Idaho State University

College of Science and Engineering

Department of Civil and Environmental Engineering

Precast Concrete Engineering Studio

3rd Year Report (2021)

February 22, 2022

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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

Grant Period

2019-2022

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

3rd Year Report: 2021

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 (2019-2022). 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.

The Studio was taught in the fall of 2021 for the third time at ISU. There were 11 students who took the class; 5 students were graduate (masters) and 6 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 in order to make the Studio an inclusive class for everyone. Student feedback from the first and second studios taught in the Fall of 2019 and 2020 was incorporated in the third studio in 2021. The class covered both precast bridges and culverts. However, more emphasis was put on the precast bridges as per the original proposal to PCI and NPCA Foundations. Class lectures were conducted in a Hyflex manner as per ISU's guidelines. This was a hybrid model where students can be present in the room or attend synchronously online via WebRTC. A student could choose either of the two options to attend the class. The majority of the students attended the class in person. Students were required to attend the hands-on labs in person if they were healthy. All class lectures and lab work were recorded and made available to students on the course website.

The course syllabus for the Fall 2021 Studio is attached in Appendix 1. The class covered a range of topics in structural and hydraulic design of precast and prestressed concrete and included several structural/hydraulics laboratory work sessions (e.g. design of prestressed beams, concrete pipes, hydraulics of culverts etc.), two online presentations from guest speakers, and a visit to a precast/prestressed concrete fabrication yard. New topics related to the use of advanced materials and new technologies in precast concrete were added to the course materials. These topics included Ultra-High Performance Concrete (UHPC), Polymer Concrete, Titanium Alloy Bars, and Accelerated Bridge Construction (ABC) in Seismic Regions among others.

On the first day of the class, all students signed up for the PCI and NPCA Student memberships. Many videos and photos were collected from the Studio activities and can be made available for use by PCI and NPCA Foundations. Based on the student numbers and detailed student evaluations (Appendix 2) and despite all the challenges imposed by the pandemic, the third Studio at ISU was a success.

Other precast updates from ISU in 2021 include, but not limited to the following activities:

1. The faculty coordinators at ISU (Dr. Mashal and Dr. Savage) were invited to write articles, sharing their thoughts and perspectives on precast concrete education in three well-known magazines. These articles were published nationally and internationally and are included in Appendix 3. The faculty coordinators have been actively spreading the word about ISU's Studio and how academia can partner with industry such as PCI and NPCA Foundations to bring attention to the important topic of precast education. The three articles published in 2021-2022 were:
    A. M. Mashal and B. Savage (2021). Bringing Precast Concrete to Classrooms, Issue 3/2021, Concrete Plant International (CPi)[1] North America and Worldwide Editions link.

[1] CPi worldwide journals are trade journals for the concrete and precast concrete industry that are published in 10 different language editions in more than 170 countries. These trade journals, with their practical

B. M. Mashal (2022). Changing Precast as the Last Lecture in Reinforced Concrete Design, Winter 2022 Issue, ASPIRE – The Concrete Bridge Magazine[2] link.

C. The Precast Inc. Magazine had an article titled "Setting a Concrete Foundation for the Future" about the ISU's Studio in the June 2021 issue link. This was the third time that the magazine has highlighted the Studio at ISU. A copy of the article is attached in Appendix 3.

2. Dr. Savage, presented in the Studio Nation Episode 107 on the important topic of "Going Hybrid in a Hands-on World" link.

3. Dr. Mashal was invited by the American Society of Civil Engineers – India Section (Western Region) and Builders Association of India to be the Expert Speaker for a webinar. The webinar was facilitated by Dr. K N Gunalan, 2020 President of the American Society of Civil Engineers (ASCE). Dr. Mashal's talk was focused on "Discover High-Performance Precast" where he covered both PCI and NPCA precast products link. The webinar was attended by nearly 300 professionals from all over the world. The attendees received an E-Certificate. Following the success of the webinar, the ASCE Sections in New Zealand and India have invited Dr. Mashal to deliver a Keynote Speech on precast concrete bridges and pavements during a second webinar that is scheduled in the Summer of 2022. The organizers are planning to invite Heads of Transportation Ministries in India and New Zealand to do remarks. The webinar will be free for everyone.

4. Upon a request from the board members for the NPCA Foundation, Dr. Mashal and Dr. Savage have submitted a proposal on "Precast Concrete Curriculum and Outreach" for four years. The focus of the proposal is on educating industry engineers from Departments of Transportation and other private/public entities on precast concrete.

5. Dr. Mashal, Dr. Savage, and a graduate student (Jared Cantrell) from ISU attended the 2021 Precast Show in New Orleans and made presentations about the Studio at ISU during the PCI Foundation and NPCA Foundation educational and board meeting sessions. Research work from ISU on precast concrete was also presented at the PCI Convention.

6. Dr. Mashal attended the PCI Foundation Professor Seminar in Sacramento, CA, June 1-4, 2021. He presented on "Best Practices for The Precast Concrete Studio" and shared his perspectives with the participants.

7. Dr. Mashal and the American Society of Civil Engineers (ASCE) Student Chapter at ISU organized a civil engineering community event in the Summer of 2021. Dozens of kids and their families learned about precast concrete pipes followed by observing three-edge baring testing of 3 ft. diameter reinforced concrete pipe to failure.

8. A graduate student, Usha Pant, who took the Studio in the Fall of 2020, Usha Pant, participated in the PCI Foundation's Video Poster Competition which was held virtual during the 2021 Precast Show and PCI Convention in New Orleans. Usha also participated in the Studio Nation Episode 104 of the PCI Foundation, representing Idaho State University link.

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editorial reporting on research, production and applications, are specifically addressing the decision makers of the concrete and precast concrete industry. https://www.cpi-worldwide.com/us

[2] ASPIRE is a quarterly magazine published by the Precast/Prestressed Concrete Institute (PCI) in cooperation with the associations of the National Concrete Bridge Council. The editorial content focuses on the latest technology and key issues in the Concrete Bridge Industry. From the federal, state, and local agencies, to consultants, to planners, universities and contractors, ASPIRE delivers to the most influential audience of more than 50,000 national stakeholders. http://www.aspirebridge.com/

9. Two graduate students, Usha Pant and Aashish Thapa, who took the Studio in the Fall of 2020, were hired by Martin Cuadra, Senior Principal at Uzun + Case in Atlanta, GA. Martin is a precast concrete champion with a long history of past and current service to PCI. Usha and Aashish graduated from ISU with their masters in civil engineering in the Fall of 2021.
10. One of the students from ISU, Samantha Kerr, who took the Studio in the Fall of 2019, received one of the competitive 2020-2021 Academic Year American Society of Civil Engineers Southern Idaho Section (ASCE SIS) Scholarships link.
11. A graduate student, Jose Duran, who took the Studio in the Fall of 2021, was awarded a 2022 American Concrete Institute (ACI) Intermountain Chapter Scholarship.
12. Four students from ISU have applied and were selected to participate in the 2022 Project Precast during the Precast Show and PCI Convention in Kansas City, Missouri. Three of these students have taken the Studio at ISU. One other is a PhD candidate who was the teaching assistant for the Studio in the Fall of 2019.
13. Dr. Mashal, Dr. Savage, and three other graduate students (excluding those selected for Project Precast) who have taken the Studio are planning to attend the 2022 Precast Show in person in Kansas City, Missouri.

3.0 Summary of Expenditures

A summary of the expenditure is presented in Table 1.

Table 1. Summary of the Expenditures for the ISU Studio

Expenses	**NPCA Foundation**	**PCI Foundation**
Total Funds Committed Over 4-Years Period	$42,563.00	$42,564.50
Expenses Incurred in Year 1 (2019)	$7,021.59	$8,609.15
Expenses Incurred in Year 2 (2020)	$5,899.68	$3,972.07
Expenses Incurred in Year 3 (2021)	$3,315.58	$4,383.04
Remaining Funds	$26,145.63	$25,447.85

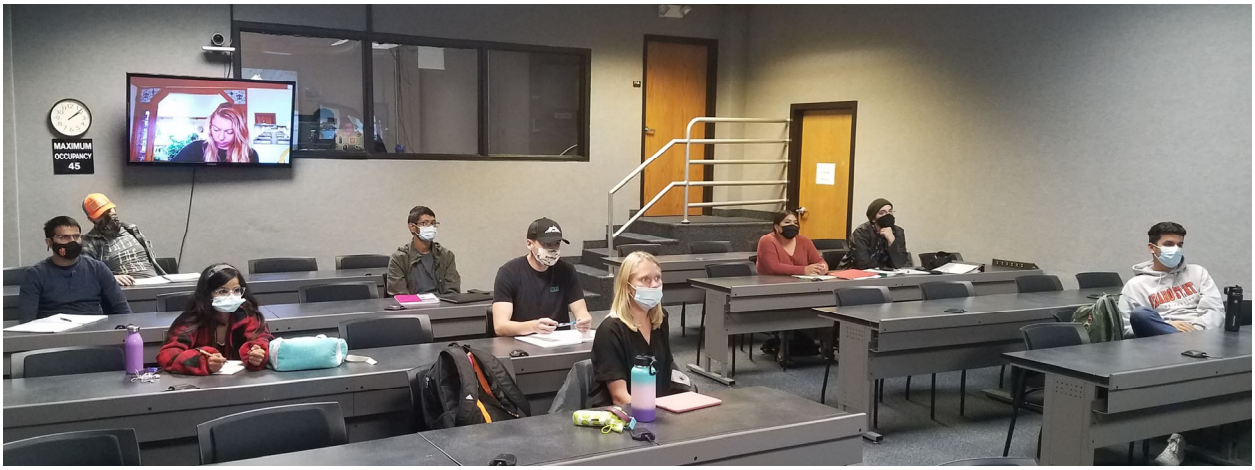
4.0 Request for No-Cost Extension

Due to the global pandemic, travel has been restricted in the last two years and therefore, most of the allocated travel funds for students have not been utilized. The coordinators for the Studio at ISU request a three year no-cost extension from the PCI and NPCA Foundations. Request for the no-cost extension is mostly driven by sabbatical leaves and utilizing the remaining funds to educate students on precast concrete. Dr. Mashal and Dr. Savage charge very small salary ($0 in 2019 and $1,500 per faculty in 2020 and 2021) for teaching the Studio at ISU. Most of the funds are used for materials and supplies, small equipment, and paying student employees who are assisting with the hands-on/laboratory component of the Studio.

5.0 Studio Activities: Guest Speakers

A. Paul Laskey – Sika

Paul Laskey, National Manager - Concrete Innovation at Sika, had a very informative presentation on "Newer Technologies for Precast Including Fiber, Integral Waterproofing, And Volume Stability". Paul's presentation was conducted over Zoom and was recorded. All students in the Studio attended the presentation and had to write a summary report from what they learned from Paul's presentation.



Paul Laskey Presenting a Zoom Lecture on Newer Technologies for Precast

B. Jim Schneider – PCI Mountain States

Jim Schneider, Executive Director at PCI Mountain States, delivered a presentation on Zoom on the very important topic of "Designing for Sustainability Using Precast, Prestressed Concrete". Jim's presentation was well received among the students taking the Studio. Recordings and slides from the presentation were shared with the students who had to write a report from what they learned.

Jim Schneider Presenting a Zoom Lecture on Sustainability Using Precast Concrete

6.0 Visit to Precast Yard

The students taking the Studio had the opportunity to travel to a nearby certified precast plant, Teton Prestress Concrete, in Idaho Falls. During the tour, the students learned about different aspects of precasting and had their questions answered by the experts. All students had to write a summary report from what they learned during the tour.

