NCDOT Model Bridge Building Competition

Guidelines, Rubric, & FAQ's

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PART I – GENERAL COMPETITION INFORMATION

Welcome to the **North Carolina Department of Transportation (NCDOT) Model Bridge Building Competition**. Each year, this event brings together some of the most creative and talented middle and high school students from across North Carolina to explore engineering principles through hands-on learning, teamwork, and innovation.

The goal of this competition is to encourage students to think like engineers—designing, constructing, and testing a functional model bridge while also developing communication, problem-solving, and presentation skills. High school and middle school teams will compete in **separate divisions**, with awards presented at the Statewide finals for each division.

Competition Overview

Participating teams will design and build a model bridge using balsa wood and glue that meets the detailed bridge specifications and material requirements outlined in this packet.

Kits of balsa wood will be provided to each competing team. Each kit includes approximately **100 sticks (1/8" × 36")** and **4 sheets (1/16" × 3" × 36")**. Competing teams may use the provided kits or purchase their own materials, as long as all materials fully comply with the required material specifications.

Each bridge will be subjected to a load test in which sand is gradually poured into a suspended bucket until the bridge fails. The final weight at failure is recorded as the bridge's load-carrying capacity. A separate **Bridge Efficiency Score**, described later in the Judging Criteria section, will be calculated by comparing the weight of the bridge to the weight it carries during testing.

Additional Team Requirements

In addition to constructing a model bridge, each team must also:

- **Submit a Written Essay** that addresses the competition's required criteria
- **Provide a Scale Drawing** of their model bridge that accurately represents dimensions and configuration
- **Perform a Skit or Presentation** that meets the specified guidelines and highlights their team's creativity, learning, and engineering process

Each of these categories will be graded based on the provided rubric and added to the Bridge Efficiency Score to determine the final team score. Winners of the middle school and high school category at each region will compete in the statewide finals in Raleigh.

We look forward to seeing your creativity, innovation, and engineering insight as you participate in this year's competition. Good luck to all teams and thank you for contributing to the continued success of the NCDOT Model Bridge Building Competition!

PART II – BRIDGE CONSTRUCTION SPECIFICATIONS

Teams must build a model bridge meeting the following criteria. Teams may use the balsa wood kits provided or purchase their own materials that meet the required material specifications. For additional guidance, diagrams, and pictures, refer to the NCDOT Model Bridge Building Competition Supplemental Guide found on the competition website.

Dimensions & Geometry

- Minimum clear span: 17 inches between supports
- Maximum bridge length: 21 inches
- Must allow a 3x3 inch cube to pass beneath mid-span, measured while the end supports are resting on a flat surface.
- The bridge deck must extend the entire length of the bridge and maintain a "vehicular roadway" without any obstruction (2 inches wide x 2 inches high). The bridge deck shall be level (or flat) and shall not be curved (or arched). The bridge deck shall be constructed using a single, solid, balsa wood sheet. The balsa wood sheet used for the deck must be 1/16 inches thick. The bridge deck shall be the full width of the "vehicular roadway" and extend the entire length of the bridge's longest dimension.
- To allow for testing, there must be a half-inch hole at midspan in the bridge deck. There must be no obstructions below the hole that would prevent the passage of the testing rod.
- The bridge must be freestanding
- There is no limit on bridge weight

Members & Materials

- The materials used in the construction of the bridge shall consist ONLY of commercially available balsa wood and glue
- Only balsa wood is allowed (no basswood)
- The bridge shall contain no member wider than 1/8 inch nor deeper than 1/8 inch. This member size requirement does not apply at the intersection of members. Gussets, dowels and mitered joint connections are allowed, but only at the joint areas. They can be no thicker than 1/8 inch and no larger than a 1/2 in^2 in area.
- Individual members shall be constructed of a single piece of balsa wood. Laminated members are not allowed.
- Notching is permitted
- Any type of bonding material (glue) may be used.
- Members may not be coated with any material (i.e. paint, stain, or glue)

Testing

- A 1-1/2-inch-wide x 3-inch-long x 1/2-inch-thick loading plate will be positioned over the hole in the deck at midspan and placed directly on the balsa wood deck.
- A testing rod will fit through the 1/2-inch hole in the balsa wood deck and attach to the loading plate. An initial load will consist of an empty bucket suspended from the testing apparatus. Sand will be added to the container at a slow, steady rate until the bridge collapses.

