



Idaho State University

College of Science and Engineering

Department of Civil and Environmental Engineering

Precast Concrete Engineering Studio

Fall 2023

1.0 Basic Studio Information

Funding Agencies

Precast/Prestressed Concrete Institute (PCI) Foundation

National Precast Concrete Association (NPCA) Foundation

Awarded Institution

Idaho State University, College of Science and Engineering, Department of Civil and Environmental Engineering

Project Title

Precast Concrete Engineering Design Studio

Principal Investigator

Mustafa Mashal, Ph.D., P.E., Associate Professor

Co-Principal Investigator

Bruce Savage, Ph.D., P.E., Professor and Department Chair

Report Type

4th Year Report: Fall 2023

2.0 Executive Summary

The Precast Concrete Engineering Studio (CE 4499/5599) at Idaho State University (ISU) is jointly funded by the PCI and NPCA Foundations for four years. It is the first jointed Studio in the United States. The Studio is focused on transportation (bridges and culverts) precast concrete products. Faculty coordinators for the Studio at ISU are Dr. Mustafa Mashal, Associate Professor, and Dr. Bruce Savage, Professor and Chair, from the Department of Civil and Environmental Engineering at ISU. The CE 4499/5599 is currently a graduate/undergraduate level technical elective. Additional requirements with respect to homework, exam problems, and lab work are required of graduate students. In 2022, The PCI and NPCA Foundations approved a no cost extension for the Studio due to Dr. Mashal's leave on sabbatical.

The Studio was taught in the fall of 2023 for the fourth time at ISU. On the first day of the class, all students signed up for the PCI and NPCA Student memberships. There were 13 students who took the class; 9 students were graduates (masters) and 4 were undergraduates. Several of the students had not taken the design of reinforced concrete structures, therefore course materials had to be balanced between basic design aspects for precast/prestressed concrete structures, hands-on components, and other activities to make the Studio an inclusive class for everyone. Student feedback from the previous classes taught were incorporated in 2023. The class covered both precast bridges and culverts. Class lectures were conducted in person. Students were required to attend the hands-on labs in person. The class covered a range of topics in structural and hydraulic design of precast and prestressed concrete; several hands-on laboratory work sessions; two presentations by guest speakers (Jim Schneider from PCI Mountain States and Claude Goguen from NPCA); and a visit to a PCI certified precaster (Teton Prestress Concrete) in Idaho Falls.

The course had a special focus on reducing the carbon footprint of concrete while achieving similar performance as conventional concrete. Two waste products (precipitated calcium carbonate and upcycled concrete aggregate) were incorporated in concrete mixes to reduce up to 70% of the carbon emissions. These were based on the latest innovative research findings from Idaho State University ([A Sustainable and Environmentally Friendly Concrete for Structural Applications](#)). The course also covered both lecture and laboratory work on the use of advanced materials such as Ultra-High-Performance Concrete (UHPC) and Titanium Alloy Bars. Other trending topics such as Accelerated Bridge Construction (ABC) was also covered in detail. All students were provided hard-hats, vests, and safety glasses as souvenirs for the Studio. They were required to wear those on during the laboratory and site visit.

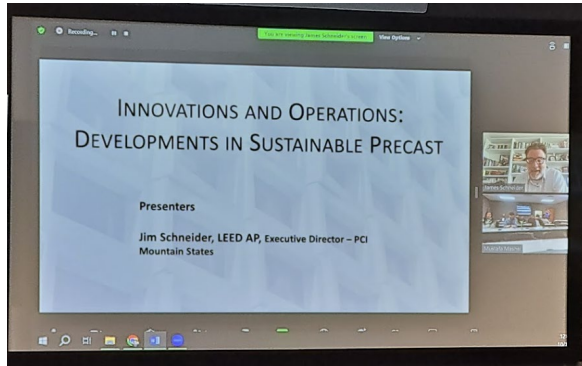
There was a final report for the course. It required the students to work in groups and build large-scale samples of precast concrete panels made of both conventional and sustainable concrete and test them under four-point bending in the ISU's Structural Laboratory (SLAB). The samples were instrumented and the testing was conducted similar to a scientific research. Students had to turn in final report and then do an oral presentation (12 minutes) followed by questions (3-5 minutes) from the course coordinator (Dr. Mustafa Mashal) and the teaching assistant (Kabiraj Phuyal).