Students Touring Teton Prestress Concrete in Idaho Falls

7.0 Studio Activities: Laboratory Work

The Studio included multiple laboratory work sessions. All lab work was held in person. ISU's lab facilities were used to mix conventional concrete and UHPC, pour samples, and conduct experimental testing for compressive strength, modulus of rupture, and hydraulics of culverts. The students had to write detailed reports and provide calculations for the lab work. As usual, PCI Foundation sent swag bags and hard hats for all students in the Studio. Sample photos from laboratory work are included here.

Studio Received Swag Bags from the PCI Foundation

Mixing and Sampling Conventional Concrete

Mixing and Sampling Conventional Concrete

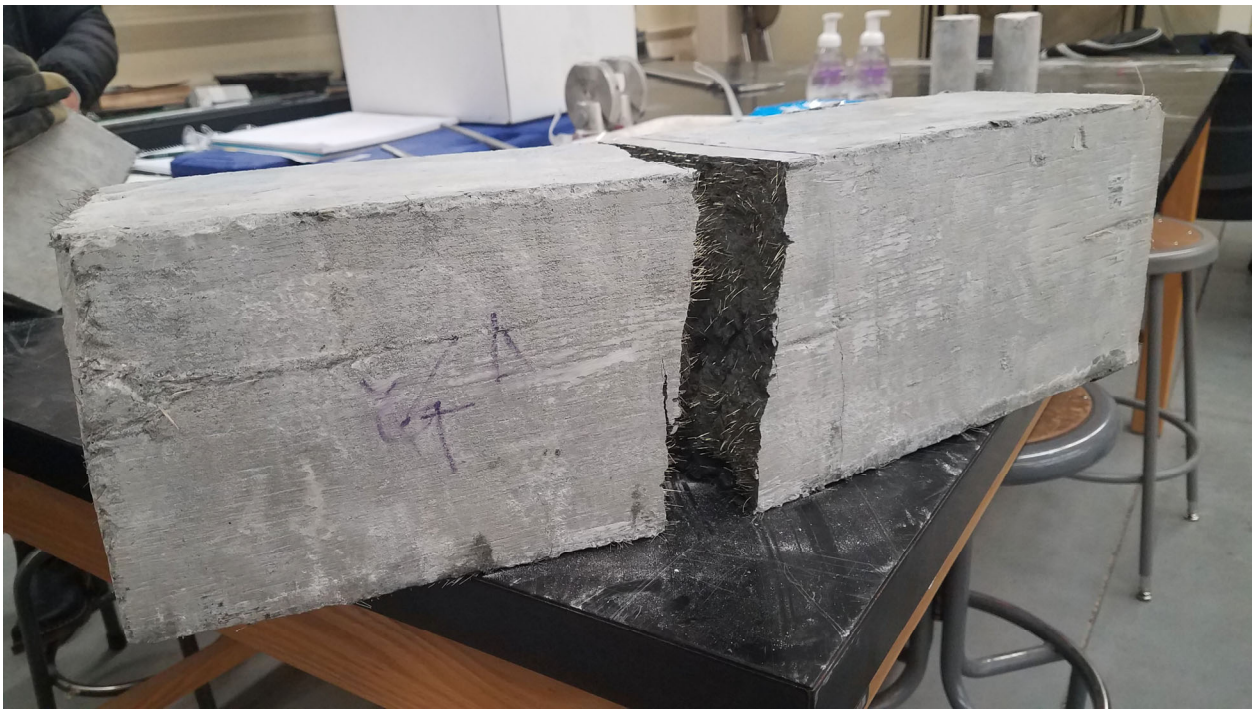
Mixing and Sampling UHPC

Measuring Conventional Concrete Samples Prior to Testing

Testing Conventional Concrete Samples for Compressive Strength and Modulus of Rupture

Measuring UHPC Samples Prior to Testing

Testing UHPC Samples for Compression and Modulus of Rupture



Testing UHPC Samples for Compression and Modulus of Rupture

Hydraulics of Culvert Laboratory Work

8.0 Other Sample Activities

A. 2021 Precast Show and PCI Convention

Dr. Mashal, Dr. Savage, and Jared Cantrell attended the PCI Convention and Precast Show in New Orleans, LA, May 17-21, 2021. Jared had a presentation titled “Large-Scale Testing of a Precast Bent System for Accelerated Construction: Seismic performance and Comparison with Cast-In-Place” during one of the peer-reviewed sessions.

TECH8 Innovations in Precast Concrete Components (peer-reviewed)

Date, Time 5/21 10-11:30AM

Room 228-230

This session will include the presentations of the following peer-reviewed papers:

- Parametric Study of Pretensioned Girders Reinforced with 19-Wire 1⅛-in.- Diameter Grade 250 Prestressing Strands
- Large-Scale Testing of a Precast Bent System for Accelerated Construction: Seismic Performance and Comparison with Cast-In-Place
- Service Load and Failure Tests of Short-Span Precast Reinforced Concrete Arch Beams

Dr. Mashal and Dr. Savage attended committee meetings, and PCI Foundation events. Both presented on the ISU’s Precast Concrete Studio to the PCI and NPCA Foundations board members.

Jared Cantrell presenting at the PCI Convention

2021 Precast Show and PCI Convention

Dr. Savage Making Remarks at the NPCA Foundation Board Meeting

Dr. Mashal and Jim Voss (former Chairman of the PCI Foundation)

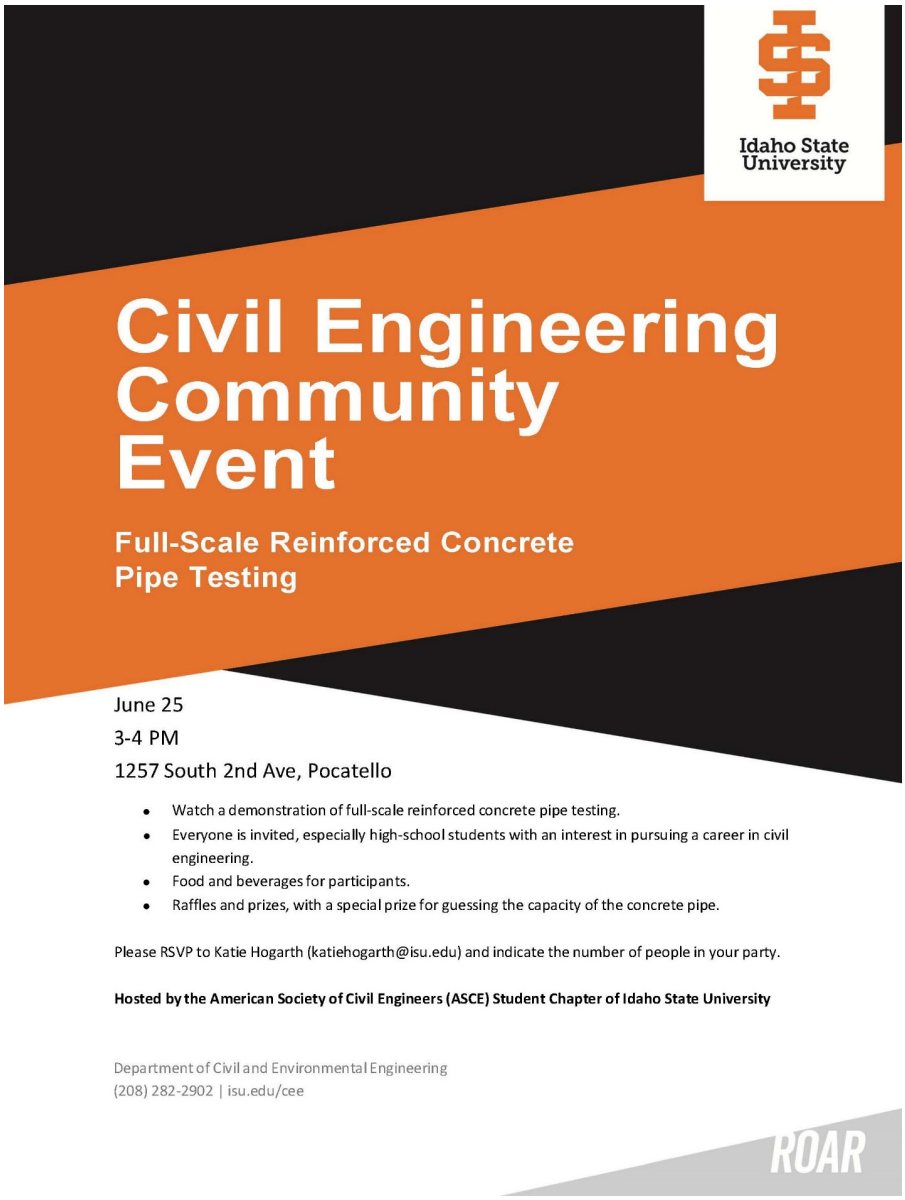
B. 2021 PCI Foundation Professor Seminar

Dr. Mashal attended the PCI Foundation Professor Seminar in Sacramento, CA, June 1-4, 2021. He presented on “Best Practices for The Precast Concrete Studio” and shared his perspectives with the participants.

Dr. Mashal presenting at the PCI Foundation Professor Seminar

C. Civil Engineering Community Event at Idaho State University

Faculty and students at ISU were very happy to welcome the community of Southeast Idaho for a civil engineering community event at Idaho State University on June 25, 2021. Dozens of kids and their families learned about precast concrete pipes followed by observing three-edge baring testing of 3 ft. diameter reinforced concrete pipe to failure. The organizers (Dr. Mashal and the ASCE Student Chapter) were amazed with the number/depth of questions and participation. There were prizes and raffles for those predicting the capacity of the pipe. The organizers think that it is important to inspire kids as they are the future of precast industry in the United States. Many of the participants had good guesses for the capacity of the pipe and came to organizers after testing asking for a souvenir piece of concrete and close-up inspection of the tested pipe. Funding for this event was provided by the Associated Students of Idaho State University (ASISU).



Flyer for the Civil Engineering Community Event

Civil Engineering Community Event at Idaho State University

Civil Engineering Community Event at Idaho State University

Three-Edge Bearing Test on a Full-Scale Reinforced Concrete Pipe

D. Precast in Mass Construction of Real Estate and Infrastructure Projects Webinar

Dr. Mashal was invited by the American Society of Civil Engineers – India Section (Western Region) and Builders Association of India to be the Expert Speaker for a webinar. The webinar was facilitated by Dr. K N Gunalan, 2020 President of the American Society of Civil Engineers (ASCE). Dr. Mashal's talk was focused on "Discover High-Performance Precast" where he covered both PCI and NPCA precast products link. The webinar was attended by nearly 300 professionals from all over the world. The attendees received an E-Certificate. Following the success of the webinar, the ASCE Sections in New Zealand and India have invited Dr. Mashal to deliver a Keynote Speech on precast concrete bridges and pavements during a second webinar that is scheduled in the Summer of 2022. The organizers are planning to invite Heads of Transportation Ministries in India and New Zealand to do remarks. The webinar will be free for everyone.

Flyer for the ASCE Webinar

Appendix 1: Course Syllabus

CE 4499-5599 – Precast Concrete Design Studio

Fall Semester 2021

Class Sessions: Tuesdays and Thursdays, 1:00-2:15 pm

Eli Oboler Library 16, Pocatello Campus

1.0 Instructor Information:

Instructor: Mustafa Mashal, Ph.D., P.E., SECB, CPEng, IntPE (NZ), M. ASCE
Associate Professor, Department of Civil and Environmental Engineering
Office Phone: 208.282.4587
Email: mashmust@isu.edu
Office Hours: Tuesdays and Thursdays, 3:00-4:00 pm on Zoom (https://isu.zoom.us/j/87048938322), or by appointment only
Co-Instructor: Bruce Savage, Ph.D., P.E., M. ASCE (savabruc@isu.edu)
Course Assistant: Mahesh Acharya (maheshacharya@isu.edu)

2.0 Prerequisites by Topic

CE/ME 3341 (Fluid Mechanics), CE 3366/67 (Civil Engineering Materials and Laboratory)

3.0 Textbook & Manuals:

1. Prestressed Concrete: A Fundamental Approach, by Edward G. Nawy, 5th Edition (Recommended)
2. PCI Bridge Design Manual (free online)
3. American Concrete Pipe Association Design Manual (free online)
4. PCI Design Handbook

4.0 Course Catalog Description:

Precast Concrete Design Studio (CE 4499/5599) is a 3-credit hours technical elective that can be taken at the senior undergraduate and graduate levels. It includes introduction to precast/prestressed concrete, detailed design procedures for flexural, shear, and other detailing for precast/prestressed sections, laboratory work on the state-of-the-art concrete mixes and technologies for precast, experimental testing and data processing, introduction to precast concrete culverts, hydraulic design and demonstration, site tour, and guest speakers from the industry.

