Delaware Bridge Design Competition
9th and 10th Grade Guidelines

Refer to the Bridge Design Competition Website for Important Dates

Bridge Performance is 40% of the Total Score

9th and 10th Grade Bridge Type: Deck Arch Truss Bridge

Bridge Performance: Achievement of performance goals and stability of construction. Bridges will be weighed and then tested on the Pitsco Tester. Results will be used to calculate a strength-to-weight ratio. Any bridge not meeting the specifications will result in a disqualification in the performance section and a score of zero (0) points. **Please securely label your bridge with your team's name.**

Bridge performance will be given a maximum of 100 points based on the following equation:

$$(Ratio_i / Ratio_{Highest})*(100 \text{ points})$$

- $Ratio_i$ = The strength-to-weight ratio of the team being judged

  Example: Weight of bridge = 20 grams (g)
  Weight held = 20 kilograms (kg) or 20,000g
  $Ratio_i$ = 20,000g / 20g = 1000:1 or 1000

- $Ratio_{Highest}$ = The highest strength-to-weight ratio recorded amongst all teams

  Example: Team 1: $Ratio_1$ = 3000; (3000 / 3000)*(100) = 100 Points
  Team 2: $Ratio_2$ = 3000; (2000 / 3000)*(100) = 66.67 Points
  Team 3: $Ratio_3$ = 3000; (1000 / 3000)*(100) = 33.33 Points

Bridge Specifications: Students will design and build a model bridge based on the following specifications.

a) The materials provided are the ONLY materials to be used when building the bridge structure.
b) The instrument used for testing will be the Pitsco Structures Testing instrument as seen in Figure 1 below.

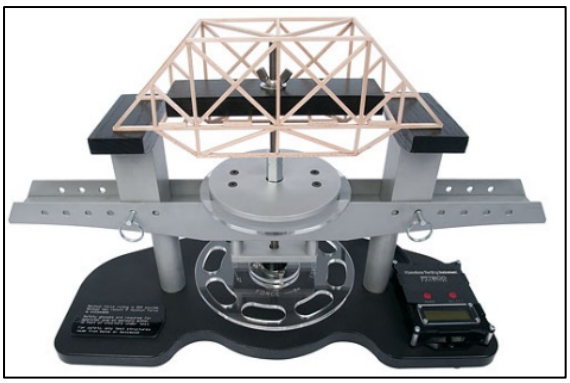

Figure 1. Pitsco Tester
(Not representative of the bridge type)

c) Lamination shall be permitted one layer thick, in either direction, as shown in the figures below. Lamination is gluing two members along their length. See Figures 2 & 3 for more details.

Acceptable:

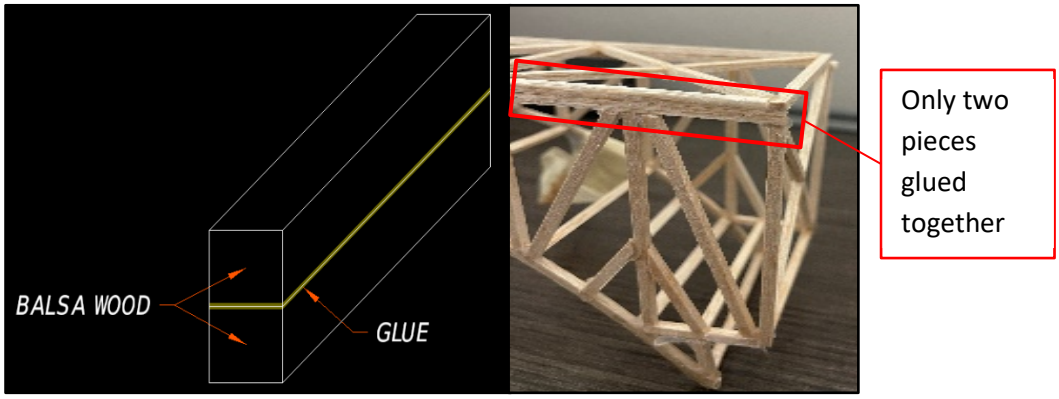

Figure 2. Acceptable Lamination

Not Acceptable:

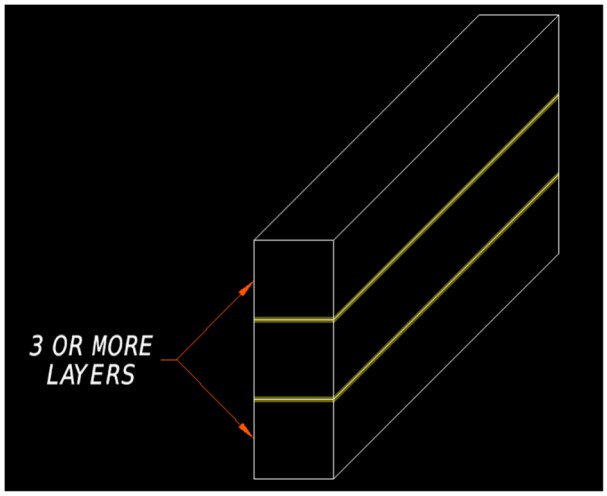

Figure 3. Unacceptable Lamination

d) Connections can be butt joints, miter joints, or notched joints. Lap splices are permitted, but no greater than 1/4 of an inch thick. Each piece of balsa wood is 1/8 of an inch thick; so, this means no more than 2 pieces of balsa wood may be used to create a lap splice. See Figures 4-6 below and Section k for more details.

Acceptable:

