PCI Big Beam Competition

2025 - 2026 Project Proposal

December 10th, 2025

Team Members:

Lander Porter | Jonah Simminger | Kaylynn Calvin | David Lucas Macaraeg

Technical Advisor:

Dr. Ben Dymond

Table of Contents

Table of Figures

Table of Tables

Table of Abbreviations

ASTM: American Society for Testing and Materials

FE: Fundamentals of Engineering Exam

INT: Engineering Intern

LBT: Lab Tech

NAU: Northern Arizona University

PCI: Precast/Prestressed Concrete Institute

PE: Principles and Practice of Engineering Exam

SE: Structural Engineering Exam

SENG: Senior Engineer

STEG: Structural Engineer

NAU NORTHERN ARIZONA UNIVERSITY
Steve Sanghi College of Engineering

BEAMLINE STRUCTURAL

Section 1: Project Understanding

1.1 Project Purpose

The purpose of this project is to design, construct, and test a prestressed concrete beam in accordance with the requirements of the PCI Big Beam Competition. The competition challenges student teams to collaborate with an industry precast producer to develop a structurally efficient beam that meets specified performance criteria for serviceability, strength, and constructability. The beam must be designed to resist the loading configuration provided by PCI, and its performance will be verified through laboratory testing at Northern Arizona University.

This project provides an opportunity to apply structural engineering principles to a real-world design scenario. Students will perform analytical modeling of flexural and shear behavior, determine appropriate prestressing and reinforcement detailing, and account for material properties and prestress losses. The team will generate a complete design package that includes calculations, drawings, and documentation of the design process. The final beam will be fabricated by TPAC, transported to NAU, and tested to evaluate deflection, cracking behavior, and ultimate load capacity. Test results will then be compared to analytical predictions to assess the effectiveness of the final design.

Beyond technical analysis, the project emphasizes collaboration, scheduling, communication, and coordination with industry partners. Through the design and testing process, team members will gain practical experience with engineering decision-making, construction planning, and performance verification skills that are essential in professional structural engineering practice.

1.2 Project Background

Prestressed concrete is used to enhance serviceability and load-carrying capacity by introducing internal compressive stresses that counteract tensile stresses generated during loading. In pre-tensioned prestressed beams such as those constructed for this project, high-strength steel strands are tensioned between fixed abutments prior to concrete placement. Once the concrete reaches its required release strength, the strands are cut, transferring the prestress force to the concrete through bond. This process compresses the tension zone of the beam, which limits tensile crack formation, increases flexural strength, and improves long-term durability and deflection performance. This can be visualized through the following prestressing bed diagram:

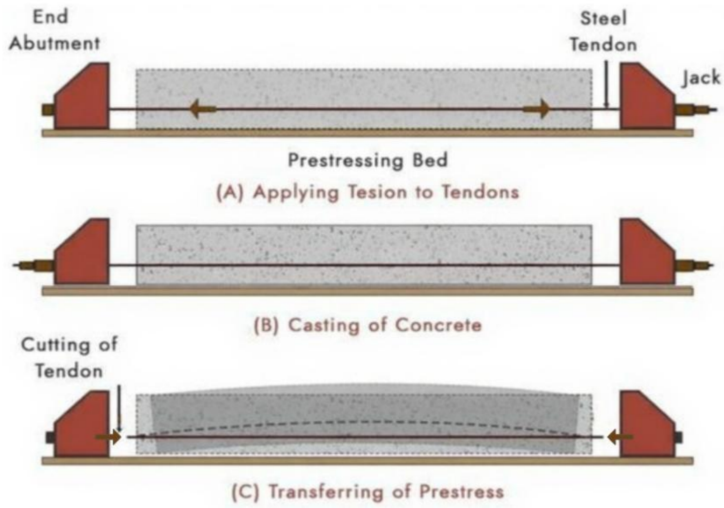

Figure 1-1: Stages of Prestressing [1]

The PCI Big Beam Competition provides a standardized testing configuration, shown in Figure 1-2, in which the beam is simply supported and loaded at two points in an asymmetric arrangement. Under this loading, the beam must demonstrate adequate serviceability and strength performance: it must remain uncracked under a 20-kip service load, and it must sustain a minimum peak total applied load of 32 kips. It must also fail between 32 and 40 kips. Exceeding 40 kips results in over-strength penalties; thus, the design must strike a balance between capacity and ductility rather than maximizing strength alone.

