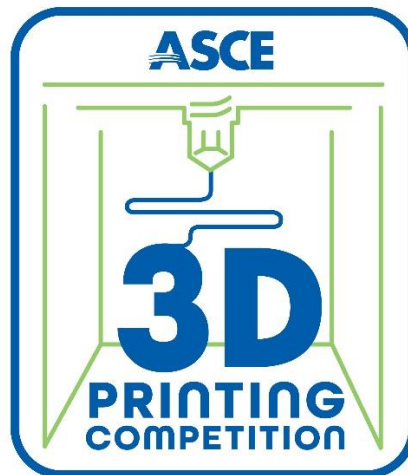




3D Printing Competition: Bridging the Future

2025 Rules and Requirements



IN PARTNERSHIP WITH  NJIT

Table of Contents

1. Welcome.....	2
2. About the Competition	2
3. Participation and Eligibility	3
4. Ethics and Required Conduct.....	4
5. Safety	4
6. Bridge Dimensions.....	5
7. Bridge Parts	6
8. Tips	6
9. Scoring.....	7
a. Load/Weight Efficiency	7
b. Stiffness Efficiency	8
c. Construction Time.....	8
d. Presentation (Poster Board)	8
e. Design	9
f. Structural Calculation Accuracy.....	9
10. Requests for Information (RFIs).....	9
11. Key Dates	10
12. Awards	10
13. Judging.....	10
Appendix A - Figures and Drawings.....	11
Appendix B - Eligibility for Student Symposium Competition.....	14

1. Welcome

The American Society of Civil Engineers (ASCE) supports and encourages a fully inclusive culture that celebrates individual uniqueness, engenders a sense of belonging, and promotes equitable opportunity for all people to participate in the 3D Printing Competition. (See ASCE [Policy statement 417 - Justice, equity, diversity, and inclusion.](#)) Participation should be inclusive, open, and fair to all interested and eligible students. Welcome!

2. About the Competition

Three-dimensional printing (3DP) is an emerging construction technology. 3DP operates by adding sequential layers of material to create a three-dimensional object, which saves labor cost, minimizes material waste, and optimizes building time. While 3DP has been used to create prototypes and small-scale models of the built environment for some time, the technology has advanced to the construction of houses and bridges.

The goal of the 3D Bridge Printing Competition is to promote the application of 3D printing technology in the field of civil engineering. For students, the goal is to design an aesthetically-pleasing, strong, and stiff bridge that will take the least amount of assembly time and meets the geometric requirements.



Figure : [First 3D-printed home](#) in the United States, 2021, Williamsburg, VA (Alquist 3D)



Figure : The world's first [3D printed footbridge](#), 2021, Amsterdam, the Netherlands (Ana Fernandez/SOPA Images/LightRocket via Getty)

Students must pay attention not only to the design, but also the details of the print, which play a significant role in the shape, tolerances, and capacity of the bridge. Students will demonstrate teamwork, organization, analytical skills, and creativity throughout the process of the competition.

The 3D Printing Competition has its origin at the New Jersey Institute of Technology's inter-collegiate competition in November 2021. ASCE gratefully acknowledges NJIT's efforts in creating the competition and working to expand its reach among civil engineering students.

3. Participation and Eligibility

a. Team Member Requirements

Team members must be undergraduate students, enrolled during all or part of the current competition academic year, members of an ASCE Student Chapter in good standing, registered participants of the student symposium, and Society Student Members of ASCE. (Society student membership is free; be sure to [join](#).)

Graduate students are encouraged to serve as advisors.

b. Team Requirements

It is an expectation that teams will reflect diversity, foster an inclusive culture, and treat everyone with dignity and respect.

Only one team per ASCE Student Chapter may compete in the competition. A student chapter may compete in only one ASCE Student Symposium. Each team must designate one captain. Conference assignments and student symposium hosts are listed [here](#).

ASCE Student Chapters hosting symposia may invite Official Guest teams, which are teams from Region 10 that have an official ASCE Student Chapter not yet assigned to any Student Conference. Official Guest teams may compete in only one student symposium per year and are eligible to place and receive awards at the student symposium competition if they meet the other requirements, including eligibility requirements. ASCE Student Programs shall be notified by the ASCE Student Symposium host school of an Official Guest team prior to the start of the student symposium via email to student@asce.org.