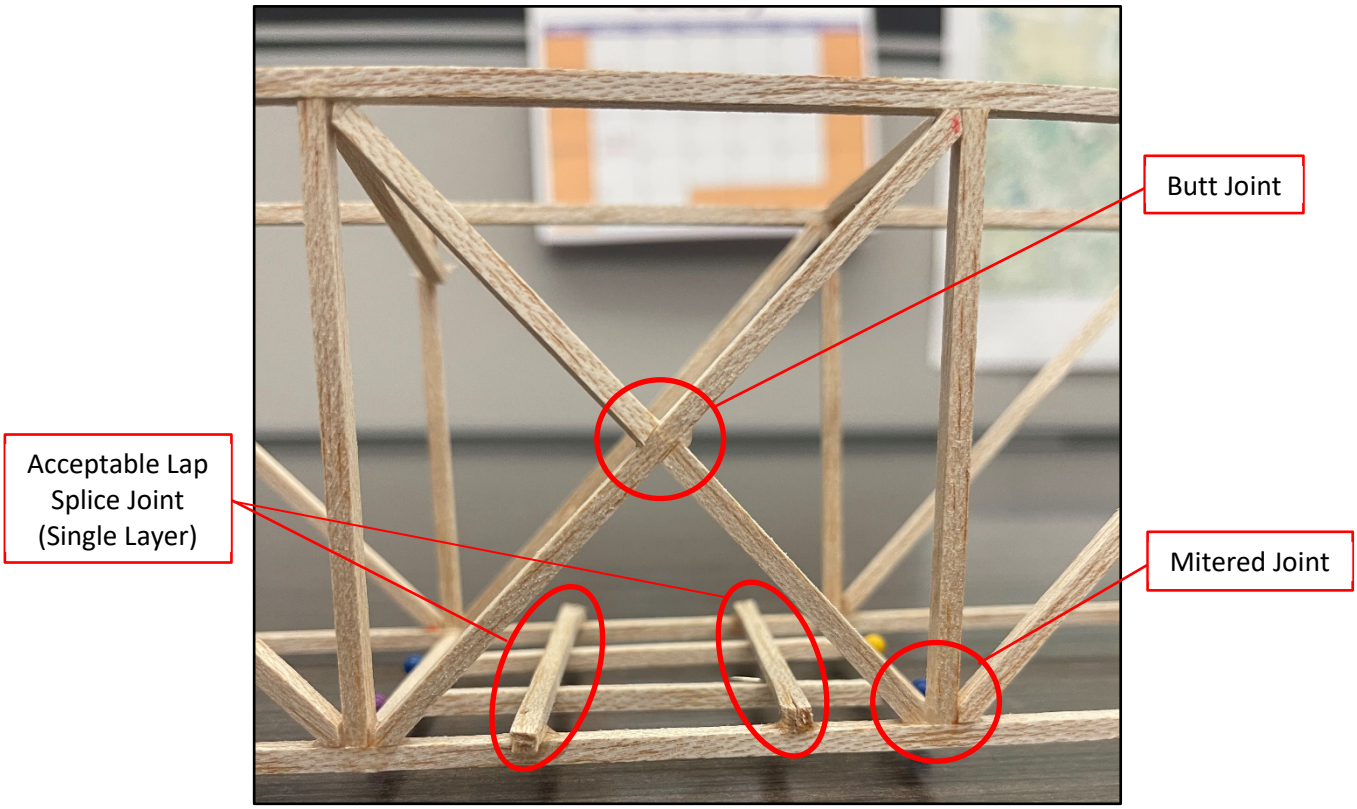

Figure 4. Acceptable Joints

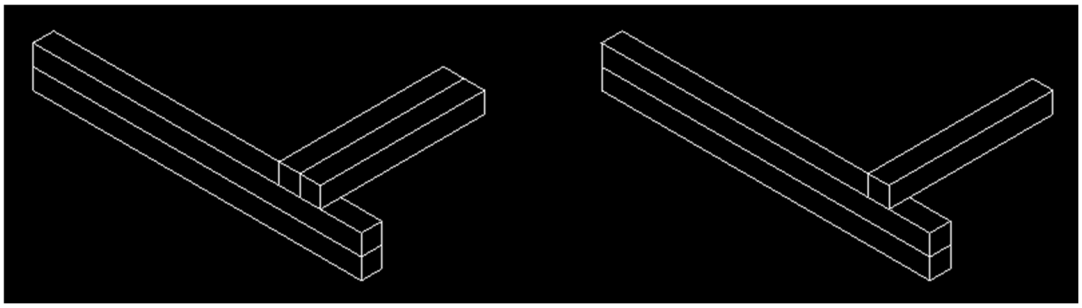

Figure 5. Acceptable Lap Splice

Not Acceptable:

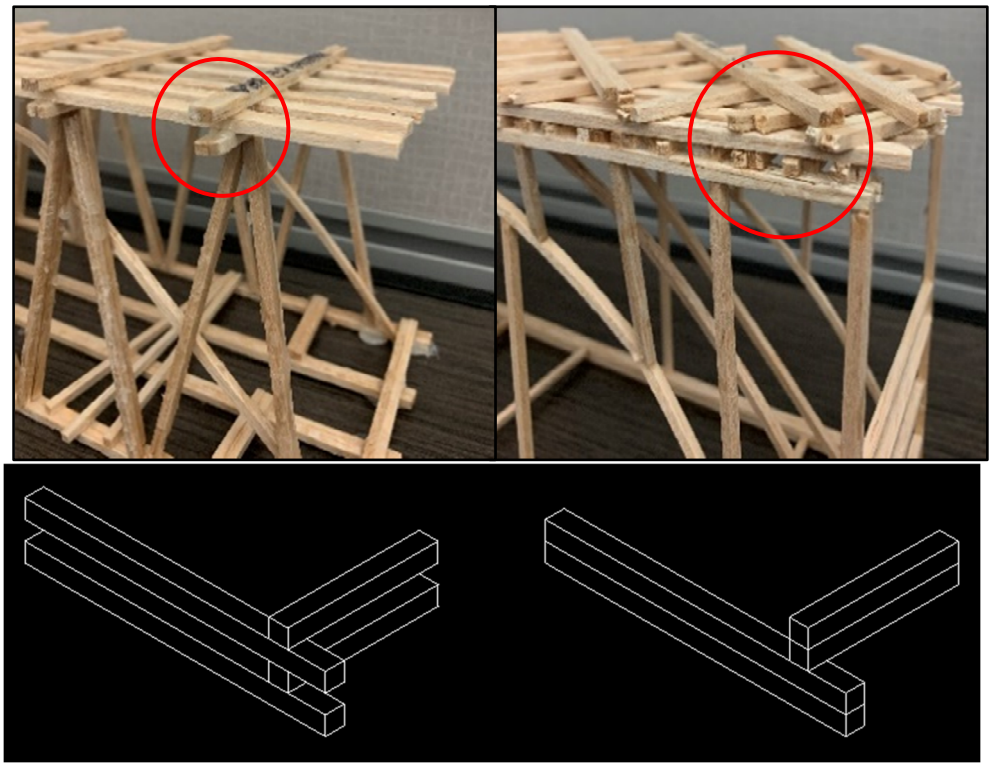

Figure 6. Unacceptable Lamination/Splices

e) End to end, the length of the entire bridge must be 14 inches, refer to Figure 7.