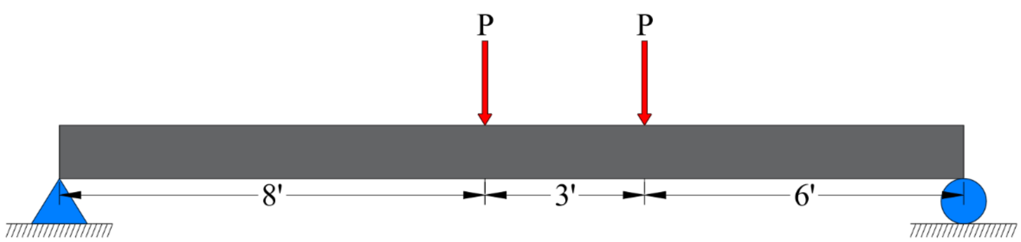

Figure 1-2: 2026 PCI Big Beam Competition Loading Diagram [2]

Competition scoring emphasizes how accurately teams predict the beam's cracking load, peak load, and midspan deflection. A beam that performs exactly as predicted demonstrates a strong understanding of prestressed concrete behavior and a sound application of structural mechanics. Additionally, designs that minimize material cost, reduce beam weight, and exhibit greater deflection capacity at peak load are viewed favorably, as these outcomes reflect efficient use of materials, thoughtful reinforcement and prestressing layout, and desirable post-cracking ductility. The written report also contributes to scoring by evaluating how effectively the team communicates its concrete mix design choice, structural design reasoning, fabrication process, and test interpretation. Together, these criteria encourage teams to approach the project from both a structural performance perspective and a design-communication perspective.

To develop accurate performance predictions, material properties will be verified through laboratory testing. Concrete cylinder testing will be conducted per ASTM C39 to determine compressive strength and per ASTM C78 or C496 to determine tensile strength. The modulus of elasticity will also be measured to support deflection calculations. Testing will occur at multiple curing intervals at 1 day, 7 days, 14 days, 21 days, and 28 days to track strength development over time. Beamline Structural will reference 21–28-day values when modeling performance, aligning analytical predictions with the expected material condition at testing.

The beam will be fabricated by TPAC in Phoenix, Arizona, using industry-standard pre-tensioned casting methods. After fabrication, it will be transported to Northern Arizona University and allowed to cure until testing. On the day of testing, the beam will be tested in the NAU Structural Laboratory under the competition loading configuration. Deflection and cracking behavior will be recorded continuously, and the full test, including ultimate failure, will be video documented for submission. Final evaluation will compare the measured performance to the team's predicted loads and deflections, providing the basis for the design accuracy scoring component and demonstrating the effectiveness of the design approach.

1.3 Technical Considerations

The technical work for the PCI Big Beam project follows a structured design and evaluation process. The first phase involves analyzing the beam under the loading configuration shown in Figure 2-1 to determine reaction forces, shear forces, and bending moments. Using these internal force diagrams, Beamline Structural will evaluate stresses at three key performance stages: prestress transfer, first flexural cracking, and ultimate flexural failure. These values will be compared against the competition performance requirements to verify that the beam remains uncracked under the service load and achieves the required peak load within the allowable scoring range. In addition to strength checks, the flexural stiffness of the section will be assessed to evaluate ductility, reflected in the expected midspan deflection at failure.

To determine an efficient and competitive beam configuration, preliminary cross-sections will be developed. Each will vary in depth, flange width, web thickness, strand eccentricity, and reinforcement layout. These alternatives will be evaluated using a decision matrix that compares predicted structural performance, material quantity, fabrication feasibility at TPAC, and likely scoring outcomes. The cross-section that demonstrates the strongest balance of strength, serviceability, ductility, and efficiency will be selected for refinement.

Once the final cross-section is chosen, reinforcement detailing and prestressing layout will be finalized. Prestress losses, including elastic shortening, creep, shrinkage, and strand relaxation, will be estimated to determine the effective prestress force at the time of testing. A moment-curvature analysis will then be performed to characterize the flexural response and determine how stiffness evolves from uncracked behavior through cracking and into the plastic range. The load-deflection behavior of the beam will be predicted by numerically integrating the moment-curvature relationship, allowing evaluation of midspan deflection at both service and peak load levels.

After design finalization, the beam will be fabricated by TPAC in Phoenix and transported to Northern Arizona University for curing and testing. Cylinder strength test results obtained near the time of testing will be used to update final performance predictions. During laboratory testing, deflection, cracking behavior, and maximum load will be recorded and compared to analytical predictions. These results will be submitted to PCI as part of the final competition report and evaluation.

