OREGON STATE UNIVERSITY

2020 CONCRETE CANOE

DESIGN PAPER

VINIFERA

Section B. Cover Letter & Project Understanding

School Name: Oregon State University

Canoe Name: *Vinifera*

This certificate represents Oregon State University's complete compliance as follows:

- All specifications in the *2020 National Concrete Canoe Competition Request for Proposals* have been adhered to.
- All Material Technical Data Sheets (MTDS) and Safety Data Sheets (SDS) have been read by the team.
- The Oregon State University Concrete Canoe Team acknowledges receipt of Addendum 2 - the Request for Information (RFI) Summary and has reviewed all responses provided.
- All registered participants are qualified National Student Members of ASCE and meet all eligibility requirements as specified in the rules and regulations of the National Competition.

Registered Participants:

PARTICIPANTS:	ASCE NATIONAL MEMBER ID:	PARTICIPANTS:	ASCE NATIONAL MEMBER ID
Brandon Conrad	11853970	Madison Hall	11174511
John Henderson	11946337	Haley Madland	10947346
Brendan Gilbreth	11932031	Anna Beran	11924582
Alan Chew	11949454	Maura Patterson	11299338
Omar Torres	11946342	Daisy Mulligan	11930051

We hereby certify that the above information is true and valid to the extent of our knowledge.

Signature: Thomas H. Miller

Date: 02.12.2020

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Signature: Madison Hall

Date: 02.12.2020

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Section C: Table of Contents

Section D: Executive Summary

This year the OSU Concrete canoe team created *Vinifera.* Themed after the lush vineyards that populate the Willamette Valley, *Vinifera* is named after the Latin name of the common grape, *Vitis Vinifera.* Vineyards were decided as the theme for this year by popular vote, after a discussion of what theme would best represent engineering, fun, and Oregon. From the trellis structures that are built to structurally support the vines, to the irrigation systems that are used to keep them watered, vineyards showcase many disciplines within civil engineering. *Vinifera* stands as testament to the capabilities of young engineers.

Canoe Prototype Dimensions	
Length	20 ft
Width	24"
Depth	14"
Thickness	½"
Weight	240 lb

Table 1: Canoe Prototype Dimensions

The largest innovation this year consisted of changing the formwork of our canoe. In previous years, the team created a formwork by filling the gaps between wooden ribs with cut and glued insulation foam. The team would then sand down the foam to the correct hull shape. Not only was this a waste of person hours, but a waste of material. Approximately half of the foam purchased was sanded off and thrown away.

Property	Determined Value
Compressive Strength (28 Days)	1070 psi
Tensile Strength (28 Days)	150 psi
Concrete Composite Flexural Strength (28 Days)	160 psi
Density (hardened concrete)	63 lb/ft^3
Density (fresh concrete)	75.4 lb/ft^3
Density (Oven dry)	55.4 lb/ft^3
Slump, Spread	0 in
Air Content	34.7%

Table 2: Mixture Design Properties

Figure 1: Wooden paint stick mold

Vinifera's new formwork consists of paint sticks laid between our 1" thick plywood ribs (Fig 1). This method was easily learned by new members. Instead of the multi-step process that was required to create the foam formwork, the paint stick formwork simply had to be stapled onto the plywood ribs, creating an easier, faster, and more efficient process.

Changes have also been made to *Vinifera's* mix from previous years. Last year, OSU used cork as a primary aggregate for the first time. Because the team was satisfied with the material properties of cork within the mix, it was decided that cork would also be the primary aggregate for *Vinifera.* To further increase the sustainability of *Vinifera,* recycled cork was purchased in combination with recycled expanded glass beads. In the end, *Vinifera* was constructed out of approximately 75% recycled materials by volume.

Additionally, in order to solve consolidation issues that were present in early test mixes this year, a new cellulose based organic VMA (Viscosity Modifying Additive) was added as a replacement for latex.

The Oregon State Concrete Canoe team is proud to submit *Vinifera*, an environmentally friendly design that prioritizes efficiency and ease of construction as our submittal to the 2020 NCCC RFP.

Section E: Introduction to Project Team
ASCE Student Chapter Profile

ASCE was founded in 1852 to represent members of the civil engineering profession worldwide, making it the oldest national engineering society in the United States. Today, it is headquartered in Reston, Virginia. Currently, the National President of ASCE is K.N. Gunalan and the Oregon Section President is Bahaar Taylor. On the student chapter level, OSU ASCE Student Members are more likely to interact directly with the Oregon Section; however, it is important for chapter leaders to understand the society outside of school, on all the branch, section and national levels.

The Oregon State ASCE Student Chapter has been in existence since 1921. There were only six student chapters started before that, and they were established in 1920. Today, the OSU ASCE Student Chapter is an exciting body of people who work hard to compete at the annual Pacific Northwest Student Conference while also participating in other chapter activities, such as: community service, outreach projects, professional speaker meetings, field trips, and networking events.

Recently, the OSU ASCE-SEI group was formed and awarded with STAY Grants for 2019 and 2020 to encourage students to remain in ASCE after graduation. OSU students and YMF professionals were able to tour two construction projects in Portland during 2019, a reservoir and courthouse. In 2020 we are planning to hold a Portland Timbers soccer game event to provide further opportunities for students and professionals to get to know each other and discuss ASCE and CE careers.

A yearly community service and outreach project is the Jacobs/OSU High School Bridge Contest. 2020 will mark the 51st year for this event. High school students design and build basswood bridges and test their strength and efficiency. Student Chapter Members volunteer by checking specifications, loading bridges, and fielding questions from high school students, parents, and their teachers – while having fun! Other community service activities include highway cleanups with the OSU ITE student chapter, Habitat for Humanity projects, STEM outreach and food drives.

Each year, members, officers, and captains alike work to make Oregon State a leading ASCE Student Chapter and a competitive Concrete Canoe Team. By recruiting in our fall term, the chapter hopes to capture new students and continue to engage with returning members. At the end of each term, the ASCE Student Chapter hosts a bowling and billiards night. During this event, students can bowl, play billiards, and eat free pizza and snacks. Student Chapter leaders intentionally plan this event to occur right before final exams. This is seen as a way for members to get together, destress, and support each other.

In summary, the OSU ASCE Student Chapter is consistently working to offer a range of activities that serve and impact its members and community. Through dedication and determination, the chapter strives to be among the top student chapters in the country.

Section E: Introduction to Project Team

Core Team Members

Haley Madland - Team Captain: assumes ultimate responsibility for the team
Madison Hall - Team Captain: assumes ultimate responsibility for the team
Joey Biever - Mix Design Lead: created the concrete mixture design
Brandon Conrad - Mix Design & Paddling Lead: led the mix and paddling teams
Maddy Rozansky - Construction Lead: helped run construction meetings
Gabe Olson - Construction Lead: helped run construction meetings
Rawan Al Naabi - Hull Design Lead: created this year's hull design
Mila Gaston - Hull Design and Safety Lead: created this year's hull design and a safety plan for the build space
Reilly Evermore - Hull Design Lead: created this year's hull design
Trevor Nakasone - Academics Lead: formatted and edited this year's technical paper
Rachael Ramsey - Academics Lead: formatted and edited this year's technical paper
Emily Caro - Aesthetics Lead: designed this year's team theme
Grace Anders - Aesthetics Lead: designed this year's team theme
Andrew Garcia - Social Media Lead: kept the club's online social media presence active
Wesley Lum - Member: assisted in the project schedule, pre-tensioning and construction
Dom Daprile - Member: guided the mixture design team, offered experience and knowledge
Cooper Frantz-Geddes - Member: consistently assisted both aesthetics and construction teams
Kyong Yi - Member: took lead's headshots, assisted aesthetics and construction teams
Tom Close - Member: created and organized fundraising documents for yearly email campaign
Quaid Ebanks - Member: designed and built the cross-section, helped facilitate construction
Nathan Schremser - Member: worked with the construction team on all phases of the project
Kevin Ero - Member: involved with the construction and mixture design teams
Diana McClure - Member: worked with the mixture design team weekly
Maura Patterson - Paddler: mentored the new paddlers, helped lead the paddling effort this year
John Henderson - Paddler: consistently attended paddling, construction and mix meetings
Anna Beran - Paddler: worked with the paddling and construction teams
Brendan Gilbreth - Paddler: attended both construction and paddling meetings
Alan Chew - Paddler: assisted paddling and construction teams
Daisy Mulligan - Paddler: worked with the paddling and mixture design teams
Omar Torres -Paddler: attended paddling and construction meetings
Macey Winter - Back Up Paddler: attended paddling and construction meetings
Cody Irish - Back Up Paddler: attended paddling meetings

TEAM CAPTAINS

Performed project scheduling & budgeting.
Oversaw management & task delegation of the project.

AESTHETICS MANAGERS

Created apparel design, canoe aesthetic, design paper, presentation, display, and stand.

CONSTRUCTION MANAGERS

Directed the construction of the formwork, canoe, and mockup.

ACADEMICS MANAGERS

Produced final technical deliverables.

MIX DESIGN MANAGERS

Researched & tested experimental concrete mixes.

PADDLING MANAGER

Trained paddlers & routinely held wet & dry practices.

STRUCTURAL ANALYSIS & HULL DESIGN MANAGERS

Designed hull geometry & performed structural analysis for loading conditions.

SPECIAL THANKS

Santiam Christian School
Dr. Thomas Miller – Faculty Advisor
Mila Gaston – Safety Manager
Andrew Garcia – Social Media Manager
Oregon State University - College of Engineering

Section F - Technical Approach to the Overall Project

The OSU concrete canoe team creates a unique hull design every year. Although this is not required in the NCCC RFP, OSU does this in order to update, modify, and improve upon our previous hull designs. This allows team members to grow as designers and creates a fluid and ever-changing OSU design.

One key aspect of this year's design is its length. Last year, OSU's *Stinger* was 18' long, two feet shorter than the prior year's *Gorgeous*. A shorter canoe has the upper hand in terms of maneuverability, while a longer canoe can reach a higher top speed on straightaways. This year, the team decided to re-prioritize speed, and drew inspiration from the 20' long design of *Gorgeous.*

In the past, the hull design team has struggled with making the sides of the canoe perfectly symmetrical. Any inconsistency in the shape of the hull can cause the canoe to be unstable and difficult to paddle, but the methods used for forming and pouring a canoe make these small inconsistencies inevitable. This year, the hull design team tackled this issue by using a shallow arch hull (as shown in Table 3) to maximize stability and adding a pointed keel and moderate rocker for increased efficiency and maneuverability.

Every year, the hull design team constructs two bulkheads to be included in the final canoe. From past experience, a common problem with this process is that the bulkheads turn out with a dull leading edge.

Figure 2: Bulkhead Construction

The increased length of this year's canoe was one of the main factors to alleviate this issue. The additional two feet compared to last year allowed the hull design team to increase the length of the bulkheads, which could then be brought to a more gradually tapered point. As opposed to the softly rounded design from last year, *Vinifera's* pointed, narrow bulkheads make it much easier for paddlers to maneuver in the water- a beneficial characteristic of short canoes- all without sacrificing the canoe's overall length.

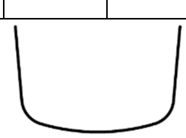
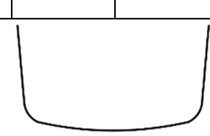
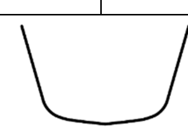
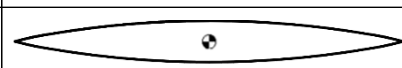
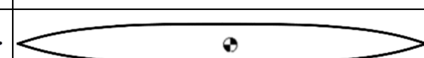
Year	**2018 - *Gorgeous***				**2019 - *Stinger***				**2020 - *Vinifera***			
Advantages	High Secondary Stability, Balanced Tracking & Maneuverability				Secondary Stability & Tracking, Medium Freeboard, Primary Stability, Maneuverability				High Top End Speed, Maneuverability, Moderate Draft			
Disadvantages	High Draft				Moderate Balance, Low Draft				Secondary Stability			
Specifications	**Length**	**Width**	**Depth**	**Chine**	**Length**	**Width**	**Depth**	**Chine**	**Length**	**Width**	**Depth**	**Chine**
	20ft.	24in.	14 in.	2 in.	18 ft.	25 in.	14 in.	3 in.	20 ft.	24 in.	14 in.	3.5 in.
Shape of Cross Section (To Scale)												
Plan View												

Table 3: Hull Design Comparison

While this year's design was built upon OSU canoes of years past, there have been some major innovations. The keel was sharpened along the span of the hull in order to assist in turning, stability, and tracking. The chine was increased from 3" to 3.5" for improved maneuverability (see Table 3). The depth of the canoe has remained the same from past years, but to prevent water from pooling inside, *Vinifera's* sides and gunwales are flared, which keeps out splashing water from the paddles.