5.0 Course Objectives:

1. Define precast/prestressed concrete
2. Identify versatility of precast/prestressed concrete, materials, construction technology, and systems
3. Differentiate between precast and prestressed concrete, PCI and NPCA products
4. Compare advantages and limitations of precast vs. cast-in-place
5. Apply principles of precast/prestressed concrete design for analysis/design of structural components for bridges, buildings, culverts
6. Implement flexural, shear, and prestress losses procedures in design of precast/prestressed sections and corbels
7. Review of advanced and state-of-the-art materials for precast/prestressed concrete structures, including Ultra-High-Performance Concrete (UHPC), High-strength steel alloys, and Titanium Alloy Bars (TiABs)
8. Construction and testing of specimens made of UHPC, TiABs, and conventional concrete
9. Identify PCI and NPCA educational resources and appropriate relevant design codes
10. Describe professional and contemporary issues and challenges faced in the concrete industry

6.0 Course Outcomes – ABET:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
4. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7.0 Course Format:

The class will be conducted in person in Eli Oboler Library 16 – Pocatello Campus. A WebRTC option will also be available for students to join the class long distance synchronously. Instructions for the WebRTC are noted below.

Go to: https://join.ets.isu.edu/
Click "Join Meeting" (Do NOT click sign in)
Meeting ID: **31254** (Leave Pass Code entry blank)
Click: Join Meeting
Enter: your name
Click: Join Meeting
If prompted, click "Allow" on notifications pop up.
Confirm "Use this computer" is highlighted
Confirm your camera is selected and displaying video
Confirm the correct microphone is selected and audio is registering on the sound meter.
Click "Test speakers" to make sure you can hear audio.
Click Join Meeting
You will not be able to connect to your class/meeting until five minutes before the scheduled start time.

- Please mute your microphone when you join the video conference.
- You may be prompted to download an extension the first time you share a document
- If you are showing a PowerPoint presentation please watch this video: https://goo.gl/swude7
- Troubleshooting: If you can't connect to your class or meeting please check to see if there are any updates available for your browser. Once you have applied the updates if you still have problems try using a different browser. Chrome, Firefox, Edge. If you have a Mac use Firefox first then Safari. If you still have problems, reboot your computer.

8.0 Health Safety on Campus:

Idaho State University requires all faculty, staff, and students to wear face coverings indoors—regardless of vaccination status—unless alone in a private office, campus residence, or workspace. This on-campus face covering requirement for indoor spaces will be reviewed every two weeks and removed as the local situation improves. This precaution will allow us to maintain a safe classroom environment, continue face-to-face instruction, and meet our shared duty to care for others in our community.

The University also strongly encourages all individuals to receive a COVID-19 vaccine. Students who are experiencing COVID-19-like illness should NOT come to class and should contact the COVID Health Committee at COVID@health.isu.edu or (208) 282-2705. All confirmed cases of COVID-19 should be provided to the COVID Health Committee on the self-reporting form. All students are required to fully participate in the university's contact tracing process and follow all instructions related to quarantine and isolation.

9.0 General Course Notes:

I. Grading:

Attendance	5%
Homework	25%
Lab Reports	25%
Midterm Exam: **Tuesday, September 28, 2021, 1:00 – 2:15 pm**	25%
Final Exam: **Tuesday, December 14, 2021, 12:30 - 2:30 pm**	20%
Total	100%

- 93-100 A; 90-92 A-; 87-89 B+; 83-86 B; 80-82 B-; 77-79 C+; 73-76 C; 70-72 C-; 67-69 D+; 63-66 D; 60-62 D-; <60 F
- If the course is changed to **ALL REMOTE STATUS** during the semester, the above exam grading percentages may be adjusted.
- There will not be any curving of the grades or extra course work for enhancing the grade. Grades are not given, but earned.
- Detailed exam instructions will be posted on Moodle at least one week before the scheduled date.
- Additional requirements with respect to assignments, lab reports, midterm/final exams will be required of **graduate students**.

II. Attendance: Attendance will be taking at the start of each class. It is 5% of the final grade. Students must be present in-person or online to earn the attendance grade, unless prior arrangement/permission has been given by the instructor for missing the class.

III. CoSE "X" Grade Policy: In the College of Science & Engineering (CoSE), a student who earns a failing grade via course work (exams, homework, etc.) and has unexcused absences that total more than 30% of class meetings will receive a grade of "X".

IV. Office Hours: Office hours for Dr. Mashal are held on Zoom (https://isu.zoom.us/j/87048938322), on Tuesdays and Thursdays from 3:00 to 4:00 pm or by appointment only. Co-instructor (Mahesh Acharya) will post their office hours on Moodle.

V. Homework: Each homework assignment consists of a single or set of problems. Homework assignments are due at the beginning of class, and should be uploaded on Moodle before the closing date. Late homework will not be accepted. Questions regarding homework problems and grading should be referred to course co-Instructor. Your homework must be submitted in standard engineering format as a single PDF file with your name, class, date, and dual page number at top of each sheet. Each page should contain only one problem. Use engineering computation or blank paper. Please upload your homework on Moodle before the closing date as a single PDF file with high resolution and proper alignment. Problems should be neatly worked out and submitted using the standard format including: (a) a statement of information given; (b) a statement of what you are required to determine; (c) appropriate sketches and diagrams; (d) logical presentation solution of the problem with all equations cited; and (e) answers identified by underlining or highlighting.

See the attachment for a template of how homework must be submitted. Remember that 20% of your grade for each homework will be assigned based on your homework format.

Alternatively, engineering calculation software (e.g., MathCAD & Excel) may be used as long as all the items (a)-(e) described above are included.

10.0 Specific Polices and Rules:

I. Academic Integrity: Academic integrity is expected of all students. Academic dishonesty, including cheating or plagiarism, is unacceptable. The Idaho State University academic dishonesty policy allows an instructor to impose one of several penalties for cheating that range from a warning up to assigning a failing grade for the course or dismissal from the University. ANY use of an electronic device or other form of unauthorized materials during an exam or other assessment will be considered cheating. For more information, see the ISU Policies and Procedures Policy 4000 (Academic Integrity and Dishonesty) located at: http://www2.isu.edu/policy/4000/index.shtml

   a. Ignorance of the policy on Academic Integrity is unacceptable.

   b. In case of an academic dishonesty, the student will be reported to Academic Affairs promptly.

   c. Examples of what constitutes academic dishonesty

      i. Taking a quiz or preparing an assignment for another person

      ii. Allowing another student to copy from you

      iii. Providing material to another student with the knowledge that such assistance could be used for cheating

      iv. Removing an exam from the testing room without permission

      v. Copying down answers to questions and giving to others who have not taken the exam

      vi. Unauthorized knowledge of an exam

      vii. Altering a grade

      viii. Unauthorized collaboration

      ix. Presenting research results from work not performed

      x. Not giving credit to others for ideas, work, etc.

   d. On the exam day, students are requested to put their cell phones in their backpacks and/ or purses which should be left inside the classroom door. Any student observed with a cell phone during an exam, regardless of the reason, will automatically receive a failing grade. The same policy is applicable to any students caught with unauthorized notes, formula sheets, etc. For online exams, similar policy will be enforced, the use of any unauthorized material while taking the exam will constitute a violation of the exam rules. Students taking the exam long-distance will be monitored using web cameras and other technologies.

   e. Unless it is specifically mentioned that an assignment is collaborative (e.g. more than one person or team work), you cannot make collaboration with others/friends to complete the assignment.

   f. If the you need help on paper, please go to Writing Center/Academic Success Center

II. Accessibility / Disability Statement: Idaho State University is committed to providing equal opportunity in education for all students. If you have a diagnosed disability or if you believe you have a disability physical, learning, hearing, vision, psychiatric) that might require reasonable accommodation in this course, please contact the Disability Services Center, Rendezvous Building, Room 125 (282-3599) or on the web at http://www.isu.edu/ada4isu. It is the responsibility of students to contact instructors during the first week of each semester to discuss appropriate accommodations.

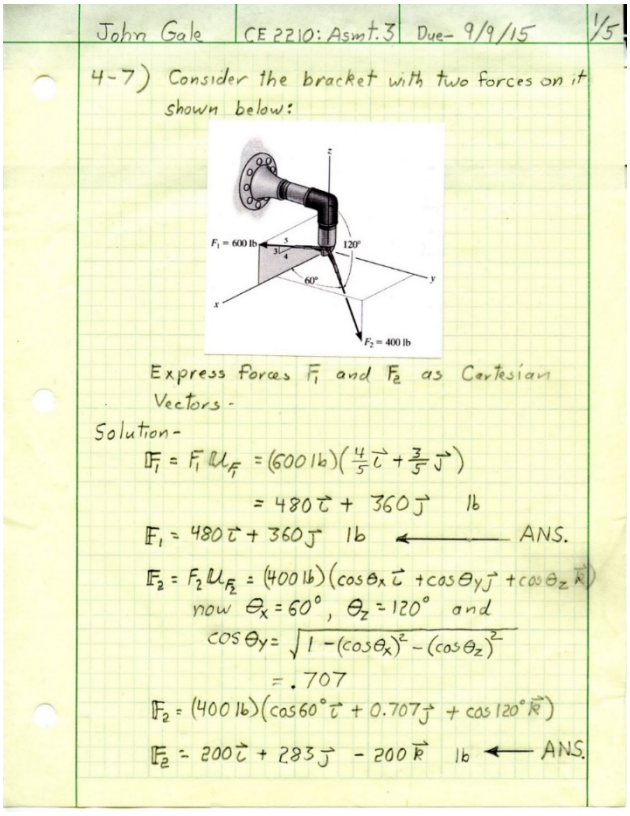
III. Academic Freedom and Responsibility: In carrying out its educational mission, Idaho State University is committed to adhering to the values articulated in Idaho State Board of Education Policy III.B. Membership in the academic community imposes on administrators, faculty members, other institutional employees, and students an obligation to respect the dignity of others, to acknowledge the right of others to express differing opinions, and to foster and defend intellectual honesty, freedom of inquiry and instruction, and free expression on and off the campus of an institution.

IV. Student Memberships: Students are encouraged to obtain free memberships of the American Society of Civil Engineers (ASCE), American Concrete Institute (ACI), American Institute of Steel Construction (AISC), and Prestressed/Precast Concrete Institute (PCI), and the National Precast Concrete Association (NPCA). There are many scholarships available from these societies for eligible students. For this class signing up for the student membership of PCI and NPCA is compulsory.

V. Recommendation Letters: Students seeking recommendation letters should know that as a requirement to obtain such letter, the student has to be a member of the American Society of Civil Engineers (ASCE) Student Chapter at Idaho State University and has been participating in the club's activities.

VI. General Class Discipline: Please avoid side conversations in the class when the Instructor is speaking. All cellphone and electronic equipment must remain silent during lectures. Those joining via long distance should mute their microphones when they are not talking. This will avoid any feedback. For those attending in-person, in case of emergency calls you may leave the class, answer your call/text, and then come back to the class. Please be considerate to other students and open/close the door gently. Students attending the class in-person are required to stop playing with their cellphones, IPads, PC etc. during regular lectures unless they are asked to use these devices for a class activity. Please prohibit from eating smelly food during the class.

