NAU
NORTHERN ARIZONA UNIVERSITY
College of Engineering, Informatics, and Applied Sciences

Engineering Laboratory

Project Plan Documentation (Binder)

NAU 2025 Concrete Canoe

Design and Construction of a Concrete Canoe to be Presented at ISWS

8/25/2025 - 5/8/2026

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Contact Information

Team Members

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Emergency Contacts

EH&S:

Chemical Safety (contained):

- Ryelan McDonough
    - Cell: (928) 679-5948
- Mick Kelly
    - Cell: (928) 308-6507

Hazardous Waste or Spilled chemicals:

- Mick Kelly
    - Cell: (928) 308-6507
- Ryelan McDonough
    - Cell: (928) 679-5948

Radioactive Substances:

- Scott Halle
    - Cell: (928) 606-3788

Air Monitoring, Environmental Permits, etc.:

- Mick Kelly
    - Cell: (928) 308-6507

For work related injuries or hospitalizations:

- Sarah Ells
    - Cell: (928) 607-6857
- Scot Hall
    - Cell: (928) 606-3788

Extraneous Emergency

NAU Police: (928) 523-3611

Poison Control: (800) 222-1222

Laboratory Manager

Dr. Adam Bringhurst

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Building 69 Room 117A

Office: (928) 523-1164
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Project Summary

In order to design a concrete mix to be used to construct this year's concrete canoe, mixing and testing of concrete will need to be conducted within the lab space and on the farm. This includes mixing concrete using the concrete mixer, testing the compressive and tensile strength of concrete using a compression device (likely the Tinius-Olsen as the Humboldt is currently out of commission), and grading of materials using the sieve shaker in Lab 116. Conducting the slump/flow tests needed to analyze mix designs pose no additional risk, but contain the same hazards as the general handling of concrete. During the construction of the canoe itself, its mold, and its stand, power tools will likely be necessary as well and would most likely be used at the CECMEE Field Station (Farm).

First Divider- Initial Project Plan

Project Name

NAU 2025 Concrete Canoe

Team Members, (Will Enter Lab)

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Project Objectives

1. Analysis of Concrete Mix Design- Testing

2. Construction of Concrete Canoe, Mold, and & Stand

Lab Based Approach

1. Analysis of Concrete Mix Design: All analysis of concrete will be done in accordance with ASTM outlined procedures. The following lab-based tests will be completed:

- Sieve Analysis of Fine and Coarse Aggregates (ASTM C136)
- Compressive Strength of Cylindrical Concrete Specimens (ASTM C39)
- Slump of Hydraulic-Cement Concrete (ASTM (C143)
- Slump Flow of Self-Consolidating Concrete (ASTM C1611)
- Splitting Tensile Strength of Cylindrical Concrete Specimens (ASTM C496)

2. Construction of Concrete Canoe, Mold, and & Stand: All construction will be done after proper planning and methodology approval by faculty. The following lab-based objectives will be completed:

- Construction of mold using power & cutting tools
- Mixing & pouring of concrete
- Construction of canoe stand using power & cutting tools
- Transportation of concrete canoe

Lab Planned Activity

1. Material Gathering & Testing (Sieve Analysis)-

Duration: 10/01/2025- 10/31/2025

- Method Summary: This activity will be completed using the sieve shaker equipment in the concrete lab (rm. 117) in the Engineering Building. A Sieve Analysis will be done following ASTM C136 methods on the acquired fine and course aggregates to be used in our mix design in order to determine a particle size distribution of aggregates. This is done by separating a sample of dry aggregate through a series of sieves of progressively smaller openings (distinguishing different particle sizes). The entire team will be participating in this activity.

2. Completed Mix Design (Mixing, Pouring & Testing of Cylinders + Slump Test)-

Duration: 10/31/2025- 11/30/2025

- Method Summary: This activity will take place in the concrete lab (rm. 117) in the Engineering Building. Concrete will be mixed by combining our dry mix of aggregates, cementitious materials, and admixtures with water using the concrete mixer in the lab. The concrete mix will then be poured into 4x8" cylindrical molds (3 molds for each mix for 7, 14, and maybe 28 day breaks). At this point, a slump test will also be conducted by filling a cone with the concrete mix, flipping it over, and observing how the concrete reacts (how much it slumps) when the cone is removed to assess strength and workability. The concrete cylinders will then be tested for tensile and compressive strength after curing for 7, 14, and 28 days. The tensile strength test involves vertically pressing the upright cylinders using the Tinius-Olsen Hydraulic Compression Testing Device, and observing the maximum load that can be applied before failure. The compressive strength test is the same, but the concrete cylinder will be placed on its side rather than upright.

3. Construction of Concrete Canoe, Mold, & Stand-

Duration: 1/1/2026- 3/15/2026

- Method Summary: All construction will be done at the CECMEE Field Station. The method for the construction of the canoe mold and stand includes utilizing various power and cutting tools & materials to construct these parts based on measurements derived from our final canoe design, while following all training and safety requirements for the use of power tools and certain materials. After constructing the concrete canoe mold, the concrete will be mixed by combining our dry mix of aggregates, cementitious materials, and admixtures with water using the concrete mixer at the field station. After mixing, the concrete will be slump tested and poured into our concrete canoe mold. The concrete will then have to cure for approximately 28 days before it is removed from the mold and transported. The entire team will participate in this activity.