PART III – WRITTEN REPORT REQUIREMENTS

Format

- 12-point font, double spaced, 1-inch margins
- 3 pages
- Submit essay in PDF format

Content

Essays shall include:

- Research on bridge building history and construction.
- Identification of career areas used in design and construction of bridges
- Describe the process the teams used to plan, design, and construct their model bridge. Incorporate but not limited to the following terminology:
    - Compression
    - Joint
    - Engineer
    - Live Load
    - Span
    - Tension
    - Truss
    - Top Chord
    - Bottom Chord
    - Dead Load

Students also may incorporate information about the following questions:

- Why do we need bridges? What purpose do they serve?
- How are bridges able to hold the tremendous amount of weight they hold?
- Why is it important to know whether parts of a bridge will be subjected to tension or compression?
- What is a polygon?
- Why is a triangle the strongest polygon?
- Why is it important to first create a scale drawing and model of a bridge before the actual construction begins?
- What materials are essential to design a scale drawing?
- What geometric shapes did you use in the bridge model? Why?
- How does the strength of the bridge compare to the weight of the bridge?
- What should you do to design a bridge for the future?
- How can computers help design bridges?

PART IV – DESIGN DRAWING REQUIREMENTS

Draw and submit a scaled diagram of your bridge. This can be done by hand, utilizing drafting tools. or by using a computer aided design (CAD) program. Your design should be detailed enough for construction.

Design Plans shall include:

- Member Sizes
- Dimensions (including required minimum clearances, etc.)
- Clearly labeled Scale (i.e. 1 in = 1 ft) placed in the title block or in a prominent location on the sheet.
- Title Block with School/Team Name and Grade (HS or MS)

Submit bridge design drawings in PDF format.

PART V – ORAL PRESENTATION REQUIREMENTS

You are promoting the bridge you designed and built for your client -- the judges. Demonstrate knowledge of bridge design and construction. In the oral presentation, describe the chosen design and explain the rationale behind the bridge design. Incorporate similar engineering terminology utilized in the written essay.

Presentations at both regionals and finals may not exceed seven minutes including set up and breakdown.

PowerPoint presentations **are not** permitted at the regional competitions. PowerPoint is allowed (optional) at the finals.

At the finals, there will be an award for the most creative presentation or skit for both middle school and high school!

The winner of this award will be chosen by the judges.

Take a look at our website to see some examples of creativity from previous competitions:

https://www.ncdot.gov/initiatives-policies/students-youth/model-bridge-competition/Pages/default.aspx

Creativity is important, but remember, content is critical and will be the main consideration in judging your presentation.

PART VI – JUDGING CRITERIA

At both the Regional Competition and Final Competition, there will be a panel of judges that will score the Written Report, Design Drawings, and Oral Presentation.

The Scoring Categories and maximum available points are:

1. Written Report: 10 pts
2. Design Drawing: 10 pts
3. Oral Presentation: 10 pts

   Total: 30 pts (see Rubric in Part VII)

Bridge Efficiency Score

The bridge efficiency score is determined independently from the three categories above.

Bridge Efficiency Score = 0.10 × weight carried (in grams) ÷ bridge weight (in grams)

The maximum weight carried by the bridge will be 20 kilograms. If the bridge carries more than 20 kilograms, only 20 kilograms will be used to calculate the bridge efficiency score. No additional credit will be given for carrying more than 20 kilograms.

The bridge efficiency score will then be added to the numbers from the written report, design drawing, and oral presentation scores to create a total score.

The winning team will be the team with the highest combined score. In the event there is a tie, the team with the highest bridge efficiency score will be the winner.

Winners from each of the 4 Regionals in the middle school and high school category get to compete in the statewide finals in Raleigh.

**Decisions made by competition judges and testers are final. There is no dispute resolution process; however, input for process improvement is encouraged.