1.4 Constraints

The PCI Big Beam project is influenced by several practical constraints that require planning and coordination. One major constraint is the fabrication schedule at TPAC. Since TPAC's prestressing beds and production resources are primarily dedicated to commercial projects, beam casting must occur when space and labor are available. If this schedule is not coordinated in advance, fabrication may be delayed. Beamline Structural will mitigate this constraint by communicating regularly with TPAC, confirming bed availability early, and providing final design information with sufficient lead time.

Transportation and handling also present constraints. The beam must be transported from TPAC in Phoenix to Northern Arizona University, and improper handling during lifting, hauling, or placement could introduce cracks before testing. To prevent damage, the team will coordinate with TPAC to ensure the beam is adequately supported and braced throughout transport and setup.

Material variability adds another consideration. Concrete strength develops over time and may differ slightly from expected design values. These variations affect cracking load, peak load, and deflection behavior. To address this, concrete cylinders will be tested at multiple curing ages, and the results closest to the test date will be used to update final performance predictions, improving the accuracy of analytical modeling.

Finally, the project must be completed within the PCI Big Beam competition timeline. Delays in design, fabrication, transport, or testing could impact submission quality or eligibility. To manage this, Beamline Structural will maintain a detailed schedule, monitor progress, and coordinate milestone dates with TPAC and NAU personnel to ensure each phase is completed on time.

1.5 Stakeholders

The PCI Big Beam Competition involves a range of stakeholders, each with a specific role and interest in the project's success. PCI is the organizer and sponsor of the competition to support education and innovation in the prestressed and precast concrete industry. By participating, students gain hands-on experience while demonstrating the next generation's technical competency and problem-solving skills.

TPAC provides Beamline Structural with access to their precast plant, materials, equipment, and fabrication expertise. Their involvement also includes financial support and knowledge gained from previous collaborations with NAU capstone teams. Encon, the parent company of TPAC, will offer additional engineering guidance and professional insight throughout the design process, helping the team ensure that the final beam reflects industry standards and practical constructability.

Beamline Structural represents Northern Arizona University in the competition. A successful performance supports NAU's reputation for strong engineering instruction, strengthens relationships with industry partners, and highlights opportunities for future students. The team's faculty advisor, Dr. Ben Dymond, provides technical guidance, evaluates progress, and oversees final testing to ensure that the beam's design and construction meet both academic expectations and professional engineering practices.

Section 2: Scope of Services/Research Plan

2.1 Task 1: Research & Preparation

2.1.1 Task 2.1: Technical Research

The purpose of this task is to review prior PCI Big Beam Competition entries and identify design strategies that led to successful results. This will be accomplished by compiling a spreadsheet of beam geometries, reinforcement layouts, concrete mixes, and performance metrics so the team can analyze patterns and narrow potential design concepts before making the best design decisions.

2.1.2 Task 2.2: Material Testing Plan

The purpose of this task is to secure laboratory access for upcoming material testing. This will be accomplished by coordinating with NAU's Structural Laboratory Coordinator, completing required documentation and safety training, and arranging card access to ensure facilities are available when testing begins.

2.2 Task 2: Beam Analysis & Design

2.2.1 Task 2.1: Analysis of Load and Material

2.2.1.1 Task 2.1.1: Calculate Reactions

The purpose of this task is to establish the beam's initial structural conditions for subsequent design and analysis. This will be accomplished by calculating support reactions under service, factored, and roughly estimated self-weight loading using static-equilibrium principles, and then developing corresponding shear and moment diagrams. These diagrams will identify critical locations along the span and provide the foundational inputs needed for prestressing layout, cross-section design, and later performance evaluations.

2.2.1.2 Task 2.1.2: Select Concrete Mix for Design

The purpose of this task is to select appropriate concrete mixtures for beam design. This will be accomplished by collecting mix designs from TPAC, reviewing existing performance data, and estimating additional mechanical properties, which include modulus of elasticity, tensile strength, and compressive strength. The team will then compare the mixtures based on these parameters to determine which options are the most suitable balance of strength, stiffness, and workability for later use in the decision matrix.

2.2.2 Task 2.2: Create Analysis Spreadsheet

The purpose of this task is to organize analytical computations and maintain accuracy throughout the continuing design process. This will be accomplished by developing a MathCAD spreadsheet that automates reaction, moment, stress, and deflection analyses for use in subsequent design tasks.

