

PCI WEST MINI-BEAM

Competition Rules

ASCE Mid-Pacific Student Symposium

April 9—11, 2027

Hosted by CSU Fresno & UC Merced

ASCE FRESNO STATE STUDENT CHAPTER

ASCE STUDENT CHAPTER University of California, Merced

PCI West Mini-Beam Competition Rules

Competition: two consecutive days (design and casting, then testing within 24 hours); dates and location to be announced in Mailer 2. All deadlines are 11:59 PM Pacific Time. Questions: ascemidpac2027@gmail.com.

Overview

Teams use tensioned bass guitar strings as the prestressing force in a mortar beam. Each team controls the beam's cross-section, while the length, width, and height of the casting form and the amount of mortar (0.28 ft^3) are fixed. Beams are cast on the first day and tested to failure the next. Teams are judged on both the ultimate load their beam carries and how accurately their design calculations predict it.

Competition Prompt

The Central Valley relies heavily on irrigation canals to support its vast agricultural industry. As part of a regional modernization project, an irrigation district needs to replace an aging canal crossing while minimizing construction time and disruptions to farming operations. Your engineering firm has been tasked with designing a precast, prestressed concrete beam to span the canal and support heavy agricultural vehicles and equipment. Teams must design and construct a miniature representation of the beam using specified materials, submit their predicted ultimate load, and test it to structural failure.

Key Dates (2027)

Item	Date
Team registration (regular, $150 per team)	Tuesday, December 1, 2026
Team registration (late, $180 per team)	Monday, January 18, 2027 (checks must be postmarked by this date)
Attendee registration and team roster due	Monday, February 15
Request for Information (RFI) deadline	Friday, February 19
RFI answers posted	Friday, February 26
Late individual registration deadline	Tuesday, March 30
Captains' meeting, online (informational only)	Thursday, April 8, 7:00 – 8:00 PM
Day 1: design and casting (8:00 AM – 3:00 PM)	TBD, announced in Mailer 2
Day 2: cylinder results, design report, and beam testing	TBD, within 24 hours of casting

Registration, roster, and chapter-standing deadlines follow Mailer 1. All submission deadlines are 11:59 PM Pacific Time. Final times and locations will be confirmed in Mailer 2 and on the symposium website.

Eligibility and Participant Rules

1. Each school may enter one (1) team, and only one beam per school will be evaluated.
2. There is no limit on the number of students on the building team. However, only three (3) students may participate in loading the beam onto the testing apparatus.
3. Each team designates a team captain, who is the team's point of contact. Students may compete in more than one competition but may captain only one team. Because each competition demands significant time before and during the symposium, students are encouraged to focus on one competition.
4. At least three (3) students from each school should take part in Day 1 (design and casting) so the beam can be completed in the allotted time.
5. Every team member must be an ASCE student member and a registered attendee of the ASCE Mid-Pacific Student Symposium, and the university's chapter must be in good standing (annual report and dues submitted by February 1).
6. All participants are expected to follow the professionalism and sanctions policies in Mailer 1. Events are drug and alcohol free.

Submissions and File Naming

Nothing is submitted before the symposium. The design report is handwritten on site on the calculation and cross-section forms provided, and is handed to the judges before any beam is tested (see Design Report).

Deliverable	Format	Due Date	How to Submit
Design Report	Handwritten on the forms provided	Day 2, before testing	Hand to the judges at the testing station. No email submission.

Late Policy

The symposium late policy does not apply because the report is submitted on site. The finalized calculations and cross-section schematic must be in the judges' hands before any beam is tested.

Requests for Information (RFIs)

Send questions and requests for information by **Friday, February 19**. Answers will be posted to all teams on **Friday, February 26**.

Contact

Send all questions about this competition to ascemidpac2027@gmail.com. Replies may take up to 3 business days. Messages sent to any other account will not be addressed.

Background

Precast, prestressed concrete beams use seven-wire steel strands as their primary reinforcement. The strands are tensioned before the concrete is cast, which places the hardened beam in compression (prestressing). In this competition, tensioned bass guitar strings take the place of the steel strands.

