NORTHERN ARIZONA UNIVERSITY

Memorandum

CENE 486: Capstone

To: Mark Lamer, P.E., CENE 486 Grading Instructor

Cc: Bridget Bero, Ph.D., P.E., Wilbert Odem, Ph.D., P.E., and Alarick Reiboldt, EIT, CENE 486 Instructors

From: North Star Engineering: ASCE 2015-16 Concrete Canoe Team
Evan Kaichi, Chelsie Kekaula, Brent Lipar, Colton McConnell, and Emily Melkesian

Date: January 25th, 2016

Re: Technical Advising Meeting #1

Attendance: Evan Kaichi, Chelsie Kekaula, Brent Lipar, Colton McConnell, Emily Melkesian
Prepared by: Chelsie Kekaula

Topic	Notes
Reinforcement	• Consider adding reinforcement along the center of the canoe • Post tensioning: test of losses and use the tightest corner • Consider looking up post-tensioning methods by other schools
Concrete	• Concrete properties: 2023 psi and 59.7 pcf • Discuss what first crack and cracking moment is
Structural Analysis	• Brent went over his waterline calculations, buoyant force calculations and flexural capacity sheets with Tommy to check for any errors and to make sure values are reasonable
Construction Management	• Finishing: should we spray our sealant? • Finishing: test different mold releasing agents to avoid the crack along the center of the canoe

Due Date	Topic	Description	Presenter
1/25/2016	Cylinder curing	Set cylinders in water to cure Weigh the rest of the cylinders	Chelsie
1/27/2016	Mixing composites	Wednesday night (28-day data by 2/24)	Chelsie
1/27/2016	Paddling	Send out email	Chelsie
2/1/2016	14-day breaks	Do we need to over dry before breaking	Chelsie
2/2/2016	Capstone Presentation	Presenting next week Tuesday	Chelsie and Brent
2/12/2016	Design Report	Start as soon as possible	All

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From: North Star Engineering: ASCE 2015-16 Concrete Canoe Team
Evan Kaichi, Chelsie Kekaula, Brent Lipar, Colton McConnell, and Emily Melkesian

Date: February 1, 2016

Re: Technical Advising Meeting #2

Attendance: Evan Kaichi, Chelsie Kekaula, Brent Lipar, Colton McConnell, Emily Melkesian
Prepared by: Emily Melkesian

Topic	Notes
Structural	• Remember in calcs that reinforcement cannot take any compressive loads • Take percent open area into consideration for calcs with reinforcement • Cracking moment calculations, make sure concrete cracks prior to reinforcement breaking • Wobble coefficient calculation for post-tensioning • Although post-tensioning cable curves around canoe, can treat it as a straight line in calculations
Concrete	• Shrinkage testing, just take measurements in the longitudinal direction • Shrinkage is calculated as a percentage or as in/in, multiply canoe length by length of canoe to determine actual length after curing • Can test shrinkage for pcc, compare difference with canoe mix
Reinforcement	• 2 layers of reinforcement vs 1 layer- 2 not necessarily needed due to strength and structural calcs, 2 layers could aid in preventing cracking from de-molding process and transportation • Multiple layers in canoe could possibly hinder bonding of concrete layers, delamination of canoe • With overlap samples, make sure concrete fails prior to reinforcement, can make samples with 2 layers of reinforcement • Overlap tests can be done at 7 days, make a cylinder with overlap samples • Create test rig for post-tensioning?
Construction Management	• When carving out bulkheads, make sure to account for post-tensioning block-outs for bow and stern • Canoe curing time affects time for sanding, patching, polishing, and sealing- determine time for activities to determine time available for moist curing in incubator • 28 days would be optimal for canoe to cure, don't have 28 days to fit within schedule

	• Can start finishing process while canoe is still curing (patch mix has to cure) • Can taper off number of humidifiers while curing , not necessary • Best way to get mold out of canoe (want to prevent cracking during de-molding process)- hanging canoe (gravity), more form oil, test different release agents • Create test rig for post-tensioning?