PART VII – RUBRIC

Written Report (10 Points Maximum)

1. Format & Organization (0–2 points)

- **2 points:** Report follows all formatting rules (12-pt font, double-spaced, 1-inch margins, 3 pages, PDF) and is well-organized, clear, and easy to read.
- **1 point:** Mostly follows format; minor errors or issues with organization or clarity.
- **0 points:** Major formatting problems or poor organization.

2. Bridge Research & Career Connections (0–2 points)

- **2 points:** Provides strong research on bridge history and construction AND clearly explains career areas involved in bridge design and construction.
- **1 point:** Addresses both topics but lacks depth or contains limited detail.
- **0 points:** Does not adequately include these required topics.

3. Team Process & Required Terminology (0–4 points)

- **4 points:** Clearly and thoroughly explains the team's planning, design, and construction process; correctly uses most or all required terms (Compression, Tension, Joint, Engineer, Span, Truss, Top Chord, Bottom Chord, Live Load, Dead Load).
- **3 points:** Good explanation; uses several terms correctly.
- **2 points:** Basic explanation; uses only a few terms or uses some incorrectly.
- **1 point:** Minimal explanation; limited terminology.
- **0 points:** Does not describe the process or use required terms.

4. Reflection & Deep Thinking (0–2 points)

- **2 points:** Thoughtful discussion using several of the optional questions (bridge purpose, geometric shapes, scale drawings, computers in engineering, etc.) with clear insight.
- **1 point:** Reflects on one or two questions with limited depth.
- **0 points:** Little or no reflection.

Design Drawing (10 Points Maximum)

1. Scale, Accuracy & Clarity (0–4 points)

- **4 points:** Drawing is to scale, neat, accurate, and detailed enough for construction; created with drafting tools or CAD.
- **3 points:** Mostly accurate and clear; minor issues.
- **2 points:** Basic accuracy; some unclear or incomplete areas.
- **1 point:** Poor clarity or unclear scale.
- **0 points:** No usable scale, drawing is sloppy, primarily freehand, difficult to read.

2. Member Sizes (0–2 points)

- **2 points:** All structural members are clearly labeled with correct sizes
- **1 point:** Some member sizes shown; inconsistent
- **0 points:** No member sizes labeled

3. Dimensions & Required Clearances (0–2 points)

- **2 points:** Shows all required dimensions, including minimum clearances, with correct and readable dimensioning
- **1 point:** Some dimensions or clearances missing
- **0 points:** No dimensions provided

4. Title Block & Required Info (0–2 points)

- **2 points:** Title block includes team/school name, grade level (MS or HS), and scale
- **1 point:** Title block incomplete or minor issues
- **0 points:** Missing title block or incorrect format

Oral Presentation (10 Points Maximum)

1. Knowledge of Bridge Design & Construction (0–4 points)

- **4 points:** Presentation shows strong understanding of bridge engineering concepts; explanations are accurate and confident
- **3 points:** Good understanding with minor errors
- **2 points:** Basic understanding; some inaccuracies
- **1 point:** Limited understanding
- **0 points:** No meaningful understanding demonstrated

2. Explanation of Design & Rationale (0–3 points)

- **3 points:** Clearly explains chosen design and why it was selected; connects choices to engineering concepts
- **2 points:** Adequate explanation; some missing details
- **1 point:** Minimal or unclear explanation
- **0 points:** No rationale provided

3. Delivery, Organization & Rules Compliance (0–2 points)

- **2 points:** Clear, audible, organized, confident presentation; stays within the 7-minute limit; follows rules
- **1 point:** Some issues with clarity, volume, organization, or timing
- **0 points:** Disorganized, unclear, goes over time, or violates rules

4. Creativity (0–1 point)

(Creativity is encouraged, especially at finals, but content still matters most.)

- **1 point:** Creative presentation that enhances engagement
- **0 points:** No creativity or creativity detracts from content

PART VIII – FREQUENTLY ASKED QUESTIONS (FAQ'S)

GENERAL COMPETITION QUESTIONS

Q: Will middle school teams compete against high school teams?

