Version 3.2

2027 New Jersey GST Bridge Competition
Official Rules and Contestant Handbook

The 2027 New Jersey GST Bridge Competition will be on

MARCH 20, 2027

at

(TBD) UNIVERSITY

Address Here
Address Here

Eligibility:

1. Open to current high school students attending a New Jersey school
2. Teams must consist of exactly two students
3. Teams must compete in good spirits and have fun throughout the competition!

Website: https://www.gstbridge.org/home
Registration Form: Click Here
Email: njgstbridge@gmail.com

Rule Book written by: Ryan Li
Last Updated: 6/21/2026

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OVERVIEW

1.1 Introduction

Bridges have long been a critical part of human development, allowing people to cross natural and man-made obstacles such as rivers, valleys, and roadways. Over time, engineers have developed a variety of bridge types, including arch, beam, and suspension bridges. These structures can be constructed from materials such as steel and concrete for large-scale projects, and from wood for smaller applications.

In bridge design, engineers must account for different types of loads. The dead load refers to the weight of the structure itself, while the live load includes additional forces such as vehicles, pedestrians, or other moving loads. To ensure safety, designs also incorporate safety factors so that bridges can support loads greater than those expected during normal use.

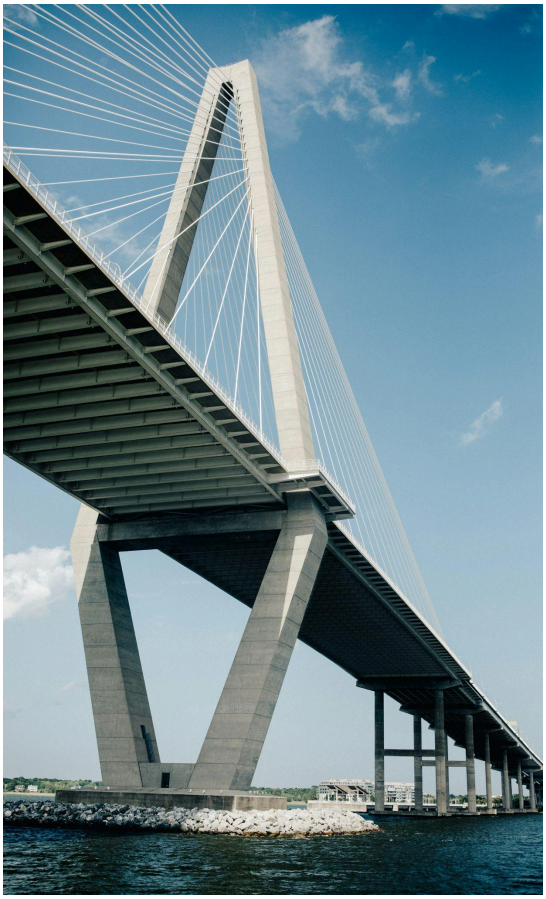
Since materials like steel, concrete, and even wood can be costly, and project budgets are often limited, engineers aim to design structures as efficiently as possible. The goal is to minimize material usage while still maintaining strength, stability, and public safety. This balance between efficiency and safety is a fundamental principle of bridge engineering and is a key focus of this competition.

1.2 Purpose and Origin

This competition is organized by Ryan Li, a graduate of Bridgewater-Raritan High School (BRHS), Class of 2026, who is currently studying civil and structural engineering at the University of Illinois Urbana-Champaign. In February 2025, Ryan founded the Mu Alpha Theta Math Honor Society at BRHS. Through this organization, he helped run several academic events, including the 2025 Integration Bee and a popsicle stick bridge competition. Both events were well-received and saw strong participation from students. Additional details about these events can be found on the competition website.

In 2026, separate from the Mu Alpha Theta MHS, Ryan expanded these efforts by organizing the NJ Statewide Integration Bee in collaboration with Raritan Valley Community College and

three faculty members. This event brought together students from seven different schools, with over 40 total participants and contributors, and around 20 competitors. The competition marked a significant increase in scale and participation.



Building on this success, the idea for the 2027 NJ GST Bridge Competition was developed. Unlike the previous Integration Bees, which mainly involved upperclassmen with knowledge of calculus, this event is designed to be more accessible to a wider range of high school students. By revisiting and expanding on the earlier bridge competition, the goal is to create a larger, more inclusive event that encourages interest in engineering, design, and hands-on problem solving.

1.3 Competition Overview

In this competition, teams will design and build a bridge using basswood. The event is intended to test a range of skills, including technical design, efficiency, cost management, accuracy of predictions, and the ability to work within time and size constraints. Each team will be given a budget to “purchase” materials for their bridge design. This introduces an additional layer of strategy, as teams must balance structural performance with material cost and efficiency. Each team’s bridge will be evaluated across several categories, all of which contribute to a final overall score. These categories are designed to reflect both the design process and the final performance of the structure. At the end of the competition, bridges will be load tested until failure to determine their maximum load capacity. This value will make up a significant portion of the total score, emphasizing the importance of both strong design and efficient use of materials.

1.4 Competition Fees

This competition is completely free for all students to join. There are no registration fees, material fees, or participation costs required. This is made possible through sponsorship from multiple companies, as well as the support and contributions of the event organizers and volunteers.

DEFINITIONS

2.1 Overview of Definitions

The following terms are used throughout the rulebook:

1. Buckling - Sudden sideways deformation of a member under compression.
2. Clear Span - The horizontal distance between supports, excluding the supports.
3. Compression - A force that pushes or shortens a structural member.
4. Cross Section - The shape and size of a member when cut perpendicular to its length.
5. Deflection - The vertical bending or displacement of the bridge under load.
6. Failure - When the bridge can no longer support load or meets defined failure criteria.
7. Gusset - A thin plate used at joints to connect and reinforce members.
8. Laminated Members - Made by gluing multiple pieces together to act as one.
9. Member - An individual structural piece that makes up the bridge.
10. Midspan - The midpoint of the clear span where loading is applied.
11. Basswood Stick / Strip - A single piece of basswood used to construct members.
12. Structural Clarity - The ability to clearly see and identify members and connections.
13. Support - The surfaces at each end that hold up the bridge.
14. Ultimate Load - The maximum load the bridge can support before failure.