11.0 Homework Problem Format Sample:



John Gale | CE 2210: Asmt. 3 | Due- 9/9/15 | 1/5

4-7) Consider the bracket with two forces on it shown below:

Express forces F_1 and F_2 as Cartesian Vectors -

Solution -

$\mathbf{F}_1 = F_1 \mathbf{u}_{F_1} = (600\,\text{lb})\left(\frac{4}{5}\vec{\imath} + \frac{3}{5}\vec{\jmath}\right)$

$= 480\vec{\imath} + 360\vec{\jmath}$ lb

$\mathbf{F}_1 = 480\vec{\imath} + 360\vec{\jmath}$ lb ← ANS.

$\mathbf{F}_2 = F_2 \mathbf{u}_{F_2} = (400\,\text{lb})(\cos\theta_x \vec{\imath} + \cos\theta_y \vec{\jmath} + \cos\theta_z \vec{k})$

now $\theta_x = 60°$, $\theta_z = 120°$ and

$\cos\theta_y = \sqrt{1 - (\cos\theta_x)^2 - (\cos\theta_z)^2}$

$= .707$

$\mathbf{F}_2 = (400\,\text{lb})(\cos 60°\vec{\imath} + 0.707\vec{\jmath} + \cos 120°\vec{k})$

$\mathbf{F}_2 = 200\vec{\imath} + 283\vec{\jmath} - 200\vec{k}$ lb ← ANS.

Appendix 2: Student Evaluations

Moodle ISU

Overview | Edit questions | Templates | Mapped courses | Analysis | Show responses

Filter by course

× CE 4499 - 01 / 5599 - 01: Precast Concrete Design Studio (MMashal), Fall 2021 | Filter | Show all

Export to Excel

Submitted answers: 11
Questions: 23

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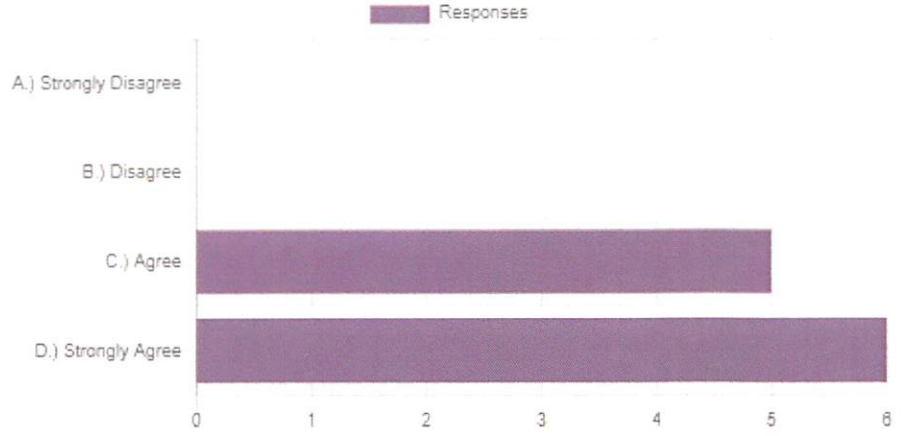
(1) The instructor was well organized and prepared.



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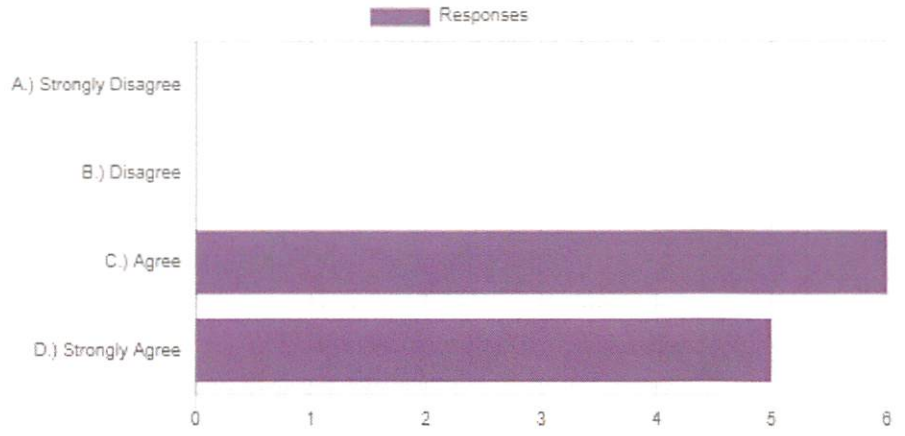
(2) The instructor clearly explained concepts.



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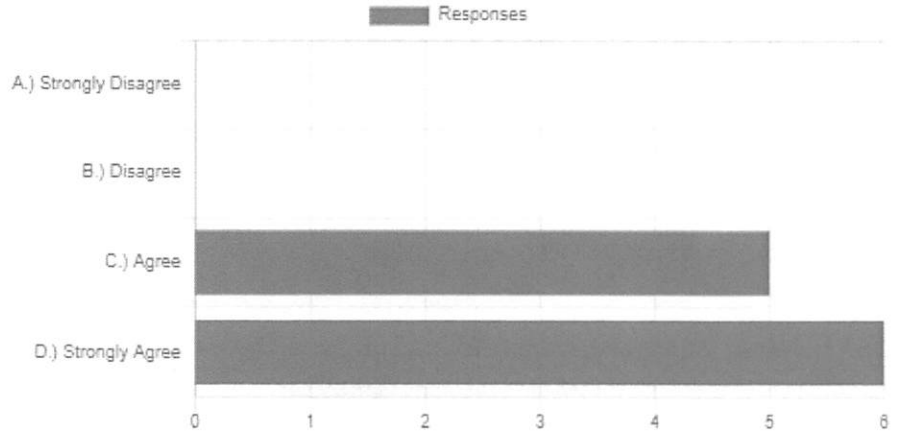
(3) The instructor used examples, activities, and problems that engaged me.



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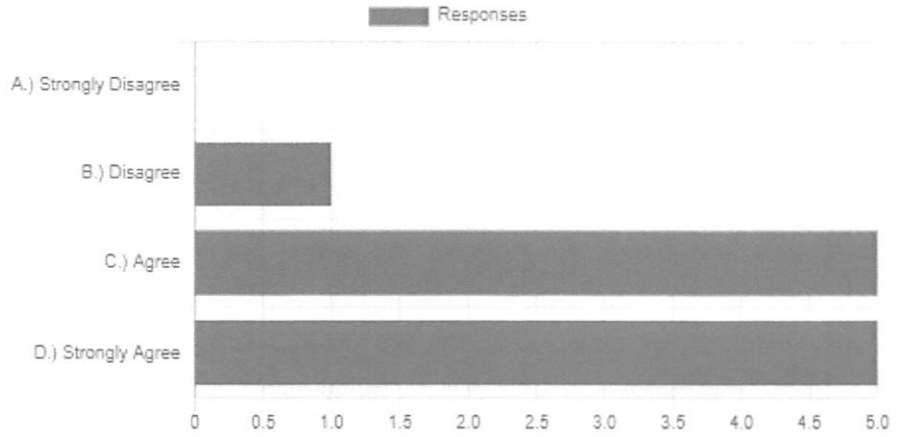
(4) The instructor challenged me to think about the course content.



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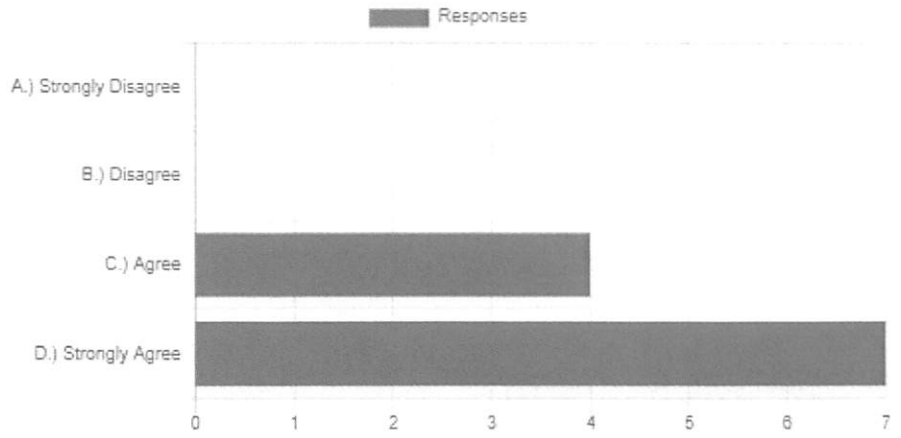
(5) The instructor encouraged questions and discussions.



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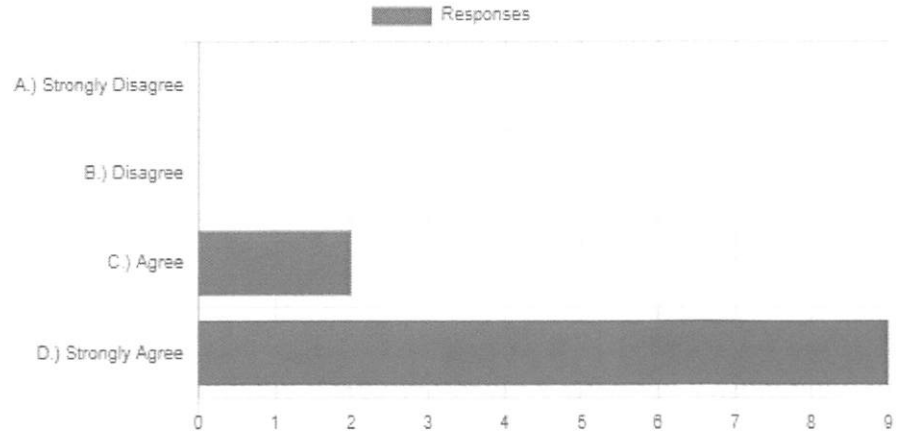
(6) The instructor showed enthusiasm for the course material.



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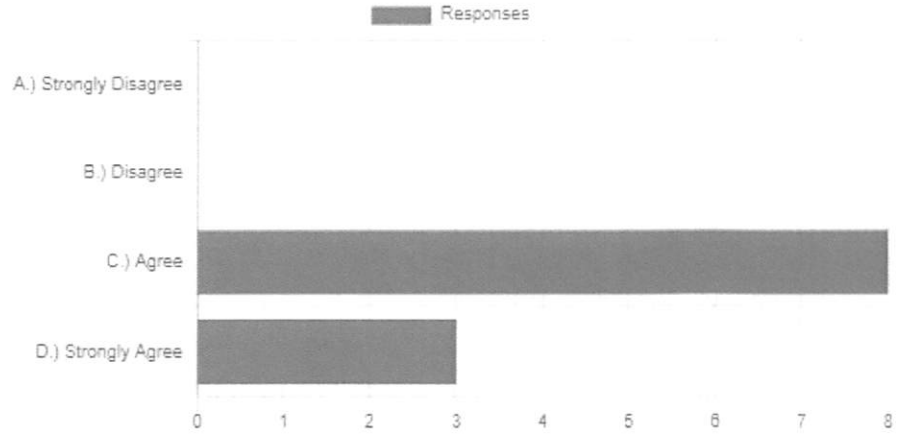
(7) The instructor was available on an individual basis outside of class.



