awards:

- Oral presentation 1st
- Design Paper 1st
- Final Product 2nd

UFCC 1st Place Overall Champions!

COMPETITION RESULTS

CONGRATULATIONS TO THE UNIVERSITY OF FLORIDA — WINNER OF THE 2019 ASCE NATIONAL CONCRETE CANOE COMPETITION

Lessons Learned

- Take pride in technicality
- Prioritize your team and its members
- Think outside the box
- Success is more than a trophy

Starting ACI at University of Florida

We were last active in 2013.

How can we move forward as a new student chapter?

Thank You!