A baseline self-weight of 240 lbs. for the canoe was determined by measuring the weight of the practice canoe. Loading scenarios including transportation, display, and two paddling scenarios were analyzed. Structural analysis was simplified and the canoe was modeled as a two-dimensional beam. These scenarios are in addition to those required for the competition structural calculations. All of those in Fig. 3 do not include the self-weight for simplicity.

The transportation loading scenario was modeled as a fully supported beam as shown in Figure 3(a). The display scenario in Figure 3(b) was modeled as the self-weight of the canoe resting on two supports 4' from each end.

The two-paddler scenario is modeled in Figure 3(c), with each paddler 4' away from bow and stern. The four-paddler scenario is modeled in Figure 3(d), the two paddlers in the outer positions are 4' from the ends of the canoe and paddlers 4' away from each other. A weight of 165 lb was chosen as an average for both the male and female paddlers. A factor of 1.2 was included in the calculations to account for dynamic loading. In both paddling scenarios, paddler locations were acting as supports and a triangular load was used to represent the buoyant force, with more displaced water near the center of the canoe compared to the ends.

The bending moments along the length of the canoe were analyzed using SAP2000 and are depicted in Figure 4. The cross section of the canoe was modeled as a U-shaped channel at the midspan.

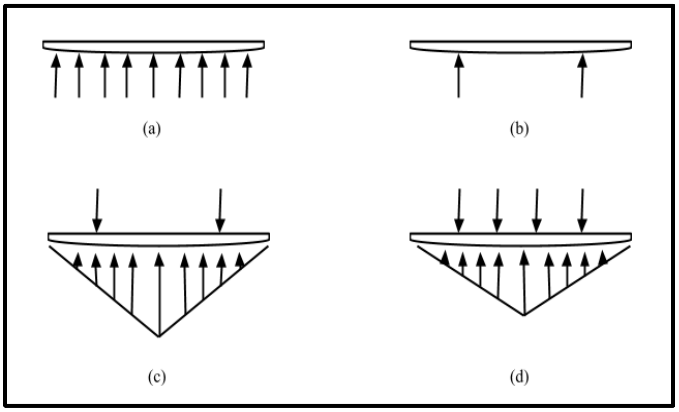


Figure 3: Load Scenarios (self-weight not shown)

Using σ =-My/I and the cross-section properties, the area moment of inertia and the internal stresses were calculated.

Finally, five prestressing wires were used at a jacking force of 150 lbs. each with one wire along the keel, and two wires on each side, 3 inches and 6 inches from the top of the gunwale. This strategic placement, far from the neutral axis, produces the greatest effect. The use of prestress wires induces compression stresses and increasing strength while reducing weight. As demonstrated in Appendix B, the concrete mixture's compressive, tensile, and shear capacities safely exceed the canoe's actual stresses. Through this design process, the 2020 team was able to confidently address safety and efficiency in *Vinifera*.

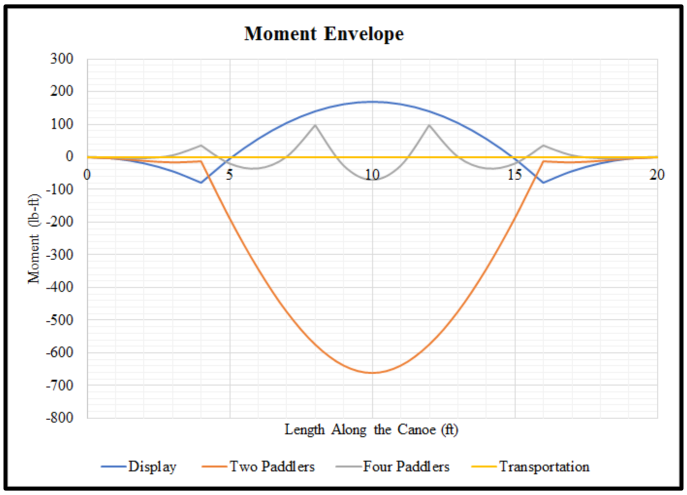


Figure 4: Moment Envelope

The mix team had two overarching goals this year: to create a mix that is less dense than water (below 62.4 pcf), and to use sustainable materials in the process. By creating a low density mix, the canoe would improve on its stability in calm waters while supporting the unbalanced weight of the paddlers.

To meet a 1.3 factor of safety, the minimum 28 day compressive strength required was 995 psi. This factor of safety was determined by considering transportation, paddling, and presentation loading scenarios. As 995 psi was an easily attainable compressive strength, lightweight aggregates were chosen to optimize the concrete's low density. Despite their impact on compressive strength, our final structural mix compression strength was 1070 psi.

Expanded glass was chosen as our first aggregate due to its very low density and availability in many gradations. The expanded glass beads used within our mix were made from recycled material, which added to the sustainability of our canoe. Because this year's rules prevent teams from using the expanded glass beads as our only aggregate, the team decided to incorporate cork as a supplementary aggregate. Last year, cork was incorporated into the final canoe but in a low quantity. With this year's push for a lighter canoe, the volume of cork was increased, making it the main aggregate in *Vinifera*.

Due to cork's high absorbency, the team dampened all the cork material that was added into the final mix. This consequently led to a higher workability and an evenly distributed mix (Fig 5). After many tests, the team determined that if the canoe was properly dried in a large oven, the water content of the concrete would decrease. This reduction of water content would lead to a 12% reduction in *Vinifera*'s total weight. After the canoe dried, sealant was coated onto the entire outer surface of the canoe to prevent any further absorption when placed in the water.

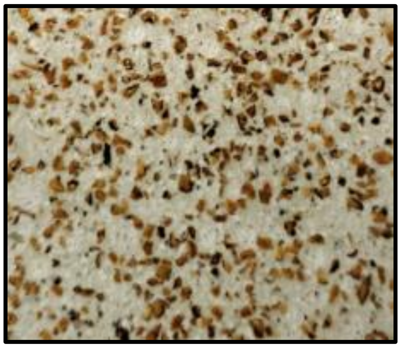


Figure 5: Concrete sample with Cork

The specific gradation of expanded glass and cork was chosen between the sieve sizes of 0.157" to 0.0041" to increase the density of the aggregates and decrease the amount of cementitious material required. Using recycled cork allowed Oregon State to grind and sort the cork according to our requirements. All cork used in *Vinifera* was ground in-house and passed through multiple sieves to achieve this gradation.

The cementitious material for *Vinifera* contained a large amount of vitrified calcium alumino-silicate. This pozzolan was chosen for its white color and superior unit weight compared to fly ash. Due to the benefits of a traditional fly ash SCM, a small quantity of it was still retained and used for *Vinifera*. To combat the shrinkage from the SCMs, a shrinkage reducing admixture was incorporated into the cementitious materials.

To increase its workability on pour day, a zero-slump mix was created to ensure the concrete was secure when placed on *Vinifera's* mold. Small vibration devices were also used on the canoe to liquefy the concrete mixture for placement behind the fiberglass mesh.

The final balance of concrete additives was the most challenging aspect of our design. Because the usage of latex was banned for the 2020 Competition, a workability additive or VMA was required for the canoe that would hold the same properties while being a more sustainable product. After conducting research, the team discovered a VMA made out of a completely organic, cellulose-based material. A new water reducer was also introduced this year that increased workability and allowed the mix's water-to-cement ratio to be reduced to 0.35. A new air-entraining additive was also used in the mix that proved to be more effective in the experimentation of cast samples than previous additives.

Due to a high aggregate content within the canoe, (roughly 74%), the finished surface of the canoe became coarse after water spraying and smoothing. To combat this issue, a third mix was developed with pumice and expanded glass beads. This added more cementitious material to the outside of the canoe where the surface was rough. Most of this “glaze mixture” was consequently sanded off after curing. The patch mix for the canoe consisted largely of finer grained cork and expanded glass to keep visible continuity with the exterior finish of the canoe and to increase workability.

The exterior finish of the canoe was accomplished using a sack finish. Due to the rough characteristics of our pumice-bearing mix, applying pigment to the outside of the surface was ideal. To finish the canoe, the glaze mix was combined with multiple different pigments to create coloration on the outside of *Vinifera*.

As done in previous years, a CNC router was used to cut 19 wooden ribs, (1” thickness). However, to create the formwork for *Vinifera*, the team decided to staple 12” long paint sticks to our ribs. Double stacked ⅛” thick (¼” total thickness) wooden paint sticks were stapled to the ribs to completely form the shape of the interior of the canoe. In previous years, insulation foam was used to form the interior of the formwork. This change served to not only drastically improve the sustainability of the canoe’s construction, but also eliminated the need for sanding, saving much-needed time. The only sections still using the high-density insulation foam are the bulkheads, and hot knives were purchased to expedite the process of cutting the foam to the right shape.

In previous years, the team spent numerous person hours cutting, gluing, and sanding down the foam. Fortunately, the use of paint sticks proved to be an extremely sustainable practice featuring minimal waste and less time.

The concrete placing techniques involve having three pre-organized groups. The “Mix Members,” “Placing Party,” the and the “Finishing Friends.” Our Mix Members used pre-batched mixes to create concrete on site. Once mixed, the Mix Members provided concrete to the Placing Party who placed concrete onto *Vinifera’s* formwork. The Placing Party used curved metal rods to lift reinforcements off the formwork to ensure an even placement onto the reinforcement and formwork. Once the concrete was evenly placed, the Finishing Friends used concrete floats to smooth the outer surface of the canoe. When finishing the concrete, the Finishing Friends used small metal “depth checkers” (Fig 6), to verify that the concrete has been placed at the desired ½” thickness. Additionally, we placed “gunwale guards” along the length of our canoe when poured, to ensure a consistent and smooth gunwale thickness.

Figure 6: Depth Checker and Gunwale Guard

This year, there was a heavy emphasis on safety and precision during the construction process. Last year, OSU’s construction team attempted to increase the tensile force in the pretension cables to 200 lbs each. This reduced the pretension uniformity across the entire canoe. This year, tensioning was to 150 lbs, allowing the team to purchase thinner, more efficient wires.

Section G - Approach to Scope, Schedule and Fee

This year, the OSU Concrete Canoe Team created a project management scheme early in the year. Every year after the conference, the team votes for new leadership within the team so the summer break can be used for canoe research and development. When electing the new leads, the team decided to have co-leads for each position. This new system increased opportunities to gain leadership experience within the team and allowed for a smoother transfer of knowledge between younger and older leads. The captains also determined that a consistent and clear weekly schedule would help members attend meetings. All overall and sub-team meetings were held in the same room, on the same day and time throughout the year. This created consistency for the team.

The scope for each lead team was based on requirements from the RFP and past experience on the team. For example, the mix design lead's scope was to determine the mixes used for the year, hold weekly meetings, and contribute to this submission in applicable sections. The planning process of assigning scope was done through the communication of the captains and the academics leads. These expectations were also presented at the weekly lead's meetings held and communicated in a team setting with captains and other leads.

Coming into the year, the captains knew that the majority of the team would be comprised of seniors who would soon graduate. Because of this, member recruitment was a huge focus at the start of the school year.

New potential members were recruited by attending club fairs, visiting first and second year classes, and completely rebuilding the team's social media presence. Through all these efforts, the team is happy to report that 56% of the 2019-2020 team are non-senior members, meaning that they can participate on the team next year (Fig 7).

As recruitment efforts settled down, the team started to focus on budgeting the funding received from the Oregon State College of Engineering and the School of Civil and Construction Engineering.

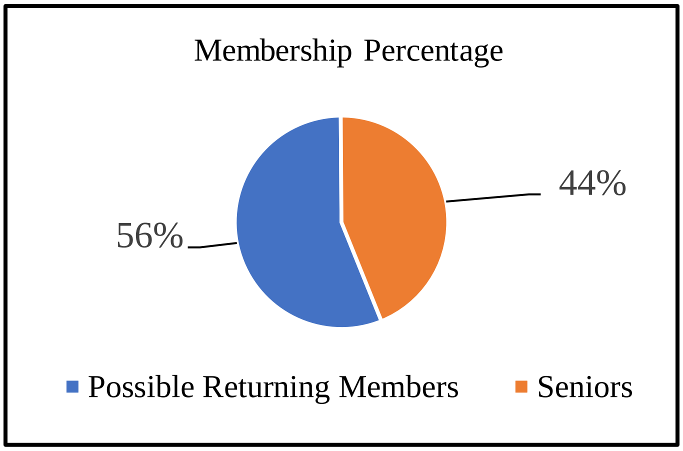


Figure 7: Returning Member Percentage

The team captains worked alongside the ASCE Treasurer to determine a shared cost accounting system. This way, when the treasurer processed reimbursements from the canoe team, both the ASCE cost accounting system and the Canoe Team cost accounting system were updated. This ensured that all spending through the project was fully tracked. In terms of funds allocation, the captains made the decisions on how the expenditures would be assigned. They based their decision on data from past years and estimations of future costs. For example, the hotels at conference this year were more expensive than last, so there was some estimation and adjustment required. The captains also consulted the leads to understand what materials, PPE and general supplies were needed for their portion of the project. Finally, the budget was communicated and finalized through the submission of the Pre-Qualification Form. Once that submission was complete, the leads knew exactly how much money they would be allocated.