2.2.3 Task 2.3: Design Decision Matrix

The purpose of this task is to evaluate multiple design alternatives and select the most efficient configuration. This will be accomplished by assigning weighted criteria—cost, strength, deflection, and rule compliance—to prototype designs and ranking them to determine the beam best suited for detailed development.

2.2.4 Task 2.4: Beam Design and Selection

2.2.4.1 Task 2.4.1: Determine Cross-Section Dimensions

The purpose of this task is to choose the beam geometry that satisfies structural and competition requirements based on the decision matrix. This will be accomplished by analyzing release stress, cracking load, ultimate load, shear, and deflection demands to establish dimensions that balance strength, stiffness, and material efficiency.

2.2.4.2 Task 2.4.2: Design Prestressing Layout

The purpose of this task is to design the size, quantity, and placement of prestressing strands. This will be accomplished by applying ACI 318 and PCI Design Handbook guidelines to achieve balanced stress conditions and adequate concrete cover while optimizing strand eccentricity for target performance.

2.2.4.3 Task 2.4.3: Refine Beam Dimensions

The purpose of this task is to predict the total prestress loss between jacking and service conditions. This will be accomplished by estimating elastic shortening, creep, shrinkage, and relaxation effects to refine effective stress levels for performance modeling.

2.2.4.4 Task 2.4.4: Evaluate Performance Against Design Criteria

The purpose of this task is to confirm that the preliminary beam design satisfies PCI Big Beam performance requirements. This will be accomplished by calculating predicted cracking load, ultimate load, and comparing these values to the competition's strength and serviceability criteria.

2.2.4.5 Task 2.4.5: Refinement of Final Beam Design

The purpose of this task is to incorporate Technical Advisor feedback and finalize the design package. This will be accomplished by adjusting the strand layout, reinforcement details, and geometry as recommended by the Technical Advisor and ensuring the design is still functional after adjustments to prepare for shop-drawing development.

2.3 Task 3: Engineering Shop Drawings

2.3.1 Task 3.1: Create Shop Drawings

The purpose of this task is to generate detailed fabrication drawings of the final beam. This will be accomplished by producing AutoCAD drawings that specify all beam dimensions, materials, and reinforcement locations to guide TPAC's production process.

2.3.2 Task 3.2: Internal Review

The purpose of this task is to ensure design accuracy before external submission. This will be accomplished by performing internal checks on calculations and drawings, followed by Technical Advisor review to confirm completeness and compliance.

2.3.3 Task 3.3: External Review

The purpose of this task is to obtain confirmation from TPAC and Encon that the final beam design is fully constructible. This will be accomplished by presenting the completed design drawings and calculations to their engineering staff, reviewing reinforcement placement, strand layout, and production constraints, and incorporating any necessary adjustments to ensure the design can be reliably fabricated using their equipment and processes.

2.4 Task 4: Fabrication & Engineer's Site Visit

2.4.1 Task 4.1: Beam Fabrication & Observation

The purpose of this task is to oversee the fabrication of the prestressed concrete beam to ensure it is constructed according to the approved design. This will be accomplished by observing TPAC's preparation of formwork, placement of reinforcement and strands, tensioning operations, and concrete placement procedures. The team will also verify concrete properties through spread testing and monitor consolidation, finishing, and curing practices to confirm that all steps meet the project's quality and performance expectations.

2.4.2 Task 4.2: Cylinder Testing & Beam Predictions

2.4.2.1 Task 4.2.1: One-day Test

The purpose of this task is to track the progress of the development of material properties. This will be accomplished by testing the compressive and tensile properties of cylinders one day after casting.

2.4.2.2 Task 4.2.2: Seven-day Test

The purpose of this task is to track the progress of the development of material properties. This will be accomplished by testing cylinders after seven days to monitor property development.

2.4.2.3 Task 4.2.3: Fourteen-day Test

The purpose of this task is to track the progress of the development of material properties. This will be accomplished by testing cylinders after fourteen days to monitor property development.

2.4.2.4 Task 4.2.4: Twenty-one-day Test

The purpose of this task is to track the progress of the development of material properties. This will be accomplished by performing cylinder tests after twenty-one days to monitor property development.

2.4.2.5 Task 4.2.5: Day of Testing Test

The purpose of this task is to collect the data that is used in the final beam predictions. This will be accomplished by conducting cylinder tests concurrent with beam testing and using the data in final predictions.