An ASCE Student Chapter team wanting to enter a competition that is NOT being hosted at their assigned student symposium, may request to compete at another ASCE Student Symposium as a guest team. If the student symposium host grants permission, the guest team may compete. The guest team will be scored but shall not win awards at the student symposium competition.

c. Student Chapter Eligibility

Eligibility criteria for the Student Symposium Competition are shown in Appendix B.

d. Intent and Eligibility Acknowledgement Form

Teams must submit online [Intent and Eligibility Acknowledgement Forms](#), no later than **5:00 p.m. Eastern Time (ET) on November 1, 2024**.

By completing this form, a student chapter states:

- Their intent to have a team participate in the competition at their assigned student symposium; and

- Their acknowledgement of the eligibility requirements for student symposium competition participation (Appendix A).

The form must be completed and separately submitted by the:

- 1) Team Captain;
- 2) ASCE Student Chapter Faculty Advisor; and
- 3) Competition Team Faculty Advisor.

All three parties will use the same form to submit. If the ASCE Student Chapter Faculty Advisor and the Competition Team Faculty Advisor are the same person, the form has a field to indicate as such and only one faculty advisor submission is required.

Teams can verify that all three parties have submitted an Intent and Eligibility Acknowledgement form by checking the [Intent Form Status Report in Cerberus](#).

4. Ethics and Required Conduct

This competition is to be conducted with the highest regard for ethical responsibility per [ASCE's Code of Ethics](#). All members of ASCE, regardless of their membership grade or job description, commit to all of the ethical responsibilities in this Code. All ASCE members should make themselves familiar with ASCE's Code of Ethics.

All participants shall act professionally and respectfully at all times. Failure to act appropriately may result in sanctions, disqualifications, and loss of invitations to future symposia competitions or Society-wide competitions. The inappropriate use of language, alcohol, or materials, uncooperativeness, and general unprofessional or unethical behavior will not be tolerated.

5. Safety

Safety is the highest priority and risk of personal injury will not be tolerated. Judges and student symposium hosts, including the Safety Officers, are empowered to stop or prohibit an activity which is deemed to be hazardous, or to postpone an activity until the hazard is rectified.

Participants acknowledge that there are risks to consider when creating and testing 3D printed structures. Bridges should be printed in a well-ventilated area, and care should be taken to avoid injury when working with a 3D printer. Connections that are 3D printed are prone to some error, and participants are encouraged to print tests of connections to account for tolerance issues. If any parts need to be filed or cut, participants need to ensure proper caution and use hand and eye protection. When testing bridges, participants must be cognizant of PLA's brittle nature. Bridges can fail suddenly and even explosively. Only participants actively involved with the testing of bridges should be within 10 feet of the loading apparatus and should wear eye protection as well as work gloves if handling the

bridge or the loading apparatus during testing. Participants should consistently use the safety features included with the loading apparatus (e.g., plexiglass shield).

All participants are responsible for complying with all campus/venue protocols and procedures, including those deemed necessary for public health purposes.

Given continually changing environments, virtual competition provisions may be provided and may be activated in coordination with ASCE.

If there is a thunderstorm, all outdoor activities shall cease and may not resume until at least 30 minutes have passed since the last observed occurrence of thunder or lightning.

6. Bridge Dimensions

The bridge must span a clear span of 20 inches (508 mm). The total bridge length must be less than or equal to 24 inches (610 mm) providing up to a 2-inch (51 mm) wide bearing surface on each abutment. The bridge shall be less than or equal to 8 inches (203 mm) from the extreme bottom surface to the extreme top surface, and less than or equal to 6 inches (152 mm) in width. The bridge superstructure must be less than or equal to 3.5 inches (89 mm) below and less than or equal to 6 inches (152 mm) above the pier bearing surface. The structure must not touch the pier on any surface other than the top bearing surface of the pier and have a 24° relief angle from the superstructure to the pier. See Appendix A - Figure 1.

The cross section through the bridge must have a continuous open width greater than 3.5 inches and a continuous open height greater than 3.5 inches (89 mm x 89 mm) through the entire length of the superstructure to allow a test square of those dimensions to pass easily through without obstructions. See Appendix A - Figure 2.

The 3.5-inch clear width should be underlain by a continuous bridge deck for a vehicle driving surface. The deck must be 3D printed and can be made of multiple pieces but must provide a smooth continuous surface after construction. The deck must be absent of any voids or obstructions besides the void to allow the threaded rod from the loading plate to be applied. The deck is considered as part of the bridge when determining the weight of the bridge. The deck, at a minimum, must span the clear span of 20 inches. See Appendix A - Figure 1.