Each team designs and fabricates a beam cross-section that meets fixed dimensions and a fixed volume, then casts the beam. Each beam is tested the day after casting to find its ultimate load capacity, using

simply supported, center-point loading. Teams are evaluated on both the strength of their beams and the accuracy of their design calculations, measured by the percentage difference between the ultimate load reached in testing and the load predicted by the team's calculations.

Procedures

Teams arrive at the designated competition location to calculate, design, build, and cast their mini-beam on site. Testing and scoring take place within 24 hours of casting.

A mortar compressive strength of 200 psi is used for initial calculations. Two (2) test cylinders of the mortar mix are cast and tested before beam testing to determine the mix's compressive strength (psi). The average compressive strength of the tested cylinders is given to the teams at the start of Day 2 and is used in their final calculation of the predicted load capacity. The finalized calculations and the schematic of the beam cross-section must be submitted to the judges before any beam is tested.

Supplies and Materials

Provided by Each Team

- One standard tarp, at least 8′ × 6′
- Paper, pens or pencils, calculators, and a bass guitar tuning app (for example, DaTuner on Google Play)
- Safety glasses and personal protective equipment (PPE)
- Teams may bring their own tools, but not materials to aid in building the form or the beam.

Provided by the Competition Committee

- Wood casting form (inside dimensions: L = 32″, W = 12″, H = 6″; see Figure 1)
- Four (4) packs of bass guitar strings; each pack contains one string of each diameter: 0.100″, 0.080″, 0.065″, and 0.045″
- One (1) aluminum L-bracket, 12″ × 1″ × 1″
- Two (2) sheets of polystyrene foam, 24″ × 24″ × 1″, for forming the beam cross-section
- Sixteen (16) machine screws for tuning and tensioning the strings
- One (1) aluminum bar, ½″ × 3/16″ × 12″
- Drywall screws, 1¼″
- Mortar mix (maximum beam volume 0.28 ft³)
- 5-gallon buckets for mixing the mortar
- Two (2) mortar test cylinder molds
- Form release agent
- Calculation and cross-section forms
- Shared tools: duct tape, drills and bits, pliers, 3/8″ ratchet sets, mallets, hacksaws, caulk, margin trowel, wrench, tape measures, wire cutters, nitrile gloves, and utility knives

