CNY Bridges Challenge Manual & Instructions

Contents

A. Introduction to the Challenge

The CNY Bridges Challenge is an annual competition open to Junior Level (Grades 4-8) and Senior Level (Grades 9-12) teams in constructing and testing model bridges. Teams of 1-4 students can register for the competition to receive a free Bridge Kit, which they should build using a truss design element (see p. 9) in collaboration with their team leader - e.g. teacher, coach, or parent. Teams then bring their assembled bridge to the event, where it will be evaluated based on the Bridge Efficiency (E). All bridges must pass inspection on the day of the event to qualify for competition. Please refer to Section D for inspection and construction details, and to Section E for more about bridge testing and evaluation.

B. Getting Started

Registration and Kit Collection: Register your team to request a free Bridge kit and schedule your pickup by reaching out to the event coordinator at eventcoordinator@most.org.

How to start: Blueprints or plans of the bridge drawn to scale will be very helpful prior to final construction of the bridge. Plans are not required for the competition. Four views should be drawn:

1) END VIEW
2) ROADBED
3) SIDE VIEW
4) TOP VEW

C. Bridge Kit Contents

Each registered team can request a free bridge kit containing the following materials:

- **15** pieces of balsa wood
- **2/3 oz.** bottle of glue

C1. Other Approved Materials and Tools

- Additional glue (any type)
- Cardboard for use as a building board
- Straight Pins to hold pieces in place as glue dries
- Single Edge Razor Blade, or X-Acto® knife, for cutting (with adult supervision)
- Waxed Paper, to cover the plan (blueprint) as you build on top of it
- Ruler or other device for measuring

The use of any unlisted materials is strictly prohibited. No additional wood beyond what is provided may be used.

D. Bridge Specifications and Construction

Note: Bridges that do not follow these specifications can still be tested but are not eligible for awards.

D1. Design Constraints

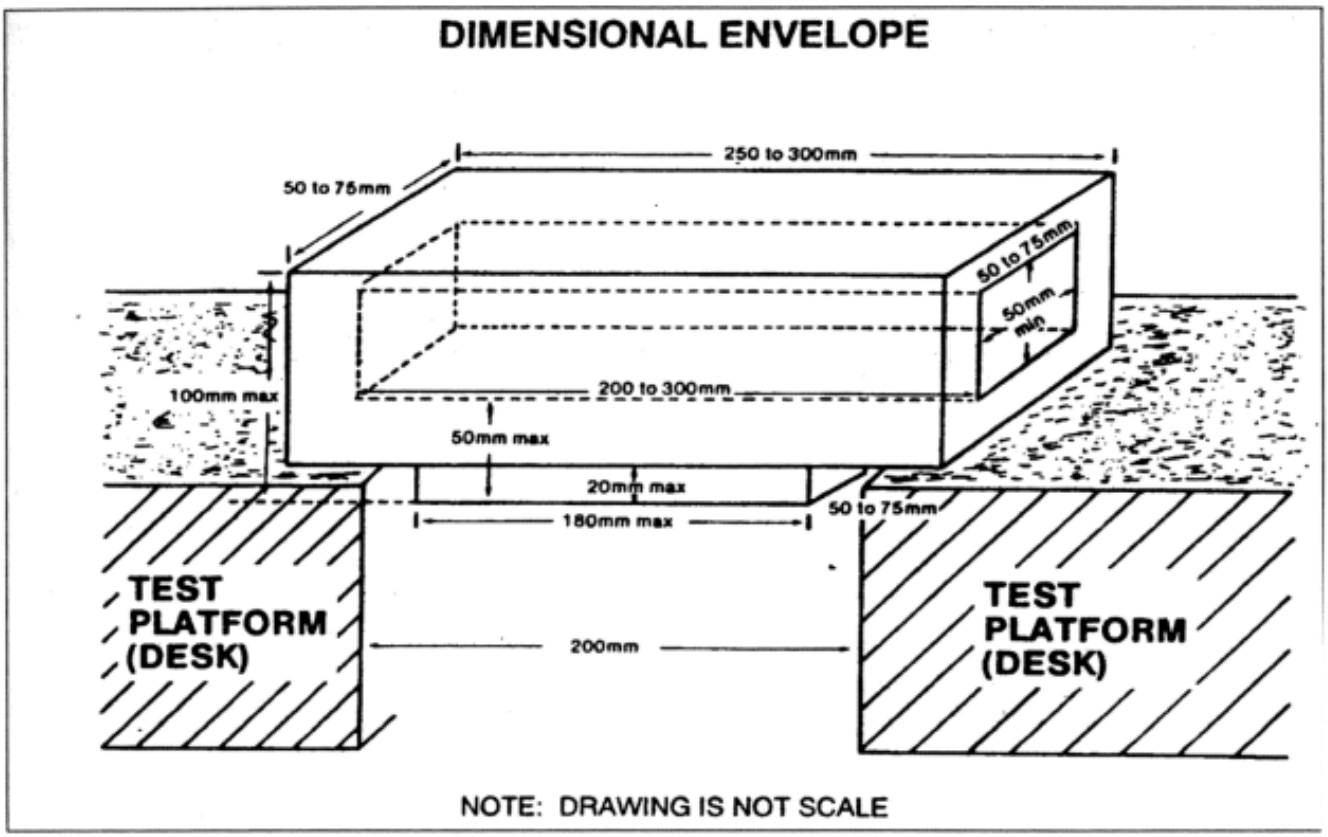
The bridge *must* be built within the dimensions in the table below. (A diagram is provided on the next page.) *Bridges not meeting the geometric requirements will not be eligible to compete.* Bridges failing inspection for these parameters may undergo repairs prior to testing in order to meet the dimensional specifications. Only team members are permitted to make alterations to the structure.

