

Mahoning Valley Miniature Bridge Building Contest 2024 Specifications

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DESCRIPTION:

In real world engineering, bridges are designed to meet certain dead load (self-weight) and live load (vehicles) requirements using prescribed safety factors. Since steel, concrete and wood are expensive materials and funding is always limited for infrastructure projects, it is incumbent upon engineers to design their structures as efficiently as possible, while maintaining public safety. Therefore, the Mahoning Valley Miniature Bridge Building Competition (MVBBC) committee extends this philosophy to our competition and focus is placed on designing the lightest, most efficient structure to carry a prescribed weight.

The objective of this event is two-fold: To design a structure to carry a prescribed target load (40 lbs.) and to design and build a structure with the highest load-to-weight capacity ratio ($\frac{\text{Failure Load}}{\text{Weight}}$), over a predetermined span using supplied materials. The bridge must have an unobstructed flat roadbed capable of allowing a wheeled car to pass over its entire length. Each team may consist of 2-3 students and one supervisor and may enter only one bridge that must be built at the competition within a 3-hour time limit. Each school may enter up to two teams. This is an engineering event; therefore, failure to adhere to the rules and regulations herein will incur penalties against the final score.

Testing of the structures for the following criteria and failure load will be performed by the MVBBC committee members and student teams. Materials will be supplied to the student teams are in limited supply. Testing will be performed using the MVBBC committee's testing devices and loading tables. Be advised the loading tables have limited capacity of weight per table. In order to test each bridge to failure, we cannot have one team using an excessive amount of load material because it limits the weight material available to the adjacent testing team. Also, be advised the loading buckets have limited volume and strength above the provided load material. Furthermore, MVBBC officials did not want to stop a loading in progress because each team naturally wants to see how strong their bridge is and to see it ultimately fail.

MATERIALS:

Each build team will be provided the following materials:

One (1) set of practice building materials to construct a bridge will be provided prior to the competition for each participating school. This set will include the same materials that will be included in the kit provided at the competition and contains the following:

- Twenty (20) - balsa wood sticks, three (3) feet long and one-eighth (1/8) inch square
- One (1) - balsa wood plank, eighteen (18) inches long by two (2) inches wide by three-thirty seconds-(3/32) inch thick. This plank MUST be used for the Bridge Roadway - any leftover may be used as each team desires.
- One (1) - 1/2 oz bottle of Insta-Cure Gap Filling cyanoacrylate adhesive.
- One (1) copy of MVBBC Rules & Guidelines

No balsa wood materials shall be permitted at the event from practice kits. This includes any practice structures previous built. Cyanoacrylate adhesive glue provided in practice kits will be permitted at the event.

1. Bridges shall be bonded using a cyanoacrylate medium density super glue, provided by the competition. This is a fast-setting, gap-filling 5-15 second curing glue that can be found at Boardman Hobby Center.

2. All tools used for construction are to be provided by each building team. Your team will know which tools you will need to complete the construction of your bridge. Be sure to pack these tools prior to the competition.

Some suggested tools are as follows:

Required tools to bring:

Protective Eyewear
Cutting Surface/Board
Exacto Knife Kit / Razor
Matchbox / Hot Wheels type car

Optional tools to bring:

Jig or Form for bridge construction
Design plans / structure layout drawings
Ruler / Scale
Clamps
Hair Dryer for drying glue (No heat guns)
Extension cord / Power Strip
Latex/rubber gloves

3. Protective eyewear for participating students must be worn during testing (provided by the building team).
4. The design team must allow a Matchbox or Hot Wheels type car to roll along the bridge deck prior to testing. A standard car will be available at the competition if not provided by build team. However, this vehicle may differ from the one used by the build team during practice.
5. Design plans or drawings are optional but highly recommended and should be provided by the building team.
Note: More than one student should have a copy of the plan in the event that another team member forgets the plan or is unable to attend.