<u>Laboratory Equipment/ Supplies</u>

1. Concrete Analysis Equipment

- Concrete Mixer
- Tinius-Olsen Hydraulic Compression Testing Device

- 4 x8” Cylindrical Concrete Molds
- Wood Stick
- Sieve Shaker
- Sieve
- Sieve Brush

2. Construction Equipment

- Sheet/Orbital Sander
- Shears
- Table Saw
- Screws/Nails
- Drill
- Hammer

3. Safety Supplies

- Gloves
- Goggles
- Dust Masks (N95)

Hazards/Risks

1. Hazards/Risks Associated with Material Gathering & Testing (Sieve Analysis)

- Inhalation, ingestion, and eye injury/ irritation associated with working with aggregates and cementitious materials (sieve analysis)

2. Hazards/Risks Associated with Completed Mix Design (Mixing, Pouring & Testing of Cylinders + Slump Test)

- Inhalation, ingestion, and eye injury/ irritation associated with working with aggregates and cementitious materials & hydraulic press (concrete cylinder testing/ hydraulic press involves significant dust and loose material)
- Crushing/entanglement and flying objects (chunks of cement flying from compressing cylinders) hazard associated with use of the Tinius-Olsen Hydraulic Press and Concrete Mixer
- Chemical hazards (possible corrosive burns) associated with high pH/alkaline cement materials (lime).

3. Hazards/Risks associated with Construction of Concrete Canoe, Mold, & Stand:

- Potential injury while using tools/power tools/cutting tools for all construction activities
- Inhalation, ingestion, and eye injury/ irritation associated with aggregates & cementitious material (during mixing), and other materials (wood, foam, etc during cutting and power tool use)

Safety Protocols

1. Waste Generation and Disposal Protocol

- All waste materials, especially chemicals, must be properly disposed of. There are different methods of disposal for different types of materials, chemicals, and other generated waste that must be followed. Any plan for hazardous waste/material; whether it be storage, disposal, or clean up requires collaboration with EH&S.

2. Trainings
   - Environmental Health & Safety Trainings
   - Power Tool Training
   - Chemical Safety Training

3. Personnel Protocol

- No one is ever allowed to be alone in a laboratory. There must always be more than one person monitoring/ assisting with lab activities.

4. Engineering Control Devices

- There must be a blockade used when using the Tinius-Olsen Hydraulic Compression Testing Device to protect persons from flying material/concrete while compressing cylinders (uncontrolled release of energy).

5. Personal Protective Equipment

- Goggles/safety glasses- required for any activity that might involve loose/flying particles or objects.
- Gloves- required for any activity that involves touching a potentially hazardous material.
- Dust Mask (N95)- required for any activity involving potential harm caused by inhalation of dust/ flying particles.

Waste Generation and Disposal Requirements

Hazardous Wastes

1. Wet Concrete- high-pH alkaline compounds (lime)
2. Cement/Fiber Dust- crystalline silica
3. Admixtures- high pH alkaline
4. Cleaning Solvents

5. Wash Water
6. Heavy Metals- possible trace amounts of heavy metals (chromium)

Non-Hazardous Wastes

1. Concrete Scraps
2. Material Waste
3. Wood and Foam
4. Fiber Reinforcement
5. Plastic Sheathing

Hazardous Waste Cleanup Plan

MUST COLLABORATE WITH EH&S TO MAKE PLAN

Trainings

Completed

- Sieve Analysis Experience- All members of the team have taken the CENE 383L course to familiarize themselves with the Sieve Analysis procedure and protocols.

Will Be Completed Before Associated Lab Use

- Power Tool Training
- Chemical Safety Trainings
- EH&S Trainings

Second Divider- Emergency Response Plan

Table 1- Hazards, Preventative Measures, and Emergency Response

Hazard	Preventative Measures	Emergency Response Plan
Chemical Burns	**PPE- chemical resistant gloves (when handling hazardous materials- cement, lime, fly ash)**	
Crushing/Entanglement	**Always keeping a distance from hazardous equipment when energized (Tinius-Olsen Hydraulic Compression Testing Device)**	
Eye Injury/Irritation	**PPE- safety glasses or goggles**	
Flying Objects (Uncontrolled Release of Energy)	**Engineering controls- barricade (when using Tinius-Olsen Hydraulic Compression Testing Device)**	
Particulate/Dust Inhalation or Ingestion	**PPE- dust Mask (N95)**	
Tools/Equipment Usage- Injury	**Power Tool Training** **PPE- safety glasses, closed-toe shoes, hard hat**	

Third Divider- Chemical Handling and Safety

SDS information for each chemical used- do not yet know specific chemicals

1. Chemical Identification Page
    a. Name of chemical
    b. Supplier or manufacture name
    c. Chemical storage
    d. Safe handling of chemical
    e. Waste accumulation procedure
    f. Waste Disposal Plan

2. Chemical SDS

Fourth Divider – Safety Training and Lab Agreements

1. Include a copy of all documentation identifying and certifying completion of the online chemical hygiene training for each team member.
    a. This training must be completed annually.

2. Include a copy of the signed EnE Laboratory User Agreement and Waiver form for each team member.
    a. These documents will be provided to you, and filled out, during the lab usage and lab safety meeting held with the lab manager.

Fifth Divider – Project Activity Log

Each project team member must document their laboratory activities using Project Activity Log forms.