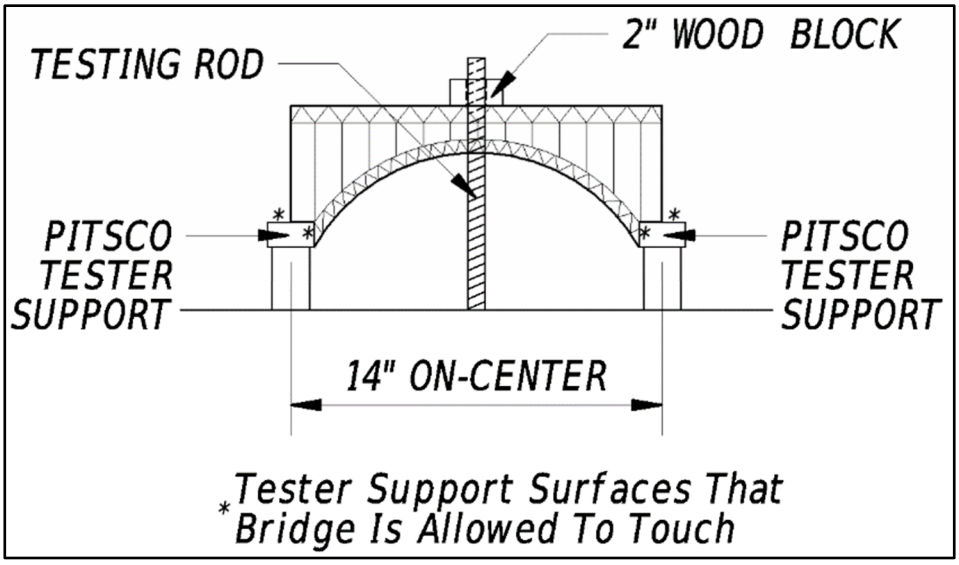

Figure 7. Tester Configuration Detail

NOTE: For deck arch truss bridges (9th and 10th grade): The top dimension of the bridge must not be significantly smaller than the bottom dimension of the bridge. Specifically, the top portion of the bridge, where the 2-inch x 2-inch wooden block will be placed for loading, shall have a minimum dimension of 12.25 inches. See Figures 8 & 9 for more details.

Acceptable:

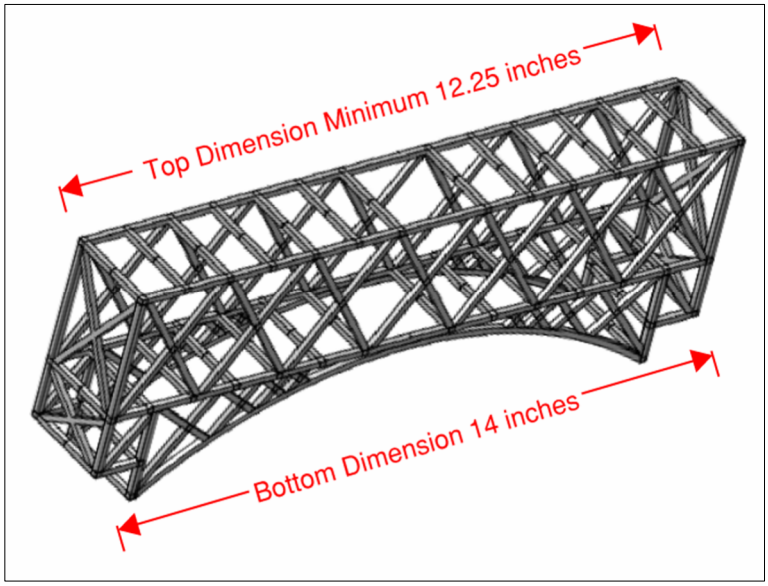

Figure 8. Acceptable Top of Bridge Dimension

Not Acceptable:

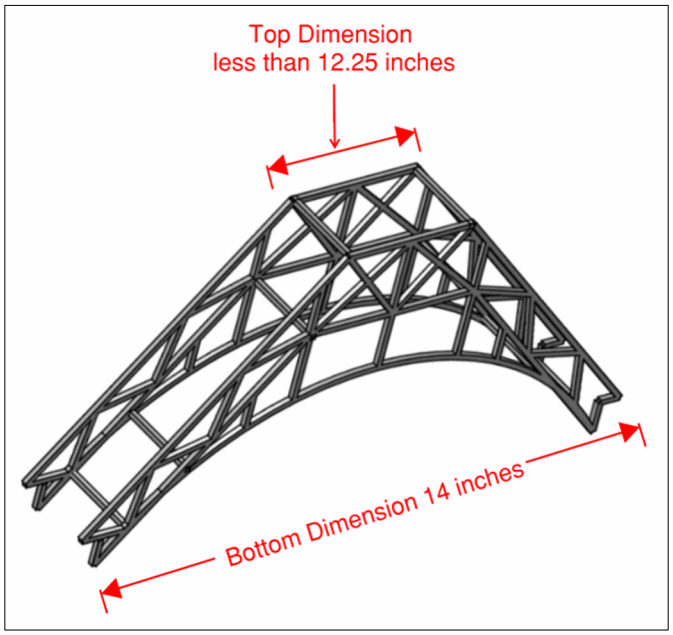

Figure 9. Unacceptable Top of Bridge Dimension

f) Maximum width of the bridge shall be no more than 4.5 inches to fit on Pitsco Tester, refer to Figure 10.

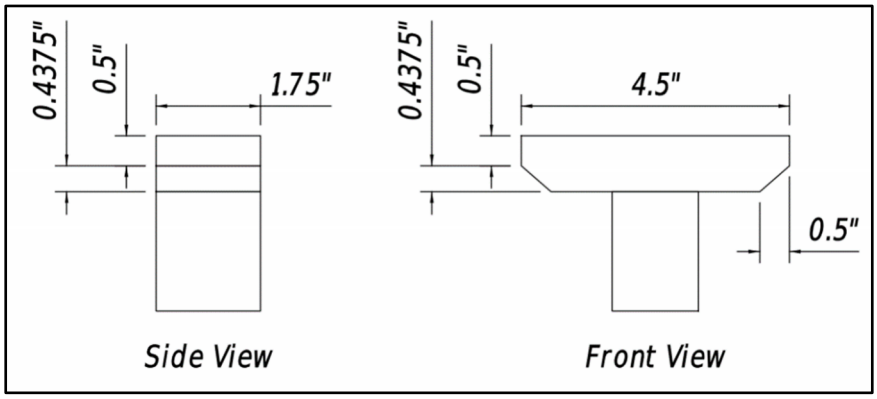

Figure 10. Support Detail

g) The area where the bridge will be loaded (center of the bridge) must have at least a ¾-inch hole to allow a 5/8-inch testing rod to pass through. The rod must also be able to pass through full height of the structure to insert the rod into the tester. This is required to attach the rod to a 2-inch x 2-inch block of wood used for strength testing by the Pitsco Tester. An example configuration can be seen in Figure 7. The block of wood must be able to be pushed across the top surface of the bridge (a solid bridge deck of any kind is not allowed). No more than 2 longitudinal members will be permitted in any single horizontal layer of the bridge structure (refer to Figures 11 & 12 for more detail). Please note, figures do not represent the required design and shall only be used for reference.