CONSTRUCTION:

1. Each build team will be allotted three (3) hours construction time to complete the construction of their bridge. A mandatory 15-minute break will be scheduled at the midpoint of the construction time. No construction work will be permitted during this break. All construction on the competing structure is to be completed on competition day within the allotted 3-hour time limit. If additional time should be required to complete the bridge, the Rules Committee judges will determine the additional allotted time and any weight penalty to be applied.
2. Teachers/Advisors may not participate in any way with assisting the students during the actual building of the structure. Any questions related to construction will be directed to the Rules Committee.
3. Any type of bridge may be constructed as long as it meets the requirements of these specifications. The bridge is to be a single structure constructed of balsa wood. All structures are to be constructed using the materials provided by the MVMBBC committee at the start of the competition. See Materials section of these specifications for provided materials.
4. Do not coat the bridge with any material (i.e., paint, stain or glue).
5. All excess glue should be removed from surfaces that are not bonded together.
6. **A bridge must have a minimum of three (3) structural members. Structural members can be floor beams, stringers, truss members, bridge deck, arched beams, etc. Bridges not having a minimum of three (3) structural members will be disqualified and not tested. Laminating to create one thick bridge deck is not permitted (i.e. no slab-type bridges are permitted, see Figure 4.).** For the purposes of this competition, lamination means the gluing together of individual pieces of balsa wood along their parallel lengths to form a built up thicker, stronger member.

Laminated Members:

While you may not glue all of your wood together to form a slab-type bridge (see Figure 4.), you may glue as many as four pieces together to form beams or truss-type members. This will help strengthen your deck and the rest of the bridge where the additional cross-section size is needed. **Be creative!** (See Figures 4 and 5.)

The laminated member cannot exceed two (2) parallel pieces in height or two (2) parallel pieces in width to form larger members. Having more than four (4) parallel laminated pieces or more than two (2) laminated parallel pieces in height or width along their lengths laminated together will result in a weight penalty. (See Figures 4, 5 and 6.) Also, a laminated member cannot be spaced closer than 1/4" perpendicular from another laminated member having the same parallel path along their individual lengths. Having a spacing less than 1/4" will result in a weight penalty. (See Figure 4, 5 and 6.)

Gluing members to the balsa wood plank to strengthen the bridge deck is permitted and encouraged. The balsa wood plank used for the roadbed will not be counted as a laminated piece. The plank will be ignored as if the wood plank is not there creating a space of 3/32 inch. Be aware this space will be viewed as less than 1/4" if members are glued above and below the wood plank.

The determination of whether or not a bridge has been laminated incorrectly is up to the discretion of the Rules Committee judges. If you feel that your design may be questionable, please contact a member of the Rules Committee as early as possible in your construction. If a lamination violation is determined, a discussion with the Rules Committee judges can help determine alternatives if it is early enough in the construction.

7. Construction of a practice prototype bridge prior to competition is strongly encouraged. However, ***prototypes and/or previous year's bridges are absolutely not permitted at competition – Drawings and/or plans only.***
8. The bridge must be constructed to meet the following specifications:
 - a. The bridge will span a clear opening of twelve (12) inches on the load table. Note that the bridge will need to be longer than twelve inches to allow for bearing on the table. The bridge will be required to have a minimum bearing to bearing distance of twelve and one half (12 ½) inches. The overall length of the structure cannot exceed fourteen (14) inches. The building kit will provide a sufficient amount of materials. Additional materials will be provided during the competition only when there is an accidental break or when the materials are judged to be structurally deficient. The Rules Committee judges should be consulted.
 - b. For truss or beam type bridges, there should be no bearing against the vertical sides of the load table. Arch type bridges can bear against the sides of the table (opening). However, caution is urged in constructing an arch type structure because a very tight fit is necessary to develop its strength.
 - c. The bridge will only be allowed to rest on the loading table, provided by the MVMBBC. No glue or physical attachments may be made to the top or sides of the loading table.
 - d. Bridge width:
 - Minimum = 2 inches to accommodate roadbed width (See Figure 4 and 6.)
 - Maximum = None
 - e. Bridge height:
 - Minimum = None
 - Maximum = None
 - i. The roadbed height is not to exceed half-inch (0.5") above the top surface of the loading table (base of bridge) at the supports. (See Figure 2.)
 - ii. Consider that if your structure has truss type overhead members or lower members that there is enough clearance to accommodate insertion and fastening of the loading block and bolt with these members in place after the structure has been built. (See Figure 1 and Figure 2.)
 - f. The bridge must contain an attached roadbed with a minimum width of two (2) inches and a length greater than twelve (12) inches. (See Note 7 under Testing.)
9. A roadbed is defined as a surface that allows free passage of a rolling Matchbox or Hot Wheels car. The car must have an axle width appropriate for successful travel from one end of the bridge to the other.

10. The roadbed must be able to accommodate the loading block and bolt at application point (see Note 7 under Testing). The loading block application point is at the midway point in the bridge (see Figure 2).