Student were strongly encouraged to apply for the available scholarships at NPCA and consider participating in the NPCA and PCI student competitions. Six students from the class applied for the 2024 Project Precast by the PCI Foundation. 61 students from 20 universities from across the nation applied for the 2024 Project Precast. ISU had the greatest number of submissions (10%) than any other schools in the nation. One ISU student was selected for the Project Precast. A team of ISU students have shown interest in making a submission to the 2023-24 PCI Big Beam competition.

3.0 Guest Speakers

A. Jim Schneider

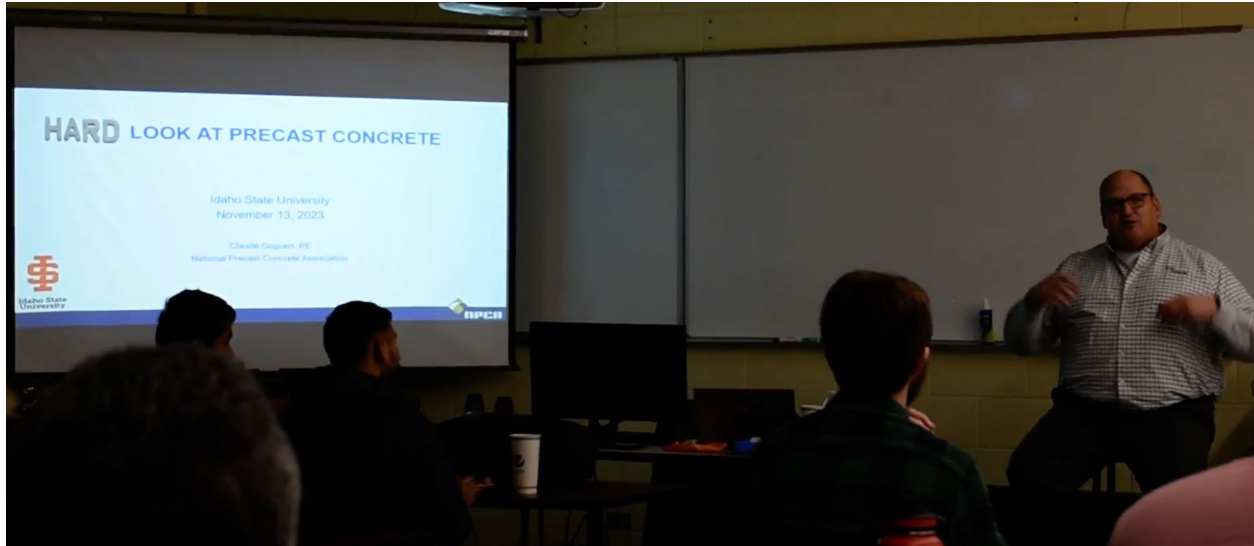
Jim Scheider, LEED AP, serves as the Executive Director of the PCI Mountain States chapter, overseeing operations in Colorado, Idaho, Montana, Utah, and Wyoming. During a significant virtual presentation on advancements in sustainable precast, conducted Via Zoom, Jim shared valuable information. The session was recorded, all students in the Studio class were in attendance.



Jim Schneider's Zoom Lecture: Designing for Sustainability with Precast, Prestressed Concrete.

B. Claude Goguen

Claude Goguen, Director of Technical Education and Outreach at NPCA, delivered an insightful presentation on precast concrete. His presentation included a comprehensive introduction to precast concrete, the essential materials for concrete preparation, the versatile application of precast concrete in projects such as detention basins, bridges, and dams, and illustrative examples of various precast projects. The session was recorded, and all students in the Studio class attended, gaining valuable knowledge from Claude's presentation.



Claude Goguen's Insightful Presentation: Unveiling the Wonders of Precast Concrete