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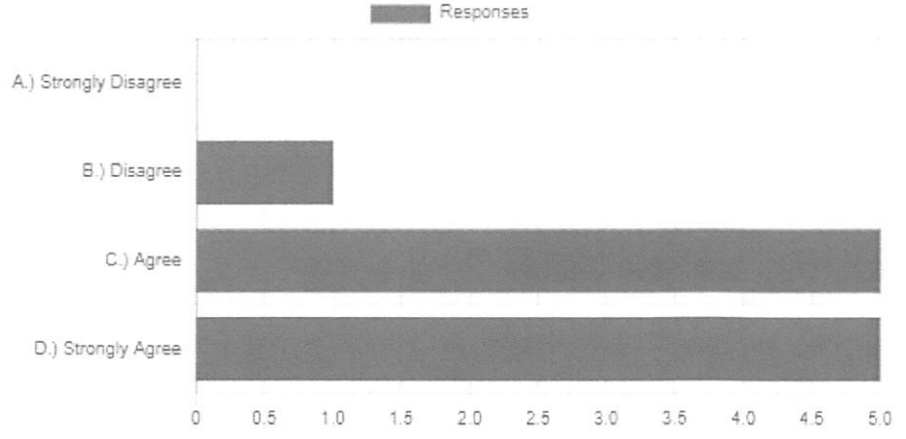
(8) The instructor graded consistently and fairly.



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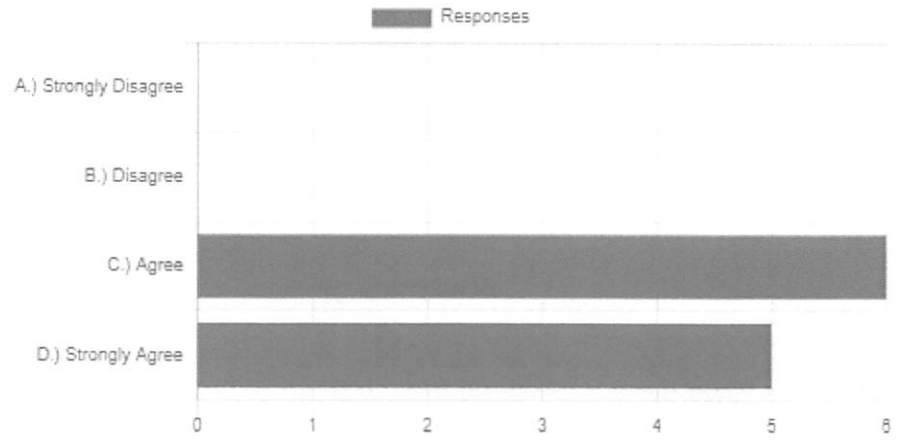
(9) The instructor met the course objectives as stated on the syllabus.



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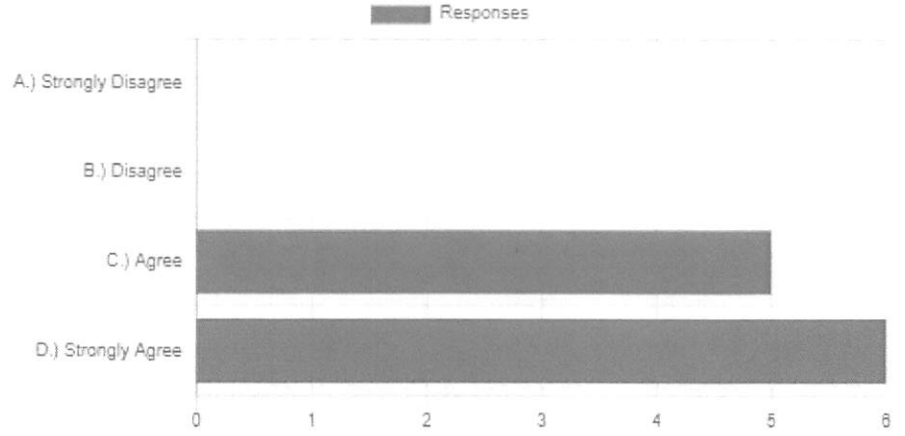
(10) Overall, the instructor was an effective teacher.



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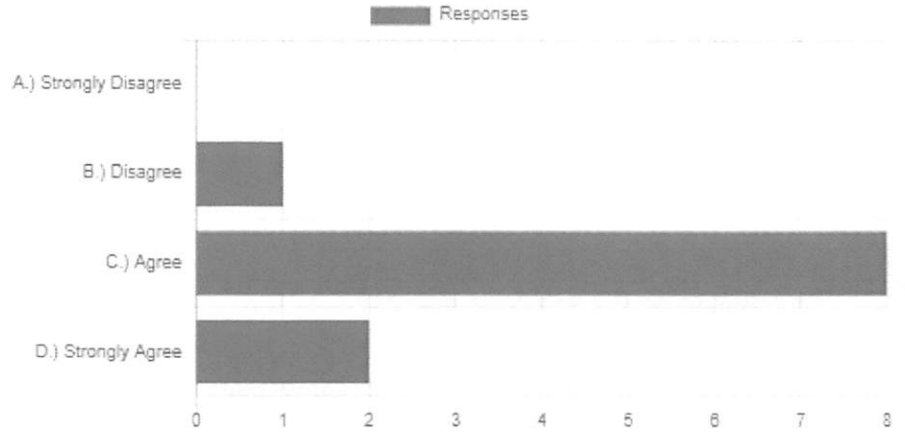
(11) The syllabus clearly explained what was expected in this class.



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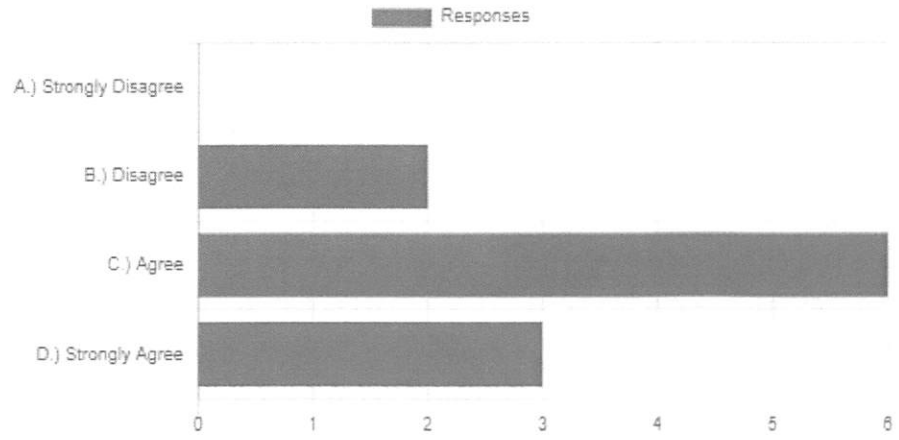
(12) The course materials (textbook or other readings) helped my learning.



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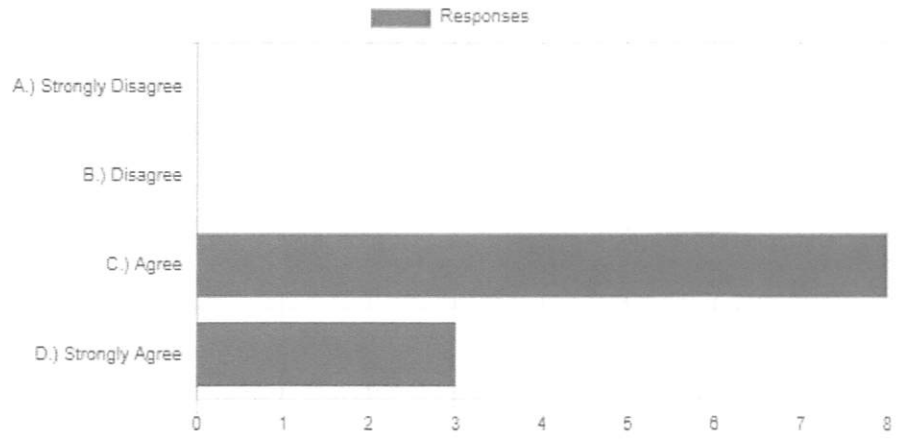
(13) The course materials (website or web supplements) helped my learning.



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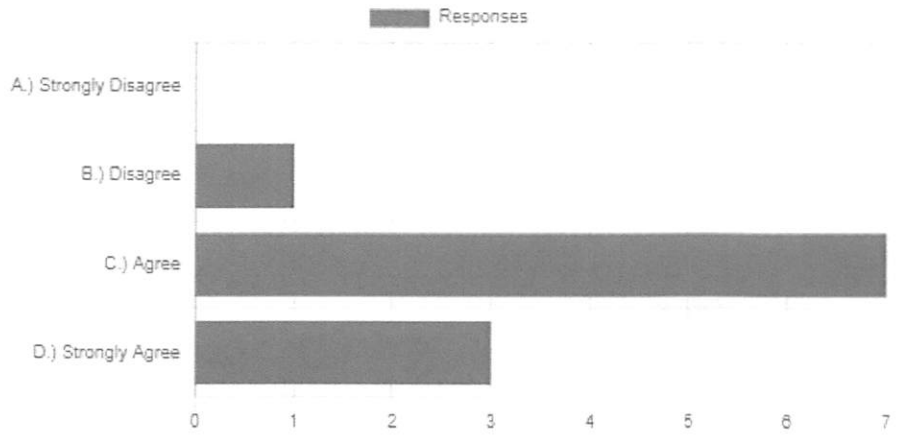
(14) The course activities (assignments, homework, projects, etc.) helped my learning.



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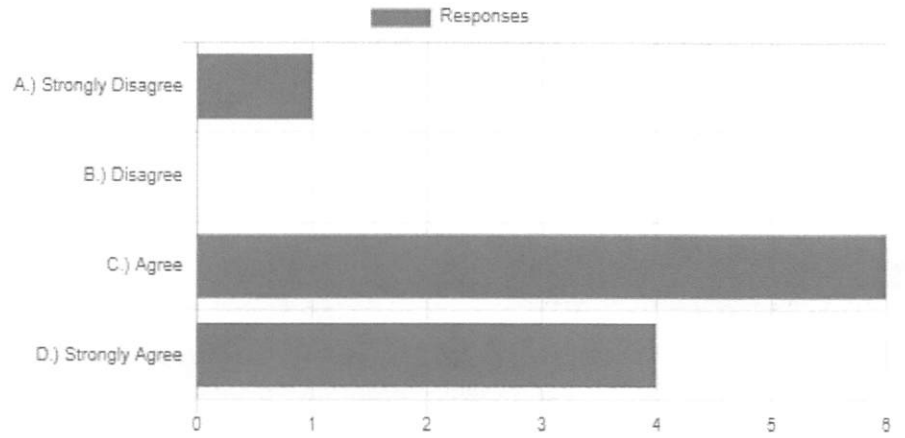
(15) The tests accurately assessed what I learned in this course.



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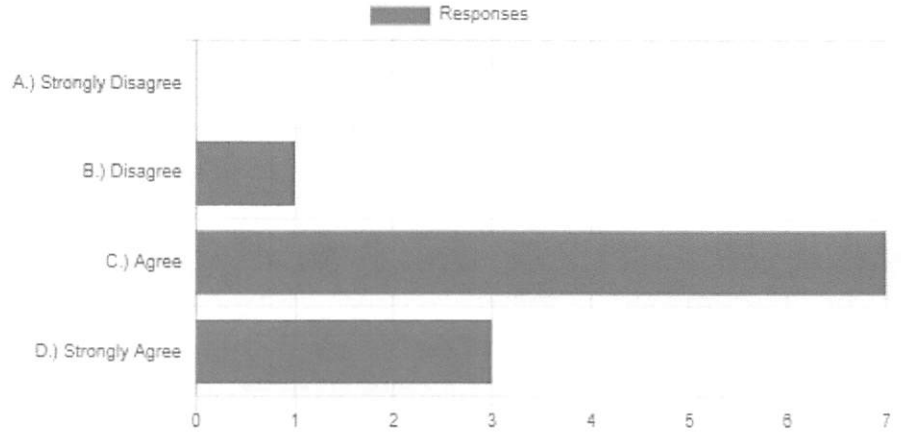
(16) The assignments and exam results were returned quickly.