A: No. We will have separate divisions for middle schools and high schools.

Q: Can teachers or schools enter more than one model bridge?

A: We will accept one model bridge entry per school per grade level.

Q: Can individual students enter the competition?

A: The competition is designed to encourage students to work in teams with the teachers acting as facilitators. Therefore, the department strongly encourages teams of at least two students with one or more teachers as facilitators. If it is impossible for a school to develop such a team, then a student with a teacher as a facilitator will be allowed to enter the competition.

Q: Are you offering the competition next year?

A: Yes, the competition is an annual event.

Q: Are model bridge building supplies free for every team

A: Yes. Schools can purchase additional supplies from other vendors if they choose as long as they meet the material specifications.

GUIDELINE QUESTIONS

Q: Your guidelines specify "no element wider nor deeper than 1/8 inches." Does that specification include joints? For example: You have two 1/8" x 1/8" balsa wood pieces that cross over each other, making the joint 1/4" - would that be legal? Or, would we need to use 1/16" x 1/16" balsa wood strips to make something like that?

A: The 1/8" x 1/8" size requirement does not apply at joint intersections. However, the intersection cannot exceed the size of two individual members, total of 1/4". This is only allowed at the joint areas.

Q: I would like to put spacers between two pieces of balsa wood, with the measurement of the entire member (balsa wood pieces and spacers) exceeding 1/8". Would the spacers be ruled as joints, making my bridge legal?

A: If a spacer is continuous, then a laminated member results. The spacers will be counted as individual members. Each individual member cannot exceed 1/8" as outlined in the guidelines.

Q: The guidelines say commercially available balsa. Does this eliminate the basswood kits that are often used in physics labs?

A: Basswood may not be used, only balsa wood may be used for the competition.

Q: Are cross-members allowed under the balsa wood deck?

A: Yes, cross-members are allowed under the balsa wood deck.

Q: Are gusset plates allowed at joint connections?

A: Yes, one per joint is allowed. However, the plate cannot exceed 1/8" in thickness and 1/2 square inch in area.

Q: What type of glue can be used? Our class was wondering if adhesives such as rubber cement, liquid nails or epoxy styrene resin were allowed, or does the label have to say glue for it to be considered glue?

A: The label does not have to say glue for it to be considered glue. If it is an adhesive that can be used to bond two pieces of wood together, it will be acceptable. Any type of glue may be used.

Q: Is there a drawing or design program that is preferred to create our plans?

A: We do not require that software be used to create drawings. Drawings may be drawn to scale by hand using drafting tools like straight edges, triangles, and compasses. There are also many drawing, design, and testing software packages available. Because we do not know what resources or technical support are available at any given school, we do not endorse any software. REMEMBER: The goal of the drawing is for an engineer to be able to build your bridge from that drawing.

DESIGN/PRODUCT QUESTIONS

Q: How is the bridge loaded?

A: The bridge must carry an initial load consisting of a container (bucket) and the testing hardware (see the *NCDOT Model Bridge Building Competition Supplemental Guide found on the competition website) Dry sand will then be added slowly and carefully to the container until the bridge breaks. The maximum weight that will count in the bridge efficiency score is 20 kg.*

Q: May we paint our bridge? May we use wood laminate?

A: Painting is not allowed, since it could provide some structural benefit. Laminated members are not allowed.

Q: Can we notch the wood?

A: Yes, the wood can be notched.

PRESENTATION AND REPORT QUESTIONS

Q: Can Powerpoint be used in the presentation?

A: Powerpoint presentations are not required, but if you choose to use one, a Powerpoint presentation may only be used at the Bridge Building Competition ***Finals****.*

Q: For the presentation, do we have to do a skit or can we do a more formal presentation.

A: This is up to the team. The primary focus is to have good content and be presented clearly. However, creativity is also important and can win you a prize at the finals competition.

Q: For the report, do you want a bibliography? Also, are footnotes required?

A: No, since this was not specified in the competition guidelines, the inclusion or exclusion of a bibliography and footnotes is up to the individual teacher. It will not be a part of the judging requirements.