2.4.3 Task 4.3: Final Beam Predictions

The purpose of this task is to predict beam behavior for service and ultimate loading. This will be accomplished by integrating laboratory test data into the MathCAD analytical model to predict cracking load, ultimate load, and deflection before physical testing occurs.

2.5 Task 5: Preparation for Beam Testing

2.5.1 Task 5.1: Transportation

The purpose of this task is to coordinate the safe and timely delivery of the fabricated beam to NAU. This will be accomplished by working with TPAC to schedule transport and verify that handling procedures maintain beam integrity.

2.5.2 Task 5.2: Testing Preparation

The purpose of this task is to prepare the beam and testing apparatus for load application. This will be accomplished by installing the beam into the loading frame to establish the required simply supported condition and calibrating the load and deflection instrumentation to ensure accurate and reliable data collection during testing.

2.6 Task 6: Beam Testing

2.6.1 Task 6.1: Load Testing on Beam

The purpose of this task is to evaluate the structural performance of the beam under both service and ultimate loading conditions. This will be accomplished by first applying the required service load to observe initial deflection and crack behavior, and then progressively increasing the load until failure while documenting load measurements, deflection response, and the mode of failure. A full video recording of the test will also be taken to capture key moments—including cracking, failure progression, and maximum deflection—which will later be used for analysis and required PCI competition submission. These observations and recordings will provide the data needed to assess beam behavior and compare test results to predictions.

2.6.2 Task 6.2: Analyze Test Results

The purpose of this task is to interpret measured performance and assess analytical accuracy. This will be accomplished by comparing experimental data to predicted results.

2.7 Task 7: Finalize Report & Submit to PCI

The purpose of this task is to complete the final PCI competition report and ensure all required documentation is submitted for judging. This will be accomplished by compiling the project's data, figures, calculations, testing results, and narrative sections into a cohesive report that meets PCI formatting requirements, including the certification, design summary, and required appendices. Once finalized, the report and testing video will be submitted through the PCI competition portal by June 5th, 2026.

2.8 Task 8: Project Impacts

The purpose of this task is to evaluate how the project contributes to engineering practice and society. This will be accomplished by analyzing global, societal, economic, and environmental implications of prestressed-concrete design innovations.

2.9 Task 9: Deliverables

2.9.1 Task 9.1: 30% Project Progress Report and Presentation

The purpose of this task is to present the progress of the project when it is 30% complete. This progress report will include Task 1.1 through Task 2.4.2.

2.9.2 Task 9.2: 60% Project Progress Report and Presentation

The purpose of this task is to present the progress of the project when it is 60% complete. This progress report will include Task 2.4.3 through Task 4.2.1.

2.9.3 Task 9.3: 90% Project Progress Report and Presentation

The purpose of this task is to present the progress of the project when it is 90% complete. This progress report will include Task 4.2.2 through Task 7.0.

2.9.4 Task 9.4: Final Presentation

The purpose of this task is for Beamline Structural to formally present the results of the project to the client and the general public.

2.9.5 Task 9.5: Final Project Report

The purpose of this task is to finalize the report that fully represents Beamline Structural and the PCI Big Beam Competition project. This progress report will include Task 1.0 through Task 8.0.

2.10 Task 10: Project Management

2.10.1 Task 10.1: Meetings

The purpose of this task is to hold team meetings weekly to ensure adequate time to work on deliverables. This also includes holding weekly meetings with the Technical Advisor to ensure the work conducted each week is of quality and accuracy. This also includes becoming familiar with pre-stressed concrete content and acquiring adequate knowledge to perform the necessary calculations in conjunction with reinforced concrete design to design the beam. Meetings with the Grading Instructor will occur before the deliverable submission dates. Meeting minutes will be used and collected for documentation purposes.

2.10.2 Task 10.2: Tracking Project Progress

The purpose of this task is to consistently update the team's schedule to ensure that tasks and subtasks are executed so that project milestones are met on time to produce high-quality results.

2.11 Exclusions

Beamline Structural is responsible for the complete design, analysis, and coordination of the PCI Big Beam Competition project; however, certain fabrication activities will be carried out by the team's industry partner, TPAC, under Beamline Structural's direction. TPAC will perform the physical fabrication and transportation of the beam to Northern Arizona University's Structural Laboratory, following the design drawings and specifications provided by the team. Although this work is subcontracted, it remains an integral part of the project. Beamline Structural will maintain frequent communication with TPAC to confirm production timelines, verify material and reinforcement details, and ensure that the final beam meets all competition and design requirements.