REGISTRATION

3.1 Registration Information

Students should register by completing the form located under the Registration tab on the official competition website. Registration is free for all participants. The registration deadline is March 12, 2027.

Teams consist of two students, and only one member of each team needs to submit the registration form. However, the registering student should have basic information for both team members in order to complete the form accurately.

After submission, all participants will receive a confirmation email with additional details, including waiver forms and further competition information. If you are unable to access the registration form or encounter any issues, please contact us at njgstbridge@gmail.com for assistance.

TEAMS

4.1 Team Rules and Requirements

The following are the rules for team participation and eligibility.

1. Each team must consist of exactly two students.
2. Students may be from the same school or different schools, as long as both meet all eligibility requirements.
3. There is no limit to the number of teams that may come from a single school.
4. Both team members are expected to actively participate in all parts of the project, including design, material selection, and construction of the bridge.
5. A student may only be a member of one team.
6. All team members must be present at the official start time of the competition. If a team is incomplete at the start time, the remaining participant may be reassigned to another team or the team may be disqualified, at the discretion of the organizers.
7. Teams will be assigned an official ID, which will be used for all identification and judging purposes throughout the competition.

SCHEDULE

5.1 Competition Date and Location

This is a one-day event, meaning students will design, construct, and test their bridges on the same day. The competition will take place at the _____ Department at _____ University on March 20, 2027, from 2:00 PM to 7:30 PM EST. The event address is: _____.

A full complimentary dinner will be provided for all competitors, staff, and volunteers around 5:30 PM. A variety of food options will be available.

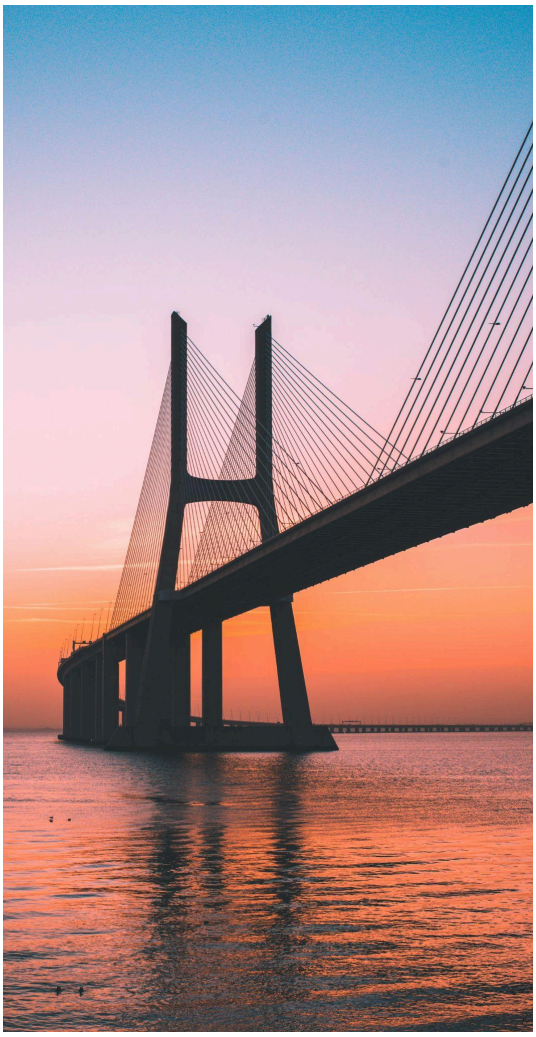
5.2 Competition Timeline

Please note that the schedule between events is flexible, as timing may vary depending on the progression of the competition. However, all participants are expected to arrive promptly by 2:00 PM at the latest to ensure their team is fully present. If a competitor is not present when the GST competition begins, the team may be disqualified, or, in special cases, the remaining participant may be merged with another incomplete team.

Time	Event
1:00 PM	Volunteers and organizers arrive to set up
1:45 PM	Competitors begin arriving for check-in
2:00 PM	Speech from the president/Rules overview/Team setup
2:30 PM	GST Competition Build Phase Begins
5:30 PM	Dinner Break! There will also be a group photo and a small show
6:15 PM	GST Competition Load Testing Begins
7:15 PM	Winners announced, prizes awarded, after-competition Q&A
7:30 PM	Clean-up by volunteers, competition concludes

ECONOMY SYSTEM

6.1 The Materials Marketplace



One of the most important considerations in any civil engineering project is cost. Engineers must design with efficiency in mind, since both overbuilding and underbuilding can create problems. If too much money is spent, the structure may be strong but not practical or cost-effective. If too little is spent, the design may become unsafe or poorly constructed. Because of this, balancing cost and performance is a key part of real-world engineering and public infrastructure design.

In this competition, each team will be given an initial budget of $1500 GSTC (Garden State Truss Currency) to use toward purchasing materials and tools for their bridge. Teams are expected to carefully plan their design and allocate their budget strategically, similar to how professional engineers must work within financial limits when designing real structures. Please note that

material and tool prices may vary slightly during the competition. The official price list in Sections 7.1 and 7.3 should be used as the reference guideline.

The following rules apply to budgeting and purchases:

1. Teams may purchase materials at any point during the competition from the designated marketplace.
2. Money may not be transferred or shared between competing teams.
3. No refunds will be issued. However, if a material is defective (for example, a broken basswood stick or faulty glue), it may be exchanged for a replacement.
4. Any unused budget remaining at the end of the competition will contribute to the team's final score, so teams are encouraged to not spend their full budget.

6.2 The Bank

At any point during the competition, teams may exchange larger bills for smaller bills or combine smaller bills into larger ones. This is the only function of the competition bank. The bank does not provide any additional services, such as loans, investments, interest, or taxes. It is strictly used for changing bill denominations. For example, a team may exchange one $100 GSTC bill for five $20 GSTC bills if needed to purchase smaller items at the Materials Marketplace.

6.3 Financial Regulations

Teams are responsible for managing their own GSTC funds. Any lost or mismanaged funds will not be replaced by the organizers. Theft, attempted theft, or interference with another team's funds is strictly prohibited and will result in disqualification. Teams may not transfer, donate, or receive GSTC funds from other teams under any circumstances.