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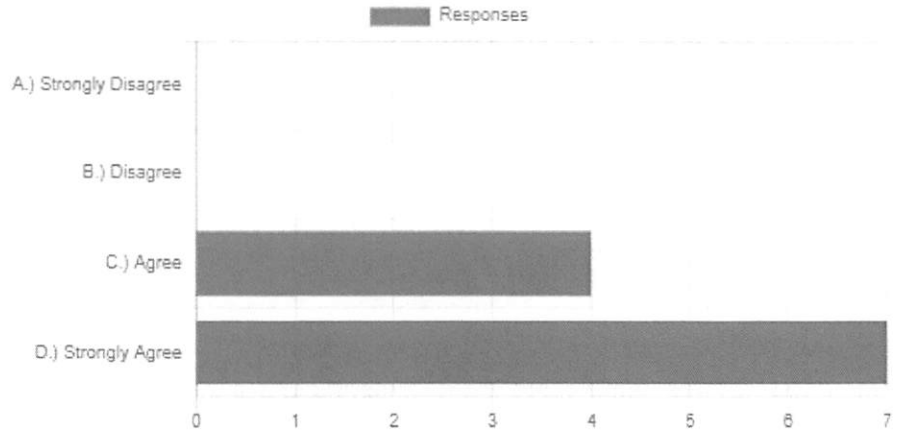
(17) My knowledge of this subject is much higher now than when the semester started.



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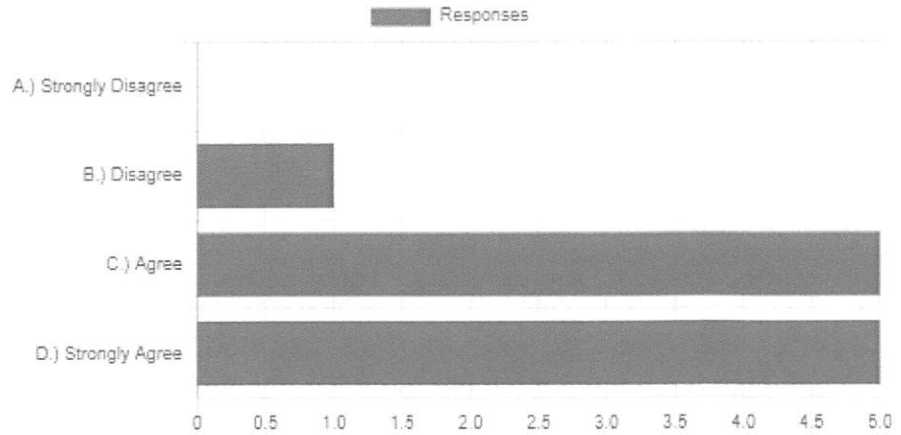
(18) My ability to apply the knowledge I gained in this course is high.



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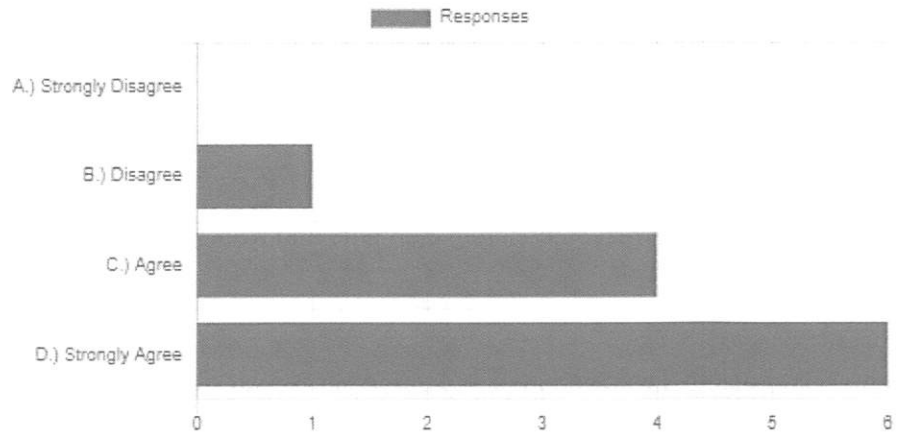
(19) My competence in this subject is high.



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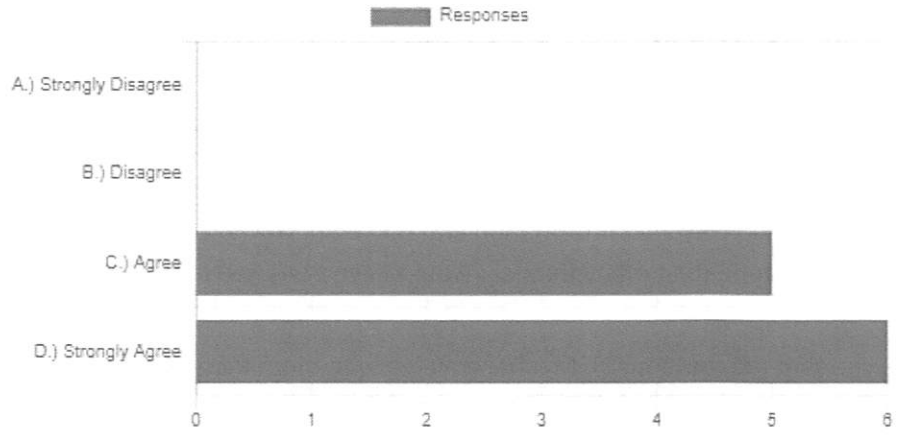
(20) This class increased my interest in the subject.



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(21) How many hours per week did you work on (a) homework and (b) other activities beyond the scheduled time of this class?

- 4 hours in average
- 10 to 12 hrs

- 5

- When there was homework: 2-3 hours each hw
Studying for the exam: 10 hours

- 6

- 6-9 hours

- 6 to 10

- 5-10

- a) 0-8, b) 1-4

---

(22) What did you like best about this course?

- It is the new technology used in the field of civil engineering. The lab work aided more to make the concept clear.

- Precast New material good to know. Interesting and Useful

- I liked the applicability and real-world nature of the course. I think this course is something I can directly apply to my career after school.

- Material

- The laboratory work and the guest lecturers

- The portion of the course that went over how to design prestressed concrete elements and work done in the laboratory.

- Doing lab work

- I thought Dr. Mashal's lectures were extremely interesting. I was engaged and found his PowerPoints very interesting. I also found Dr. Savages lectures very interesting and I really like his style of homework, in which we have problems to solve.

- I have learned on the class a lot of the concrete and the experiment that we did at the lab getting more ideas how to develop the concrete in the future it's been an amazing course for me.

---

(23) Describe any specific changes that could be made to improve student learning.

- I would have much rather had more homework problems with calculations and problem solving than writing papers. I do not mind writing short papers here and there but we had to write so many pages and eventually you just loose interest in the topic. We had a minimum amount of pages we had to write, which I think is bad engineering practice. In reality you are supposed to convey your information and move on. However having a minimum amount of pages to write, I found myself repeating many things. I would have preferred to work out a problem instead.

- As far as the improving of learning I have see that the material Dr. Meshal covered was more than enough for our class and he's being an amazing and the explanation of the material and seeing it on the video that gives us the idea how it's work on the real life

- Overall I thought the course was successful and well taught. Maybe a bit more design homework/projects would help improve the design/analysis of precast structures.

- It would be better if we could do some more design problems in class.

- I would like this course better if it involved solving more design problems than just lecture and lab on material properties

- Nothing in particular

- N/A

- Change professors sooner, these last few days mainly with the report feels rushed. The hydraulic part has been interesting, but more time would be helpful.

- I believe it would be good to teach more theory on the design of prestressed and post-tensioned elements given that in modern day consulting practices engineers are required to know how to design with different materials, prestressed concrete being one of them.

Also, another laboratory that required students to mix, pour and cast structural elements and subsequently test them would have been ideal as this develops the students' knowledge and experience of construction materials and methods, analytical thinking, and technical writing.

- Try to provide more design problem rather than writing a report.
Take Fair Exam
Do not be in hurry at the end of semester.
Grading need to be done fairly.

◄ Computer Science: Instructor Course Evaluations F21 CoSE

Jump to...

Engineering/Health Physics: LAB Course Evaluations F21 CoSE ►

Appendix 3: Published Articles

Concrete Plant International
North America Edition

3 | 2021
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REPRINT | NEWS

Bringing Precast Concrete to Classrooms

REPRINT
CPI 3/2021

Precast Concrete Education

Bringing Precast Concrete to Classrooms

Mustafa Mashal and Bruce Savage, Idaho State University, Pocatello, Idaho, United States

When it comes to a traditional civil engineering curriculum, precast concrete is commonly the last lecture in a reinforced concrete class. Graduating civil engineering students typically have minimal exposure to precast concrete design, production, and construction during their programs. This creates a significant lack of knowledge among entry-level civil engineers who join the workforce. If asked to design a prestressed girder or a precast pipe, most civil engineers have to learn the design procedures themselves. Idaho State University (ISU) wants this trend to change and is leading the way. This article provides an overview of the precast design studio at ISU, the needs for such curriculum in today's world, creative ways to introduce precast concrete in the civil engineering curriculum, hands-on and effective classroom and lab activities for students, and the long-term benefit of having students who can identify the versatility of precast concrete before they join the industry.

Background

In 2019, the Precast/Prestressed Concrete Institute (PCI) Foundation [1] and the National Precast Concrete Association (NPCA) Foundation [2] joined forces to sponsor a unique curriculum called "Precast Concrete Design Studio" at ISU for four years and to change the status quo in precast concrete curriculum. The Precast Concrete Engineering Studio (CE 4499/5599) at ISU is the only joint PCI/NPCA Foundations studio in the United States. The Studio is focused on transportation precast concrete products such as precast bridges, culverts, and pipes. 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 studio is taught at senior undergraduate and graduate levels as a technical elective (3-credits). Additional requirements with respect to homework, exam problems, and lab work are required of graduate students. The content of the Studio is not fixed and can change every time the Studio is offered. This provides the opportunity for a student to take more than one Studio. Additionally, this helps to revisit the content of the class every year as the technologies evolve in the precast industry.

The Studio was taught in the fall of 2019 for the first time at ISU. There were 25 students who took the class; 4 students were graduate (masters) and 14 were undergraduates. The class covered both precast bridges and culverts. However, more emphasis was put on the precast bridges. The Studio was taught in the fall of 2020 for the second time at ISU. There were 9 students who took the class; 6 students were graduate (masters) and 3 were undergraduates. Student feedback from the first studio taught in the fall of 2019 was incorporated in the second studio in 2020. The class covered both precast bridges and culverts. However, more emphasis was put on the precast culverts and pipes. Due to the global pandemic, class lectures were conducted in a HyFlex manner as per ISU's guidelines. This was a hybrid model where students can

Fig. 1: Civil Engineering Large-Scale Laboratory (CELL) at ISU

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■ Bruce Savage is a Professor and Chair in the Department of Civil and Environmental Engineering at Idaho State University in the United States. He obtained his PhD, Masters, and Bachelors in Civil Engineering with a focus on Water Resources Engineering from Utah State University in the United States. His research interests include precast concrete, water resources, computational fluid dynamics, and large-scale experimental testing.
savabruc@isu.edu

be present in the room or attend synchronously online via WebRTC. A student could choose either of the two options to attend the class. Students were encouraged to attend the hands-on labs in person if they were healthy. All class lectures and lab work were recorded and made available to students on the course website. Travel outside the campus was restricted due to the pandemic so the students could not travel to a nearby precast plant. The class provided a virtual tour of a precast plant for both PCI and NPCA products. In addition, most of the students in the Studio were able to see samples of full-scale PCI and NPCA products in the Civil Engineering Large-Scale Laboratory (CELL) which is an outdoor facility at ISU that has been used for a different project (Figure 1). The CELL has a variety of precast products that can be used as demonstration pieces.