Action Items	Notes	Due Date
Structural	Continue working on calcs	ASAP
Concrete	Determine overall shrinkage of canoe once shrinkage tests are done	ASAP
Reinforcement	Finalize overlap length for reinforcement sections, determine whether to place 1 or 2 layers in canoe, finalize post-tensioning net	2/4/16
Construction Management	Research/test other release agents for canoe mold	ASAP

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From: ASCE 2015-16 Concrete Canoe Team
Evan Kaichi, Chelsie Kekaula, Brent Lipar, Colton McConnell, and Emily Melkesian

Date: February 8, 2016

Re: Technical Advising Meeting #3

Attendance: Evan Kaichi, Chelsie Kekaula, Brent Lipar, Colton McConnell, Emily Melkesian
Prepared by: Chelsie Kekaula

Topic	Notes
Concrete	• Final mix has a compressive strength of 1950 psi, dry unit weight 59 pcf • 28-day compressive strength test will be done next week Monday • On pour day should we have 6 cylinders? (3 unbroken, 3 split for display?) • Flexural strength: do we need to have a first crack and ultimate strength? – we would get that from doing the flexural capacity test and marking at what deflection and load the first crack appears. For flexural capacity testing, look into finding a spring compressing ring • Should pre-batch at least a day in advance
Structural Analysis	• Brent checked structural calculations with Tommy to make sure all values obtained were reasonable
Reinforcement	• We picked a 4-in overlap • We noticed that they had a layer of reinforcement around the gunwale and ribs. We have also chosen to place a layer of reinforcement along the center of the canoe in the longitudinal direction; how would we determine what thickness to choose? Our judgement – maybe about 4 to 6 inches • How should we test losses associated with post-tensioning? We need to do testing, no way to just calculate accurately
Construction Management	• We cut our bulkheads and have shrink-wrapped the table • The mold is currently screwed to the table • We also checked our pour day schedule with Tommy to make sure we didn't miss anything • We also had our post-tensioning structure checked by Tommy to comment on any improvements, he said that it would be helpful to have a structure with an adjustable height • For curing, ask CeraTech what curing agent they would use and how to use it

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From: North Star Engineering: ASCE 2015-16 Concrete Canoe Team
Evan Kaichi, Chelsie Kekaula, Brent Lipar, Colton McConnell, and Emily Melkesian

Date: March 19th, 2016

Re: Technical Advising Meeting #4

Attendance: Evan Kaichi, Chelsie Kekaula, Brent Lipar, Colton McConnell, Emily Melkesian
Prepared by: Brent Lipar

Updates

Updates	Notes
Construction	Canoe has been poured

Topics

Topic	Description

Structural Analysis	• Post-tensioning Calculations:
	  • What is the curvature frictional losses?
	  • The equation for curvature frictional losses has a dalpha in it and was wondering how that worked?
	  • What would the best way to test the anchorage losses be?
	  • Is there any other way to typically determine the anchorage losses through calculations?
	  • What are the stresses that we are comparing to determine how much tension we will be applying to each strand?

Construction	• Looked at the "live" end of canoe to see how it was and how we were going to post-tension it.
	• Questions:
	  • Best way to crimp it?
	  • Which way do you think the canoe will fail when the tendons are being applied tension?

Tommy's Answers	• Post-Tensioning Calculations: • It is the losses due to the contact between the duct and the wire across the entire canoe.

	• Dalpha is the change in angle between the bow and the stern ends for the tendon. • Use the post-tensioning jig and apply to the end which will hold the turnbuckles • In the field, it is common to determine losses through the elongation of the tendon. So for how much tension is being applied it will elongate correspondingly due to PL/AE. • You are to compare the stresses at the critical section of the canoe experiencing the most stress in tension and then determining how to apply to create a "0" psi system. Just need to verify that the compressional stresses along the canoe does not exceed the compressional strength of the concrete. • Construction: • There is no good way to crimp it without crimpers. Last year used bolt cutters, and that is really sketch. • Well unfortunately due to the construction of the bulkhead and how you are going to have to tension the tendons, I would say it would fail due to a splitting failure. Meaning that the tendons would pull out of the canoe toward the external face and take all the reinforcement and concrete with it.

Action Items

Task	Team Member	Due Date
Finalize Post-Tensioning Calculations	Brent Lipar	2/27/2016