TOOLS & MATERIALS

7.1 List of Materials

The following materials will be available during the competition. Please note that the currency used is not real money, but GSTC. As stated earlier, each team will receive a $1500 GSTC budget. The "while building" cost is approximately 130% of the "before building" cost, reflecting the increased expense of in-competition purchasing. There will also be up to a 15% off bulk discount pricing on basswood strips, allowing teams to purchase bulk items (30 strips, instead of 10) at a cheaper price. However teams must determine if they are willing to commit to buying at a bulk and are encouraged to plan ahead. Teams will have exactly 20 minutes to make purchasing decisions before the while-building pricing takes effect.

All listed materials are optional to purchase and use in the construction of the bridge. Pricing and availability may change; use this list as a guideline, not a final reference. To help teams compare strip options, the table includes each strip's moment of inertia (MOI) about its cross section, relative stiffness, cost per strip, and weight relative to the smallest size strip.

<table>
<tr><th rowspan="2">Material</th><th rowspan="2">Before Building</th><th rowspan="2">While Building</th><th colspan="4">Additional Notes</th></tr>
<tr><th>MOI - $\left[\frac{1}{12}bh^3\right]$</th><th>MOI</th><th>Cost</th><th>Weight</th></tr>
<tr><td>10 Basswood Strips (1/16" x 1/16" x 12")</td><td>$35</td><td>$45</td><td rowspan="2">$1.27 \times 10^{-6}\ in^4$</td><td rowspan="2">1x</td><td rowspan="2">1x</td><td rowspan="2">1x</td></tr>
<tr><td>30 Basswood Strips (1/16" x 1/16" x 12")</td><td>$90</td><td>$120</td></tr>
<tr><td>10 Basswood Strips (1/8" x 1/8" x 12")</td><td>$90</td><td>$120</td><td rowspan="2">$2.03 \times 10^{-5}\ in^4$</td><td rowspan="2">16x</td><td rowspan="2">2.6x</td><td rowspan="2">4x</td></tr>
<tr><td>30 Basswood Strips (1/8" x 1/8" x 12")</td><td>$230</td><td>$300</td></tr>
<tr><td>10 Basswood Strips (1/8" x 1/4" x 12")</td><td>$170</td><td>$220</td><td rowspan="2">$1.63 \times 10^{-4}\ in^4$</td><td rowspan="2">128x</td><td rowspan="2">4.9x</td><td rowspan="2">8x</td></tr>
<tr><td>30 Basswood Strips (1/8" x 1/4" x 12")</td><td>$435</td><td>$565</td></tr>
<tr><td>1 Basswood Sheet (1/8" x 3" x 3")</td><td>$200</td><td>$260</td><td colspan="4">Basswood sheets may only be used for gusset plates, max size 1/8" x 1/2" x 1/2", meaning the minimum number of gussets you can get from this sheet is 36. Gussets may only connect members at joints and may not be load-bearing or span gaps between supports.</td></tr>
<tr><td>Cyanoacrylate (CA) Adhesive (1 bottle)</td><td>$80</td><td>$100</td><td colspan="4">CA glue may be used as the primary adhesive for bonding structural members and joints. Excessive use that creates load-bearing masses or obscures structural connections is not permitted.</td></tr>
<tr><td>String/Twine (5' in length)</td><td>$30</td><td>$40</td><td colspan="4">String or twine may only be used as a tension element attached to basswood members. It may not directly suspend or support the bridge from external objects. Horizontal orientation beneath the deck to carry loads is prohibited, as it bypasses structural design.</td></tr>
</table>

7.2 Material Regulations

Basswood strips may be physically altered in the following ways:

1. Cut or notched to any angle or length
2. Sanded to adjust width or surface smoothness
3. Bent or curved using water only
4. Marked on the surface using pencils, pens, markers, or similar tools for measurement or labeling purposes
5. Decorated with colored pencils or markers.

The sticks must not be altered in the following ways

1. Soaked, coated, or treated with any substance other than water
2. Impregnated, reinforced, or hardened using adhesives or any external substances beyond normal joint bonding

7.3 List of Tools

Tools used during construction must not be part of the final bridge. All listed tools are optional to purchase and use to assist in bridge construction. Please note that available tools and pricing may change, and this list should be treated as a general guideline rather than a final reference.

Material	Before Building	While Building	Additional Notes
Painters Tape (5’ in length)	$20	$25	Painter's tape may be used only for temporary alignment and assembly. It may not be structural, and must be fully removed before testing. Since painter's tape is usually less effective than binder clips, the painter's tape is marked at a lower price than the binder clips.
Sand Paper (2 Sheets)	$15	$20	Sandpaper may be used to smooth, shape, or adjust basswood members before assembly. It may not be used to act as structural reinforcement for the bridge.
Small Binder Clips (10 Clips)	$45	$60	Small binder clips may be used only as temporary clamping aids during assembly to hold joints while glue dries. They may not remain attached to the bridge during testing, and may not serve any structural or load-bearing purpose.

7.4 Available Tools and Materials

The following tools and materials will be provided to all teams free of charge for use during construction. Items marked with an asterisk (*) are available upon request and may require approval/supervision from judges, as they are not commonly used or may have restricted usage depending on the situation.