	Bridge	Roadbed	Optional Underhang	Testing Platform
Length	250 to 300mm	200 to 300mm	Less than 180mm	50mm
Width	50 to 75mm	50 to 75mm	50 to 75mm	50mm
Height	Less than 100mm	Less than 50mm	Less than 20mm**	7mm

** Included in the overall height of the bridge

All bridges must pass inspection before testing. If a bridge does not meet the following criteria, it will need adjustments before testing to qualify for the competition. A repair/supply station will be available during the event. Test Block (50mm x 50mm) must be able to pass through bridge

- Test Block (50mm x 50mm) must be able to pass through bridge
- Bridges must have a deck structure to support the test platform. Bridge decks must be accessible to test platforms.
- Bridges shall be loaded only on the bottom of the truss (deck and lower chord)
- Allow space for a 5cm square wooden board to be placed in the center of your bridge. (See Diagrams 1 and 2 for a schematic of the testing platforms.)



Courtesy: MIDWEST PRODUCTS CO., INC. 400 S. Indiana St. P.O. Box 564 Hobart, IN 46342
www.midwestproducts.com

D2. Is Splitting or Lamination Allowed?

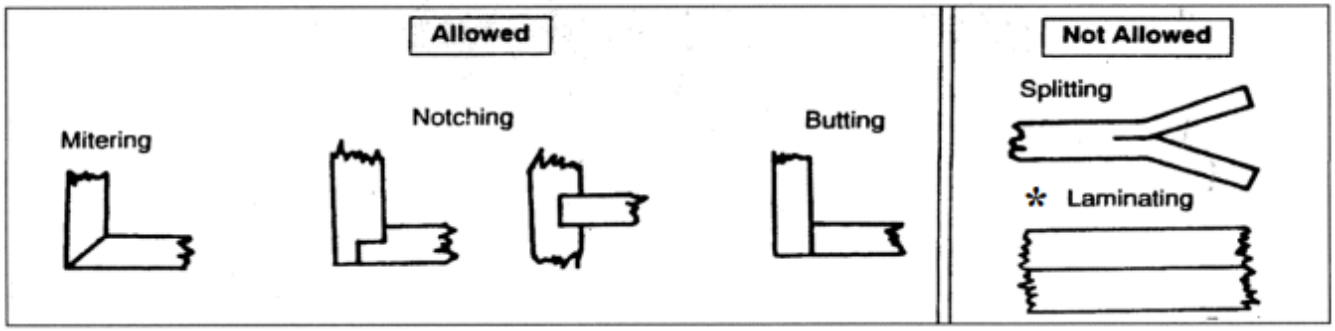
Splitting, or breaking a single piece of wood into multiple layers, **is not allowed.**