Loading will be applied to the bridge by a loading plate that is 3-inch by 3-inch (76mm x 76mm) located at the center of the clear span and center of the bridge width. Load will be applied to the loading plate by a ¼-inch (6 mm)-diameter threaded steel rod with a washer and nut bearing on the top surface of the loading plate. The bridge deck must have a minimum ½-inch diameter hole located at the center of the clear span and center of the bridge width for the ¼-inch loading rod to pass through the bridge deck. See Appendix A - Figure 3.

7. Bridge Parts

The following rules and deductions are applicable for the bridge parts.

- a. All parts must be printed with 100% Plain PLA (Polylactic acid). No other fill material is allowed.
 - i. Deduction: Disqualification
- b. The maximum allowed bridge weight is 35.27 ounces (1,000 grams).
 - i. Deduction: 15% deduction of the measured vertical load for every 2 ounces (50 grams) increment over 35.27 ounces (1,000 grams).
- c. The design must include at least one complete circle feature with a minimum radius of 2-inches (5.08 cm).
 - i. Deduction: 10% increase in measured weight
- d. All parts together must fit in an 8.7 in. (220 mm) wide, 8.7 in. (220 mm) long, and 6.5 in. (165 mm) high box.
 - i. Deduction: 10% increase in the measured deflection for each part that does not fit in the box.
- e. Only mechanical connections are allowed. No adhesives are allowed.
 - i. Deduction: Disqualification
- f. No unextruded filament may be used in the bridge.
 - i. Deduction: Disqualification

8. Tips

The following tips are provided for a successful bridge.

- a. Pre-competition testing of parts and bridge is permitted to optimize bridge. Make sure that all parts you design can fit within the bed of the 3D printer you are using.
- b. 3D printed sockets tend to be slightly smaller than designed, so be sure to adjust your designs to accommodate shrinkage as the filament cools during printing. Test printing the connections will help you calibrate connection fit with your printer/filament.
- c. Check the fits of all components before the day of the competition.
- d. It is important to engage the entire superstructure in supporting the load—not just the bridge deck or the point at which the load is applied, so make sure the area where the load is applied is well-connected to the superstructure.
- e. Because there is a maximum load of 70 lbs., a team only wants as much material as required to support the maximum load. Building a bridge capable of carrying more than 70 lbs. is of no benefit. (The 70 lbs. load is based on sand volume in a 5 gallon bucket.)

9. Scoring

Five weighted metrics will be added in aggregate to determine a team's overall score. The metrics and their weighted contribution are shown below in Table 1. In addition to overall 1st, 2nd, and 3rd place awards, the top team in each metric will be separately recognized for their superior performance in each metric.

Table 1: Overall Point Value Per Metric

Load/Weight Efficiency	Stiffness Efficiency	Construction Time	Presentation	Design
30	30	15	15	10

Adherence to the rules is crucial to ensuring fair competition. Teams will be subject to deductions determined by the judges for deviations from the rules as they relate to each metric. The Head Judge has final say over deductions. The Head Judge may consult with the ASCE 3D Printing Rules Committee regarding deductions, but the Rules Committee will not overturn their decision.

Information on each metric is detailed in the following sections.

Presentation and Design scores will be determined by a direct scoring system based on the judgment of the judges. Team scores will be assigned as a percentage of a maximum metrics system. The first-place team will receive the full points (e.g., maximum 10 points for Design). The remaining teams will be allocated points based on a ratio of their Design score divided by the largest Design score. e.g., if four teams compete and have Design scores of 95, 85, 80, and 70 the high score will receive 10 points, the second team will receive 8.9 points [$10 \times (85/95)$], the third team will receive 8.4 points [$10 \times (80/95)$], and the fourth team will receive 7.4 points [$10 \times (70/95)$]. The presentation score will be calculated similarly.