4.0 Visit to Teton Precast Yard

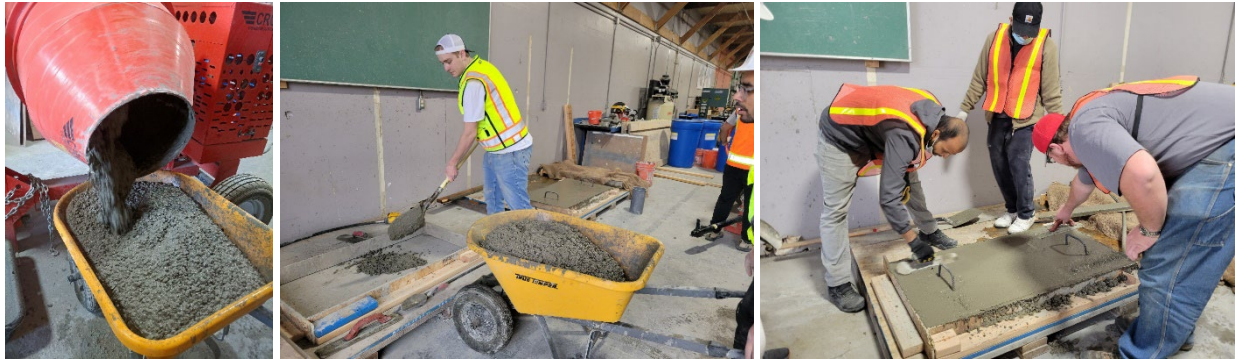
Students had the unique opportunity to visit Teton Prestress Concrete, a certified precast plant located in Idaho Falls. The tour provided hands on insights into practical application of precast concrete. Knowledgeable experts from Teton prestressed Concrete were on hand to answer all questions posed by the students. Subsequently, students synthesized the information acquired during the visit by crafting detailed summaries.



Exploring Precast Concrete Applications: Student's Visit to Teton Prestress Concrete in Idaho Falls

5.0 Laboratory Work

The Studio comprised several laboratory work sessions, with this year's emphasis on developing sustainable concrete mixes incorporating Precipitated Calcium Carbonate (PCC) and Upcycled Recycled Concrete Aggregate (UCA). The lab activities encompassed Ultra High-Performance Concrete (UHPC) mix design. Beyond the concrete pouring stage, both concrete slabs and cylinders underwent testing at the 28-day mark. Additionally, the lab explored the hydraulics of culverts. Students were tasked with producing detailed reports and conducting calculations related to the lab work. Notably, for safety during laboratory activities, students were provided with safety hats, vests, and glasses.