Laminating, defined for the purposes of this competition as bonding (gluing) together multiple pieces of wood parallel to one another to create a larger composite truss member, is allowed only for SENIOR LEVEL teams. Please refer to the diagrams below.

- ***No laminating is permitted for JUNIOR LEVEL TEAMS (GRADES 4-8).*** Wood pieces may be bonded together with glue only at joints. If two or more strips of wood are placed parallel to each other, they must be at least the thickness of a sheet of paper apart from each other.
- ***Laminating is permitted for SENIOR LEVEL (GRADES 9-12) teams ONLY***

See sketch below for allowed types of connections:

The Following Types of Connections Must be Considered For Your Bridge:

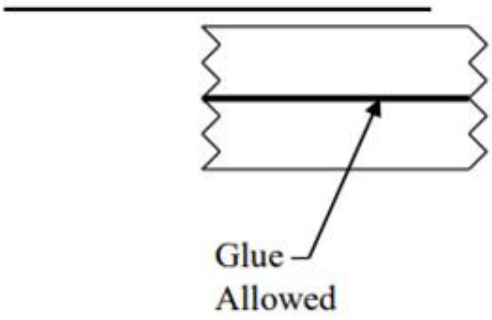


*** Lamination of wood pieces is allowed for SENIOR LEVEL teams only.**

MIDWEST PRODUCTS CO., INC.
Courtesy: 400 S. Indiana St. P.O. Box 564 Hobart, IN 46342
www.midwestproducts.com

* Laminating:

Senior Level Teams:



Junior Level Teams:

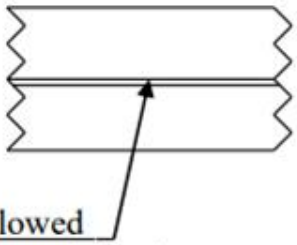
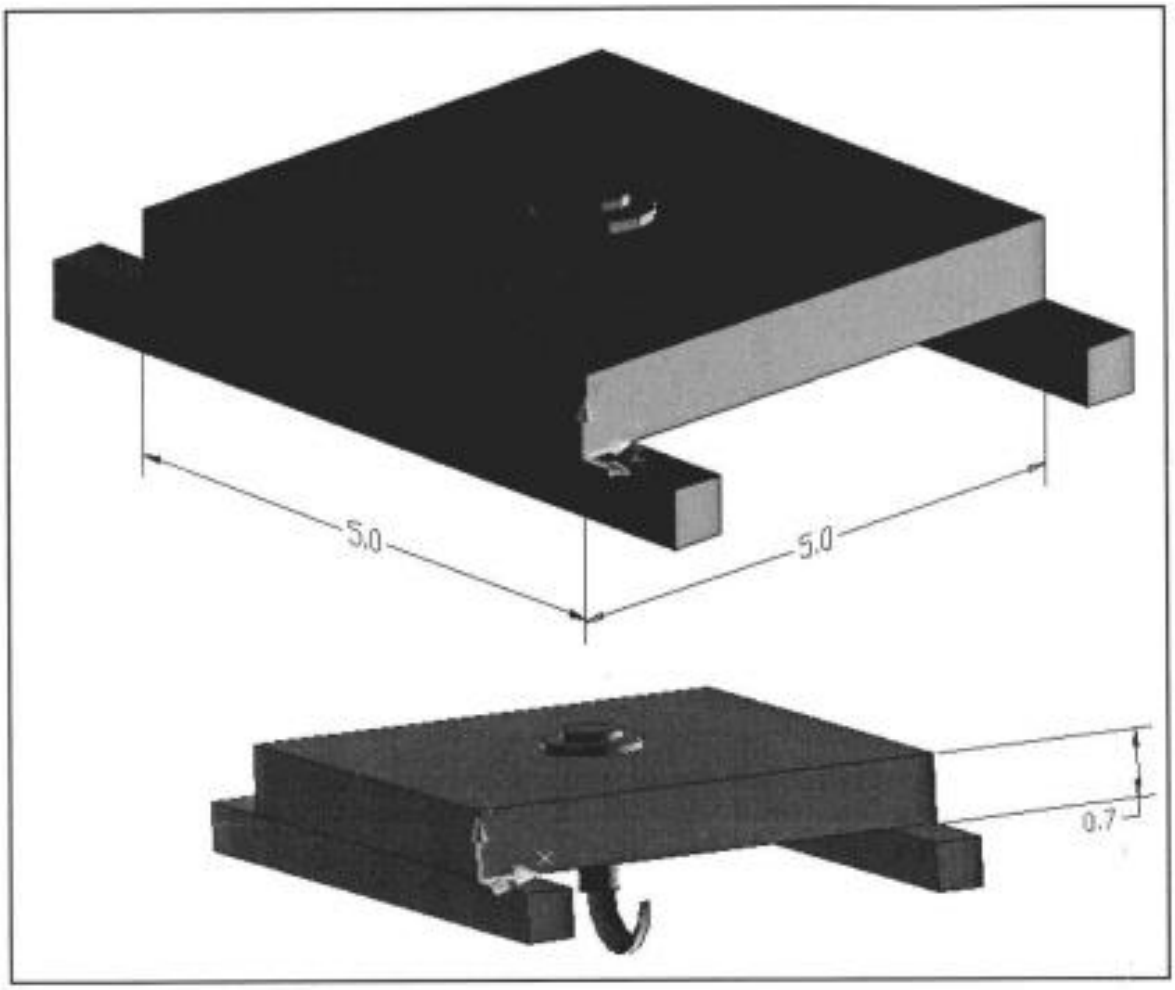


Diagram 1 – JUNIOR LEVEL Test Platform

Sketch of the Testing Platform

(All dimensions in cm)

Note: Figure Not Drawn to Scale



Dimensions of the wooden board:

Length = 50 mm
Width = 50 mm
Height = 7 mm

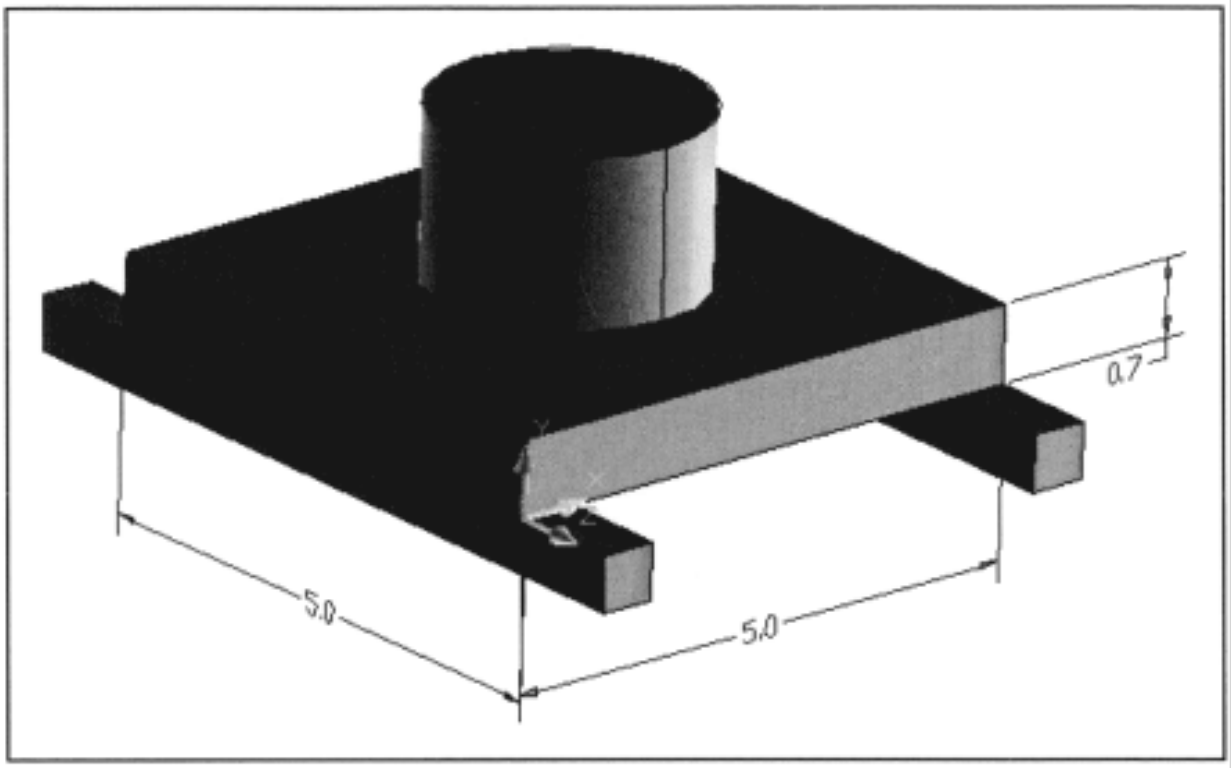
A wooden board has been provided which can be used as a testing platform. The board should be kept at the center of the roadbed on the bridge. The board has been fixed with a hook to which weight will be attached.

Diagram 2 – SENIOR LEVEL Test Platform

Sketch of the Testing Platform

(All dimensions in cm)

Note: Figure Not Drawn to Scale



Dimensions of the wooden board:

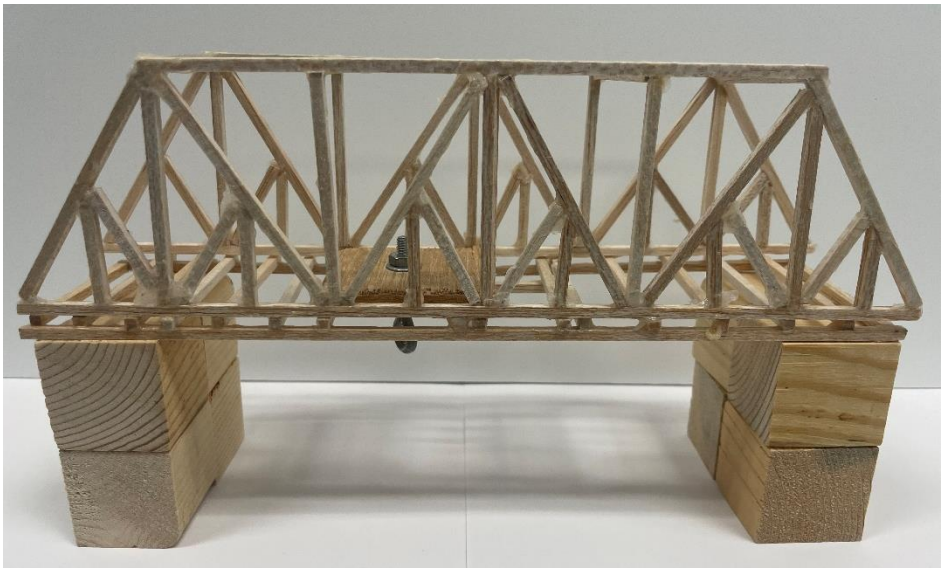
Length = 50 mm
Width = 50 mm
Height = 7 mm

A wooden board has been provided which can be used as a testing platform. The board should be kept at the center of the roadbed on the bridge. Load will be applied from above the board.