Load/Weight efficiency, Stiffness efficiency, and Construction Time will be based on the ratios defined below. Team scores will be assigned as a percentage of a maximum metrics system. The high score will receive the full points (e.g., maximum 30 points for Load/Weight efficiency). The remaining teams will be allocated points based on a ratio of their Load/Weight efficiency divided by the largest Load/Weight efficiency. e.g., if four teams compete and have Load/Weight efficiencies of 22, 17, 12, and 9, the first team will receive 30 points, the second team will receive 23.2 points [$30 \times (17/22)$], the third team will receive 16.4 points [$30 \times (12/22)$], and, and the fourth team will receive 12.3 points [$30 \times (9/22)$]. The Stiffness efficiency and Construction Time scores will be calculated similarly.

a. Load/Weight Efficiency

- i. Loading will be applied vertically at center span up to a maximum load of 70 lbs.
- ii. The Load/Weight Efficiency will be calculated by dividing the load supported by the weight of the bridge e.g., Load/Weight.
- iii. Maximum points will be awarded to the bridge with the highest Load/Weight efficiency.

- iv. Other bridges will be awarded points based on the ratio of their efficiency to the maximum Load/Weight efficiency.

b. Stiffness Efficiency

- i. Deflection will be measured at the center of the clear span on the bottom surface of the bridge. All bridges will be measured on the same side of the bridge. Deflection will be measured when the bridge is supporting a 25 lb. load.
- ii. The bridge must carry 25 lbs.
- iii. The Stiffness Efficiency will be calculated by dividing the 25 lbs. load by the deflection in mm divided by the weight of the bridge. e.g., Load/Deflections/Weight.
- iv. Maximum points will be awarded to the bridge with the highest stiffness efficiency.
- v. Other bridges will be awarded points based on the ratio of their efficiency to the maximum efficiency.

c. Construction Time

- i. A team may have multiple constructors working together to construct the bridge.
- ii. The construction time will be multiplied by the number of constructors to calculate the total construction time.
- iii. A construction time limit of 15 minutes will be imposed. A team exceeding 15 minutes will receive a score of 22 minutes.
- iv. Maximum points will be awarded to the team with the shortest total construction time.
- v. Other bridges will be awarded points based on the ratio of their total construction time to the shortest total construction time.
- vi. If a team has finished constructing their bridge, but needs to go back to make corrections to any errors made in the construction process, they will be given a period to do so. The time allowed to make corrections cannot exceed 5 minutes. The total time spent to make corrections will be multiplied by 1.5 and added to the initial construction time to determine a team's total construction time.
- vii. After a team has finished constructing their bridge and made any corrections if necessary, no other changes can be made and the bridge must be handed off to the judges until it is loaded.

d. Presentation (Poster Board)

- i. Each team will create a poster board (24 inches x 36 inches) outlining:
 - 1. Team composition
 - 2. Design inspiration for bridge
 - 3. 3D images of bridge
 - 4. Print details
- ii. Each team will give a presentation on their poster board. All team members must participate in the presentation. Judges will rank the presentations based on:

1. Readability of poster
 2. Aesthetics of poster
 3. Adherence to a 5-minute time limit. Presentations longer than 5 minutes will have 10 percent deducted from the score of each increment of 30 seconds over 5 minutes.
 4. Presentation mechanics (projection, pace, facing judges, flow, etc.).
- iii. Maximum points will be awarded to the team with the highest presentation score.
 - iv. Other teams will be awarded points based on the ratio of their presentation score to the highest presentation score.

e. Design

- i. The design theme for this competition is Accelerated Bridge Construction (ABC). Designs should reflect some aspect of the ABC mindset and keep ABC ideologies in mind throughout the design process.
- ii. Include information about the design inspiration in the presentation.
- iii. Judges will score bridges based on their correspondence to an inspiration the team chooses.
- iv. Judges will also score bridges on the innovation in the design/printing techniques, print quality and resolution, and tolerances.
- v. A 2-inch (5.08 cm) diameter circle must be incorporated into the design of the bridge.
- vi. Maximum points will be awarded to the team with the highest Design score.
- vii. Other bridges will be awarded points based on the ratio of their Design score to the highest Design score.

f. Structural Calculation Accuracy

- i. Teams will be required to predict the ultimate load based on structural calculations.
- ii. The team whose ultimate failure load is closest (absolute value) to their predicted load will receive the Engineer of the Day award. (This award is not included in the overall score).