Activities excluded from the project are those that fall outside the direct scope of design, analysis, fabrication coordination, and testing for the PCI Big Beam Competition. These include the independent operation of TPAC's production equipment, the fabrication of unrelated precast products, and any administrative or logistical duties not directly associated with this beam. Similarly, Beamline Structural will not conduct field installations, perform long-term performance monitoring, or carry out non-competition laboratory tests. These exclusions ensure that the team's efforts remain focused on the defined competition objectives.

By clearly outlining these boundaries, the team maintains a professional and efficient workflow, prioritizing critical tasks such as structural design, analytical modeling, fabrication coordination, and laboratory testing while ensuring accountability for every aspect of the project under its control.

Section 3: Schedule

3.1 Schedule Overview

The project will begin on January 12, 2026, and will be completed on May 7, 2026. The total duration of this project is 115 days. Beamline Structural's schedule can be found as a Gantt chart in Appendix A.

The following table includes a synopsis of the major tasks contained within the project schedule.

Table 3-1: Major Tasks from Project Schedule

Task Name	Start	Finish
Task 1 Research & Preparation	1/12/26	1/14/26
Task 2 Beam Analysis & Design	1/15/26	2/26/26
Task 3 Engineering Shop Drawings	2/27/26	3/11/26
Task 4 Fabrication & Engineer's Site Visit	3/19/26	4/20/26
Task 5 Delivery & Setup	4/8/26	4/20/26
Task 6 Beam Testing	4/20/26	4/22/26
Task 7 Finalize Report & Submit to PCI	4/23/26	5/7/26
Task 8 Project Impacts	4/23/26	4/24/26
Task 9 Deliverables	1/12/26	5/7/26
Task 10 Project Management	1/12/26	5/7/26

Per the PCI Big Beam competition rules, the last date for submission is June 5th, 2026. This project, however, will be submitted before that date to conform to the Spring 2026 NAU semester end date.

3.2 Critical Path

The project schedule is comprised of tasks that, when combined, produce a complete project. Certain tasks throughout this process are crucial to the flow and success of the project. The completion of these tasks is considered the critical path due to the nature of how they can affect the end date of the project. These tasks are delineated in red in the Gantt chart found in Appendix A. It is imperative that these tasks are completed on time so as not to affect the completion date of the project.

The critical path for this project begins with the early research and preparation tasks, which establish all information needed before design work can proceed. Technical research and confirming laboratory access are critical because design decisions and material testing schedules cannot progress without them. The structural analysis tasks, including calculating initial beam conditions, selecting a concrete mix, and developing the design decision matrix, form the next major segment of the critical path. These tasks are critical because each design step depends directly on the outputs of the previous one; any delay in analysis immediately delays cross-section selection, prestressing layout, and performance evaluation.

Following design development, the creation and review of shop drawings is a critical milestone. TPAC cannot begin fabrication until drawings are reviewed and approved, so maintaining communication and quick response during this period prevents bottlenecks later in the schedule. Beam fabrication, curing, and cylinder testing also lie on the critical path. These activities are time-dependent, and curing intervals cannot be shortened. To prevent delays, the team will coordinate regularly with TPAC to ensure fabrication aligns with the planned schedule and that cylinder testing occurs on the required days.

Finally, beam testing, data analysis, and preparation of the PCI report complete the critical path. These tasks are critical because test results are required before any sections of the final report can be finalized or submitted.

To protect the project from schedule risks, the team will maintain routine communication with TPAC, build buffer time before major deadlines, and prepare intermediate sections of the final report before testing occurs. These contingencies ensure that unexpected delays in fabrication or testing do not jeopardize the final PCI submission date.

Section 4: Staffing

4.1 Staff Positions and Qualifications

The project team includes a Senior Engineer (SENG), a Structural Engineer (STEG), an Engineering Intern (INT), and a Lab Technician (LBT). Each member brings defined qualifications and experience directly relevant to the beam design and testing process.

Senior Engineer (SENG) holds a bachelor's degree in civil engineering with an emphasis in structural analysis and design, is a licensed PE and SE in Arizona, and has 17 years of experience in prestressed concrete, load-rating, and structural review. The SENG provides high-level technical oversight, performs QA/QC on design calculations and drawings, ensures code compliance, and supervises the STEG and INT.

Structural Engineer (STEG) holds a bachelor's degree in civil engineering, is a licensed PE in Arizona, and has 8 years of experience in structural design and preparation of shop drawings. The STEG leads the beam analysis and design, develops and verifies engineering models, coordinates loading requirements, directs the INT's work, and supervises the LBT during material-testing activities.