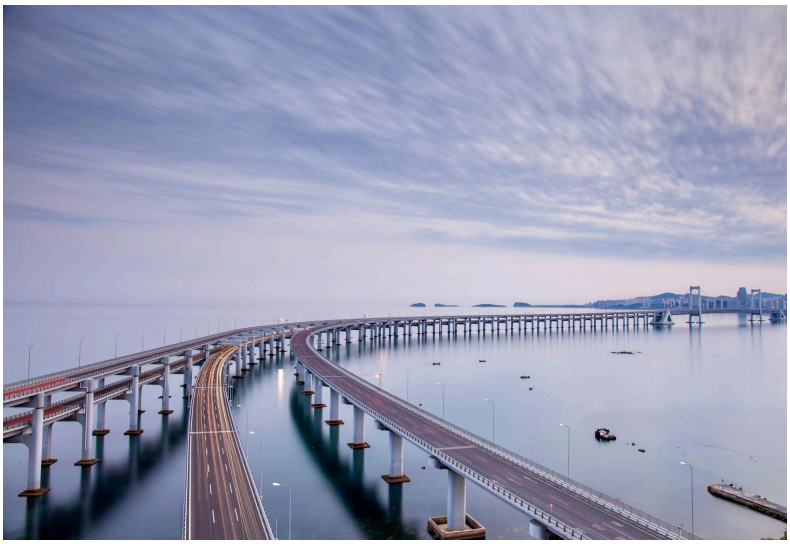
1. Rulers / Metersticks
2. Squares (90° angle guides)
3. Pencils and erasers
4. Colored Pencils / Markers
5. Scissors
6. Hobby knives
7. Cutting mats
8. Paper towels
9. Paper (for notes and planning)
10. Protractors*
11. Water (for soaking and bending basswood strips)*
12. Drill and drill bits*

CONSTRUCTION

8.1 General Construction Overview

The construction phase will run from 2:30 PM to 5:30 PM during the competition and is divided into two parts: the design phase and the building phase.

The design phase is used for planning and selecting materials from the materials marketplace (see Section 6.1). The during-competition prices will kick in at 20 minutes in, but there is no strict time limit for any team bridge planning. Once 20 minutes is up, the pricing will immediately shift from the before-building price to the during-building price.



If a team has not placed any material orders after 20 minutes, the pricing will automatically switch to the during-building pricing regardless of design progress. Once materials are purchased, they are considered final and may not be refunded or exchanged except in cases of defective materials approved by judges.

The building phase will last until 5:30 PM, during which teams must construct their bridge using only their purchased materials. Teams are expected to work efficiently and continuously during this period.

Teams may ask judges questions at any time regarding rules or clarifications; however, judges will not provide design advice or structural suggestions.

8.2 Electronic Devices and References

The use of external references, prior designs, or pre-made structural templates is not permitted during construction or testing. This includes but is not limited to printed bridge plans, previously prepared design notes, or any pre-constructed design guides brought into the competition.

Participants may have personal electronic devices (such as phones) in their possession; however, they may only be used for basic utility functions such as timekeeping or simple calculations. Devices may not be used to search for bridge designs, construction methods, structural examples, or any form of engineering guidance during the competition.

If a participant is found actively searching for, referencing, or using external design information during the competition, the team may be subject to penalties, including disqualification at the discretion of the judges.

That said, teams are encouraged to research bridge designs and come up with a game plan before competition day. The goal is to come prepared with a clear design strategy in mind, not to rely on external references during construction.

8.3 Tips and Suggestions

This section includes helpful advice to improve your design, efficiency, and overall bridge performance during construction.

1. Read all rules carefully before starting. If anything is unclear, ask a judge early. It is easier to fix confusion before it becomes a problem.
2. Choose a design that matches your skill level and available materials. Plan purchases ahead of time to stay within budget.
3. Think about how forces travel through your bridge, including compression and tension, and how to prevent buckling in critical members.

4. Pay close attention to joints. Failures often happen at connections rather than in the members themselves. Gussets or reinforcement can help.
5. If your design has repeating parts, consider making a simple jig or template to improve consistency and speed.
6. Test small sections of your design if possible. This can help you compare strength and improve weak connections before final assembly.
7. You may plan or sketch designs before competition day, but no notes or electronic devices may be used during construction.
8. Dry-fit your joints before applying glue. This lets you check fit and alignment before committing, saving you from awkward fixes later.
9. Your bridge will be lifted, handled, and inspected. Make sure it is stable and stiff enough to survive handling, not just loading.
10. Clean, well-organized bridges are easier to evaluate and tend to score better in aesthetics. Go with unique and interesting designs to impress the judges.
11. Divide tasks within your team, such as cutting, gluing, and measuring, to stay efficient and avoid bottlenecks during construction.
12. Keep your workspace organized. A clean work area helps you find materials quickly, reduces mistakes, and makes it easier to stay focused during construction.

CRITERIA

9.1 Overall Dimensions

The completed bridge must span a clear gap of 24 inches and have a maximum overall length of 32 inches, including any overhangs. The bridge must not exceed a maximum height of 20 inches or a maximum width of 8 inches at any point. All dimensions will be measured at the widest, tallest, and longest points of the bridge.

9.2 Weight

No maximum weight of the bridge is specified; however, the bridge must comply with all dimensional requirements outlined in the rules.

9.3 Supports

The bridge must rest only on the provided supports at each end. No abutments, anchors, or additional support structures may be used to transfer load to or interact with the supports. The contact between the bridge and supports must be purely vertical, and the bridge may not be designed to exert horizontal forces on the supports beyond friction at the contact surface.

9.4 No Building Zone

There are no additional no-build zones beyond those defined in Section 9.3. Provided the bridge satisfies all dimensional requirements and support rules, structural elements may extend below the level of the supports or beyond the span, as long as they do not interact with the supports in a way that provides lateral (horizontal) restraint or additional support.

For example, inverted truss bridges or inverted king post trusses are permitted only if they do not transfer load to the supports in a horizontal or externally bracing manner, and do not provide additional lateral restraint to the support system.