10. Requests for Information (RFIs)

Requests for information (RFI) must be submitted through the online [2025 ASCE 3D Printing Competition RFI Form](#). Clarifications will be posted on the [ASCE 3D Printing Competition Collaborate Site](#) approximately one week after being received starting September 27, 2024 until February 14, 2025. The cutoff date for submitting an RFI is Wednesday, February 5, 2025, at 11:59 p.m. Eastern Standard Time (EST). Those received after this date will not be acknowledged or addressed. **Teams are strongly encouraged to submit RFIs to avoid misinterpretation of the rules and project tasks. All RFIs will be made public.** All teams are responsible for all information provided in the Rules and Regulations and RFI responses posted to the Collaborate site.

11. Key Dates

- a. Release of 3D Bridge Competition Rules and Regulations – September 3, 2024
- b. Intent and Eligibility Acknowledgement Form - due by November 1, 2024 at 5:00 p.m. EST
- c. Last day to submit an RFI – February 5, 2025 at 11:59 p.m. EST

12. Awards

- a. Awards for 1st, 2nd and 3rd places will be awarded for the highest overall scores.
- b. Awards for 1st place will be awarded for the following metrics:
 - i. Largest Load,
 - ii. Stiffest Bridge,
 - iii. Fastest Construction Time,
 - iv. Best Presentation,
 - v. Best Design, and
 - vi. Most Accurate Ultimate Load Calculation

13. Judging

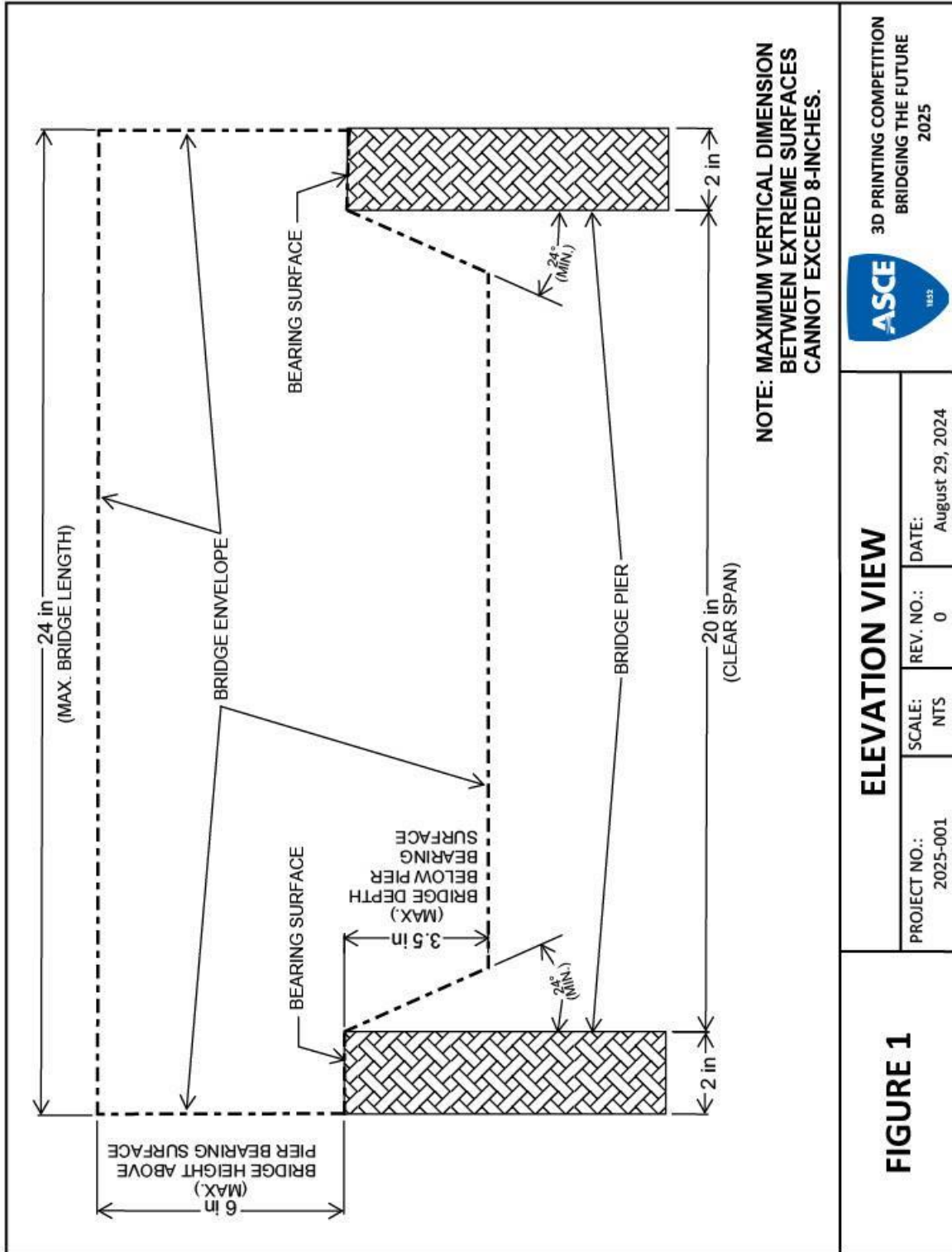
The student symposium host shall recruit judges. The judging panel, consisting of a minimum of three judges, shall be composed of industry professionals or educators familiar with bridge design, structural testing, and/or 3D printing.