Engineering Intern (INT) is enrolled in an ABET-accredited civil engineering program and has completed a majority of upper-division coursework in structural analysis, reinforced concrete, and mechanics of materials, supported by 2 years of internship experience. The INT assists with research, preliminary calculations, drafting, and documentation, and works under the STEG's direction while supporting the LBT in incorporating test data into design assumptions.

~~LBT (~~**Lab Technician** (LBT)**)** is an upper-division engineering student with one year of laboratory experience, including concrete material testing, specimen preparation, and data recording. The LBT conducts material sampling and testing needed to validate mix properties, works under the STEG for technical direction, and coordinates with the INT for data documentation.

4.2 Project Staffing Plan

The following table 4-1 delineates the estimated time for the positions indicated above to complete the project. The Staffing plan is separated into the tasks associated with Section 2, Scope of Services/Research Plan.

Table 4-1: PCI Big Beam Staffing Plan

Task Name	SENG	STEG	INT	LBT	Total Hours
Task 1 Research & Preparation	***0***	***0***	***30***	***0***	***30***
Task 1.1 Technical Research			15		
Task 1.2 Material Testing Plan			15		
Task 2 Beam Analysis & Design	***20***	***145***	***82***	***0***	***247***
Task 2.1 Analysis of Load and Material	-	-	-	-	
Task 2.1.1 Calculate Beam Initial Conditions		10	10		
Task 2.1.2 Select Concrete Mix for Design		10	2		
Task 2.2 Create Analysis Spreadsheet	5	20	10		
Task 2.3 Design Decision Matrix	5	15	5		
Task 2.4 Select Best Design	-	-	-	-	
Task 2.4.1 Determine Cross-Section Dimensions		20	15		
Task 2.4.2 Design Prestressing Layout		15	15		
Task 2.4.3 Refine Beam Dimensions		15	10		
Task 2.4.4 Evaluate Performance Against Design Criteria	5	15	10		
Task 2.4.5 Refinement of Final Beam Design	5	25	5		
Task 3 Engineering Shop Drawings	***5***	***30***	***20***	***0***	***55***
Task 3.1 Create Shop Drawings		25	10		
Task 3.2 Internal Review	5	5	5		
Task 3.3 External Review			5		
Task 4 Fabrication & Engineer's Site Visit	***10***	***6***	***16***	***17***	***49***
Task 4.1 Beam Fabrication & Observation	2	2	5		
Task 4.2 Cylinder Testing & Beam Predictions	-	-	-	-	
Task 4.2.1 One-Day Test			1	3	
Task 4.2.2 Seven-Day Test			1	3	
Task 4.2.3 Fourteen-Day Test			1	3	
Task 4.2.4 Twenty-One-Day Test			1	3	
Task 4.2.5 Day of Testing Test	2	2	2	5	
Task 4.3 Final Beam Predictions	6	2	5		
Task 5 Delivery & Setup	***5***	***5***	***10***	***5***	***25***
Task 5.1 Transportation		5	5		
Task 5.2 Testing Preparation	5		5	5	
Task 6 Beam Testing	***6***	***0***	***8***	***0***	***14***
Task 6.1 Load Testing on Beam	2		3		
Task 6.2 Analyze Test Results	4		5		
Task 7 Finalize Report & Submit to PCI	5	15	40		60
Task 8 Project Impacts	1	2	5	2	10
Task 9 Deliverables	***8***	***14***	***104***	***0***	***126***
Task 9.1 30% Project Progress Report	1	2	16		
Task 9.2 60% Project Progress Report	1	2	16		
Task 9.3 90% Project Progress Report	1	2	16		
Task 9.4 Final Presentation	1	2	16		
Task 9.5 Final Project Report	4	6	40		
Task 10 Project Management	***5***	***24***	***24***	***24***	***77***
Task 10.1 Meetings	4	20	20	20	
Task 10.2 Tracking Project Progress	1	4	4	4	
Total Hours	***59***	***224***	***294***	***46***	***693***

Section 5: Cost of Engineering Services

The total cost of engineering services of **$82,709** covers travel expenses, testing equipment, software, personnel, and subcontracting. Travel costs include a trip to TPAC to observe the beam manufacturing process. Testing equipment costs include all necessary additional equipment that is required for the setup and testing of the beam in the NAU laboratory. Software expenses consist of yearlong MathCAD subscriptions for each member of Beamline Structural, in addition to AutoCAD access. Personnel expenses are determined from the corresponding hourly rate for each position and total hours worked. Beam manufacturing and delivery by TPAC is included in subcontracting.