TESTING:

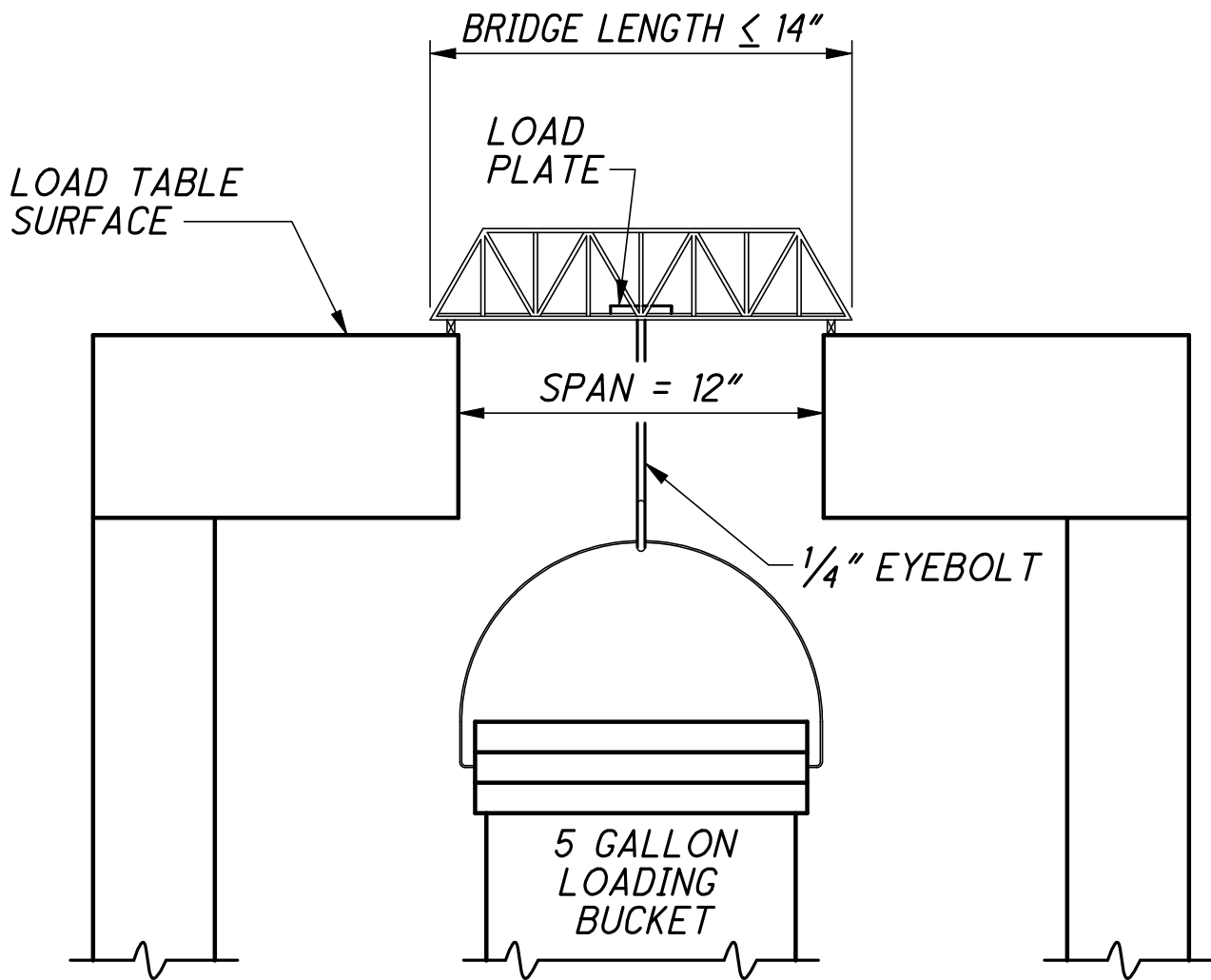
1. At the conclusion of the 3-hour construction period, all bridges will go to the drying tables to start the curing and mandatory one (1) hour drying time. This will also be the lunch break.
2. No alterations will be allowed after the allotted 3-hour construction period unless deemed necessary by the Rules Committee. The Rules Committee reserves the right to assess a penalty depending on the nature of the change.
3. The order of testing will be determined by a discussion with the Teacher/Advisors prior to lunch. Teams requiring earlier departures for bus schedules will be tested at the start of testing. Other teams will be placed by random selection to determine order of testing.
4. Teams will be called up to bring their bridges from the drying tables to the Check Station where they will be weighed and scored based on compliance with the construction requirements (See Figure 6). Bridges that are completed but do not meet the construction guidelines will have points deducted from the bridge score as noted (see Figure 6.).
5. At the Check Station, the bridge will be checked for "drivability." One end of the bridge will be placed on a wooden block approximately 2-1/4 inches in height to incline the bridge. A model car (Matchbox or Hotwheels) will be placed on the elevated end of the bridge and allowed to roll the length of the roadbed (minimum of twelve (12) inches). If the car fails to roll the whole length, the student may restart the roll from that point. Students will be allowed two (2) restarts. If, on the second restart, the model car cannot freely roll along the surface of the roadbed from beginning to end, points will be deducted from the bridge scoring as noted. (See Figure 6.).
6. Once the team has passed the Check Station, the team will wait by the edge of the stage to be called for Load Testing. Students must wear protective eyewear during loading and testing. No exceptions.
7. Once a testing table becomes available, the team will be called to the stage and begin attaching the provide loading block and testing apparatus. The bridge will then be placed in the center of the testing apparatus containing a span of twelve (12) inches. (See Figures 1, 2 and 3.)
8. The load will be applied to a 2"L x 1-3/4"W x 1/4"H loading plate resting at the midpoint of the span on the deck. Structural members must be clear of the eyebolt. A standard five-gallon plastic bucket will be attached to the loading block by a one-fourth (0.25) inch diameter eyebolt, which will be pass up **through the bridge from below**. The roadbed must be constructed to accommodate the 1-3/4"-wide loading plate and the one-fourth (0.25) inch eyebolt at the midpoint of the span. (See Figure 1 and 2.)
9. At this point, the bridge will be pre-loaded with ten (10) pounds, placed into the loading bucket prior to setting the loading bucket onto the testing apparatus. The team will then transfer loading material to the five-gallon bucket until the structure fails. For this contest, structural failure is defined as obvious structural collapse. At point of structural failure, no more loading materials can be transferred to the loading bucket.
10. The total load incorporates the total mass of the loading apparatus, bucket and loading material.