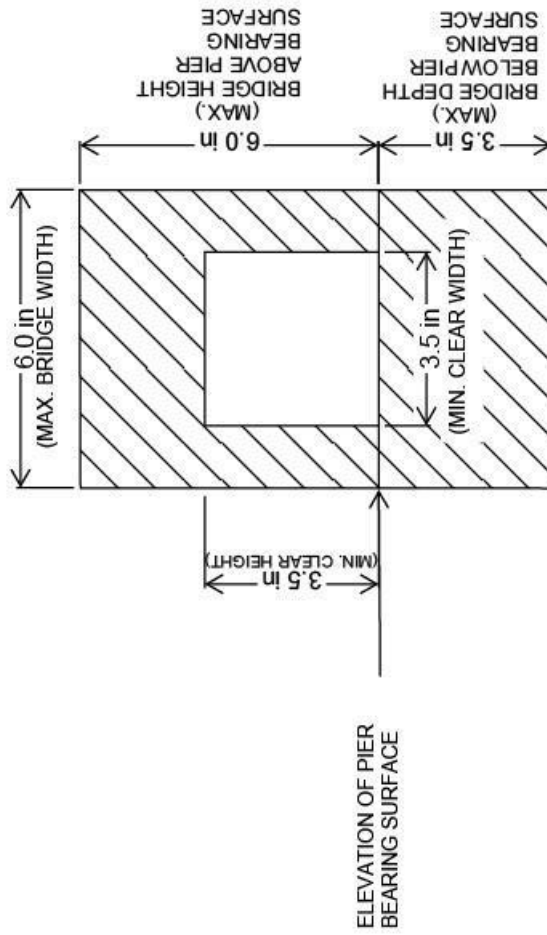
Judges should be well versed in the rules and RFI responses posted on the [Collaborate site](#). The Head Judge is required to attend the Head Judge Webinar hosted by ASCE in February 2025.

Scoring data shall be recorded for each team that competes. Official judging forms shall be used and will be provided by the competition rules committee prior to the symposia. The information from the judges' data sheets is entered into an official scoring spreadsheet which tabulates the official results of the competition. A summary report will be provided to each symposium host for their records and distribution.

At the end of the student symposium competition, the Head Judge shall promptly upload the completed official scoring spreadsheet for a student symposium competition to ASCE's Cerberus ftp server. ASCE will provide the Head Judge a secure submission link for ASCE's Cerberus ftp server in February 2025.