9.5 Loading

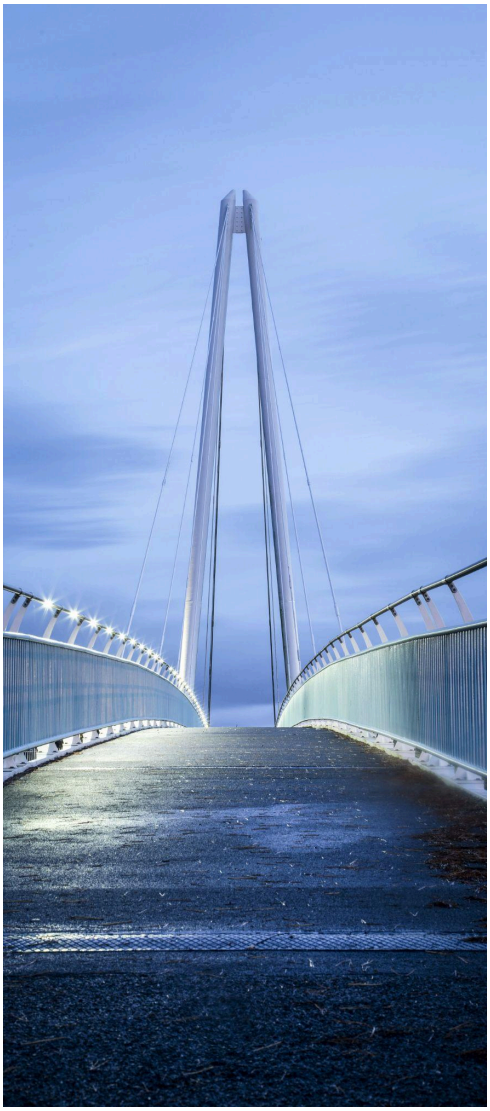
This section defines the required loading location and design specifications that all bridges must accommodate during testing. For loading procedures, please visit Section 11.2

1. The load will be applied at the center of the bridge span (midpoint of the roadway). This loading location is the same for all bridges.
2. The bridge must provide a clearly defined and structurally reinforced loading area at the center of the span.
3. The loading system consists of a rigid 3 in x 3 in x 1/2 in loading plate attached to a central hook. The plate must be fully supported by the bridge and may not rest on voids or openings.
4. A minimum 1.5 in x 1.5 in clear vertical clearance must be maintained directly below the loading point to allow attachment of the loading apparatus. No structural members may obstruct this zone.
5. The bridge must provide sufficient space for proper placement of the loading plate.
6. The loading region should be designed to safely accommodate concentrated forces without localized failure.

9.6 Laminated Members

1. Members may be built up by laminating multiple basswood strips together to form beams or truss elements. Laminated members must remain identifiable as individual structural elements and may not form solid slab-like blocks.

2. Each laminated member may contain up to 6 strips total in its cross-section at any point along its length. The cross-section may not exceed 4 layers in height or 4 layers in width.
3. Parallel laminated members placed adjacent to each other must be spaced at least 1/4 inch apart, unless they serve different structural functions (e.g., diagonals crossing in a truss).
4. Gluing members to the bridge deck is permitted and encouraged. The deck itself is not subject to lamination limits, but members attached above or below it still are.
5. Laminated members must maintain a truss-like or beam-like geometry and may not be used as plate-like or sheet-like structural elements.
6. Violations of these rules may result in penalties at the judges' discretion. If uncertain about a design, consult a judge before building..



9.7 Roadway

A 3 in x 3 in x 3 in clearance cube must be able to pass through the full length of the bridge without obstruction. This ensures sufficient clearance for the loading apparatus and testing system. No structural elements may obstruct the required clearance volume at any point along the bridge.

A continuous roadway deck is not required. However, the center of the span must provide a stable and clearly defined load-bearing surface capable of supporting the loading plate, as described in Section 9.5.

9.8 Structural Clarity

All structural members and connection points must remain clearly identifiable at all times. Judges must be able to reasonably observe the load path and structural behavior during inspection and testing.

Excessive use of gussets, adhesive, or reinforcement that obscures structural elements or prevents clear identification of load transfer may result in penalties or disqualification at the judges' discretion.

9.9 Judges' Discretion

Judges reserve the right to inspect, evaluate, and reject any bridge that violates the rules, exploits unintended loopholes, or is otherwise deemed inconsistent with the intent of the competition. Such bridges may be penalized or disqualified at the judges' discretion.

SUBMISSION

10.1 Submission Worksheet

Each team will receive a worksheet to complete during the competition period. It must be filled out before the end of the building phase.

The worksheet will include sections for:

1. Estimated maximum load
2. Predicted failure mode
3. A short description of your bridge (optional, may be considered for aesthetics scoring)

Judges will complete sections such as actual load, efficiency, and scoring during testing.
At the end of the building period, leave your bridge, remaining money, pencil, and completed worksheet together at your table. After submission, teams may leave for dinner while judges evaluate the bridges, record remaining budget, and complete scoring. No modifications may be made after the building period ends.

TESTING

11.1 General Testing Process

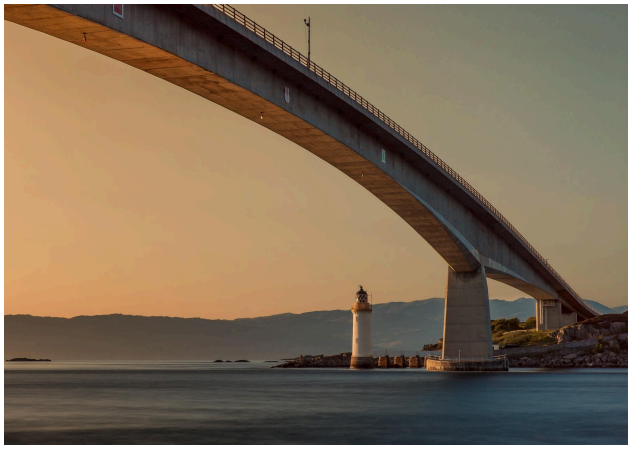
Teams will be called up in a random order for testing. If a team has scheduling constraints (such as needing to leave early), they must inform the judges prior to the loading phase so accommodations can be made when possible. There is also no advantage to testing earlier or later in the order.

Each test is expected to take approximately 3-7 minutes per bridge to ensure an efficient flow for all teams. If necessary, multiple loading stations may be used to reduce wait times and maintain schedule efficiency.

11.2 Loading Procedures

This section outlines how all bridges will be tested and how performance will be evaluated.

1. The clear span between the provided supports will be 24 ± 0.5 inches.
2. Loading will be conducted using a bucket and sand system (or equivalent incremental loading method). Sand will be added in equal increments until failure occurs.
3. The bridge will be considered failed when either:
    a. A maximum vertical deflection of 2 inches is reached, or
    b. Any structural member or joint fails.
4. The load at the moment of failure will be recorded as the ultimate load capacity.
5. Testing will terminate when the applied load reaches 200 lbs, regardless of bridge failure status.
6. Bridges that cannot accommodate the loading apparatus will receive a modified setup but will incur a 15% penalty on their total score.
7. The loading method may be adjusted by organizers if necessary to ensure fairness and consistency across all teams.