In terms of the schedule, the captains used the motto, "start early and start fast." In the beginning of Fall term, the captains decided to work backwards from the national and regional competitions when creating the Preliminary Project Schedule, as they were the first two major milestones that could be identified. Other obvious milestones were laid out in the RFP, such as the submissions of the Pre-Qualification Form, the Preliminary Project Schedule, and the Technical Proposal and MTDS Addendum. A few more very clear milestones were the two pour days (practice pour day and pour day) and the acknowledgment of regional Mailers I, II, and III. Along with the issuance of the Mailers came some milestone dates set by our regional hosts. These milestones were acknowledgement of receiving mailers, individual and registration deadlines and mini-competition deadlines. The other major milestones we identified were the first general meeting of the year, the first safety meetings of the year (each sub-team had their own unique safety meeting including; mix, construction and paddling), the Practice Conference hosted at OSU, and the completion of major parts of the project such as; canoe demolding, completed structural calculations, final mix selections, and final hull selection.

There were many points in the project that could pose as a potential threat to our critical path. The major tasks on the critical path this year were the issuance of the RFP (what we considered to be the first task of the schedule), the first safety meeting for each sub-group within the project, and material and tool procurement for construction and mixture design. The captains worked with the project leads to determine long lead time items and to order them as early as possible. Also along the critical path was the completion of the hull design, the cutting of the plywood ribs, and the selection of the mixture design.

The hurdles of the critical path were managed because they were discovered early, leaving ample time to complete each task. A large setback the team encountered was finding a CNC machine to cut the ribs for the framework of *Vinifera*. In year's prior, a CNC machine located on campus was used to cut the ribs. Unfortunately, this machine required repairs during the team's scheduled timeline for cutting the ribs. After weeks of research and cold-calls, the team found a local high school that could accommodate our needs. While this pushed the date back for our Practice Pour Day, the team was able to complete a full-scale practice canoe without interfering with the schedule of the final canoe. Another major hurdle that was not identified until the beginning of January was a scheduling conflict between a large ASCE event and our scheduled Final Pour Day. Because many canoe members are also active members of the ASCE OSU Student Chapter, our Final Pour Day needed to be pushed back by one week. Despite this setback, the team still managed to complete their final canoe prototype on schedule. This preventable conflict could have been solved through more communication between ASCE executive officers and the canoe captains.

Another way the team combatted potential hurdles in the schedule was to account for these unexpected circumstances when designing the schedule. The team decided to add a generous two weeks of float to the overall project schedule. Aggressive internal deadlines were also placed leading up to the competition, including the construction of a full-scale practice canoe and a practice conference in early February. During this practice conference, the captains presented their rough draft of the oral presentation and the team successfully swamp tested the practice canoe.

Itemized Fee Summary Sheet

Raw Labor Rate – Construction of Formwork:

Job	$/hr.	Hours
Principal Design Engineer	$50	8
Design Manager	$45	25
Project Construction Manager	$40	30
Construction Superintendent	$40	30
Project Design Engineer	$35	12
Quality Manager	$35	8
Graduate Field Engineer	$25	20
Technician/Drafter	$20	15
Laborer/Technician	$25	95
Clerk/Office Admin	$15	12
Sum of Cost and Hours	**$7,980**	**250**

Lump Sum - Formwork Expenses:

Formwork Costs	Dollars
Paint Sticks	$242
Foam	$60
Liquid Nails	$10
Visqueen	$10
Consultant Hours	$1200
Staple Gun	$70
Lump Sum	**$1,592**

Projected Total Hours:

Project Categories	Hours
Project Management	676
Hull Design	50
Structural Analysis	42
Mix Design	329
Mold Construction	539
Canoe Construction	459
Preparing the Technical Proposal	150
Preparing the Presentation	75
Preparing the Display	100
Total	**2420**

Expenses Producing One Single Canoe:

$E = (\$282.10) * (1 + .10)$

$\boldsymbol{E = \$310.31}$

Cost of Producing One Single Canoe:

Material	Amount	Units	Cost/Unit	Cost
Shrinkage Reducer	10.67	lbs.	$6.16	$12.30
Cement	196.00	lbs.	$0.03	$5.88
FlyAsh	20.00	lbs.	$0.02	$0.40
VCAS	30.00	lbs.	$0.32	$9.60
Expanded Glass (.5-1mm)	46.67	lbs.	$0.25	$11.67
Expanded Glass (2-4mm)	12.44	lbs.	$0.25	$3.11
Expanded Glass (.1-.3mm)	36.27	lbs.	$0.25	$9.07
Cork	17.95	lbs.	$5.35	$96.02
Water	12.7	gal	$0.03	$0.38
Liquid Curing Compound	0.04	gal	$11.00	$0.43
Air Entrainer	0.15	gal	$3.34	$0.51
High-Range Water Reducer	0.38	gal	$5.50	$2.11
VMA	0.18	gal	$9.25	$1.64
Steel Cable	2.04	lbs.	$0.15	$0.31
Fiberglass Mesh	73.50	ft^2	$0.12	$8.82
Sealant	220.00	ft^2	$0.50	$110.00
Pigment	1.63	lbs.	$5.00	$8.17
Pumice	4	lbs.	$0.42	$1.68
Stitching Wire	0.0125	lbs.	0.15	$0.00
Grand Total				**$282.10**

Shipping Cost of Canoe and Display from Corvallis, OR to Madison, WI

Method of Travel: Driving Canoe and Display

Corvallis to Madison: 2,079.4 miles

Rental Truck Gas Mileage: 15.5 mpg

Total Gallons: 134 and Assuming: Gas = $3.00/gallon

Estimated Shipping Cost (Lump Sum): $402.46

Direct Labor and Expenses (Formwork):

$DL = (\$7{,}980) * (1.30 + 1.50) * (1 + .18)$

$DL = \$26{,}365.92$

$E = (\$1{,}592) * (1 + .10)$

$E = \$1{,}751.20$

DL + E = $28,117.12

Section H - Approach to Health and Safety

The OSU Concrete Canoe team ensured all members were wearing appropriate PPE at all times during the fabrication of the canoe. This includes, and is not limited to appropriate eyewear, proper clothing and footwear, as well as wearing gloves and face masks during the placement of the concrete and sanding. Additionally, a complete and concise list from the Oregon State University Safety Code of Ethics and Policy was developed and shared with the whole team. Each team member was required to date and sign a safety form before using any machinery to keep track of who was using which tools and to ensure everyone had the proper training on how to properly use the tools. Respirators were used when sanding the canoe. A safety lead was present during every construction meeting to ensure that all safety measures were followed by the team at all times. All members were also given "Stop Work Authority." This means that each member was told that if they see anything unsafe happening, they have the authority and obligation to tell other members to stop whatever work they are doing so that the issue could be addressed immediately.

After every construction meeting, the build space was thoroughly swept to ensure cleanliness and to mitigate injuries. An elaborate safety plan was developed by the safety lead and captains to organize a fire evacuation plan as the team shared a build space with another competition team on campus. Due to the fact that the build space is shared with another team, captains from both teams met and decided on what areas of the space would be used by each team, and ensured all members were aware of the respective areas. In order to satisfy the needs of both teams, three first aid kits and three fire extinguishers were purchased.

Section I - Approach to Quality Control and Quality Assurance

The OSU Concrete Canoe team focuses each year on recruiting new members to diversify our team and ensure there will be new leads for the future. However, this means new members come with limited canoe experience. As our way to rectify that, and also to ensure new members have an opportunity to gain experience, the team builds a practice canoe, so all members can practice procedures and learn lessons that can lead to new innovations. All members attending our final concrete pour day will have already helped during our practice pour day, thus reducing mistakes and new member confusion in the critical final construction.

We use depth checkers when placing our canoe to verify that we are actually achieving our desired thickness. Without this tool, we would be estimating our concrete thickness over the entire hull of the canoe, which would lead to an uneven concrete spread, and weight distribution. This would have negative structural strength impacts, as well as making the canoe unsymmetrical and off-balance for our paddlers.

In terms of quality control of our concrete mixture, we held concrete mixture design meetings, which began at the start of fall term. This allowed members who were specifically interested in concrete mixture design to learn the processes associated with mixture design, and why we use the materials we do. It also meant our final mixture was tested multiple times, and allowed members to practice the mixing process to ensure that on our final pour day we would able to create a homogenous mixture, and know the order of materials added, to ensure the highest quality mix possible.

Section J - Approach to Sustainability

This year, Oregon State has taken a very large step in sustainability. Rather than use aggregates that waste resources, it was decided that a recycled material should be used. Cork was chosen for its extremely low density, relatively strong structural integrity, and its deadening characteristics. It was ground into angular shapes to increase the strength of the mix.

Our cork was 100% recycled from local restaurants, bars, and wineries. Most of the cork material used on *Vinifera* was cork that would have ended up being discarded, but instead was collected and ground for reuse in this year's canoe. All the expanded glass materials in the mix came from a recycled glass source as well.

Another big step towards sustainability was our choice of admixtures. In initial tests run during the beginning of the year, it became clear that that consolidation was a problem, and the team searched for a new viscosity modifying additive. Through research and testing, the mixture design leads found a new completely organic cellulose-based additive to test in the concrete mixture design. Fortunately, it was extremely successful in creating a more homogenous mix.

Other approaches to sustainability include OSU's commitment to reducing waste by always batching the exact amount needed for testing. In order to design the concrete mixture this year, over 15 test batches were designed, mixed, and tested for workability, appearance, consolidation, density, and strength. We reduced waste by mixing these batches in the smallest amounts possible. Additionally, many of the materials used are surplus research materials that would have otherwise been thrown away in the lab.

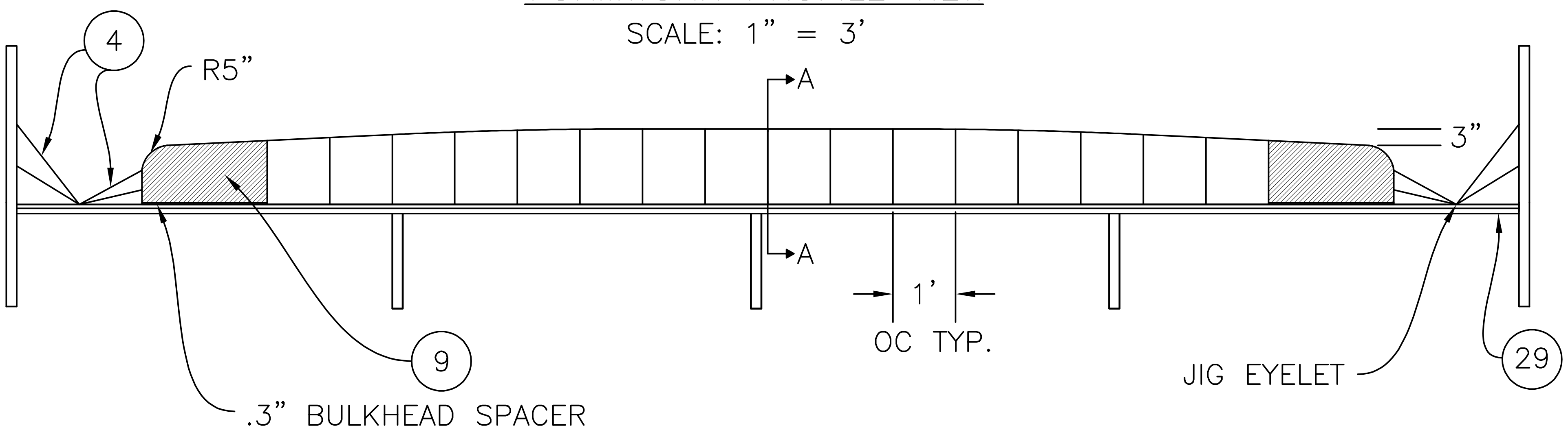
Throughout the past several years, OSU has used a male mold, and continues to use a male mold this year with *Vinifera*, because members are confident and comfortable with the approach. However, one new method used this year which decreased OSU's environmental impact, was the use of paint sticks to build the formwork instead of insulation, as described in previous sections.