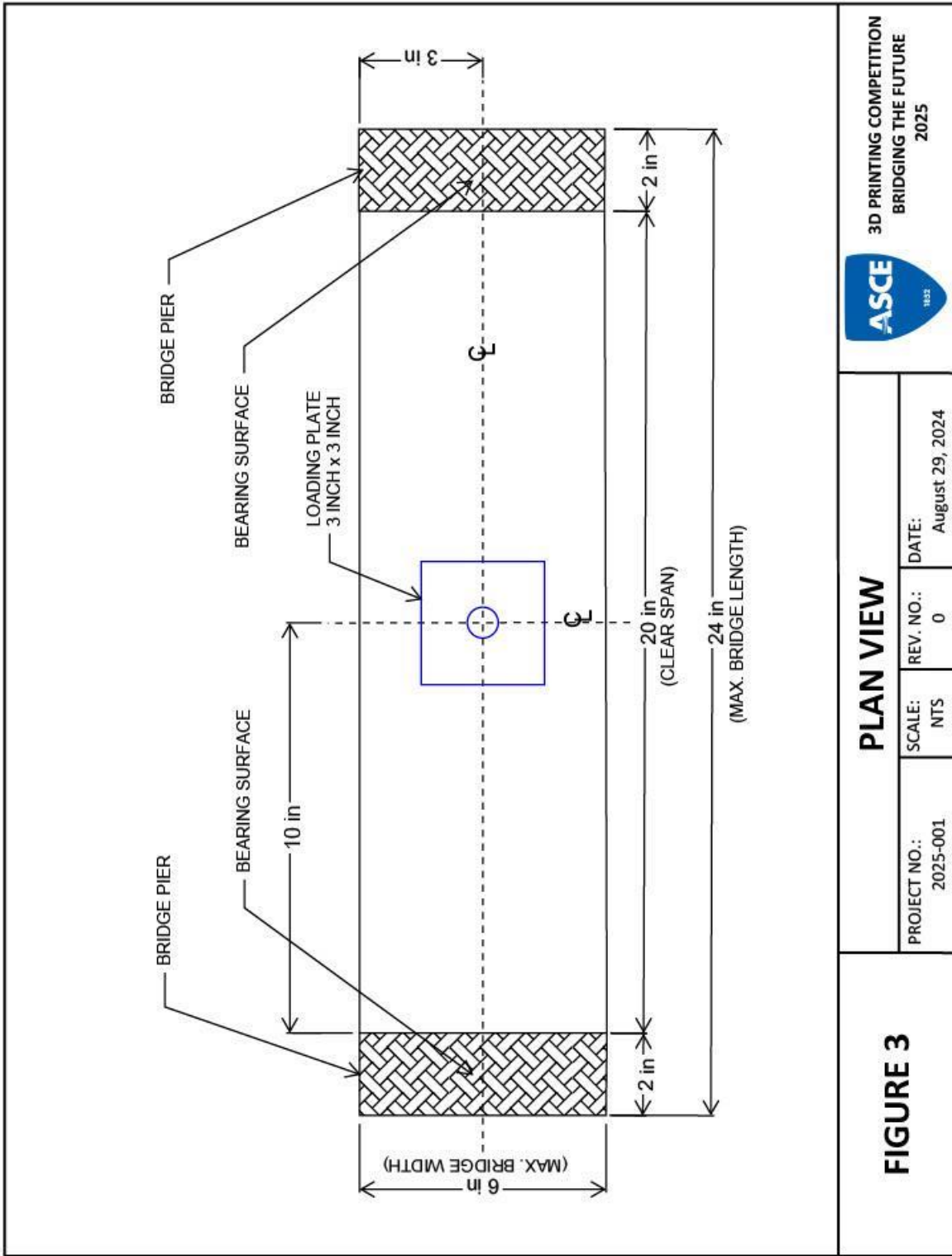
Appendix A - Figures and Drawings





NOTE: MAXIMUM VERTICAL DIMENSION BETWEEN EXTREME SURFACES CANNOT EXCEED 8-INCHES.

FIGURE 2	CROSS SECTION VIEW				 3D PRINTING COMPETITION BRIDGING THE FUTURE 2025
	PROJECT NO.: 2025-001	SCALE: NTS	REV. NO.: 0	DATE: August 29, 2024	



PLAN VIEW

PROJECT NO.: 2025-001	SCALE: NTS	REV. NO.: 0	DATE: August 29, 2024
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FIGURE 3

Appendix B - Eligibility for Student Symposium Competition

The purpose for student competitions is to provide student members career-enrichment opportunities to gain hands-on, practical experience and leadership skills. Society Competitions are an important and special opportunity to showcase the engineering and professional skills of student teams. As such, mutual respect is required for all stakeholders, including competitors, judges, hosts, and guests. Participation in the Student Symposia competitions is a privilege, not a right. Failure to act professionally can result in sanctions, disqualifications, and loss of invitations.

Student Chapter Eligibility for Student Symposium Competition

The following qualifications are required of all ASCE Student Chapters to compete at the Student Symposia Competitions:

An ASCE Student Chapter must:

1. Be in good standing with ASCE:

a. Have paid their annual dues, as received by ASCE, no later than the start of their Student Symposium.

b. Have submitted their student chapter's full Annual Report or EZ Annual Reporting Form no later than February 1, 11:59 p.m. Eastern Standard Time (EST).

Questions regarding eligibility should be directed to student@asce.org.