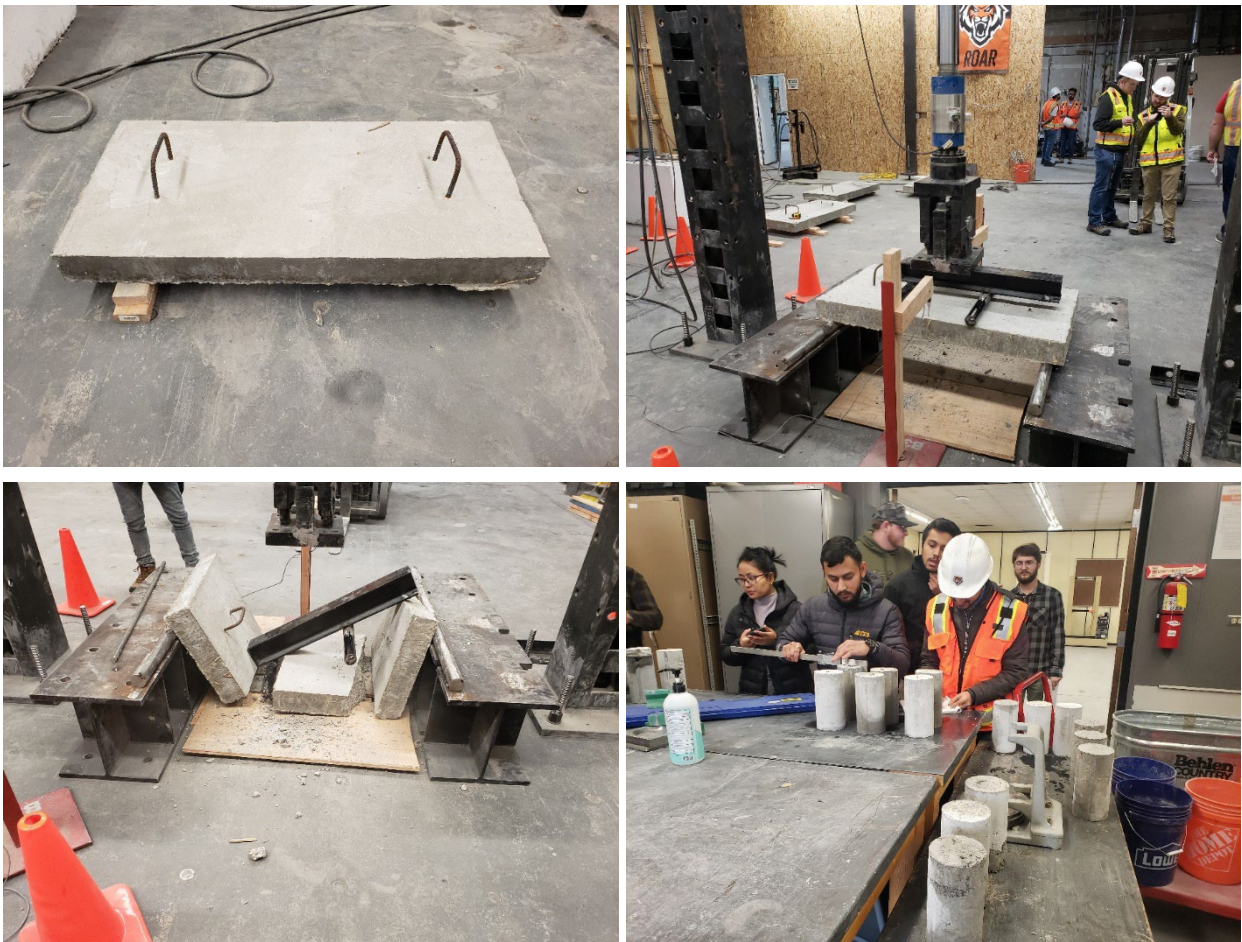


Mixing and Sampling Conventional Concrete

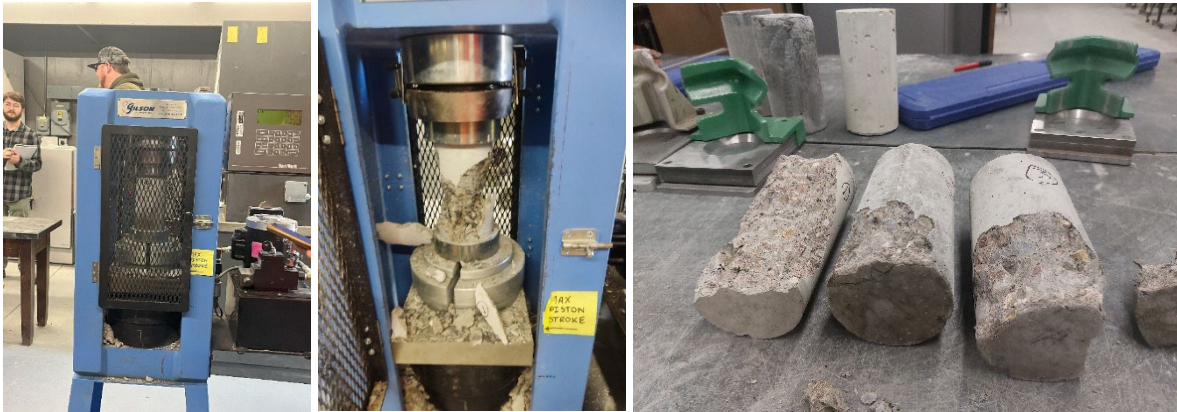




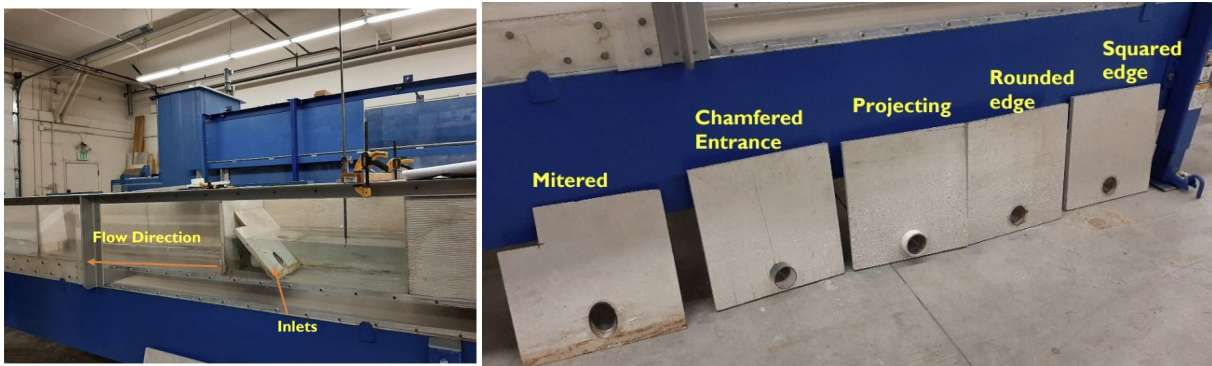
Mixing and Sampling UHPC



Measuring Conventional Concrete Samples Prior to Testing



Testing UHPC Concrete Samples for Compressive Strength



Hydraulics of Culvert Laboratory Work



Final project presentations