SCORING (See Figure 6):

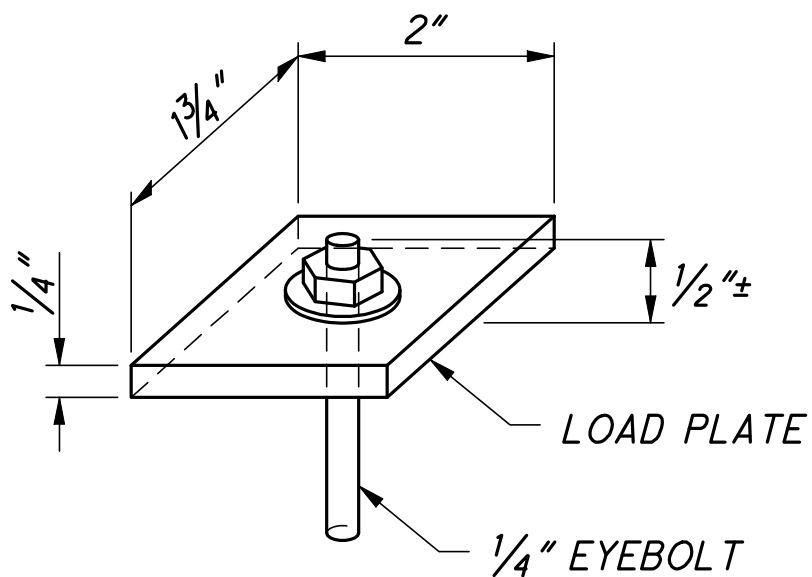
1. Overall ranking will be based on the combined construction requirements and structural stability scores.
2. The structural stability will be determined by the equation:

[Maximum load supported (grams) / mass of bridge (grams) including any weight penalty assessments]
3. When a bridge has passed through the Check Station, it will remain at the Waiting Station until the time of load testing.
4. Event sponsors may take pictures of all bridges that are entered in the tournament for future assessment and instructional purposes.
5. Engineering ethics are an important factor in today's engineering design. If it is determined by the judging committee that a deliberate violation of the competition rules has occurred, it may result in the disqualification of the offending team.
6. **Aesthetics** by definition means "a pleasing appearance or effect." Bridge aesthetics will be judged prior to bridge loading during the drying time. Because aesthetics is highly subjective by nature, there are no "rules" for this portion of the competition.