11.3 Team Responsibilities During Loading

Teams are encouraged to participate in the loading process under the supervision of judges. The rate of loading must remain steady and controlled; judges may intervene if loading is conducted too quickly or too slowly. No additional load may be applied after structural failure has occurred.

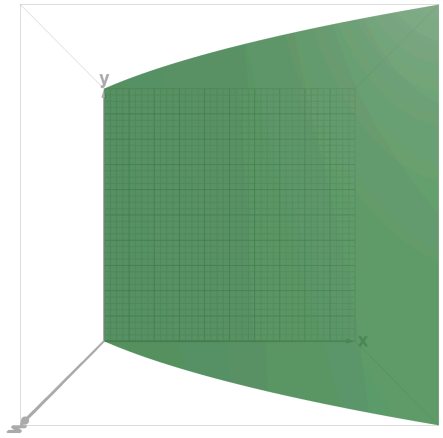
Teams must record their final load on their worksheet and submit it to the designated judge for verification and entry into the official record. Judges have final authority over loading rate, failure determination, and recorded results.

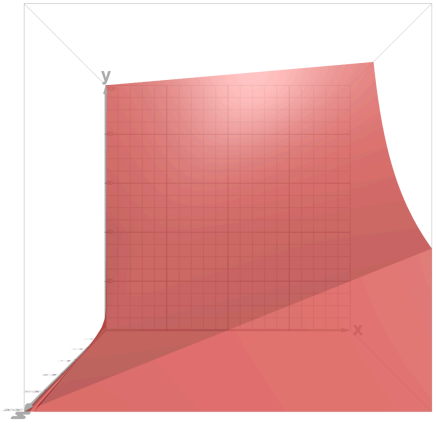
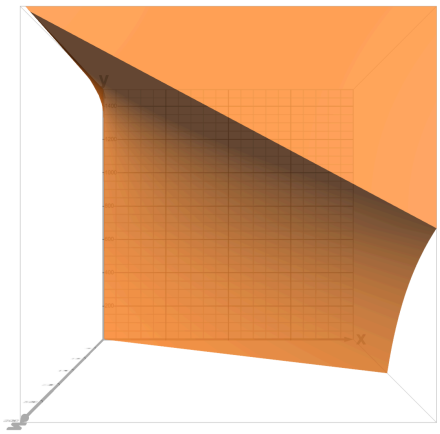
EVALUATION

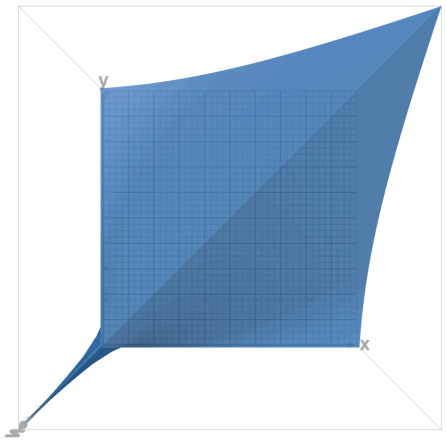
12.1 Official Scoring Breakdown

A team's final score will be based on five categories: Strength, Structural Efficiency, Cost Efficiency, Aesthetics, and Load Prediction. A detailed breakdown of each category is provided below. Strength appears in multiple categories, so building a reasonably strong bridge is important. However, teams are encouraged to also consider creative and lightweight structures to score well in Aesthetics, Structural Efficiency, and Cost Efficiency. The best strategy is typically to balance performance across all five sections rather than overemphasizing any single category.

1. M_{act} = Maximum load the bridge can support before failure (lbs)
2. M_{pred} = Predicted maximum load capacity of the bridge (lbs)
3. B_{act} = Actual weight of the completed bridge (lbs)
4. C_{GSTC} = Remaining budget after construction from the original $1500 budget (GSTC)

Category	Score Calculation Formulas	Max Points	Graph Image*
Strength Score (SS)	$min\left(50\left(1 - e^{\frac{ln(0.4)}{200}M_{act}}\right), 20\right)$	20	
	The Strength Score uses M_{act} as the x-axis, so higher M_{act} directly increases the score, while the z-axis shows points earned in this category (The y-axis does not represent anything). The score rises quickly at lower loads and then levels off due to diminishing returns, approaching a 20-point cap, meaning early strength gains matter much more than pushing to extreme loads. For competitors, the best strategy is to reach a reliable mid–high strength level rather than overbuilding, since gains near the top give very small score increases compared to improving efficiency in other categories. The score is capped at 20 to prevent extreme values from dominating the category.		

<table>
<tr><td rowspan="2">Structural Efficiency (SE)</td><td>$min\left(\frac{M_{act}}{30B_{act}}, 20\right)$</td><td>20</td><td>  </td></tr>
<tr><td colspan="3">This is a visual representation of the equation in 3D, where the x-axis represents M_{act}, the y-axis represents B_{act}, and the z-axis represents the points earned for this category. Higher values of M_{act} and lower values of B_{act} both increase the score, so you want a bridge that can carry more load while staying as light as possible. The 1 to 30 ratio rewards bridge weight more than load, so lower B_{act} has a stronger effect on increasing the score than increasing M_{act}. The score is capped at 20 to prevent extreme values from dominating the category.</td></tr>
<tr><td rowspan="2">Cost Efficiency (CE)</td><td>$min\left(20, \frac{80M_{act}}{(1500-C_{GSTC})}\right)$</td><td>20</td><td>  </td></tr>
<tr><td colspan="3">This is a 3D visualization of the Cost Efficiency equation, where the x-axis represents M_{act}, the y-axis represents C_{GSTC}, and the z-axis represents the final points for this category. The score increases when the bridge achieves better performance with lower cost. The M_{act} term acts as a performance factor, while the budget term controls efficiency so that cheaper builds score higher when they achieve similar strength. The score is capped at 20 to prevent extreme values from dominating the category.</td></tr>
</table>