Industry Champions from across the United States support and actively participate in the Studio. These professionals represent private and public entities, including the Idaho Transportation Department. Some of the students who took the Studio ended up working for the Industry Champions upon graduation.

A shorter version of the Studio with a focus on hydraulics for culverts to practicing engineers from the Idaho Transportation Department (ITD) was also conducted by Dr. Bruce Savage in 2020. The 4-day course consisted of 14 practicing engineering from two different ITD districts (Districts 5 & 6).

Studio Activities

The content of the Studio is different than a traditional civil engineering class. It includes topics and opportunities such as structural and hydraulic design, hands-on work in the laboratories, large-scale structural testing, traveling to precast concrete yards and production facilities, listening to presentations from professionals in the industry, and participation in precast concrete competitions at the national level. These activities are described in the following sections.

Class Lectures

Class lectures consist of 35-40% of the course activities. Lectures are conducted in a traditional classroom setup. The class does have pre-requisites such as Fluid Mechanics and Reinforced Concrete Design. Lectures cover introduction to precast concrete and materials, flexural and shear design of precast/prestressed girders, slabs, hydraulic design of culverts/bridges, and design of concrete pipes. Students are assigned homework problems from the lectures. Graduate students are assigned more and complicated problems compared to undergraduates.

Tour of Precast Yards and Precast Structures

In-person and virtual visits are an important activity of the Studio where students get to observe and learn about how precast elements and structures are built. Students get to tour one to two actual precast concrete yards (Figure 2). It is preferred to arrange the tours on days where an actual project is being cast at the precast yard. Also, the plants are selected to include precast plants that produce PCI and NPCA products (e.g. above the ground and under the ground precast components). Students are required to write a summary report from these tours. The tours are supplemented with a visit to an actual precast concrete structure.

Fig. 2: Students tour an actual precast yard when the elements are being cast

Guest Speakers

The Studio hosted many guest speakers from the precast and bridge industry from across the United States in the first Studio in 2019. For the second Studio in 2020, this was held long-distance due to travel restrictions imposed by the global pandemic. The speakers presented practical lectures on a variety of topics including the precast concrete for construction of resilient structures; wildlife crossings; durability and water-proofing; design and fabrication of underground precast products; precast segmental bridge construction; cement production and types; bridge bearings; small classroom

Fig. 3: A guest speaker, Ray Clark from US Formliners, instruct students how to build formlining for precast concrete

activities; and formlining techniques. Students are asked to write a one-page summary of the lectures conducted by guest speakers. The students are strictly evaluated for their technical writing skills and feedback are provided for improvement.

Laboratory Work

The Studio typically includes five to seven laboratory sessions. These sessions are focused on students doing hands-on work to mix concrete, build their own concrete samples, and subsequently testing them (Figure 4). Laboratory tests included concrete slump testing, compressive strength, tensile testing, modulus of rupture, freeze/thaw test for durability, three-edge bearing testing of a full-scale reinforced concrete pipe (Figure 5), and flume testing of hydraulics of culverts using the state-of-the-art laboratories at ISU. Students are required to write a detailed report from the laboratory work.

Student Membership and National Competitions

On the first day of the Studio, all students sign up for the PCI and NPCA Student memberships. PCI and NPCA offer significant technical resources in precast concrete as well as potential scholarships for students. Students are encouraged to participate in the national competitions organized by the PCI and NPCA. For instance, two teams of students from the Studio signed up for the PCI and NPCA Competitions in 2019. A team of six students participated in the 2019/2020 PCI Big Beam competition which came 2nd in the nation. Another team of four students was selected as a finalist in the 2020 NPCA Competition and came third in the nation. One other student from the Studio participated as an alternate candidate in the 2020 Project Precast organized by the PCI Foundation. Funding was provided by the NPCA and PCI Foundation for the faculty and several students in the Studio to attend professional conferences such as the PCI Convention, NPCA Convention, Precast Show, and PCI Committee Days and National Bridge Conference. Several students from the Studio applied for scholarship opportunities through NPCA.

Student Feedback

Given the fact that the Studio is not a traditional class, detailed student surveys were collected to: 1) evaluate students experience of taking the Studio, 2) to refine the Studio based on the student's feedback. Studio evaluations showed over-

Fig. 4: Student conduct laboratory tests on the samples they cast

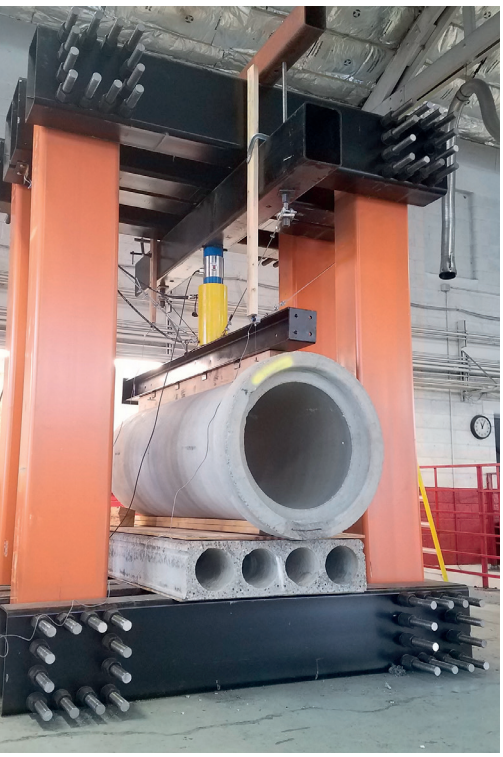

Fig. 5: Three-edge bearing test of a full-scale reinforced concrete pipe

whelmingly positive feedback from the students. Some of the feedback for the question "what did you like best about this course?" are included verbatim below.

Student 1. "I like the fact that it was more practical than book based"

Student 2. "Lab experiments"

Student 3. "Spent a lot of time doing design work. The lab work helped to understand some of the limitations of design and how to apply the design to the real world"

Student 4. "Exposure to real life application of theories and calculations learnt in class"

Student 5. The course was more on practical level. With all the lab works and industry visit I actually got to learn much more than along with the lectures and guest speaker.

Student 6. "I really like going out to the plants and being able to see real problems. I also liked talking to industry leaders and their stories. This course helped me a lot in understanding not just precast concrete but the industry in general. Now I have a better understanding of what to expect once I graduate"

Conclusions

The traditional civil engineering curriculum is strengthened by the inclusion of novel and practical courses such as the Studio where academics partners with industry. Such courses help students in many ways such as hands-on work and getting exposed to real-life projects and construction technologies. The Studio at ISU is an example of the successful implementation of new curriculum in precast concrete. Students overwhelmingly enjoyed the class and some were even inspired to join the precast industry upon graduation. The faculty at ISU are planning to make the Studio a permanent class in the civil engineering curriculum.

Acknowledgements

The authors are grateful for financial and other support from the PCI and NPCA Foundations. In addition, the Studio greatly appreciates the help from the Industry Champions in the United States. The assistance provided by the College of Science and Engineering as well as the Department of Civil and Environmental Engineering at Idaho State University with the curriculum is acknowledged. Furthermore, the authors are thankful for the opportunity from CPI Worldwide to publish their perspective on a Studio type curriculum in precast concrete education. ■

References

[1] Precast/Prestressed Concrete Insititue Foundation, https://www.pci-foundation.org/
[2] National Precast Concrete Association Foundation, https://precast.org/foundation/

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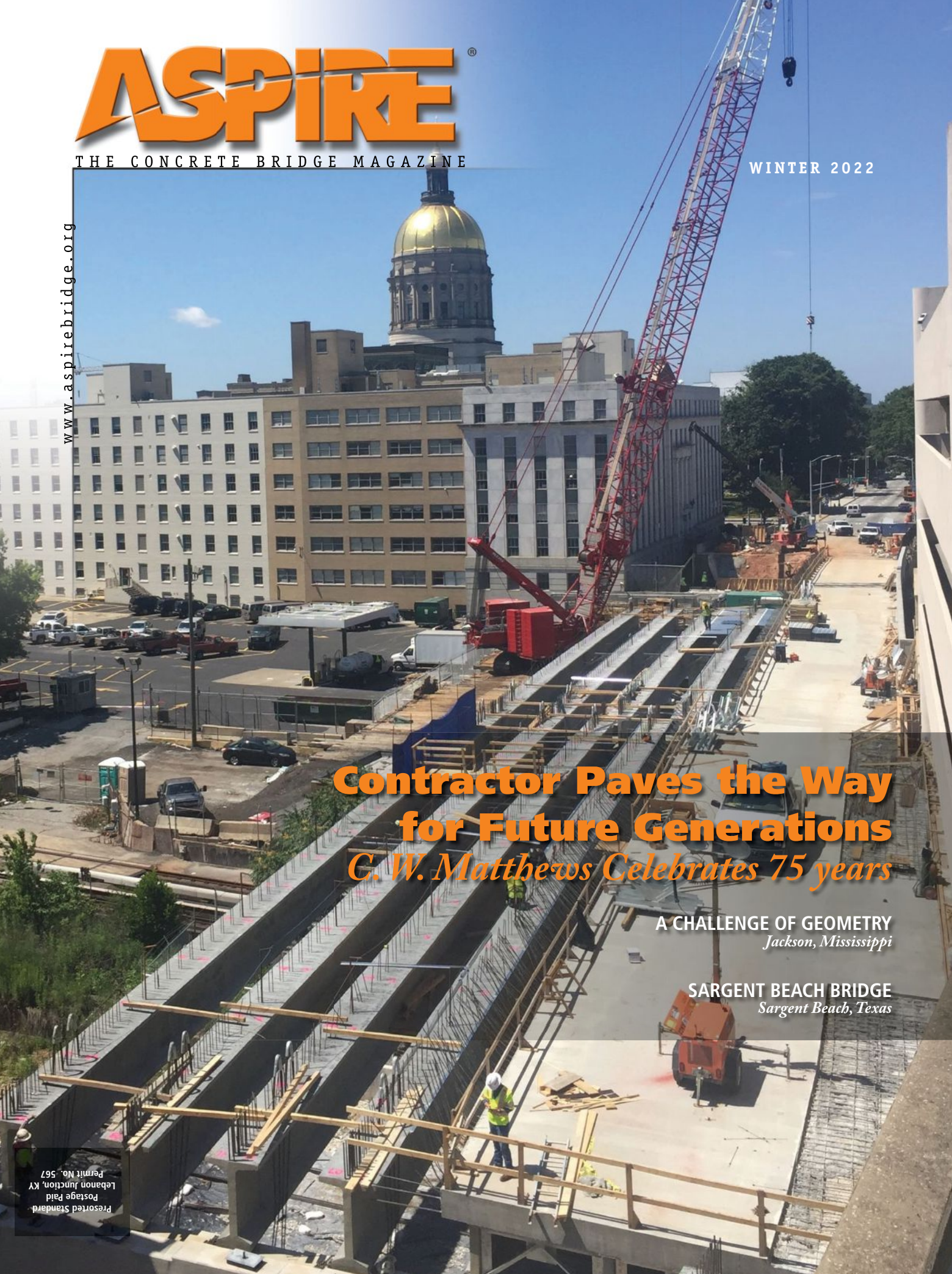

Contractor Paves the Way for Future Generations

C. W. Matthews Celebrates 75 years

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Jackson, Mississippi

SARGENT BEACH BRIDGE
Sargent Beach, Texas

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Lebanon Junction, KY
Permit No. 567

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Dr. Lubin Gao is the Federal Highway Administration's load rating engineer. He provides leadership in advancing technology for bridge load rating and evaluation.

Elaine (Lainey) Lien is a certified executive and leadership development coach, business consultant, speaker, and the founder and CEO of ReVive Careers.