Students are also advised that their participation in the MV MBBC will be a significant factor for those competing for a future scholarship award to YSU!



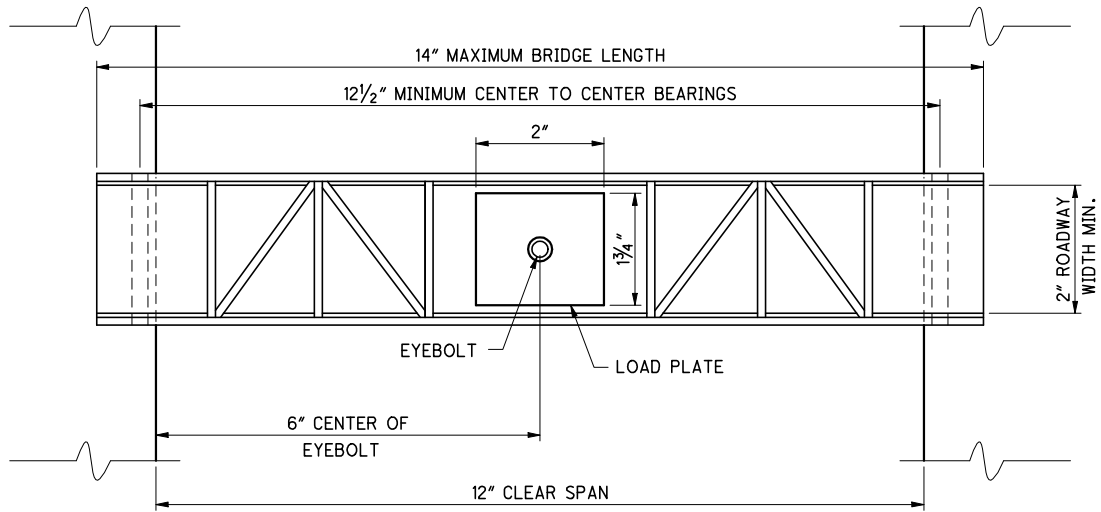
LOADING TABLE SETUP



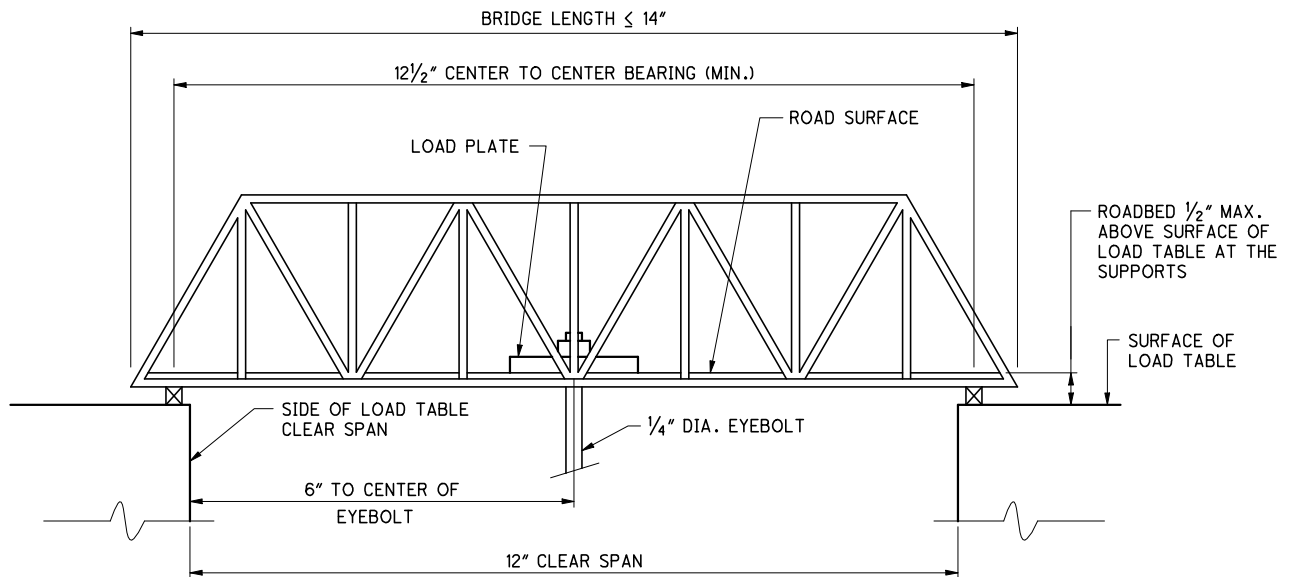
LOAD PLATE DETAIL

FIGURE 1

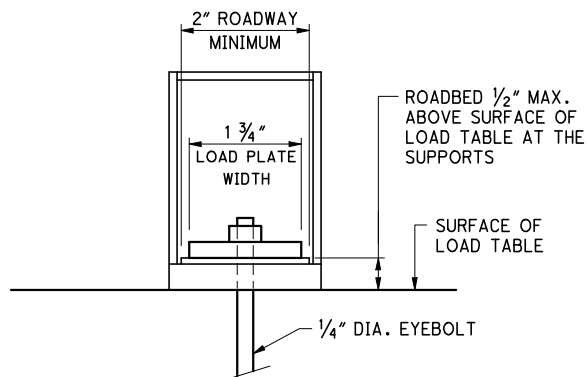
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STRUCTURE PLAN