Acceptable:

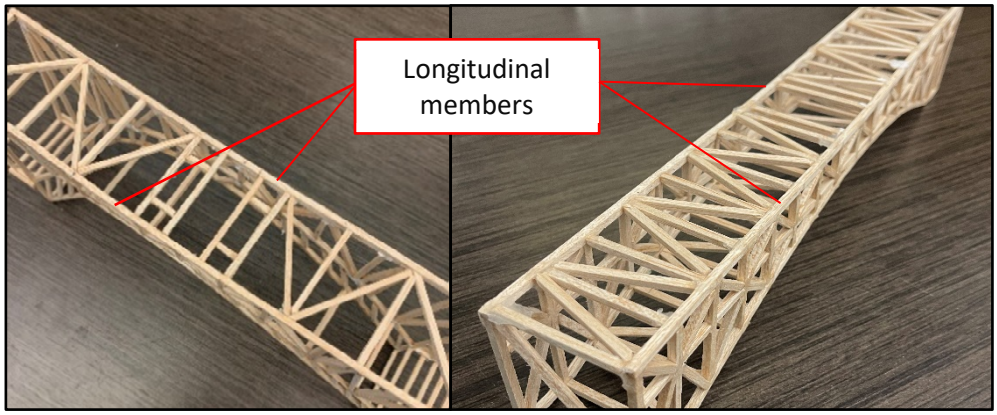

Figure 11. Acceptable Cross Framing

Not Acceptable:

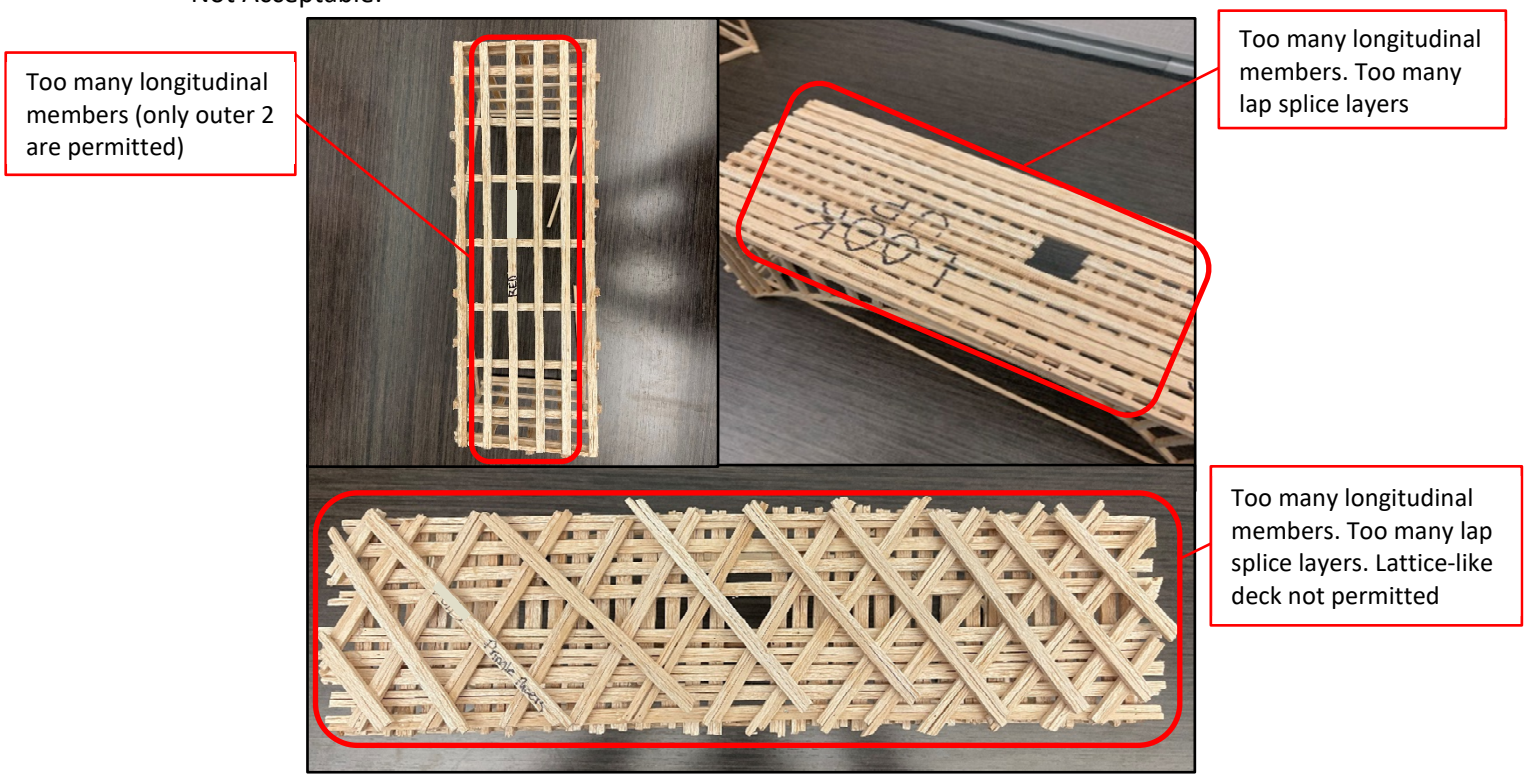

Figure 12. Unacceptable Cross Framing/Deck System

h) Tester supports will be placed at 14 inches on center. Support dimensions are shown above in Figure 7.

i) The bridge is allowed to touch the tester support surfaces ONLY where shown by the "*" in Figure 13. Bridges are not allowed to touch any portion of the tester not denoted by "*" in Figure 13. **It is recommended, but not required, to utilize both the horizontal and vertical support surfaces (denoted by "*") for strength advantages.**

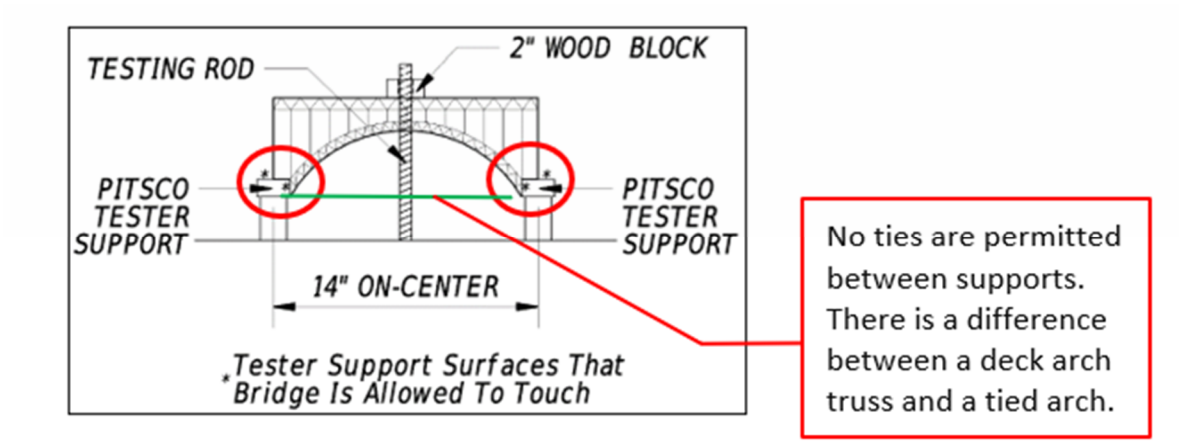

Figure 13. Support Detail

j) In real world applications, bridges should not be permitted to deflect more than a tolerated amount, even if the structure itself does not fail. This concept will be applied to each team's model bridge. The tolerated deflection during testing for each model bridge is the limit of the Pitsco Tester. If the maximum deflection is reached before bridge failure the resulting load will be measured and used to calculate the strength-to-weight ratio.

k) The following will result in a bridge receiving a strength-to-weight ratio of zero (0). PLEASE NOTE, if you have questions or concerns of violating any of these, please contact us.
    i. Modification to the structural properties of the balsa wood (soaking wood pieces to allow for bending does not count as modifying the structural properties of the balsa wood).
    ii. Using any material (including glue) other than provided.
    iii. Laminations greater than two (2) layers in any direction (see figures above).
    iv. Structures having a deck (see figures above). The bridge is designed to function as a deck arch truss bridge. If the deck is carrying a majority of the load without distributing it to the rest of the members, it will be disqualified.
    v. Creating a lap splice greater than ¼" thick (see figures above). Stacking more than 2 members on top of one another will violate this criteria.
    vi. Deviation from the specifications outlined above.