To keep the canoe as sustainable as possible, the team also made use of much of the previous year's leftover material (primarily lumber) to reduce waste. Much of the base skeleton of the canoe formwork has remained the same this year, with some modifications in the hull design. Examples of leftover materials include the use of a plywood platform salvaged from previous years, and a leftover 2 x 4 rail running the length of the canoe (minus the bulkhead areas) to keep the canoe straight

A primary goal for the OSU Concrete Canoe team this year was to create a canoe as sustainable as possible and to improve on the canoes of previous years. A balance was needed to make a canoe in a sustainable way without compromising other important factors such as buoyancy, aesthetics, timeline, constructability, and most importantly, safety. The decision to use paint sticks in place of foam for the skeleton of the canoe represents a very significant increase in sustainability of the canoe and its construction process

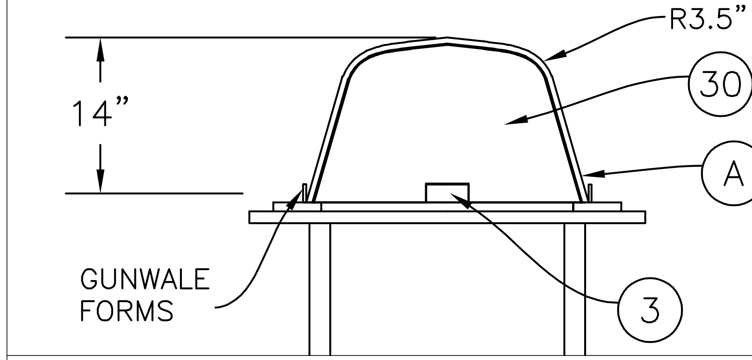
FORMWORK PROFILE VIEW

SCALE: 1" = 3'



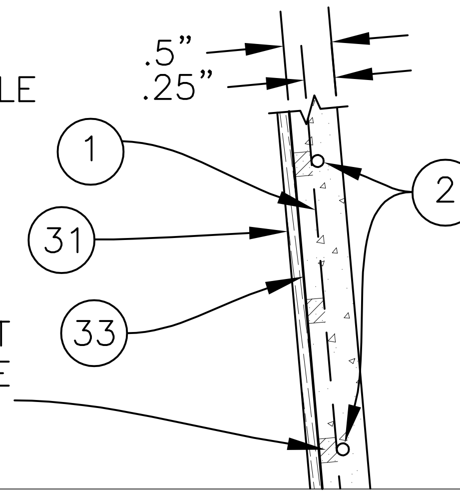
CENTERLINE CROSS SECTION A–A

SCALE: 1" = 1.5'



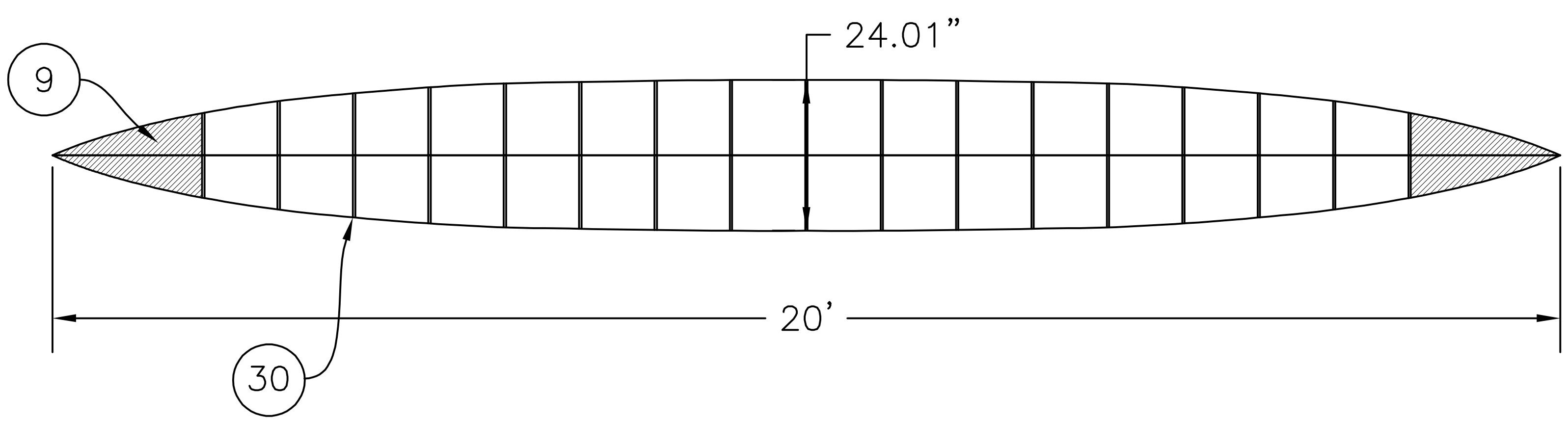
DETAIL A

NOT TO SCALE



FORMWORK PLAN VIEW

SCALE: 1" = 3'



RENDERED VIEW

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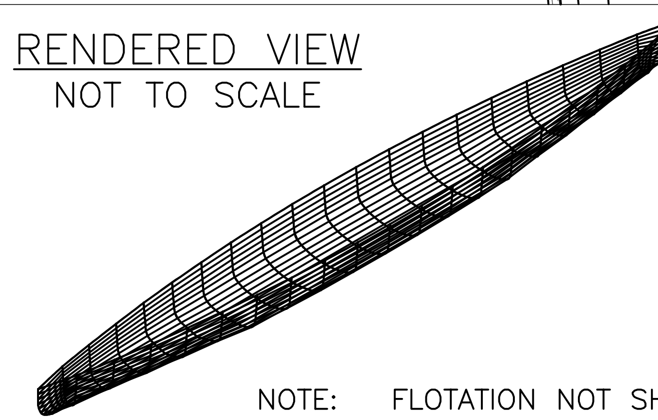


NOTE: FLOTATION NOT SHOWN

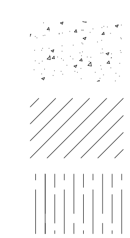
BILL OF MATERIALS

ITEM	QTY.	UNIT	DESCRIPTION
REINFORCEMENT AND FLOTATION			
1	73.5	SQ FT	FIBERGLASS MESH
2	10	FT	24 GAUGE STEEL STITCHING WIRE
3	16	8'	2"X4" LUMBER
4	110	FT	3/32" BRAIDED STEEL WIRE
5	10	EA	FERRULES
6	5	EA	SPRINGS
7	5	EA	TURNBUCKLES
8	16	EA	SCREW EYE BOLTS
9	3	4'X8'	1" INSULATION FOAM BOARD
FINISHING			
10	62	EA	VINYL LETTERING DECALS
11	64	FL OZ	CLEAR CONCRETE SEALER

ITEM	QTY.	UNIT	DESCRIPTION
CONCRETE MIXTURES			
12	10.67	LB	SHRINKAGE REDUCER
13	196	LB	PORTLAND CEMENT TYPE I
14	20	LB	FLY ASH
15	30	LB	VCAS
16	46.67	LB	EXPANDED GLASS BEADS .5–1.0MM
17	12.44	LB	EXPANDED GLASS BEADS 2–4.0MM
18	36.27	LB	EXPANDED GLASS BEADS .1–.3MM
19	17.95	LB	RECYCLED CORK
20	10.59	GAL	WATER FOR CM HYDRATION
21	2.11	GAL	WATER FOR AGGREGATES
22	.04	GAL	HYDRATION STABILIZER
23	.15	GAL	AIR–ENTRAINING ADMIXTURE
24	.38	GAL	WATER–REDUCING ADMIXTURE
25	.18	GAL	ORGANIC VMA
26	.8	LB	PURPLE CONCRETE PIGMENT
27	.8	LB	GREEN CONCRETE PIGMENT
28	4	LB	PUMICE

ITEM	QTY.	UNIT	DESCRIPTION
FORMWORK			
29	2	4'X8'	3/4" PLYWOOD
30	2	4'X8'	1" OSB (CNC RIBS)
31	1100	EA	PAINT STICKS
32	200	EA	1.5" SCREWS
33	220	SQ FT	POLYETHYLENE MEMBRANE