E. Testing and Evaluation Procedures

- For Junior Level (Grades 4-8) bridges, the load will be applied to this board from beneath the bridge. The hook, illustrated in Diagram 1 (p.7), must be able to pass below the bed where the load device will be connected.
- For Senior Level (Grades 9-12) teams, the load will be applied to the board by a dowel rod placed vertically on top of the bridge deck. Again, make sure your bridge is designed so that the dowel can be **CENTERED** on the bridge deck from above. See Diagram 2 (p. 8).

Images of the testing setup are shown below:



Junior Testing Setup (Front View)

Junior Testing Setup (Top View)

Senior Testing Setup (Front View)

Senior Testing Setup (Top View)

E1. Evaluation of Bridge Performance

Teams will be evaluated based on **Bridge Efficiency (E)**

Efficiency of your bridge will be determined using the following formula:

$$\mathrm{E} = \text{Bridge Efficiency} = \frac{(\text{Load in kg}) \times (1000\ \text{g/kg})}{(\text{Mass of Bridge in g})}$$

The load will be measured in kilograms, while the mass of the bridge will be measured in grams.

Example: If your bridge weighed 22 grams, and supported 42 kilograms of weight during the test, you would calculate efficiency as follows:

$$\mathrm{E} = \frac{(\text{Load in kg}) \times (1000\ \text{g/kg})}{(\text{Mass of Bridge in g})} = \frac{(42\ \text{kg}) \times (1000\ \text{g/kg})}{22\ \text{g}} = 1909$$

F. Awards and Recognition

F1. Awards

The following prizes will be awarded at the conclusion of the event:

- Top Overall Bridge Efficiency, 1st – 4th Place (Senior Division)
- Top Overall Bridge Efficiency, 1st – 4th Place (Junior Division)
- Best Team Name (Senior Division)
- Best Team Name (Junior Division)
- Team Spirit

G. Tips for Bridge Construction

1) **Be sure you understand the event rules before designing your prototype.** Revisit the “Bridge Specifications and Construction” and “Testing and Evaluation Procedures” sections of this manual in particular.

2) **Draw your preliminary design with full wood outlines.** This should help you to decide whether to use butt joints or lap joints.