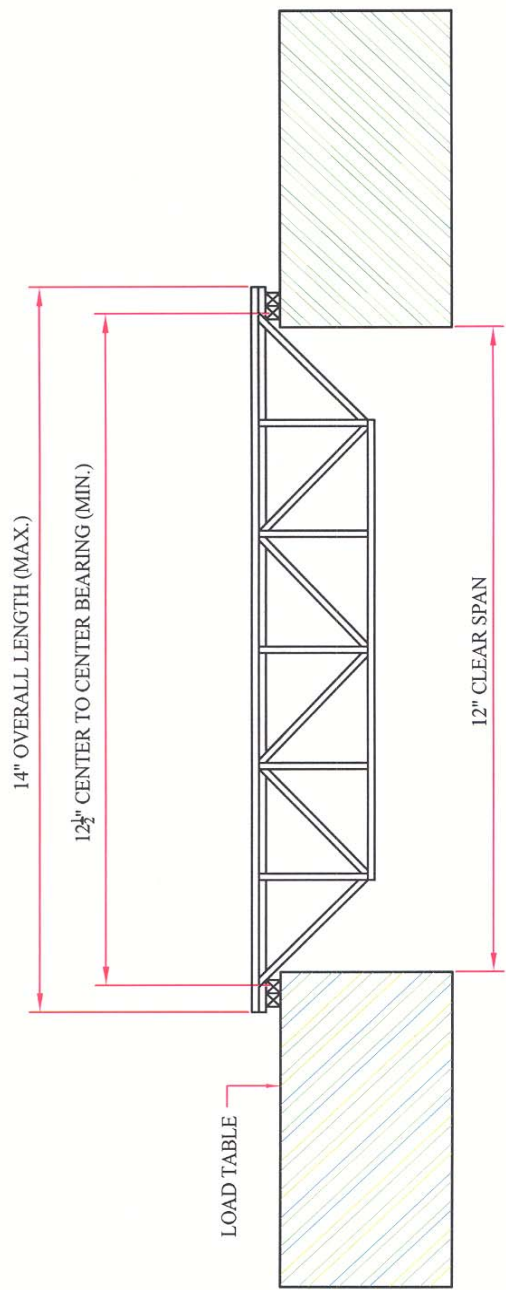
STRUCTURE ELEVATION



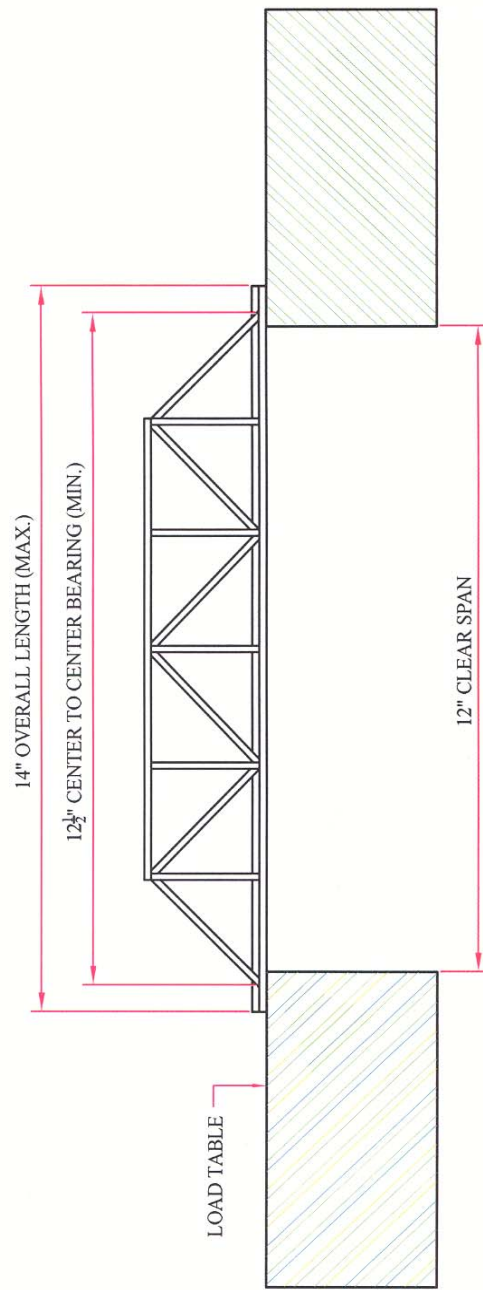
STRUCTURE SECTION

FIGURE 2

(NOT TO SCALE)



STRUCTURE BELOW TABLE



STRUCTURE ABOVE TABLE

FIGURE 3
(NOT TO SCALE)

LAMINATION

**LAMINATED
“BRICK” / SLAB-
TYPE DECK: NO**

Bridge Deck

These types of bridges, where all of the wood has just been glued together to form a slab-type bridge, will not be allowed.

The purpose of this competition is to encourage **creative thinking** in your bridge design!

Your bridge deck WILL need to be braced! It is a thin piece of wood and if you do not brace it, the loading plate will pull right through the wood. You may brace it in several ways, some of which might include truss members, cross-bracing, or pieces of wood glued together to form beams to support the deck.

