2026 PCI Big Beam

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PROJECT DESCRIPTION AND LOCATION

The Precast/Prestressed Concrete Institute Big Beam competition assigns students from across the country with the design and testing of a prestressed concrete beam subject to a defined length and loading.

NAU's team, Beamline Structural, developed a MathCAD spreadsheet for design analysis, coordinated with Tpac for manufacturing and delivery of the beam to NAU's concrete lab, and conducted testing on concrete cylinders and the beam.

Designs are scored on cracking, strength, and deflection performance, in addition to weight, cost, report quality, and prediction accuracy.

Design Requirements:
- 17 ft long simply supported beam loaded asymmetrically with two-point loads
- Cracking load of greater than 2P=20 kips
- Failing load of greater than 2P=32 kips, but less than 40 kips
- Must comply with PCI/ACI Code

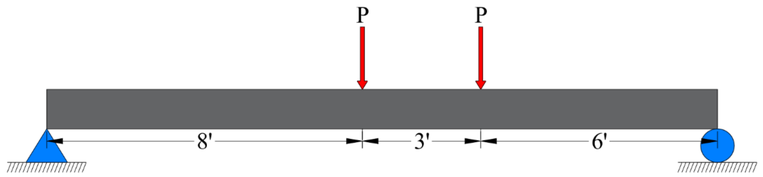


Figure 1: Beam Loading Diagram

DESIGN

The final design cross-section is shown in Figure 2.

Some noteworthy beam design selections are explained below:

- 22-inch section optimizes strength-to-weight ratio
- Bottom strands refined to support competition loading
- Top strands tensioned to resist transfer stress
- I beam minimizes concrete weight
- S-shape and spacing of stirrups are optimized for shear performance
- Strand spacing ensures cover and avoids congestion

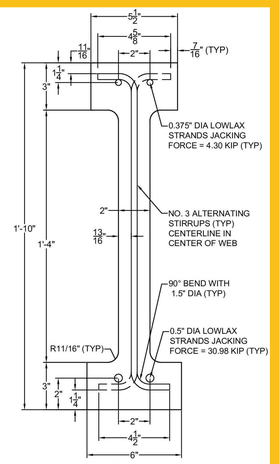


Figure 2: Cross Section Design

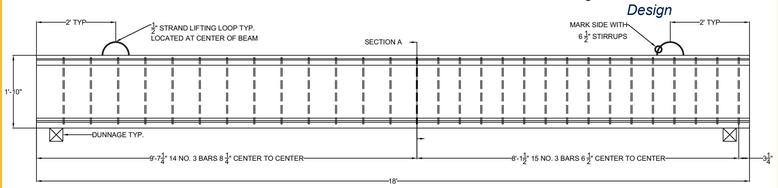


Figure 3: Stirrup Design

MATERIAL COST OF BEAM

The PCI Big Beam Competition defines a standardized method for calculating cost to ensure consistency between a variety of vendors. The following outlines how the cost is calculated for the NAU team's beam.

Table 1: PCI Competition Cost of Beam

Material	Cost Basis		Cost Equation	Cost
Concrete	Concrete Strength at Test	8 ksi	$85 + ($10 x Concrete Strength at Test in ksi)	$ 165.00
Formwork	Contact Surface Area	84.94 ft^2	$1.25 x (Contact Surface Area)	$ 105.60
3/8" Prestressing Strand	$0.27/ft	2 Strands	$0.27 x (2 Strands) x (18 ft)	$ 9.72
0.5" Prestressing Strand	$0.30/ft	2 Strands	$0.30 x (2 Strands) x (18 ft)	$ 10.80
Stirrups	$0.45/lb	29 Stirrups	$0.45 x (1.95 ft x 0.376 lb/ft x 29)	$ 9.58
Total Cost				**$ 300.70**

IMPACTS OF PCI COMPETITION

The PCI Big Beam Competition can be evaluated using the triple bottom line framework, which considers economic, social, and environmental impacts. The positives and negatives of hosting and participating in the competition are outlined below.

Table 3: PCI Competition Positives and Negatives

Category	Positives of PCI Big Beam Competition	Negatives of PCI Big Beam Competition
Economic	■ Industry sponsorship (e.g., fabrication and materials) reduces direct student costs ■ Provides practical experience that improves employability after graduation	■ Requires funding for materials, transportation, and testing ■ Significant time investment from students and faculty
Social	■ Enhances hands-on learning, teamwork, and communication skills ■ Builds connections between students and industry professionals	■ High workload and time pressure on students ■ Resource differences between universities can impact competitiveness
Environmental	■ Encourages efficient structural design and material use	■ Concrete production contributes to carbon emissions ■ Transportation of beams adds to environmental impact

Overall, participating in the PCI Big Beam Competition offers greater economic, social, and environmental benefits than not participating.

BEAM FABRICATION

On March 27, 2026, Beamline Structural visited the TPAC plant in Phoenix, Arizona, to observe fabrication following coordination of the design and shop drawings developed using AutoCAD. The team verified all measurements.

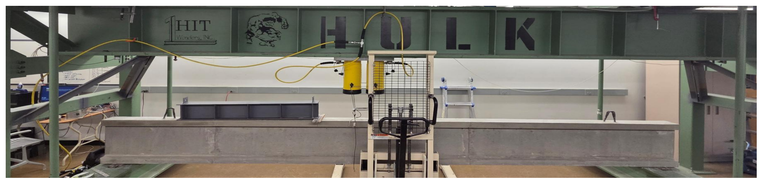


Figure 4: Beam on Testing Apparatus

Figure 5: Form Fabrication

Figure 6: Form Concrete Pour

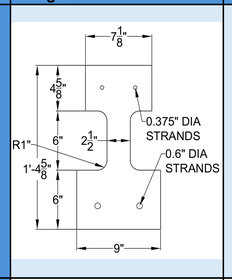
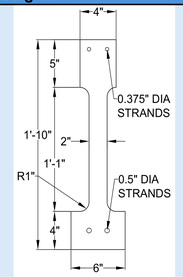
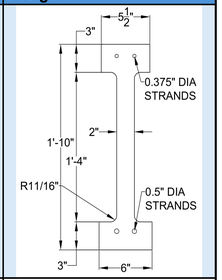
Figure 7: Cylinder Testing

DESIGN ALTERNATIVES

The NAU team performed all calculations using MathCAD. For complete details, refer to https://www.ceias.nau.edu/capstone/projects/CENE/2026/PCI/

The design alternatives considered are outlined below.

Table 2: Decision Matrix

	Design 1	Design 2	Design 3
Design			
Difference	■ Most Ductility ■ Greatest bottom flange thickness ■ Smallest overall height ■ Greatest flange widths	■ Most Economic ■ Greatest top flange thickness ■ Narrowest design	■ Lightest ■ Smaller chamfer radius ■ Overall slender shape ■ Uniform design for ease of construction
Result	Weight: 1660 lbs Cost: $298.42	Weight: 1161 lbs Cost: $293.61	Weight: 1079 lbs Cost: $300.70

REFERENCES / ACKNOWLEDGEMENTS

We want to sincerely thank Dr. Ben Dymond and Dr. Robin Tuchscherer for their guidance and support throughout this project. We are also grateful to PCI for hosting the competition and providing this opportunity, and to TPAC for serving as our sponsor.

For more information on this project please see:
https://www.ceias.nau.edu/capstone/projects/CENE/2026/PCI/

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