LEGEND OF HATCHING



LOW DENSITY CONCRETE

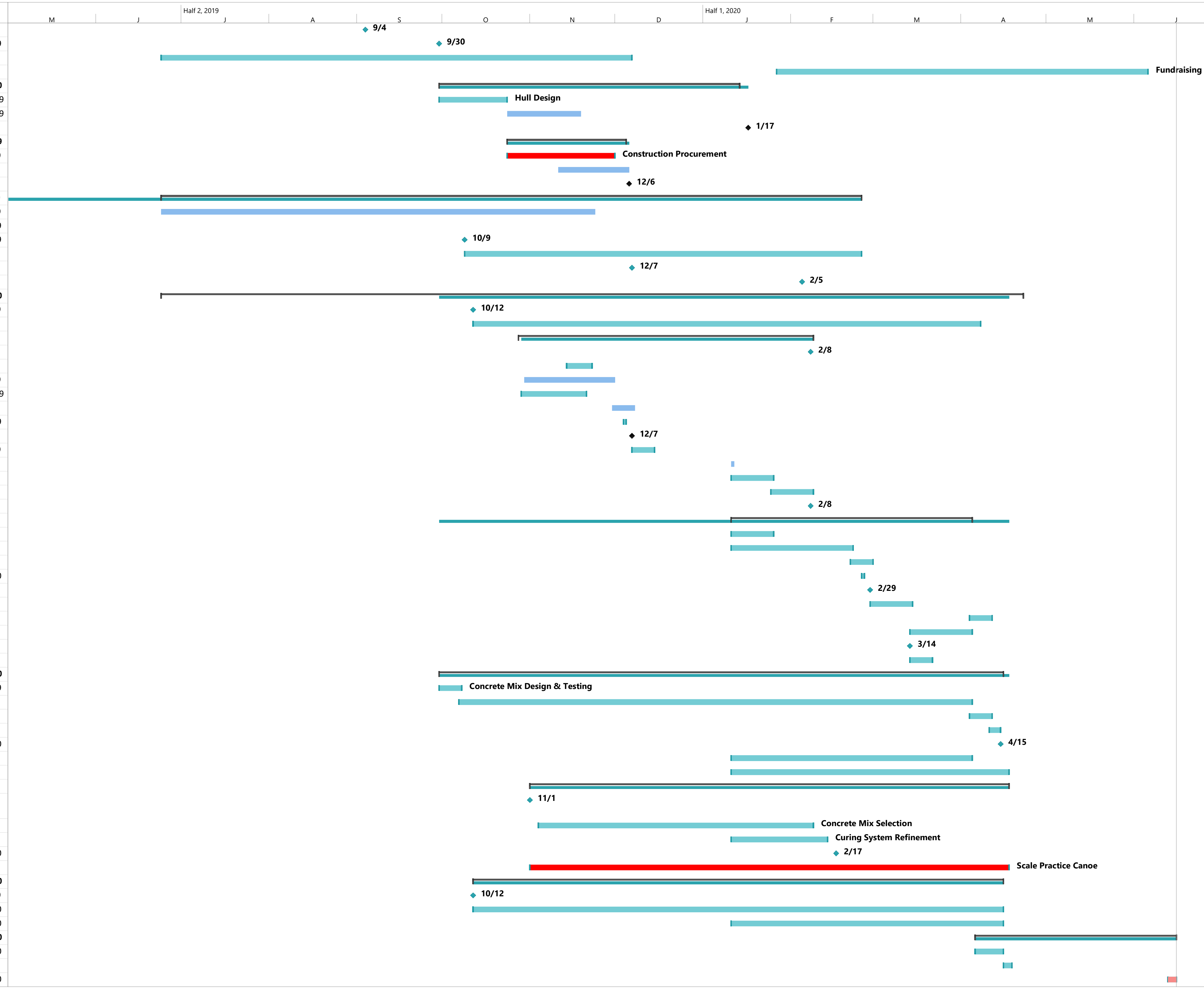
FOAM BOARD

WOOD FORMWOORK

DRAWN BY: REILLY EVERMORE
CHECKED BY: RAWAN AL NAABI
DATE: 02/06/2020

Oregon State UNIVERSITY OSU College of Engineering

ID	Task Name	Duration	Start	Finish
1	2020 Concrete Canoe RFP Issuance	0 days	Wed 9/4/19	Wed 9/4/19
2	First General Meeting	0 days	Mon 9/30/19	Mon 9/30/19
3	Pre-Construction Planning for the Racing Prototype	125 days	Mon 6/24/19	Fri 12/6/19
4	Fundraising for Nationals	95 days	Mon 1/27/20	Fri 6/5/20
5	**Hull Design**	**83 days**	**Mon 9/30/19**	**Mon 1/13/20**
6	Draw Hull and Construction Drawings in AutoCAD	18 days	Mon 9/30/19	Wed 10/23/19
7	Hull Design and Research	21 days	Thu 10/24/19	Mon 11/18/19
8	Final Hull Design Selection	0 days	Fri 1/17/20	Fri 1/17/20
9	**Structural Analysis**	**35 days**	**Thu 10/24/19**	**Wed 12/4/19**
10	2D Analysis	32 days	Thu 10/24/19	Sat 11/30/19
11	Prestress Analysis	22 days	Mon 11/11/19	Thu 12/5/19
12	Structural Analysis Complete	0 days	Fri 12/6/19	Fri 12/6/19
13	**Concrete Mixture Design**	**184 days**	**Mon 6/24/19**	**Tue 2/25/20**
14	Research New Materials	114 days	Mon 6/24/19	Sat 11/23/19
15	Material Procurement	57 days	Wed 11/14/18	Wed 1/30/19
16	Initial Safety Meeting	0 days	Wed 10/9/19	Wed 10/9/19
17	Mixture Design and Testing	107 days	Wed 10/9/19	Tue 2/25/20
18	Concrete Placement Technique Testing (Practice Pour Day)	0 days	Sat 12/7/19	Sat 12/7/19
19	Final Mixture Selection	0 days	Wed 2/5/20	Wed 2/5/20
20	**Construction**	**225 days**	**Mon 6/24/19**	**Wed 4/22/20**
21	Initial Construction Safety Meeting	0 days	Sat 10/12/19	Sat 10/12/19
22	Material and Tool Procurement	135 days	Sat 10/12/19	Tue 4/7/20
23	**Practice Prototype**	**82 days**	**Mon 10/28/19**	**Sat 2/8/20**
24	Practice Conference	0 days	Sat 2/8/20	Sat 2/8/20
25	CNC Cross Sectional Cutting	8 days	Thu 11/14/19	Fri 11/22/19
26	Formwork Construction	27 days	Wed 10/30/19	Sat 11/30/19
27	Construction of Bulkheads	19 days	Tue 10/29/19	Wed 11/20/19
28	Reinforcement and Pre-Tension Set-Up	7 days	Sat 11/30/19	Sat 12/7/19
29	Concrete Mixture Batching	1 day	Wed 12/4/19	Wed 12/4/19
30	Practice Prototype Casting (Practice Pour Day)	0 days	Sat 12/7/19	Sat 12/7/19
31	Concrete Curing	7 days	Sat 12/7/19	Sat 12/14/19
32	Canoe Demolding	1 day	Sat 1/11/20	Sat 1/11/20
33	Canoe Sanding	12 days	Sat 1/11/20	Sat 1/25/20
34	Canoe Sealing	12 days	Sat 1/25/20	Sat 2/8/20
35	Completed Practice Canoe	0 days	Sat 2/8/20	Sat 2/8/20
36	**Final Prototype**	**62 days**	**Sat 1/11/20**	**Sat 4/4/20**
37	Formwork Modification	12 days	Sat 1/11/20	Sat 1/25/20
38	Construction of Bulkheads	32 days	Sat 1/11/20	Sat 2/22/20
39	Reinforcement and Pre-Tension Set-Up	7 days	Sat 2/22/20	Sat 2/29/20
40	Concrete Mixture Batching	1 day	Wed 2/26/20	Wed 2/26/20
41	Concrete Canoe Casting POUR DAY!	0 days	Sat 2/29/20	Sat 2/29/20
42	Concrete Curing	12 days	Sat 2/29/20	Sat 3/14/20
43	Concrete Canoe Drying (Subject to Change)	7 days	Sat 4/4/20	Sat 4/11/20
44	Sanding	17 days	Sat 3/14/20	Sat 4/4/20
45	Canoe Demolding	0 days	Sat 3/14/20	Sat 3/14/20
46	Canoe Patching	7 days	Sat 3/14/20	Sat 3/21/20
47	**Aesthetics Design**	**150 days**	**Mon 9/30/19**	**Wed 4/15/20**
48	Theme Selection	6 days	Mon 9/30/19	Mon 10/7/19
49	Canoe Aesthetics Design	138 days	Mon 10/7/19	Sat 4/4/20
50	Pigmented Concrete Application	7 days	Sat 4/4/20	Sat 4/11/20
51	Finishing, Sealing, and Vinyl Applique	3 days	Sat 4/11/20	Tue 4/14/20
52	Completed Competition Canoe	0 days	Wed 4/15/20	Wed 4/15/20
53	Competition Display Cutaway Section	62 days	Sat 1/11/20	Sat 4/4/20
54	Competition Final Product Display	71 days	Sat 1/11/20	Fri 4/17/20
55	**Academics**	**127 days**	**Fri 11/1/19**	**Fri 4/17/20**
56	Preliminary Project Schedule and Pre-Qualification Form Submittal	0 days	Fri 11/1/19	Fri 11/1/19
57	Technical Proposal Draft	77 days	Mon 11/4/19	Sat 2/8/20
58	Completed Technical Proposal	25 days	Sat 1/11/20	Thu 2/13/20
59	Technical Proposal and MTDS Addendum Submittal	0 days	Mon 2/17/20	Mon 2/17/20
60	Completed Oral Presentation Material	127 days	Fri 11/1/19	Fri 4/17/20
61	**Paddling**	**141 days**	**Sat 10/12/19**	**Wed 4/15/20**
62	Initial Paddling Safety Meeting	0 days	Sat 10/12/19	Sat 10/12/19
63	Paddling Practice and Training	141 days	Sat 10/12/19	Wed 4/15/20
64	Timed Racing Practices	69 days	Sat 1/11/20	Wed 4/15/20
65	**Competitions**	**51 days**	**Mon 4/6/20**	**Mon 6/15/20**
66	Conference Preperations	8 days	Mon 4/6/20	Wed 4/15/20
67	Pacific Northwest Student Conference	3 days	Thu 4/16/20	Sat 4/18/20
68	National Concrete Canoe Competition	2 days	Sat 6/13/20	Mon 6/15/20



Project Schedule: Vineyard - Vinifera
Oregon State University

Critical Split | Task | Milestone | Critical

Appendix A – Mixture Proportions and Primary Mixture Calculation

See following pages.

Mixture: 1 (Structural)

CEMENTITIOUS MATERIALS

Component	Specific Gravity	Volume	Amount of CM	
White Portland Cement Type I, c_1	3.15	0.739 ft^3	245 lb/yd^3	Total cm (includes c) 320 lb/yd^3 c/cm ratio 0.766, by mass
Class F Fly Ash. cm_1	2.6	0.109 ft^3	30 lb/yd^3	

AGGREGATES

Aggregates	Expanded Glass (EG) or Cenosphere (C)[1]	Abs (%)	SG_{OD}	SG_{SSD}	Base Quantity, W: W_{OD}	Base Quantity, W: W_{SSD}	Volume, $V_{agg, SSD}$
Recycled Cork, agg_1	no	70%	0.09	0.4	151.78 lb/yd^3	671.80 lb/yd^3	0.663 ft^3
Expanded Glass 1, agg_2	yes	35%	0.49	0.96	830.65 lb/yd^3	1612.80 lb/yd^3	0.496 ft^3
Expanded Glass 2, agg_3	yes	20%	0.3	0.71	503.24lb/yd^3	1201.71 lb/yd^3	0.932 ft^3
Expanded Glass 3, agg_4	yes	29%	0.25	0.37	414.72 lb/yd^3	629.35 lb/yd^3	0.534 ft^3

LIQUID ADMIXTURES

Admixture	lb/US gal	Dosage (fl. oz/ cwt)	% solids	Amount of Water in Admixture	
Hydration Stabilizing Admixture, $admx_1$	9.6	1.25	20%	0.298 lb/yd3	Total Water from liquid admixtures = 3.83 lb/yd3
Air Entraining Admixture, $admx_2$	8.5	3	10%	0.597 lb/yd3	
Water Reducing Admixture, $admx_3$	8.9	10	35%	1.473 lb/yd3	
Viscosity Modifying Admixture, $admx_4$	15	5.65	20%	1.460 lb/yd3	

SOLIDS (DYES, POWDERED ADMIXTURES, AND MINERAL FILLERS)

Component	Specific Gravity	Volume (ft^3)	Amount (lb/yd^3)
Calcium Aluminio-Silicate, $S_{p\ admix\ 1}$	2.6	0.164	45.00
Magnesium Oxide, $S_{p\ admix\ 2}$	3.55	0.06	16.00

WATER

	Amount		Volume
Water, w, $[=\sum(w_{free} + w_{admx} + w_{batch})]$	w/c ratio, by mass, 0.581	145.63 lb/yd3	1.11 ft^3
Total Free Water from All Aggregates, $\sum w_{free}$		0 lb/yd^3	
Total Water from All Admixtures, $\sum w_{admx}$	w/cm ratio, by mass, 0.350	3.83 lb/yd3	
Batch Water, w_{batch}		142.25 lb/yd^3	

DENSITIES, AIR CONTENT, RATIOS AND SLUMP

Values for 1 cy of Concrete	cm	Fibers	Aggregate (SSD)	Solids, S_{total}	Water, w	Total
Mass, M	320 lb	0 lb	168.85 lb	36.15 lb	145.63 lb	$\sum M$: 670.63 lb
Absolute Volume, V	1.71 ft^3	0 ft^3	11.81 ft^3	0.224 ft^3	1.87 ft^3	$\sum V$: 15.62 ft^3

Theoretical Density, T, $(=\sum M/\sum V)$	42.93 lb/ft3	Air Content, Air, $[= (T - D)/T \times 100\%]$	43%
Measured Density, D	55.4 lb/ft^3	Air Content, Air, $[= (27 - \sum V)/27 \times 100\%]$	42.15%
Total Aggregate Ratio[2], $(=V_{agg,SSD}/15.62)$	75.80%	Slump, Slump flow, Spread (as applicable)	0 in.
EG + C Ratio[3], $(=V_{EG+C}/V_{agg,SSD})$	98.80%		

Mixture: 2 (Patch)

CEMENTITIOUS MATERIALS

Component	***Specific Gravity***	***Volume***	***Amount of CM***	
White Portland Cement Type I, *c_1*	*3.15*	*0.092 ft^3*	*245 lb/yd^3*	*Total cm (includes c) 189.63 lb/yd^3 c/cm ratio, by mass*
Class F Fly Ash. *cm_1*	*2.6*	*0.014 ft^3*	*30 lb/yd^3*	

AGGREGATES

Aggregates	***Expanded Glass (EG) or Cenosphere (C)*** [1]	***Abs (%)***	***SG_{OD}***	***SG_{SSD}***	***Base Quantity, W***		***Volume, $V_{agg,\,SSD}$***
					W_{OD}	***W_{SSD}***	
Recycled Cork, *agg_1*	*no*	*70%*	*0.09*	*0.4*	*151.78 lb/yd^3*	*671.80 lb/yd^3*	*0.663 ft^3*
Expanded Glass 1, *agg_2*	*yes*	*35%*	*0.49*	*0.96*	*830.65 lb/yd^3*	*1612.80 lb/yd^3*	*0.496 ft^3*
Expanded Glass 2, *agg_3*	*yes*	*20%*	*0.3*	*0.71*	*503.24lb/yd^3*	*1201.71 lb/yd^3*	*0.932 ft^3*
Expanded Glass 3, *agg_4*	*yes*	*29%*	*0.25*	*0.37*	*414.718 lb/yd^3*	*629.35 lb/yd^3*	*0.534 ft^3*

LIQUID ADMIXTURES

Admixture	***lb/US gal***	***Dosage (fl. oz/ cwt)***	***% solids***	***Amount of Water in Admixture***	
Hydration Stabilizing Admixture, *$admx_1$*	*9.6*	*1.25*	*20%*	*0.048 lb/yd^3*	*Total Water from liquid admixtures = 0.85 lb/yd^3*
Air Entraining Admixture, *$admx_2$*	*8.5*	*3*	*10%*	*0.102 lb/yd^3*	
Water Reducing Admixture, *$admx_3$*	*8.9*	*10*	*35%*	*0.356 lb/yd^3*	
Viscosity Modifying Admixture, *$admx_4$*	*15*	*5.65*	*20%*	*0.339 lb/yd^3*	

SOLIDS (DYES, POWDERED ADMIXTURES, AND MINERAL FILLERS)

Component	**Specific Gravity**	**Volume (ft^3)**	**Amount (lb/yd^3)**
Calcium Aluminio-Silicate, *$S_{p\ admix\ 1}$*	2.6	0.021	45.00
Magnesium Oxide, *$S_{p\ admix\ 2}$*	3.55	0.06	16.00

WATER

	Amount		***Volume***
Water, *w, [=∑(w_{free} + w_{admx} + w_{batch})]*	***w/c ratio, by mass, 0.570***	*235.21 lb/yd^3*	*0.14 ft^3*
Total Free Water from All Aggregates, *∑w_{free}*		*0 lb/yd^3*	
Total Water from All Admixtures, *∑w_{admx}*	***w/cm ratio, by mass, 0.350***	*0.85 lb/yd^3*	
Batch Water, *w_{batch}*		*117.60 lb/yd^3*	