Dr. Mustafa Mashal is an associate professor of civil engineering at Idaho State University. He is also the director of the Structural Laboratory and the Disaster Response Complex.

David H. Parker is the president of Parker Intellectual Property Enterprises LLC in the Charlottesville, Va., area. He has more than 30 years of experience in metrology.

CONCRETE CALENDAR FOR WINTER 2022

The events, dates, and locations listed were accurate at the time of publication but may change as local guidelines for gatherings continue to evolve. Please check the website of the sponsoring organization.

January 9–13, 2022
Transportation Research Board Annual Meeting
Walter E. Washington Convention Center
Washington, D.C.

January 18–20, 2022
World of Concrete
Las Vegas Convention Center
Las Vegas, Nev.

February 21–26, 2022
PTI Certification Training: All Levels
Sonesta Atlanta Airport North
Atlanta, Ga.

March 1–5, 2022
PCI Convention at The Precast Show
Kansas City Convention Center
Kansas City, Mo.

March 14–19, 2022
PTI Certification Training: All Levels
Doubletree DFW Airport North
Dallas, Tex.

March 21-22, 2022
ASBI Construction Practices for Segmental Concrete Bridges Seminar
Marriott Seattle Airport
Seattle, Wash.

March 27–31, 2022
ACI Spring Conference
Caribe Royale Orlando
Orlando, Fla.

April 6-8, 2022
Design-Build for Transportation & Aviation Conference
Orlando, FL

April 24–27, 2022
PTI Convention
Hilton La Jolla Torrey Pines
La Jolla, Calif.

May 2–7, 2022
PTI Certification Training: All Levels
Westin Baltimore Washington – BWI
Baltimore, Md.

June 20–23, 2022
AASHTO Committee on Bridges and Structures Annual Meeting
Pittsburgh, Pa.

July 17–20, 2022
International Bridge Conference
David L. Lawrence Convention Center
Pittsburgh, Pa.

August 2022
AASHTO Committee on Materials and Pavements Annual Meeting
Miami, Fla.

September 21–23, 2022
PCI Committee Days
Loews Chicago O'Hare Hotel
Rosemont, Ill.

October 4–7, 2022
PTI Committee Days
JW Marriott Cancun Resort & Spa
Cancun, Mexico

October 23–27, 2022
ACI Fall Convention
Hyatt Regency Dallas
Dallas, Tex.

October 31–November 2, 2022
ASBI Annual Convention and Committee Meetings
Hyatt Regency
Austin, Tex.

December 7–9, 2022
International ABC Conference
Miami, Fla.

EDITOR'S NOTE

In follow-up to this issue's Editorial on pages 2 and 3, you can learn more about the National Concrete Bridge Council (NCBC) at https://nationalconcretebridge.org. Additional information can also be found at the Concrete Bridge Views website at www.concretebridgeviews.com

A PROFESSOR'S PERSPECTIVE

Making Precast Concrete Part of the Core Curriculum

by Dr. Mustafa Mashal, Idaho State University

Precast concrete has traditionally been the final lecture topic of reinforced concrete design courses. Many universities do not require a course in precast concrete or prestressed concrete, including both pretensioned and post-tensioned concrete designs, for an undergraduate (bachelor's) degree in civil engineering. However, bridge and precast concrete firms expect college graduates to be familiar with designing precast, prestressed concrete products such as double tees, beams, wall panels, culverts, and bridge girders. Engineers who have not been adequately exposed to the design, production, and installation of precast concrete elements have four options to choose from: learn precast concrete design on their own, ask their employer to assign someone to teach them precast concrete at work, convince their employer to not use precast concrete, or abandon their plan to work as a structural/bridge engineer and find another area of civil engineering to pursue. None of these options is beneficial to either the engineer or the employer.

One way to prepare students for a career in structural engineering including precast, prestressed concrete design is to have them take a semester-long course in precast concrete. In 2019, the PCI Foundation and the National Precast Concrete Association (NPCA) Foundation joined forces to fund a unique curriculum for precast concrete at Idaho State University (ISU) for four years. The precast concrete curriculum is the first studio jointly funded by the PCI and NPCA Foundations with a focus on transportation products such as bridges and culverts. ISU's Precast Concrete Engineering Studio is a three-credit-hour course that is offered every fall semester at the senior undergraduate and graduate levels. The studio has already been taken by 45 students and is a popular class. Many industry champions from across the nation have actively supported the studio and its growth.

The studio is very different from traditional design classes in civil engineering. It includes a variety of activities such as design lectures; visits to precast concrete production facilities; guest speakers; laboratory work and physical testing; introduction to complimentary PCI and NPCA resources; exposure to the latest technologies and materials such as ultra-high-performance concrete; participation in national PCI, NPCA, and American Segmental Bridge Institute (ASBI) student competitions; and opportunities to attend and present posters at the PCI Convention and The Precast Show. Some of the key activities for the class are discussed in the following sections.

Visits to Precast Concrete Plants

While it is common in traditional precast concrete courses to show videos and photos of how precast concrete elements are fabricated, students benefit much more from visits to actual precast concrete production facilities. When visiting in person, students can observe the whole process of how precast concrete elements are fabricated, cured, handled, and stored. The visits prepare students to identify the advantages and the limitations of precast concrete and give them an opportunity to directly interact with, listen to, and ask questions of the experts. The knowledge gained during a precast concrete plant tour will stay with the students for a lifetime. If they end up working in a bridge or structural engineering firm and a suitable project comes along, they might even consider proposing precast concrete for it. Furthermore, precast concrete yard personnel typically enjoy hosting students and faculty.

ISU is fortunate that several PCI and NPCA plants around the region have

Students pose during a plant tour, which is a key component of the Precast Concrete Engineering Studio at Idaho State University. The knowledge gained during a precast concrete plant tour will stay with the students for a lifetime. All Photos: Mustafa Mashal.

Students prepare concrete specimens for testing in the Idaho State University engineering materials laboratory.

always opened their doors for visits. Tours of precast concrete yards also build partnerships and collaboration between industry and academia on research, student competitions, and even internships.

Guest Speakers

To successfully prepare students for careers in precast concrete and bridge engineering, it is of utmost importance that the instructor teaching the class collaborate closely with industry champions. One effective way to help students learn about the state of the art for precast concrete is to invite speakers from the industry. Students always enjoy learning from industry experts about the practical aspects of what they are being taught in class and what they can expect as an engineer after graduating. Guest presentations also provide a chance for speakers to get to know students and consider them for future job opportunities in their firms.

Laboratory Work

Hands-on lab activities should be an integral part of teaching precast concrete. In most universities, it is a common practice to reserve structural laboratories primarily for research activities. However, all laboratories should be leveraged to teach precast concrete. Students will not only learn how to develop concrete mixtures and make precast concrete specimens; they will also learn how structural testing should be carried out in accordance with standards used in the precast concrete industry. Observations from testing and processing test data will remain with students far longer than the content of a purely theoretical lecture in the classroom.

Student Competitions

Participation in PCI, NPCA, ASBI, and other precast concrete and bridge-related competitions gives students opportunities to develop communication and hands-on skills, experience teamwork, practice technical writing, and network with industry leaders. For instance, there are some wonderful opportunities for students to take part in the PCI Convention and The Precast Show. In addition to the aforementioned benefits to the students, a competition can be a great venue for students to connect with future employers and peers from other institutions.

Full-scale testing of a precast concrete pipe.

Conclusion

Precast concrete should be considered part of the core curriculum in civil engineering, especially for students who are interested in pursuing a career in bridge engineering. In addition to theoretical design lectures, innovative and hands-on activities are an important component of an effective precast concrete curriculum. Partnerships and collaboration with the precast concrete industry are essential for the success of the curriculum. A course such as ISU's Precast Concrete Engineering Studio can prepare students for rewarding careers in the precast concrete and bridge industries. Given the success of the studio, ISU faculty are planning to make it a permanent class in the civil engineering curriculum.

Students from Idaho State University's Precast Concrete Engineering Studio with their professor during a poster session at the 2020 PCI Convention at The Precast Show.

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Setting a Concrete Foundation for the Future

Idaho State University is using an NPCA Foundation grant to provide a hands-on precast concrete studio for students to experience the industry.

By Joe Frollo

Engineering students at Idaho State University are getting a hands-on education in precast concrete thanks to a joint grant from the NPCA Foundation and PCI Foundation.

The Pocatello campus is home to a precast concrete engineering design studio designed to expose students to precast concrete manufacturing and its benefits.

"The studio class is very hands on, very different than a typical lecture class," said Dr. Mustafa Mahal, an ISU assistant professor in the ISU department of civil and environmental engineering. "We have some fantastic laboratories for concrete and large-scale testing where we can have students mixing concrete, building specimens and testing full-scale concrete sections such as reinforced concrete pipes. Having these facilities is definitely something we are proud of, and it helps the students tremendously.

"Modular construction using precast concrete should not be limited to civil infrastructure but also critical infrastructure. The potential for precast concrete in both civil and critical infrastructure is significant."

The four-year grant that continues through May 2022 provides the funding to support an annual four-semester program, two of which are dedicated to precast and prestressed bridges and two of which are dedicated to precast culvert design, construction and seismic considerations. In addition to educating ISU civil engineering students, the school is partnered with the Idaho Transportation Department to support the proposal.

"We tailored it such that Idaho State would cover both above-ground and underground precast concrete sections," Mustafa said.

Students also benefit from regional and national precast industry leaders, including NPCA, who supply online resources, guest speakers and in-person facility tours so the young, soon-to-be professionals can see actual precast manufacturing in person.

"Hands-on education is one of the best ways to learn," said Bruce Savage, chair and associate professor of ISU civil and environmental engineering. "The design studio will allow us to strengthen the number of real-world projects in our curriculum. This will make our graduating engineers better prepared to the profession."

Alongside the studio learning, Idaho State has been a regular competitor in national competitions, including earning third place in the NPCA Foundation Student Competition at The Precast Show 2020, where students were given real-world issues that precasters faced and are tasked with finding solutions.

"Having the opportunity to compete against other student groups is big for us," Mustafa said. "That way, students get not only technical and hands-on experience, but they actually get the opportunity to present in front of a panel of judges from the precast concrete industry to build up on their communications skills."

Photo courtesy of Idaho State University

Students at Idaho State University get their hands dirty in and out of the classroom as they learn about precast concrete through a joint grant from the NPCA Foundation and PCI Foundation.

Many civil engineering students graduate with a minimal knowledge of precast concrete, Mustafa said. That is changing at Idaho State.

"Precast is typically the last lecture in a reinforced concrete class," he said. "We are trying to educate the next generation of students who can go on and pursue a career in precast and serve the industry long term."

The program is already paying dividends as some graduates have accepted jobs at precast companies and are already contributing to the work.

"Our goal is to have this class permanently up within our system," Mustafa said. "We will continue to work with NPCA and PCI Foundations to achieve this."

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> – Dr. Mustafa Mahal, *ISU assistant professor*

NPCA FOUNDATION GRANT SUPPORTS NEW JERSEY INSTITUTE OF TECHNOLOGY

The NPCA Foundation also recently approved a $60,000 grant for the New Jersey Institute of Technology's (NJIT) Concrete Industry Management program.

Through close collaboration and input from industry partners, the School of Engineering and Applied Technology at NJIT will implement three new required courses and three new elective courses that will be integrated into the CIM program and School of Architecture.

Approximately 300 students from five majors will attend precast courses during their four-year degree programs starting in the fall. PCI Foundation also provided $60,000 for the project, ensuring students and teachers will be exposed to all areas of the precast industry.

Partnerships between the NPCA Foundation and universities such as these help build the future workforce while educating students about the benefits of precast concrete. Learn more about the Foundation by visiting: precast.org/foundation. **PI**

Joe Frollo is NPCA's acting director of communications and managing editor of Precast Inc.