<table>
<tr><td rowspan="2">Load Prediction Score (LPS)</td><td>$20exp\left(\frac{-3|M_{act}-M_{pred}|}{M_{act}+M_{pred}}\right)$</td><td>20</td><td>  </td></tr>
<tr><td colspan="3">This is a 3D visualization of the Load Prediction Score equation, where the x-axis represents M_{act}, the y-axis represents M_{pred}, and the z-axis represents the points earned in this category. The score is highest when $M_{act} = M_{pred}$, forming a ridge along $x = y$. As your prediction error grows, the score drops off smoothly. The equation is symmetric too, so over-predicting by 50 lbs hurts just as much as under-predicting by 50 lbs. A perfect prediction on a 5 lb bridge earns the same 20 points as a perfect prediction on a 200 lb bridge. The only thing that matters is how close the prediction is, not how strong the bridge was. Even a completely wild guess, such as predicting 200 lbs when the bridge holds 0 lbs, still earns about 1 point. This ensures every competitor receives some credit for attempting a prediction.</td></tr>
<tr><td rowspan="2">Aesthetic Score (AS)</td><td>$c_C + c_D + c_S + c_O$</td><td>20</td><td>No graphs for this category.
c_C = Craftsmanship
c_D = Design Intention
c_S = Symmetry and Balance
c_O = Overall Visual Impression</td></tr>
<tr><td colspan="3">The Aesthetic Score is the sum of four subcategories, each scored from 0 to 5, for a maximum total of 20 points. c_C is how cleanly and carefully the bridge is built, including build quality and material discipline. c_D is how clearly the bridge looks purposefully designed rather than random or improvised. c_S is how visually balanced and proportional the structure appears. And c_O is the judge's general "final look" score based on how complete and visually appealing the bridge feels overall, with uniqueness playing a major role in the c_O subcategory. Each subcategory is scored from 0 to 5, where 0 is very poor and 5 is excellent. This category is inherently more subjective and based on visual judgment.</td></tr>
</table>

Total (T)	$SS + SE + CE + AS + LPS$	100	No graphs for this category. SS, SE, CE, AS, and LPS represent the different categories
	The Total Score T is calculated by summing all five categories: SS, SE, CE, AS, and LPS. The maximum possible score is 100 points, though reaching this would require near perfect performance across all categories, which is not realistically achievable under competition constraints. To give teams a rough sense of what to aim for, a poorly designed bridge typically scores 30-50 points, an average bridge falls around 50-70 points, a well-designed bridge lands between 70-85 points, and exceptional, near perfect bridges may reach 85-95 points. The highest scores come from teams that balance all five categories rather than overemphasizing any single one.		

*3D graphs were created using Desmos 3D graphing tools and may be visually exaggerated.

12.2 Tiebreakers

In the event of a tie in a total overall score, rankings will be determined using the following tie-breakers, in order:

1. Highest Strength Score (SS)
2. Highest Structural Efficiency (SE)
3. Highest Cost Efficiency (CE)
4. Highest Load Prediction Score (LPS)
5. Highest Aesthetic Score (AS)

If a tie remains, teams will be declared co-winners for Overall Placement Awards. This does not apply to Special Category Awards, which have a different tiebreak system.

VIOLATIONS & PENALTIES

13.1 Violation Examples

Violations may include, but are not limited to:

1. Horseplay or safety guideline breach during bridge construction
2. Minor dimensional inaccuracies (slightly exceeding / falling short of size requirements)
3. Inability of the required 3” x 3” clearance object to pass through the full span
4. Excessive use of glue or gussets that obscure structural members
5. Misuse of materials in a way that deviates from the intended structural purpose
6. Unauthorized use of reference materials or design aids during construction
7. Interference with other teams or their materials

13.2 Penalty System

Penalties will be determined by judges based on the severity of the violation, with final authority resting with them to ensure fair and consistent rulings. All penalties are deducted from the final score. Judges retain final authority over penalty assignment and competition rulings.

1. Warning:
    a. Given for minor issues or small rule deviations that must be corrected. Teams may be asked to adjust their bridge. Examples include slight dimension errors, small clearance issues, or minor excess glue/gussets that do not affect structural behavior. Most, if not all teams will receive a warning before any penalty or disqualification is given.
2. Minor violation (15% penalty):
    a. Applies to more serious rule breaches that affect fairness or structural integrity, resulting in a 15% deduction from the final score. Examples include using prohibited planning materials during construction, improper material use, inability to correct mistakes that were given warnings, clearance issues during testing, or designs that create a slight to mid unfair advantage.
3. Disqualification:
    a. Severe violations such as interfering with other teams, intentional rule exploitation, or fundamentally invalid construction methods (e.g., large continuous laminated slabs used to bypass structural rules). Any dangerous safety breach such as horseplay will also result in an immediate disqualification.

SAFETY GUIDELINES

14.1 General Safety

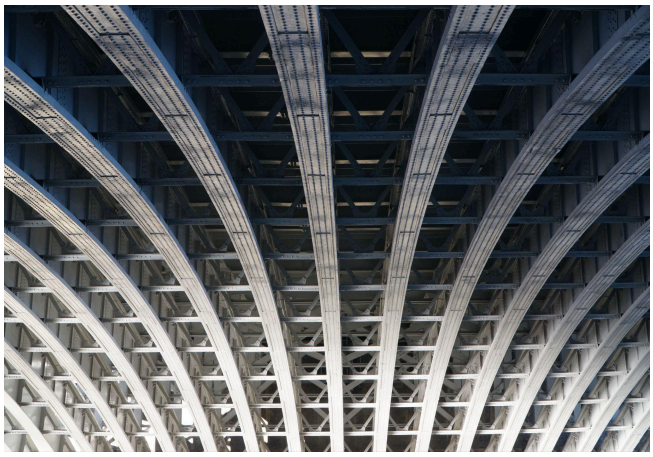
All participants must follow standard classroom and lab safety rules at all times. Horseplay, running, or unsafe behavior is strictly prohibited and may result in disqualification. Teams should remain aware of their surroundings and nearby groups throughout the competition. Any injuries, hazards, or unsafe conditions must be reported to a judge immediately.