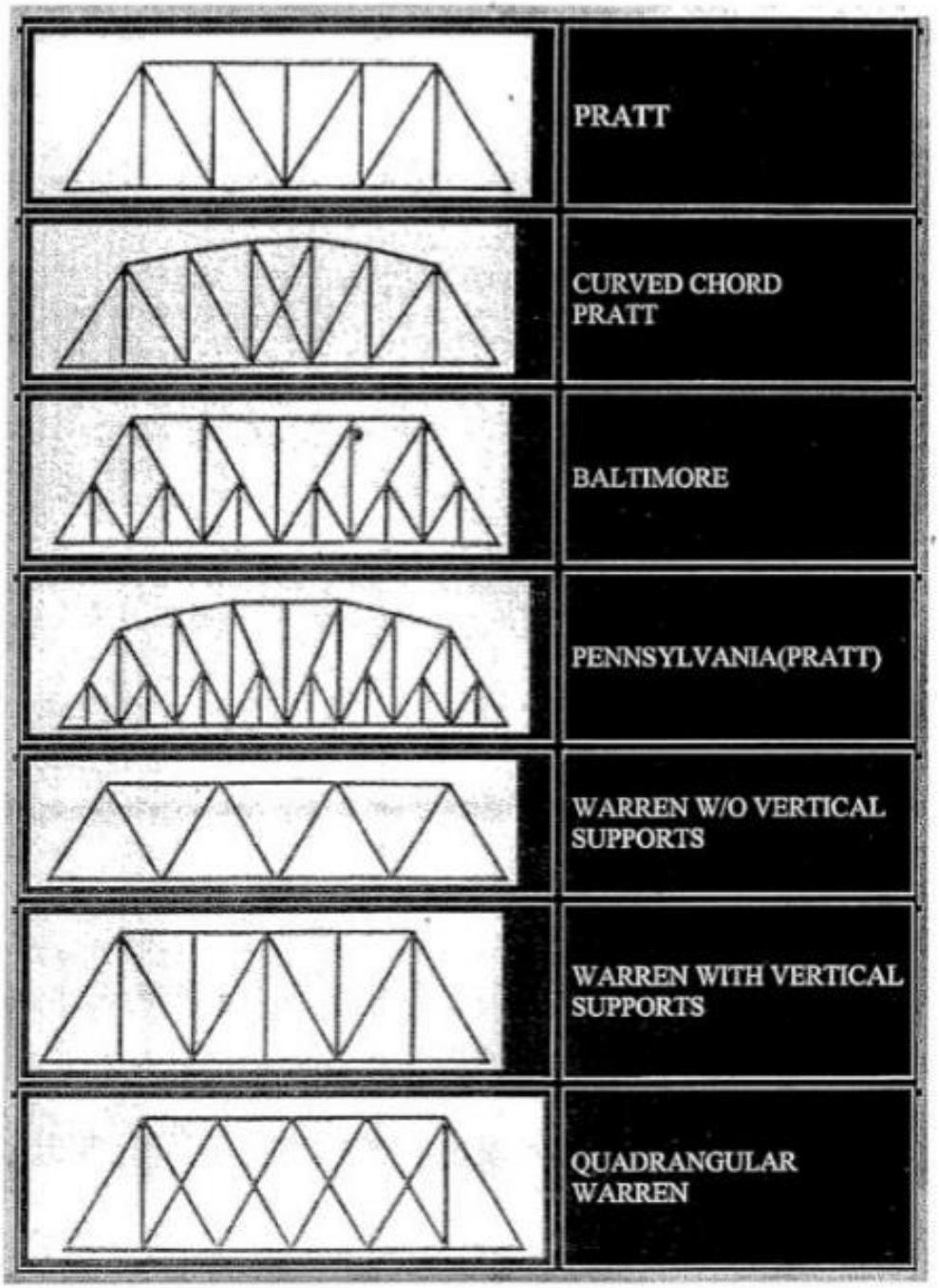
3) **ALL joints should have absolutely flush surfaces before applying glue.** Anytime glue is used as a "gap filler", it dooms the structure! Cut the wood precisely and carefully sand the part so that it fits flush. Then, number the part and use it as a template to make numbered duplicates in assembly sequence (i.e.: two for bridges, four for towers).

4) **Structures are symmetric.** When building a bridge or a tower with two or four sides, build the two primary sides one on top of the other. Once the first side is built, cover it with wax paper and **build the second side directly on top of the first.** This helps ensure the structure’s symmetric integrity.

5) Most competitions require these structures to be weighed**. Up to 20% of the structure's mass may be from over-gluing.** Adhesives do not work better when they are drooled all over the structure. Use the adhesives sparingly where any more than a translucent, moist surface becomes wasted, excess mass.

6) When building a balsa wood structure, **pretest all the strips for tensile strength before assembly.** A simple deflection test works best. The strips that deflect the least are the strongest. Use those for the longest pieces. The ones that deflect the most, you should use as the shortest pieces. When the structure is finished, it should have a relatively consistent load-carrying capability.

7) See example truss designs below:



H. Resources

https://engineeringstatics.org/Chapter_06-trusses.html

https://www.sciencebuddies.org/science-fair-projects/project-ideas/CE_p006/civil-engineering/the-design-process-creating-a-stronger-truss

https://skyciv.com/docs/tutorials/truss-tutorials/types-of-truss-structures/#pratt

I. Vocabulary List

- **Member:** Framework of the truss (beams usually made out of wood or metal)
- **Truss:** Multiple members joined together in a certain pattern with the objective of withstanding loading
- **Zero-force member:** Member that does not bear any load, but adds structural stability to the rest of the truss
- **Failure:** Breaking point of a member where it can no longer function
- **Ultimate Tensile strength:** The amount of tensile force it takes for an object to fail
- **Flexural strength:** Resistance to deformation when a load is applied, specifically bending
- **Bridge Efficiency:** Ratio of how much load the bridge can handle to the mass of the bridge