The following table 5-1 delineates the breakdown cost estimate for the project. The hours of Section 4, Staffing, were used for these calculations.

Table 5-1: Cost Estimate for Engineering Services

	Unit	Quantity	$/unit	Cost
1.0 Personnel				
SENG	HR	59	$ 275	$ 16,225
STEG	HR	224	$ 140	$ 31,360
INT	HR	294	$ 65	$ 19,110
LBT	HR	46	$ 70	$ 3,220
Total Personnel	HR	693		$ 69,915
2.0 Travel	MILE	288	$ 0.67	$ 193
3.0 Supplies				
Lab Rental + Consumables	DAY	6	$ 100	$ 600
Software Licensing	WEEK	17	$ 87	$ 1,479
Forklift and Operator	HR	2	$ 300	$ 600
Total Supplies				$ 2,679
4.0 Subcontract	LS	1	$ 10,000	$ 10,000
5.0 Total				$ 82,787

Section 6: References

[1] "What is Prestressing?," İntaç, 7 August 2023. [Online]. Available: https://www.intacinsaat.com/en/what-is-prestressing/.

[2] "PCI Big Beam Competition," 2024. [Online]. Available: https://www.pci.org/bigbeam/.

[3] "Google Maps," Google, 2025. [Online]. Available: https://www.google.com/maps.

[4] "TPAC - Providing Engineering Concrete Solutions," 2024. [Online]. Available: https://www.tpacaz.com/.

[5] "Autodesk," 3D Design, Engineering & Construction Software, 2025. [Online]. Available: https://www.autodesk.com/.

[6] Microsoft, "Excel," 2025.

[7] Microsoft, "Project," 2025.

[8] "Career Community & Conversations," Glassdoor, [Online]. Available: https://www.glassdoor.com/Community/index.htm.

[9] "Indeed," [Online]. Available: https://www.indeed.com/.

Section 7: Appendix

Appendix A: Project Schedule Gantt Chart

Appendix A: PCI Big Beam Project Schedule

ID	Task Mode	Task Name
1		**Task 1 Research & Preparation**
2		**Task 1.1 Technical Research**
3		**Task 1.2 Material Testing Plan**
4		**Task 2 Beam Analysis & Design**
5		**Task 2.1 Analysis of Load and Material**
6		Task 2.1.1 Calculate Beam Initial Conditions
7		Task 2.1.2 Select Concrete Mix for Design
8		**Task 2.2 Create Analysis Spreadsheet**
9		**Task 2.3 Design Decision Matrix**
10		**Task 2.4 Select Best Design**
11		Task 2.4.1 Determine Cross-Section Dimensions
12		Task 2.4.2 Design Prestressing Layout
13		Task 2.4.3 Refine Beam Dimensions
14		Task 2.4.4 Evaluate Performance Against Design Criteria
15		Task 2.4.5 Refinement of Final Beam Design
16		**Task 3 Engineering Shop Drawings**
17		**Task 3.1 Create Shop Drawings**
18		**Task 3.2 Internal Review**
19		**Task 3.3 External Review**
20		**Task 4 Fabrication & Engineer's Site Visit**
21		**Task 4.1 Beam Fabrication & Observation**
22		**Task 4.2 Cylinder Testing & Beam Predictions**
23		Task 4.2.1 One Day Test
24		Task 4.2.2 Seven Day Test
25		Task 4.2.3 Fourteen Day Test
26		Task 4.2.4 Twentyone Day Test
27		Task 4.2.5 Day of Testing Test
28		**Task 4.3 Final Beam Predictions**
29		**Task 5 Delivery & Setup**
30		**Task 5.1 Transportation**
31		**Task 5.2 Testing Preparation**
32		**Task 6 Beam Testing**
33		**Task 6.1 Load Testing on Beam**
34		**Task 6.2 Analyze Test Results**
35		**Task 7 Finalize Report & Submit to PCI**
36		**Task 8 Project Impacts**
37		**Task 9 Deliverables**
38		**Task 9.1 30% Project Progress Report**
39		**Task 9.2 60% Project Progress Report**
40		**Task 9.3 90% Project Progress Report**
41		**Task 9.4 Final Presentation**
42		**Task 9.5 Final Project Report**
43		**Task 10 Project Management**
44		**Task 10.1 Meetings**
45		**Task 10.2 Tracking Project Progress**