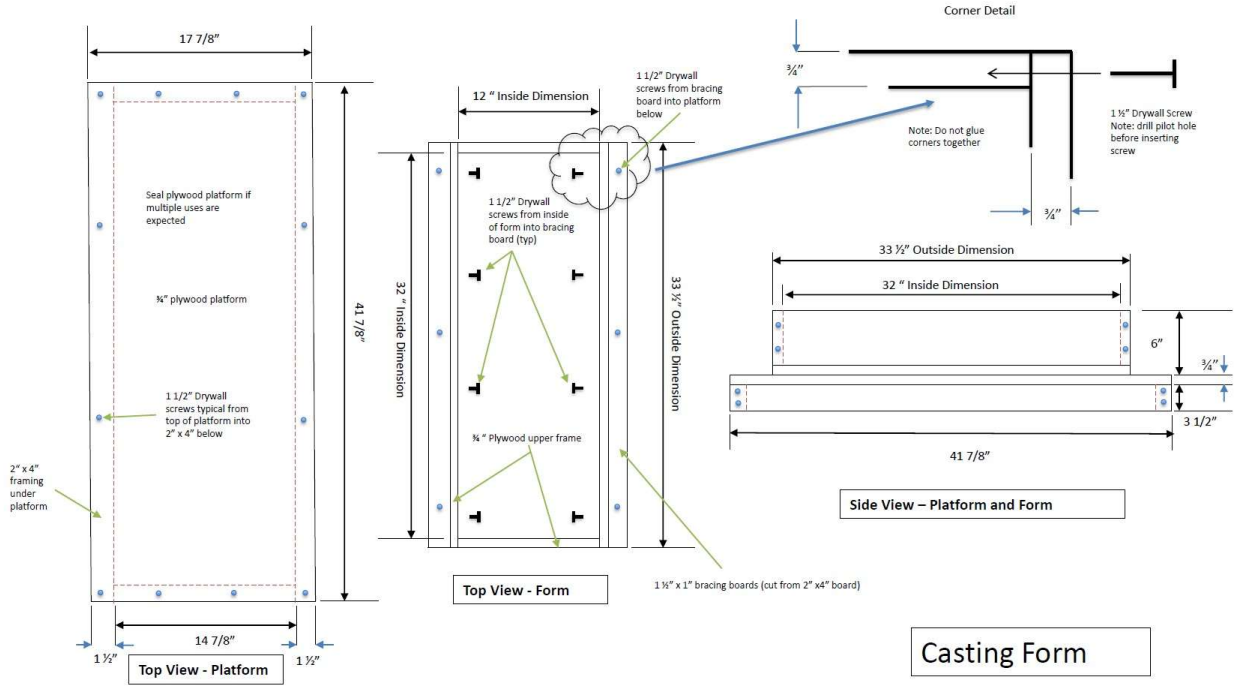


Figure 1: Casting form (top views of the platform and form, side view, and corner detail)

Construction

Beam construction starts at 8:00 AM local time on Day 1, unless otherwise noted. All construction, including casting, must be completed by 3:00 PM local time on Day 1. Only materials provided by the competition may be used, and no additional materials will be given to the teams beyond what was initially provided. Teams must use the bass guitar strings as the prestressing strands in the beam. Students may use tools (measuring devices, a guitar tuner app, and so on) at their discretion to aid in constructing the beam.

The beam must conform to the maximum depth, width, and length (32″) of the form provided. Depth and width may be smaller, but the length may not be shorter than the inside length of the form. The beam shall not be disturbed, touched, or handled after 3:00 PM local time.

Constraints

1. Teams may use only the materials provided at the competition.
2. Beams must match the length of the form provided. Beams shorter than the form will be disqualified.
3. Other dimensional constraints:
   a. Width: no greater than 12″.
   b. Height: no greater than 6″.
   c. Volume: the beam may not exceed the 0.28 ft³ of mortar mix provided.
4. All casting, finishing, and handling must be completed by 3:00 PM local time.
5. The beam shall stand freely, without added support, on a flat surface.
6. The beam must keep a minimum of 1″ of bearing at each end during testing (see Figure 3).
7. The top (loading) surface of the beam must be flat so it can be loaded uniformly during testing.

8. The Competition Committee sets the water/cement ratio, which is the same for all teams; typically 72 oz of water for the 0.28 ft³ of mortar mix. Teams mix their own mortar. Concrete mix design knowledge is not required, because the mortar mix is already an engineered material.

Forming and Tensioning the Strings

- Plan the cross-section carefully: the wood form and foam boards must be removed without damaging the beam.
- Each team chooses the quantity, location, and orientation of the strings in its cross-section. No additional strings will be given.
- Teams drill holes in each end of the wood form at the chosen string locations and thread the strings through. Each string is tightened to an appropriate tension using the machine screws provided (Figure 2).
- Each string has a diameter and a design frequency in hertz (Hz). When a string is tightened correctly and plucked, it sounds the matching musical note. Teams can check this with a bass tuning app on their phones.
- The actual string tension is unknown until the string is in the form, tensioned, and tested, so the manufacturer's recommended tensions for 34″ normal bass guitar strings are given in Table 1.
- Teams can use www.stringtensioncalculator.com to help determine the force in each string.

Table 1: Manufacturer's recommended tension for 34" normal bass guitar strings

String	Diameter (in.)	Tension (lb)	Frequency (Hz)
E1	0.102	40.359	41.203
A1	0.079	43.04	54.99
D2	0.065	52.962	73.416
G2	0.045	46.54	97.99

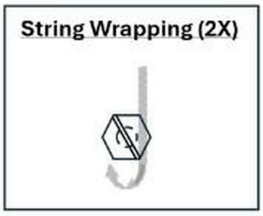


Figure 2: String wrapping on the machine screw (2×)

Testing

Beams are tested with simply supported, center-point loading. The judges measure each beam and mark a centerline on its top surface before testing. Bearing is 1″ in from each end (Figure 3).