Safety is important, not just for you and your team, but for everyone around you. A safe workspace allows all teams to focus on building their best bridge without unnecessary risks or distractions. Violations of safety rules may result in

warnings, point deductions, or disqualification at the judges' discretion. By following these guidelines, you and your team help create a positive and productive environment for all competitors.

14.2 Cutting and Construction Safety

Hobby knives must be used on cutting mats only. Always cut away from your body and keep fingers behind the blade. Blades must be retracted or capped when not in use. Drills may only be used at designated locations with judge supervision. You are encouraged to have long hair be tied back and loose clothing secured.



14.3 Loading and Testing Safety

All judge instructions must be followed during the loading process. Safety glasses are required during testing. Participants must keep their hands, face, and body clear of the bridge and loading apparatus at all times unless instructed otherwise. Bridges may fail suddenly and without warning, so caution is required throughout testing.

14.4 CA Glue Safety

CA (cyanoacrylate) glue must be handled carefully to avoid skin or eye contact. It should never be ingested or inhaled. Certain materials (such as cotton) may react with CA glue and produce heat, so teams must use caution when applying adhesives. If glue bonds skin, notify a judge immediately; do not attempt to separate, as proper removal methods will be provided.

14.5 Cleanup and Tool Return

Teams are responsible for cleaning their work area before leaving. Dispose of scrap wood, glue bottles, and paper towels in designated bins. All borrowed tools must be returned to judges before leaving. Missing tools may result in penalties.

Bridges may be discarded in the trash after testing. Teams are also welcome to take their bridges home if they prefer.

14.6 Problem Reporting and Assistance

If any rule, procedure, or safety concern is unclear, teams should ask a judge before proceeding. Broken tools, spills, or unsafe conditions must be reported immediately. Judges are available at all times to provide guidance and ensure a safe competition environment.

PRIZES

15.1 Overall Placement Awards

The Overall Placement Awards are given to the teams with the highest total scores across all five categories, based on the final score T defined in Section 12.1. Three teams will receive these awards. The total value of the Overall Placement Awards is approximately $320!

1. 1st Place Overall Champion Team
    a. $50 cash each
    b. Champion T-shirts
    c. Champion Trophy
2. 2nd Place Overall Team
    a. $30 cash each
    b. Portable Chargers
3. 3rd Place Overall Team
    a. $20 cash each
    b. School Supplies
4. All Top 3 Teams
    a. Custom Certificates
    b. Custom Hats

15.2 Special Category Awards

These awards recognize excellence in design and performance, with a total value of around $120. Each category winner receives $10 cash and a custom certificate.

1. Highest Strength Award
2. Highest Structural Efficiency Award
3. Best Cost Efficiency Award
4. Best Aesthetics Award
5. Best Load Prediction Award

15.3 All Contestants Award

All participating teams that have not earned an award will receive a certificate recognizing their completion of the competition.

15.4 Award Information

The following guidelines apply to all awards:

1. Award categories and prizes are subject to change prior to or during the competition.
2. Teams may receive multiple awards if they qualify for them.
3. In the event of a tie within any award category:
    a. Tie-breaker procedures defined in Section 12 will be applied for the overall score but not for category rankings.
    b. If a tie remains, the award may be shared between teams.
    c. If necessary, or if too many teams are tied for an award, judges may issue joint recognition, distribute awards at a later time, or cancel the award.
    d. All final decisions remain at the discretion of the judges.

ADDITIONAL INFORMATION

16.1 Contact Information

For any questions or clarifications, please contact us at njgstbridge@gmail.com. We aim to respond within 24 hours. Additional information and updates may also be available on the official competition website.

16.2 FAQ

Some commonly asked questions:

1. Are we allowed to soak or treat members with anything other than water?
    a. No, only water may be used for soaking or bending members.
2. Can we bring our own tools or materials?
    a. No, only materials and tools offered by our competition are allowed.
3. Can we decorate the bridge?
    a. Yes, non-structural decorations are allowed.
4. Can we design curved or bent members?
    a. Yes, as long as they comply with material and visibility rules.
5. Can a student participate in multiple teams?
    a. No, each student may only compete on one official team.
6. What counts as bridge failure?

    a. A bridge is considered failed when it can no longer support a load or shows visible structural collapse, as determined by the judges.
7. Are we allowed to drill holes in the members?
    a. Yes, as long as the members remain structurally identifiable and comply with all other visibility and material rules.
8. What type of food will be provided?
    a. Previous events have included pizza, pasta, salads, desserts, snacks, and drinks. This year's selection will be similar but may vary.
9. Can I donate or sponsor the event?
    a. Yes. Please contact us at njgstbridge@gmail.com for sponsorship opportunities.
10. Can middle school or college students participate?
    a. No. This competition is currently intended for high school students only, though expansion may be considered in the future.

16.3 Consent Forms

All competitors must submit a signed consent form acknowledging liability, the code of conduct, and related competition policies. If a competitor is under 18 years old at the time of the competition (March 20, 2027), a parent or guardian signature may also be required. Parents and guardians are not required to attend the competition but are welcome to accompany participants if they choose. Signed consent forms should be submitted via email prior to the competition; however, printed forms will also be available on competition day for completion if needed. Competitors aged 18 or older may complete the form independently, while those under 18 must complete it with a parent or guardian. Organizers will maintain records of all submitted forms and may share necessary documentation with the host school as required.

16.4 Media & Photography Notice

This competition will be professionally filmed and photographed. Each bridge will be photographed and uploaded to our website. To consent to being included in photos or videos, you must complete the required waiver forms prior to or on competition day.

Photos and videos may be taken throughout the event to document the competition, including bridge construction, final testing, and general event moments. This also includes group photos of participants and volunteers, as well as coverage of key highlights during the day. Media collected may be used for event recaps, promotional materials, educational purposes, and archival records.

Efforts will be made to ensure that photography and recording do not interfere with competition activities. All media will be reviewed before publication to ensure appropriate content is shared. If you do not submit a waiver, you may still appear in general event footage, but you will not be individually identified in any published photos or videos.

16.5 Image Credits

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