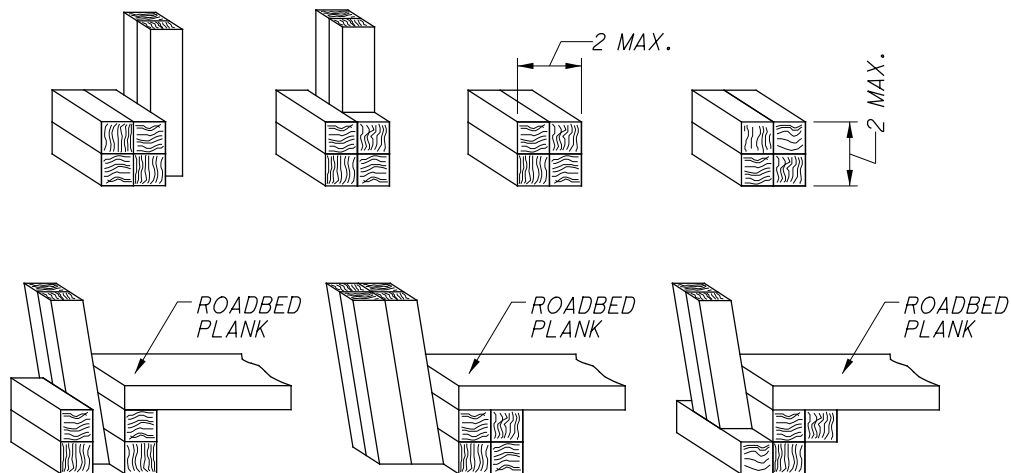
Truss Members

Beams

Cross-Bracing

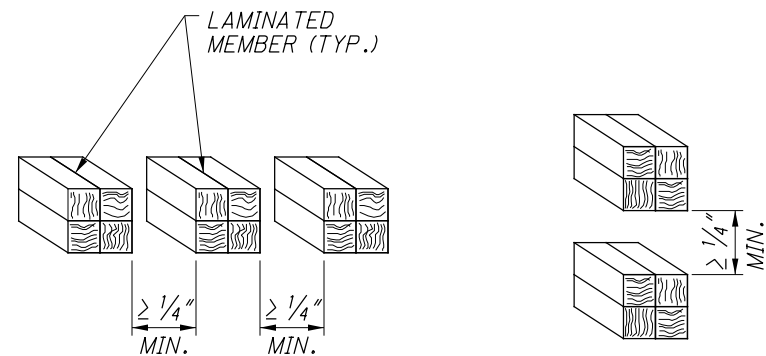
**LAMINATED
MEMBERS: YES**

FIGURE 4

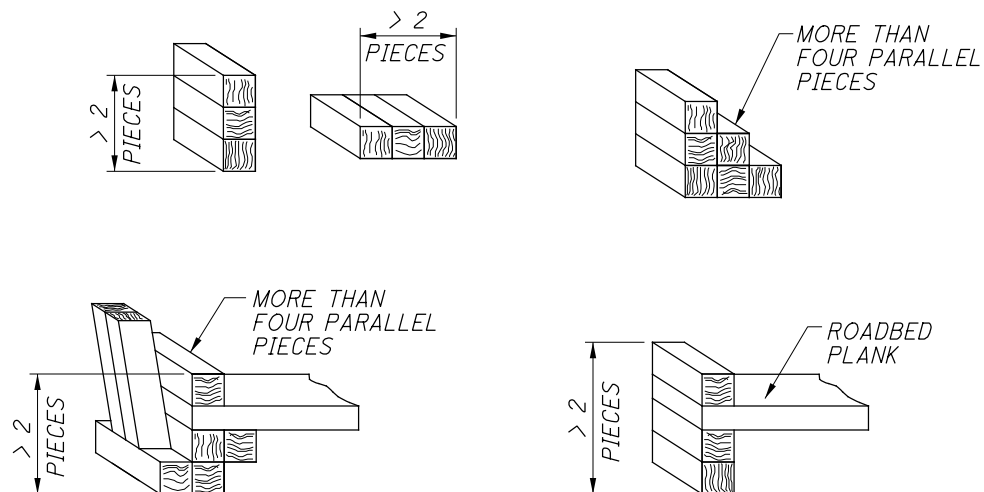


ALLOWABLE LAMINATED MEMBERS

(MAXIMUM OF FOUR PARALLEL PIECES LAMINATED)



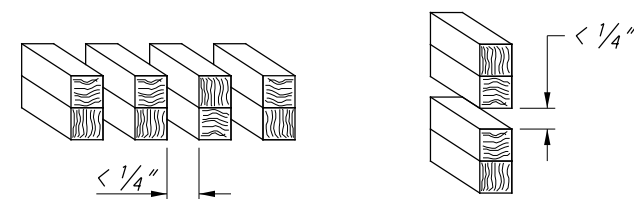
ALLOWABLE LAMINATED MEMBER SPACING



LAMINATED VIOLATIONS

NOTE:

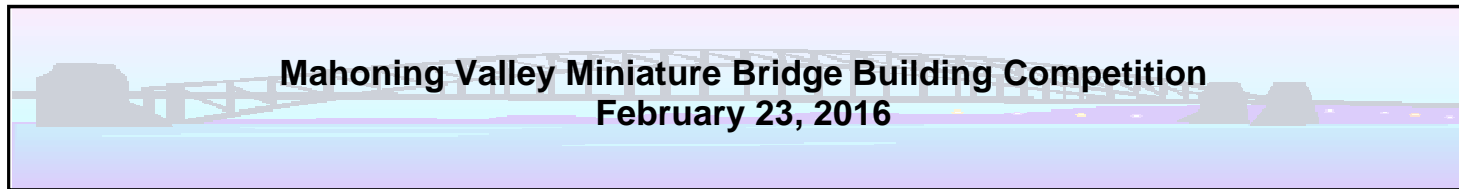
THE ROADBED PLANK WILL NOT BE CONSIDERED CREATING A $\frac{3}{32}"$ SPACING.



LAMINATED SPACING VIOLATIONS

FIGURE 5

(NOT TO SCALE)



BRIDGE SCORE for: High School Name - Team Number

Construction Requirements			
Item	Penalty / Weight Increase	Weight	Notes
Structure Weight, Grams		32	Actual Structure Weight
Structure Length < 12" but >14"	100%		Does Not meet design specifications
Roadbed Length < 12" but >14"	10%	3.2	Does Not meet design specifications
Roadbed Height above Table > 0.5"	10%		Does Not meet design specifications
Clear Roadbed Width < 2"	20%		Does Not meet design specifications
Car does not roll freely along roadbed	5%	1.6	Does Not meet design specifications
Greater than 3 laminated pieces parallel or greater a total of 6 pieces	30%		Inefficient use of materials
Laminated members spacing	30%		Inefficient use of materials
Penalty Total	15%	<u>4.8</u>	
Revised Structural Weight		36.8	

Structural Stability			Ranking
Failure Load, Pounds		60	
Failure Load, Grams		27,216	
Efficiency (Failure Load/Weight)	<u>740</u>		

Structure Ranking	<u>0</u>
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Figure 6