The beam is loaded at midspan until the force no longer increases. One judge applies the load manually and consistently, one reads and records the gauge, and one observes and determines failure. The judges visually determine when the ultimate load has been reached or failure has occurred.

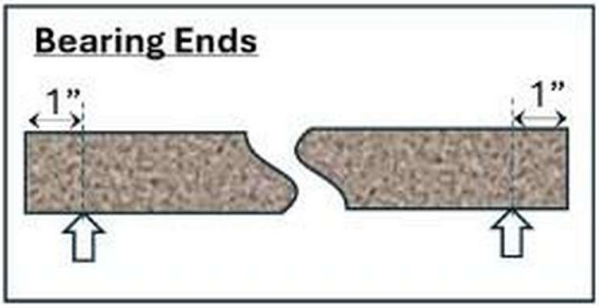


Figure 3: Bearing at each end of the beam during testing

Design Report

Each team submits its report to the judges right before beam testing. The report is expected to be written neatly by hand on the calculation and cross-section forms provided.

Report Content

1. A drawing of the beam cross-section with dimensions, the location and size of each string used, and the total cross-sectional area (ft^2).
2. A calculation of the total volume of the beam (ft^3), assuming a length of 32″. The total volume may not exceed 0.28 ft^3.
3. A calculation of the predicted ultimate load (lb), based on simply supported, center-point loading and the average mortar compressive strength (psi) from the test cylinders.

Scoring

Each beam is ranked in two categories:

- **Ultimate load:** the actual load at failure (lb), ranked from highest (rank 1) to lowest.
- **Prediction accuracy:** the percentage difference between the predicted and actual ultimate loads, calculated as |Predicted − Actual| ÷ Actual × 100%, ranked from smallest (rank 1) to largest.

A team's final score is the sum of its two ranks, and the team with the lowest final score wins. Ties are broken by the smaller percentage difference between the predicted and actual ultimate loads. If teams are still tied, a team whose predicted load did not exceed its actual load ranks ahead.

Competition Schedule and Logistics

Mailer 1 does not yet schedule the Mini-Beam Competition. Days, times, and the location will be confirmed in Mailer 2 and on the symposium website. Day 1 and Day 2 are consecutive symposium days.

Date and Time	Event
Thursday, April 8, 7:00 – 8:00 PM	All-competition captains' meeting (online, synchronous). Informational only; attendance is encouraged.
Day 1, 8:00 AM	Beam construction begins. Test cylinders are cast from the mortar mix.

Date and Time	Event
Day 1, 3:00 PM	All construction, casting, and finishing complete. Beams may not be disturbed, touched, or handled after this time.
Day 2, start of day	Average cylinder compressive strength given to teams for final calculations.
Day 2, before testing	Design reports (calculation and cross-section forms) handed to the judges.
Day 2, within 24 hours of casting	Beam testing and scoring.
Sunday, April 11, 5:00 – 9:00 PM	Awards Ceremony & Banquet (results announced).

Policies

AI Use and Plagiarism

The use of generative artificial intelligence (AI) and natural language processing models (NLP), such as OpenAI's ChatGPT©, is neither encouraged nor discouraged. However, if such models are used, all instances shall be cited as work completed by the respective generative AI/NLP. Failure to cite all instances of generative AI/NLP use will be considered plagiarism.

Plagiarism of any kind will not be tolerated. Teams caught plagiarizing any portion of their submitted work will be disqualified.

Professionalism and Judging

All participants are expected to follow the professionalism and sanctions policies in Mailer 1. The judges follow the rules as published, using reasonable judgment and interpretation. The head judge is the arbiter of any dispute, which may be brought only by the team captain, and decisions of the head judge are final.

Drug and Alcohol-Free Events

The use of drugs and alcohol is prohibited at all ASCE Student Symposium events, including this competition.