DENSITIES, AIR CONTENT, RATIOS AND SLUMP

Values for 1 cy of Concrete	***cm***	***Fibers***	***Aggregate (SSD)***	***Solids, S_{total}***	***Water, w***	***Total***
Mass, *M*	*320 lb*	*0 lb*	*139.5 lb*	*36.15 lb*	*139.33 lb*	*∑M: 635 lb*
Absolute Volume, *V*	*1.71 ft^3*	*0 ft^3*	*8.74 ft^3*	*0.224 ft^3*	*1.87 ft^3*	*∑V:12.54 ft^3*
Theoretical Density, *T, (=∑M/∑V)*	*48.61 lb/ft^3*		***Air Content, Air,*** *[= (T - D)/T x 100%]*			*54.4%*
Measured Density, *D*	*59.3 lb/ft^3*		***Air Content, Air,*** *[= (27 - ∑V)/27 x 100%]*			*53.50%*
Total Aggregate Ratio [2]*, (=$V_{agg,SSD}$/27)*	*2.40%*		***Slump, Slump flow, Spread*** *(as applicable)*			*1 in.*
EG + C Ratio [3]*, (=V_{EG+C}/$V_{agg,SSD}$)*	*9.98%*					

Mixture: 3 (Finishing)

CEMENTITIOUS MATERIALS

Component	*Specific Gravity*	*Volume*	*Amount of CM*	
White Portland Cement Type I, c_1	3.15	0.739 ft^3	245 lb/yd^3	Total cm (includes c) 32.67 lb/yd^3 c/cm ratio 1, by mass

AGGREGATES

Aggregates	*Expanded Glass (EG) or Cenosphere (C)* [1]	*Abs (%)*	SG_{OD}	SG_{SSD}	*Base Quantity, W*		*Volume,* $V_{agg, SSD}$
					W_{OD}	W_{SSD}	
Expanded Glass 1, agg_1	yes	35%	0.49	0.96	830.65 lb/yd^3	1612.80 lb/yd^3	0.496 ft^3
Pumice, agg_2	yes	30%	0.83	1.2	1399.64 lb/yd^3	2031.64 lb/yd^3	0.0532 ft^3

SOLIDS (DYES, POWDERED ADMIXTURES, AND MINERAL FILLERS)

Component	**Specific Gravity**	**Volume (ft^3)**	**Amount (lb/yd^3)**
Pigment, (color varies)	5	0.005	12.25

WATER

	Amount		*Volume*
Water, w, $[=\sum(w_{free} + w_{admx} + w_{batch})]$	***w/c ratio, by mass, 0.400***	13.03 lb/yd^3	0.19 ft^3
Total Free Water from All Aggregates, $\sum w_{free}$		0 lb/yd^3	
Total Water from All Admixtures, $\sum w_{admx}$	***w/cm ratio, by mass, 0.350***	0 lb/yd^3	
Batch Water, w_{batch}		13.03 lb/yd^3	

DENSITIES, AIR CONTENT, RATIOS AND SLUMP

Values for 1 cy of Concrete	*cm*	*Fibers*	*Aggregate (SSD)*	*Solids,* S_{total}	*Water, w*	*Total*
Mass, M	245 lb	0 lb	52 lb	12.25 lb	98 lb	∑M: 407.25 lb
Absolute Volume, V	1.25 ft^3	0 ft^3	1.94 ft^3	0.04 ft^3	1.44 ft^3	∑V: 4.67 ft^3
Theoretical Density, T, $(=\sum M/\sum V)$	87.31 lb/ft^3		***Air Content, Air,*** $[= (T - D)/T \times 100\%]$			83%
Measured Density, D	85.4 lb/ft^3		***Air Content, Air,*** $[= (27 - \sum V)/27 \times 100\%]$			82.70%
Total Aggregate Ratio [2], $(=V_{agg,SSD}/27)$	2.00%		***Slump, Slump flow, Spread*** *(as applicable)*			7 in.
EG + C Ratio [3], $(=V_{EG+C}/V_{agg,SSD})$	36%					

NOTE: ALL CALCULATIONS ARE PER CANOE BATCH ($15.62\ ft^3$).

CEMENTITIOUS MATERIAL

$$Mass_{Type1PC} = 245.0\ lbs$$

$$Mass_{FlyAshClassF} = 30.0\ lbs$$

$$Mass_{VCAS} = 45.0\ lbs$$

$$\sum \boldsymbol{Mass_{cementitous} = 320.00\ lbs}$$

$VOLUME_{TYPE1PC} = \frac{amount}{SG\ x\ 62.4\frac{lb}{ft^3}} = \frac{245.0}{3.15\ x\ 62.4\frac{lb}{ft^3}} =$ **1.246** ft^3

$VOLUME_{FLYASHCLASSC} = \frac{amount}{SG\ x\ 62.4\frac{lb}{ft^3}} = \frac{30.0}{2.62\ x\ 62.4\frac{lb}{ft^3}} =$ **0.183** ft^3

$VOLUME_{VCAS} = \frac{amount}{SG\ x\ 62.4\frac{lb}{ft^3}} = \frac{45}{2.60\ x\ 62.4\frac{lb}{ft^3}} =$ **0.277** ft^3

$$\sum \boldsymbol{Volume_{cementitous} = 1.71\ ft^3}$$

FIBERS

$$Mass_{PVA\ fibers} = 0\ lbs$$

$VOLUME_{PVAFIBERS} = \frac{amount}{SG\ x\ 62.4\frac{lb}{ft^3}} = \frac{0}{1.3\ x\ 62.4\frac{lb}{ft^3}} =$ **0**

AGGREGATES

Aggregate: (in.)	SG_{SSD}	W_{OD} (lb/yd^3)	W_{SSD} (lb/yd^3)	MC_{Total} (%)
Expanded Glass (0.0196 – 0.0394)	0.71	503.24	1201.71	139%
Expanded Glass (0.0039 - 0.0118)	0.96	830.65	1612.80	94.16%
Expanded Glass (0.0787 – 0.157)	0.37	414.72	629.35	51.75%
Cork	0.40	11.80	11.80	342.62%

PORAVER (0.0196 – 0.0394)

$W_{STK} = W_{SSD} + W_{FREE} = 1201.71 + 0 =$ **1201.71 (lb/yd^3)**

$MC_{TOTAL} = \frac{Wstk - W_{od}}{W_{od}} * 100\% = \frac{1612.80 - 503.24}{503.24} * 100\% =$ **139%**

$ABS = \frac{Wssd - Wod}{Wod} * 100\% = \frac{1201.71 - 503.24}{503.24} * 100\% =$ **139%**

$MC_{FREE} = MC_{TOTAL} - ABS = 139\% - 139\% =$ **0%**

$W_{FREE} = Wod * (\frac{MCfree}{100\%}) = 503.24 * (\frac{0\%}{100\%}) =$ **0 LB**

PORAVER (0.0039 – 0.0118)

$W_{STK} = W_{SSD} + W_{FREE} = 1612.80 + 0 =$ **1612.80 (lb/yd^3)**

$MC_{TOTAL} = \frac{Wstk - W_{od}}{W_{od}} * 100\% = \frac{1612.80 - 830.65}{830.65} * 100\% =$ **94.16%**

$ABS = \frac{Wssd - Wod}{Wod} * 100\% = \frac{1612.84 - 830.65}{830.65} * 100\% =$ **94.16%**

$MC_{FREE} = MC_{TOTAL} - ABS = 94.16\% - 94.16\% =$ **0%**

$W_{FREE} = Wod * (\frac{MCfree}{100\%}) = 830.65 * (\frac{0\%}{100\%}) = 0$ LB

PORAVER (0.0787 – 0.157)

$W_{STK} = W_{SSD} + W_{FREE} = 629.35 + 0 =$ **629.35 (lb/yd^3)**

$MC_{TOTAL} = \frac{Wstk - W_{od}}{W_{od}} * 100\% = \frac{629.35 - 414.72}{414.72} * 100\% =$ **51.75%**

$ABS = \frac{Wssd - Wod}{Wod} * 100\% = \frac{629.35 - 414.72}{414.72} * 100\% =$ **51.75%**

$MC_{FREE} = MC_{TOTAL} - ABS = 51.75\% - 51.75\% =$ **0%**

$W_{FREE} = Wod * (\frac{MCfree}{100\%}) = 414.72 * (\frac{0\%}{100\%}) =$ **0 LB**

CORK

$W_{STK} = W_{SSD} + W_{FREE} = 671.80 + 0 =$ **671.80 (lb/yd^3)**

$MC_{TOTAL} = \frac{Wstk - W_{od}}{W_{od}} * 100\% = \frac{671.80 - 151.78}{151.78} * 100\% =$ **342.61%**

$ABS = \frac{Wssd - Wod}{Wod} * 100\% = \frac{671.80 - 151.78}{151.78} * 100\% =$ **342.61%**

$MC_{FREE} = MC_{TOTAL} - ABS = 342.61\% - 342.61\% =$ **0%**

$W_{FREE} = Wod * (\frac{MCfree}{100\%}) = 151.78 * (\frac{0\%}{100\%}) =$ **0 LB**

ADMIXTURES

$W_{HSTABILIZE} = \text{DOSAGE } (\frac{fl\,oz}{cwt}) * \text{CWT OF CM} * \text{WATER CONTENT } (\%) * \frac{1gal}{128\,floz} * \frac{lb}{gal} \text{ OF ADMIXTURE}$

$W_{HSTABILIZE} = 1.25\,(\frac{fl\,oz}{cwt}) \times 3.336 \text{ CWT} \times (1 - 0.048)\,(\%) * \frac{1gal}{128\,floz} * 9.6\frac{lb}{gal} =$ **0.298LB**

$W_{AIR\ ENTRAIN} = \text{DOSAGE } (\frac{fl\,oz}{cwt}) * \text{CWT OF CM} * \text{WATER CONTENT } (\%) * \frac{1gal}{128\,floz} * \frac{lb}{gal} \text{ OF ADMIXTURE}$

$W_{AIR\ ENTRAIN} = 3.0\,(\frac{fl\,oz}{cwt}) * 3.336 \text{ CWT} * (1 - 0.102)\,(\%) * \frac{1gal}{128\,floz} * 8.5\frac{lb}{gal} =$ **0.597 LB**

$W_{WATER\ REDUCER} = \text{DOSAGE } (\frac{fl\,oz}{cwt}) \times \text{CWT OF CM} \times \text{WATER CONTENT } (\%) \times \frac{1gal}{128\,floz} \times \frac{lb}{gal} \text{OF ADMIXTURE}$

$W_{WATER\ REDUCER} = 10\,(\frac{fl\,oz}{cwt}) \times 3.336 \text{ CWT} \times (1 - 0.365)\,(\%) \times \frac{1gal}{128\,floz} \times 8.9\frac{lb}{gal} =$ **1.473 LB**

$W_{VMA} = \text{DOSAGE } (\frac{fl\,oz}{cwt}) \times \text{CWT OF CM} \times \text{WATER CONTENT } (\%) \times \frac{1gal}{128\,floz} \times \frac{lb}{gal} \text{OF ADMIXTURE}$

$W_{VMA} = 5.65\,(\frac{fl\,oz}{cwt}) \times 3.336 \text{ CWT} \times (1 - 0.339)\,(\%) \times \frac{1gal}{128\,floz} \times 15\frac{lb}{gal} =$ **1.460 LB**

$\sum WATER_{ADMIXTURES} = 3.828$ LB

WATER

$w = \frac{w}{cm} * cm = 0.35 * 320.00 =$ **112.0 LB**

$V_{WATER} = \frac{w}{62.4\frac{lb}{ft^3}} = \frac{112.0}{62.4\frac{lb}{ft^3}} =$ **1.79 FT^3**

CONCRETE ANALYSIS

DENSITIES

$$\sum \textbf{Masses} = \textbf{Mass}_{\textbf{concrete}} = \mathbf{670.63}\ \boldsymbol{lbs}$$

$$\sum \textbf{Volumes} = \textbf{Volume}_{\textbf{concrete}} = \mathbf{15.62}\ \boldsymbol{ft^3}$$

$$\textbf{Theoretical Density (T)} = \frac{\textbf{Mass}_{\textbf{concrete}}}{\textbf{Volume}_{\textbf{Concrete}}} = \frac{670.63 lbs}{15.62 ft^3} = 42.93\ lbs/ft^3$$

$$\textbf{Measure Density (D)} = 55.4\ lbs/ft^3$$

IMPORTANT RATIOS

$$\textbf{cement/cementitious ratio}: \frac{\textbf{c}}{\textbf{cm}} = \frac{245.00\ lbs}{320\ lbs} = \mathbf{0.77}$$

$$\textbf{water/cement ratio}: \frac{\textbf{w}}{\textbf{cm}} = \frac{112.0\ lbs}{320.0\ lbs} = \mathbf{0.35}$$

AGGREGATE RATIO CHECK

$$\textbf{Aggregate Ratio } (\%) = \frac{\boldsymbol{Volume_{total\ aggregate}}}{\mathbf{15.63}\boldsymbol{ft^3}} \times \mathbf{100\%}$$

$$\textbf{Aggregate Ratio}\ (\%) = \frac{11.841\ \text{ft}^3}{15.62\ \text{ft}^3} \times 100\% = 75.8\%$$

ASTM C330 AGGREGATE RATIO CHECK

$$\mathbf{V_{ASTM\ C330}} = \frac{\boldsymbol{Volume_{ASTM\ C330\ aggregate}}}{\boldsymbol{Volume_{total\ aggregate}}} \times \mathbf{100}\%$$

$$\mathbf{V_{ASTM\ C330}} = \frac{4.321\ \text{ft}^3}{11.841\ \text{ft}^3} \times 100\% = \mathbf{36.5}\%$$

37% of the concrete aggregate is expanded glass

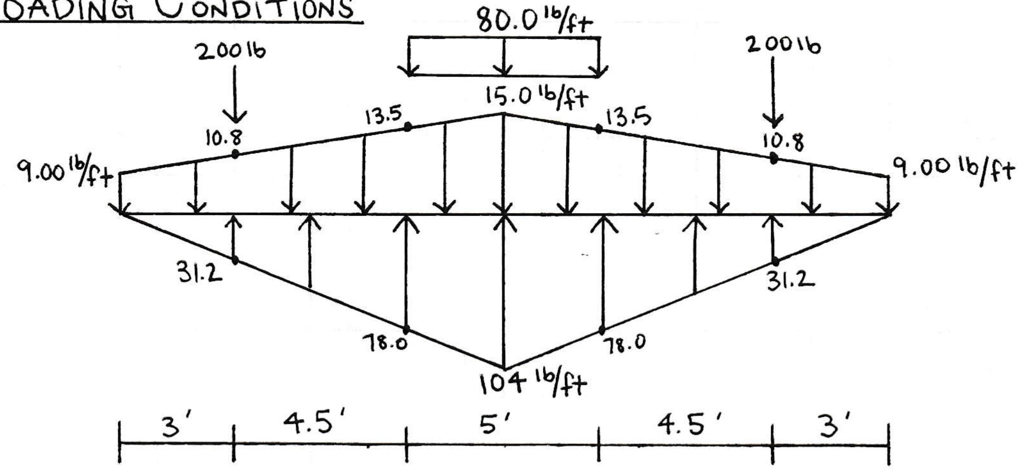
SLUMP MEASURED AT 0”

Appendix B – Structural Calculations

See following pages.

Oregon State University College of Engineering School of Civil and Construction Engineering	Job No.	Sheet 1 of 4	Rev.
	Job Title OSU Concrete Canoe		
	Made by		Date
	Checked by		Date

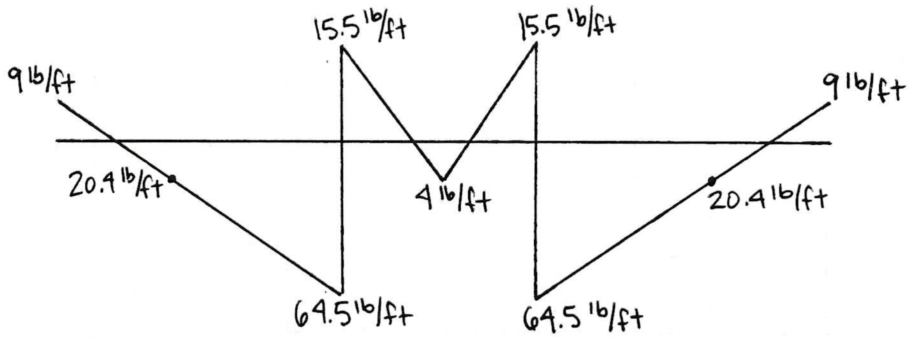
Loading Conditions



Calculating Buoyancy

$$2(200\,lb) + (80\,lb/ft)(5') + 240\,lb = 1040\,lb \Rightarrow \frac{(1040\,lb)}{(1/2)(20')} = 104\,lb/ft$$

Resulting Loads



Assumptions

- Estimated self weight of canoe ≈ 240 lb
- Self weight is modeled as distributed triangular load to account for varied weights along the length of the canoe

Check

$$\Sigma F_y = 0$$

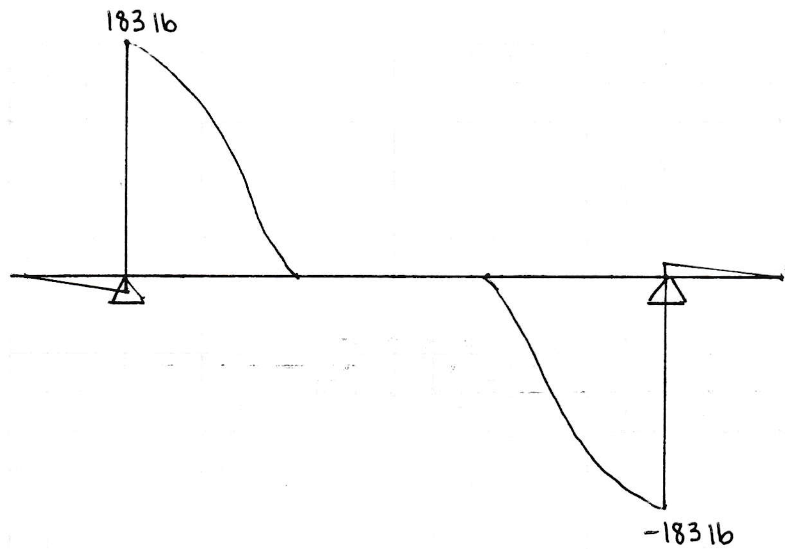
$$-2(200\,lb) - (80\,lb/ft)(5') - (1/2)(15 - 9\,lb/ft)(20') - (9\,lb/ft)(20') + (104\,lb/ft)(20')(1/2) = 0$$

OK!

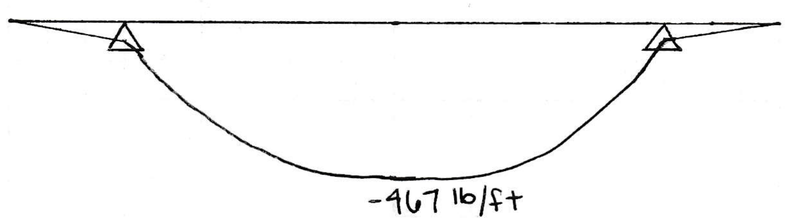
Oregon State University College of Engineering School of Civil and Construction Engineering	Job No.	Sheet 2 of 4	Rev.
	Job Title OSU CONCRETE CANOE		
	Made by		Date
	Checked by		Date

SHEAR AND BENDING MOMENT DIAGRAMS

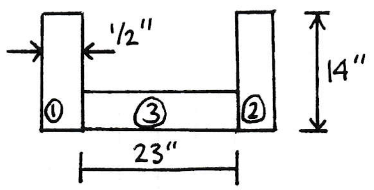
V(X)



M(X)



Idealized Shape at Midspan (where maximum moment occurs)



$A_1 = A_2 = (0.5")(14") = 7\,in^2$

$A_3 = (23")(0.5") = 11.5\,in^2$

$A_{TOTAL} = A_1 + A_2 + A_3 = 25.5\,in^2$

$Y_1 = Y_2 = 7"$

$Y_3 = 0.25"$

$$Y_{CENTROID} = \frac{Y_1A_1 + Y_2A_2 + Y_3A_3}{A_{TOTAL}} = \frac{(7")(7in^2) + (7")(7in^2) + (0.25")(11.5in^2)}{(25.5in^2)}$$

$y_c = 3.96\,in$

$$I_1 = I_2 = \frac{(0.5")(14in)^3}{12} = 114\,in^4$$

$$I_3 = \frac{(23")(0.5in)^3}{12} = 0.239\,in^4$$

$d_1 = d_2 = 7" - 3.96" = 3.04"$

$d_3 = 3.96" - 0.25" = 3.71"$

$$I_{TOTAL} = (I_1 + A_1d_1^2) + (I_2 + A_2d_2^2) + (I_3 + A_3d_3^2)$$

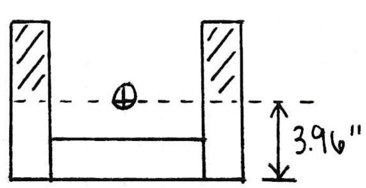
$$I_T = (114 + (7)(3.04)^2) + (114 + (7)(3.04)^2) + (0.239 + (11.5)(3.71)) = 516\,in^4$$

Compressive and Tensile Stress at Midspan

$$\sigma_T = \frac{My}{I} = \frac{(467\,lb/ft)(12in/ft)(10.0in)}{516in^4} = 109\,psi$$

$$\sigma_C = \frac{My}{I} = \frac{(467\,lb/ft)(12in/ft)(3.96in)}{516\,in^4} = 42.9\,psi$$

Shear Stress



$I_T = 516\,in^4$

$V_{MAX} = 183\,lb$

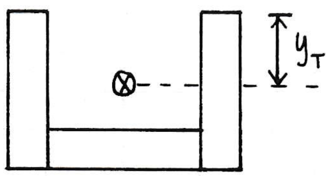
$t = 2(0.5") = 1"$

$$Q = \bar{A}y' = [(2)(0.5")(14" - 3.96")]\left[\frac{10.0in}{2}\right] = 50.2\,in^3$$

$$\tau = \frac{VQ}{It}$$

$$\tau = \frac{(183lb)(50.2in^3)}{(517in^4)(1in)} = 17.8\,psi$$

Bending Moment When Cracking Occurs



$f'_c = 1070$ psi

$\lambda = 0.75$ (LIGHT WEIGHT CONCRETE)

$f_R = 7.5\lambda\sqrt{f'_c} \Rightarrow 7.5(0.75)\sqrt{1070 psi} = 184$ psi

WHERE f_R IS THE MODULUS OF RUPTURE

$I_T = 516$ in^4

MOMENT WHEN CRACKING OCCURS $= M_{CR} = \frac{f_R I_T}{y_T} = \frac{(184 psi)(516 in^4)}{(10.0 in)} = 9{,}513$ lb-in

$M_{CR} = 9.51$ k-in

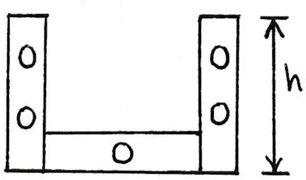
$M_{MAX} = (467$ lb ft$)\left(\frac{12 in}{ft}\right) = 5{,}600$ lb in

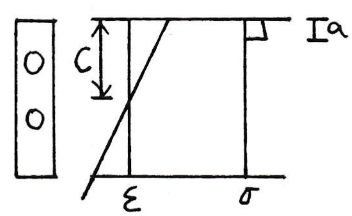
$M_{MAX} = 5.60$ k-in

$M_{MAX} < M_{CR}$ ✓ OK!

$5.60 < 9.51$

Ultimate Bending Moment





5 PRE TENSION WIRES

$F_y = 31.2$ ksi (GRADE 304 STAINLESS STEEL)

$A_s = 0.0089$ in^2

$5A_s = 0.0345$ in^2

$a = \beta c = 0.85c$

$\varepsilon_y = F_y / E_s$

$\frac{0.003}{c} = \frac{\left[\frac{31.2}{29{,}000}\right] + 0.003}{14}$

$T_u \leq \phi T_n$

$M_{ULT} = A_s F_y (h - a/2)$

$M_{ULT} = (0.0089 in^2)(31.2 ksi)(14" - 8.76 in/2) = 9.53$ k-in

$\therefore c = 10.3$ in

$a = 8.76$ in

$M_{ULT} > M_{MAX}$

$9.53 > 5.60$ OK!

Appendix C – Hull Thickness/Reinforcement and Percent Open Area Calculations

Per RFI No. 71, the use of Sections (4.3.1 and 4.3.2) from the 2019 ASCE National Concrete Canoe Competition Rules and Regulations is permitted. According to Section 4.3.1 of the 2019 ASCE National Concrete Canoe Competition Rules and Regulations, the thickness of a reinforcement layer is determined by placing reinforcement on a flat surface under a ¼" or thinner piece of plate glass. The distance from the bottom of the plate to the top of the supporting flat surface is the reinforcement layer thickness. This thickness is then divided by the total thickness of the canoe wall at any point. This resulting value cannot exceed 50%. If individual rods of reinforcing bars are used in such a way that they cross each other, it is considered two layers of reinforcement. The 2020 OSU Concrete Canoe team has measured hull reinforcement thicknesses and the calculations are as follows:

Average Hull Thickness: 0.50 in

Reinforcement Thickness 1: (Titan FE – FG10 Bi-Axial Fiberglass Grid) = 0.0970 in

Reinforcement Thickness 2: (prestressing wires) = .0625 in. diameter

$$\frac{0.097\ in + 0.0625\ in}{0.50\ in} \times 100 = \mathbf{31.9}\% \ (< 50\%\ max \therefore OK)$$

As shown in the above calculations, the reinforcement configuration used in *Vinifera* is in compliance with Section 4.3.1.

According to Section 4.3.2 of the 2019 ASCE National Concrete Canoe Competition Rules and Regulations, the minimum percent open area (POA) of any reinforcing material is 40%. The POA for both reinforcing materials in *Vinifera* was calculated as follows using the same notation and variables as seen in Section 4.3.2:

Titan FE – FG10 Bi-Axial Fiberglass Grid

Measurements		Calculations	
T1	0.2330 in	**d1**	$aperture_1 + 2\left(\frac{t_1}{2}\right)$ = 1.0885 in
T2	0.3325 in	**d2**	$aperture_2 + 2\left(\frac{t_2}{2}\right)$ = 1.0410 in
N1	5	**Length**	$n_1 d_1$ = 5.4425 in
N2	5	**Width**	$n_2 d_2$ = 5.2050 in
Aperture1	0.8655	**ΣAreaopen**	$n_1 \times n_2 \times Area_{open}$ = 15.33 in^2
Aperture2	0.7085	**Areatotal**	$Length \times Width$ = 28.33 in^2

POA = $\frac{\sum Areaopen}{Area}\ x\ 100\%$ = **54.12%** (>40% min, therefore it's OK)

As shown in the above calculations, the POA for all reinforcement used within *Vinifera* is in compliance with Section 4.3.2. (NCCC 2019)

Appendix D – References

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ASTM C138/C 138M. Standard Test Method for Density (Unit Weight), Yield, and Air Content. ASTM International, West Conshohocken, PA, 2017. <www.astm.org>.

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ASTM C330 / C330M-14. Standard Specification for Lightweight Aggregates for Structural Concrete. ASTM International, West Conshohocken, PA, 2017. <www.astm.org>.

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ASTM C39 / C39M-18. Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. ASTM International, West Conshohocken, PA, 2018. <www.astm.org>.

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ASTM C496 / C496M-17. Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens. ASTM International, West Conshohocken, PA, 2017. <www.astm.org>.

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ASTM C979 / C979M-16. Standard Specification for Pigments for Integrally Colored Concrete. ASTM International, West Conshohocken, PA, 2016. <www.astm.org>.

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ASTM D5759-12. Standard Guide for Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses. ASTM International, West Conshohocken, PA, 2017. <www.astm.org>.

ASTM D6337-98(19). Standard Practice for Physical Characterization of Woven Paint Applicator Fabrics. ASTM International, West Conshohocken, PA, 2019. <www.astm.org>.

Oregon State University (2017). “Willamette.” 2017 Concrete Canoe Design Report. Oregon State University, Corvallis, OR.

Oregon State University (2018). “Gorgeous.” 2018 Concrete Canoe Design Report. Oregon State University, Corvallis, OR

Oregon State University (2018). “Stinger.” 2019 Concrete Canoe Design Report. Oregon State University, Corvallis, OR

Appendix E – Supporting Documentation

See following pages.

Pre-Qualification Form (Page 1 of X) 6

OREGON STATE UNIVERSITY
(school name)

We acknowledge that we have read the 2020 ASCE National Concrete Canoe Competition Request for Proposal and understand the following (*initialed by team project manager and ASCE Faculty Advisor*):

The requirements of all teams to qualify as a participant in the Conference and National Competitions as outlined in Section 2.0 and Attachment 1.	✓
The requirements for teams to qualify as a potential Wildcard team including scoring in the top 1/3 of all Annual Reports, submitting a Statement of Interest, and finish within the top 1/2 of our Conference Concrete Canoe Competition (Attachment 1)	✓
The eligibility requirements of registered participants (Section 2.0 and Attachment 1)	✓
The deadline for the submission of *Preliminary Project Delivery Schedule* and *Pre-Qualification Form* (uploaded to ASCE server) is November 1, 2019; 11:59 p.m. Eastern	✓
The last day to submit *ASCE Student Chapter Annual Reports* to be eligible for qualifying (so that they may be graded) is February 1, 2020	✓
The last day to submit *Request for Information* (RFI) to the CNCCC is January 15, 2020	✓
Teams are responsible for all information provided in this *Request for Proposal*, any subsequent RFP addendums, and general questions and answers posted to the ASCE Concrete Canoe Facebook Page, from the date of the release of the information.	✓
The submission date of *Technical Proposal* and *MTDS Addendum* for Conference Competition (hard copies to Host School and uploading of electronic copies to ASCE server) is Monday, February 17, 2020.	✓
The submission date of *Technical Proposal* and *MTDS Addendum* for National Competition (hard copies to ASCE and uploading of uploading of electronic copies to ASCE server) is May 19, 2020; 5:00 p.m. Eastern.	✓

Madison Hall — 10.29.19
Project Manager (print name) — *(date)*

M. Hall
(signature)

Haley Madland 10.29.19
H. Madland

Thomas H. Miller — 10/29/19
ASCE Student Chapter Faculty Advisor (print name) — *(date)*

Thomas H. Miller
(signature)

In 150 words or less, provide a high-level overview of the team's Health & Safety (H&S) Program. If there is currently not one in place, what does the team envision their H&S program will entail?

Our Health and Safety program consists of training members on safety procedures and completing safety quizzes at our first general, mix, paddling, and construction meetings. In this way, new and old members alike can familiarize themselves with our safety protocols, and we can discuss safety means and methods. The quizzes also serve as a way for members to recognize and agree to the safety policies. If there is any machinery to be used, from saws to compression testing machines for concrete cylinders, our leads who are familiar with safety procedures demonstrate to team members how to properly use the machinery. A strict policy enforced is to always work with a buddy when using machinery. We provide safety glasses, dust masks, gloves, lifevests and other appropriate PPE to all meetings. In the event of an emergency, the team has been trained to first call 911, then the team captains and advisor.

In 150 words or less, provide a high-level overview of the team's current QA/QC Program. If there is currently not one in place, what does the team envision their QA/QC program will entail?

Some of our current Quality Assurance/Quality Control methods include using "depth checkers" when placing concrete on our formwork, to ensure the thickness of our canoe hull is as designed. We "measure twice, cut once" as a principle, to ensure the desired cut is correct. In this way, the team hopes to reduce waste in material and time while practicing precision. Also, many different concrete mixes are tested, and the data collected from these tests allow us to select the mix design of the highest quality. This year we are also constructing two full-scale canoe prototypes, a practice prototype, and a final, racing prototype to refine our tested and true methods and experiment with innovative ideas. From the practice prototype, we hope for new members to gain experience and returning members to hone their skills, to achieve the highest quality final canoe possible.

Has the team reviewed the Department and/or University safety policies regarding material research, material lab testing, construction, or other applicable areas for the project?

Yes, our team's Safety Lead has put together a document containing all relevant University policies. Including; Emergency Response Protocol for fire, Building Evacuations, and Emergency Treatment, the OSU Safety Program, the Construction Safety Program, Hazard Communication, Fire and Life Safety, Chemical Spill Management and Laboratory Safety and Personal Protective Equipment for Hazardous Materials in the Laboratory. This document was discussed with the team during the first meeting of the year and placed on the file sharing system that all members have access to.

The anticipated canoe name and overall theme is – (please provide a brief description of the theme. The intent is to allow ASCE to follow up to determine if there may be copyright or trademark issues to contend with, as well as to provide insight)
Name: Vinifera
Theme: Vineyards

Oregon State chose Vineyards for the theme this year. Vinifera is short for "Vitis Vinifera"; the scientific name of the red wine grape used to make Pinot Noir. Vineyards are excellent examples of engineering like water irrigation systems, making this the perfect theme for the 2020 Concrete Canoe Prototype. The team is focusing strictly on the science and engineering of vineyards and will not be using any specific brands or copyrights of any kind.

Has this theme been discussed with the team's Faculty Advisor about potential Trademark or Copywrite issues?
Yes. We agree there will not be issues during this year.

The core project team is made up of 14 people.

Provide an estimated project budget for the year (including materials, transportation, etc.). Base this on real costs (not costs provided in the Detailed Cost Assessment). List and approximate (percentage (%) of overall) anticipated financial sources for the upcoming year (University, material donations, sponsors, monetary donations, etc.)
See attached.

Anticipated Financial Sources		Approximate Percentage of Overall Budget
University Funding	$13,538.00	77.41%
Material Donation (Plywood)	$300.00	1.72%
Material Donation (Mix Design)	$500.00	2.86%
Free Wetsuit Rental (Sponsor)	$150.00	0.86%
Nationals Fundraising (Monetary Donations)	$3,000.00	17.15%
Overall Budget for 2019-2020 Year	**$17,488.00**	**100.00%**

Budget	
Construction	$3,000.00
Aesthetics	$400.00
Mix	$500.00
Paddling	$600.00
Submittals	$500.00
Regionals	$3,650.00
Food	$700.00
Nationals	$2,000.00
Apparel	$950.00
Recruitmemt	$250.00
Safety	$988.00
Donations	$3,950.00
TOTAL	**$17,488.00**

Construction	
Paint Sticks	$125.00
Skill Saw	$100.00
Table Saw	$300.00
Drill	$100.00
Staple Gun	$50.00
Staples	$4.00
Table 1 (Miter)	$80.00
Uhaul in Spring	$86.00
Uhaul in Fall	$80.00
Foam (2 sheets)	$60.00
Mock Up Table	$71.00
Tires For Dolly	$88.00
Other Spending	$1,856.00
TOTAL	**$3,000.00**

Safety	
PPE for Mix	$50.00
First Aid Kits	$25.00
Fire Extinguishers	$20.00
Other Orders	$893.00
TOTAL	**$988.00**

Aesthetics	
Painting/Posters for decor	$100.00
Poster for conference	$24.00
Display	$276.00
TOTAL	**$400.00**

Mix	
Initial Materials	$80.00
Innovations	$420.00
TOTAL	**$500.00**

Paddling	
TOTAL	**$600.00**

Submittals	
Regionals (10 Copies)	$200.00
Nationals (12 Copies)	$240.00
Postage for the year	$60.00
TOTAL	**$500.00**

Recruitment	
Sticker Order 1	$107.00
Sticker Order 2	$107.00
Poster (Expo and CC)	$20.00
Other Spending	$16.00
TOTAL	**$250.00**

Regionals (25 people)	
Registration	$200.00
Travel	$700.00
Lodging	$2,500.00
Food	$250.00
TOTAL	**$3,650.00**

Food (for the year)	
Construction in Spring	$43.00
Mix week 6	$80.00
Practice Pour Day	$200.00
Pour Day	$200.00
Construction 2	$50.00
Other Events	$127.00
TOTAL	**$700.00**

Nationals (10 people)	
TOTAL	**$2,000.00**

Apparel	
30 Conference Shirts	$600.00
13 Lead's Polos	$325.00
Extra Costs	$25.00
TOTAL	**$950.00**

RFP Addendum Acknowledgment Form

OREGON STATE UNIVERSITY
(school name)

We acknowledge that we have received and acknowledge the following Addendums to the 2020 ASCE National Concrete Canoe Competition Request for Proposal (*initialed by team project manager and ASCE Faculty Advisor*):

Addendum No. 1: Presentation Q&A

This Addendum provides the Technical Presentation score card and a list of questions that the judges can use during the 10-minute Judge's question & answer period. In addition, a scorecard was provided.

Per Section 8.0 of the Request for Proposals (RFP), the presentation is limited to 3 minutes and will be cutoff at precisely 3 minutes by a signal. Also, per Section 8.0 of the RFP, the technical presentation "...should focus on the primary aspects of the design, construction, and technical capabilities. Briefly summarize the major aspects of the project, with the intent of demonstrating why your team, design, and prototype should be selected by the panel of judges for the standardized design (recall this is a hypothetical scenario to provide an end goal for the RFP and the competition)." X

Addendum No. 2: Durability & Repairs

This Addendum provides information regarding how the durability of the canoe prototype is to be assessed, allowable repairs and materials, and forms including *Damage / Accident Report*, *Repair Procedure Report*, and *Reconstruction Request*. X

Addendum No. 3: Detailed Cost Assessment

This Addendum provided a list of material costs for a variety of cementitious materials, pozzolans, admixtures, fibers, aggregates, and other constituents that were not presented in *Attachment 4: Detailed Cost Assessment* of the Request for Proposal. Teams were also advised that if they have products that were not given a specific price for, they should use their best judgement to use a price for a similar material in their Material Cost Estimate. X

MADISON HALL — 02.12.2020
Project Manager (print name) — *(date)*
Madison Hall
(signature)

HALEY MADLAND 02.12.2020
Haley Madland

THOMAS MILLER — 02.12.2020
ASCE Student Chapter Faculty Advisor (print name) — *(date)*
Thomas H. Miller
(signature)

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