Bridge Equipment/Construction/Evaluation

Equipment List

Basswood 3/8" x 3/8" x 24" (~15-20 sticks /group)
Tite Bond Glue
11 x 14 gridded paper for full scale drawings
Foam board
Wax paper
Beaded Pins
Scissors/Xacto type knives/Timber cutter (optional)
Balance
Instrument Tester:
    Commercial--Pitsco
    Home-made--Free Weight

Construction

Project Group of 4

Basswood 3/8" x3/8" x 24" strips were used for the bridge (balsa wood may also be used). These are available at hobby shops. However, the first time it may be preferable to purchase them from Pitsco and obtain their brief pamphlet on tips for construction. (It is copy written so it is not included here.). Pitsco includes glue, small bottles, graph paper (all of which is readily available locally)

Although green glue is provided by Pitsco, I prefer tite bond and subdivide it into small dropper bottles. This glue is advertised as forming a stronger bond than wood and it does. This stronger bonding glue puts the focus on the truss design, which is the key design feature. Small balsa sheets are preferred for the gussets, since it is also a wood bond. Cereal box cardboard will work but is a weaker bond. The gussets are employed to provide for surface area for contact and make the joints more robust. The quality of the workmanship is quite varied. Some groups angle the members for better wood-wood contact, while others are content to get close.

The wood strips can be cut to size with a scissors, with an X-acto knife, under supervision, or with a Pitsco timber cutter ($20). This cutter allows for angles, but adds to the expense. The 50 g limit for the bridge is not a severe limitation, since strength to weight ratio is the primary evaluation factor. Most bridges weighed in at ~30 g. As an estimate, that is about 15-20 sticks/group (including waste). We began with 150 sticks and have about 40 left over. That's about $6-8/bridge.

On one earlier occasion, Popsicle sticks have been used. The quality of the design was not as good creative since only full length sticks were used. In another trial, half-width popsicle sticks were evaluated. These sticks easily bent under stress which distorted the testing. Overall, the use of popsicle sticks turned out to be a test of the strength and quantity of the wood, rather than the truss design.

Construction

After the truss design is complete, the students use 11 x 14 graph paper to lay out the exact design in top, bottom and truss views. This drawing is covered with a sheet of wax paper and attached to a foam board with headed pins. The members are cut to size, held in place with the pins, fit with gussets and glued. Clips are also provided and some groups use these during the initial phase.

The roadway only has to support the testing block. However there should be enough cross supports to that this is not a limiting step. It is important that the members be attached to the upper-side of the roadway so that the member is supported by the beams and that the glue joints are not the weakest link.

When the components are assembled, s is important that the bridge unit is square. If it is not, a torque will develop when it is placed on the instrument tester and the additional stress will reduce the load capacity. The different groups are welcome to discuss techniques (but not design).

It is important also to have the testing block available to be able to check the dimensions—both that the block will fit and be supported by the roadway and that there is clearance in the exact center so that the testing rod can be inserted.

Some class time is spent to be sure that the groups are on the right track, but the bulk of the work is done by the groups on their own.

Testing

Safety glasses should be worn during testing, since the members may splinter

All bridges are weighed and inspected for compliance before stress testing.

There are several options for stress testing the bridge. The Pitsco Instrument Tester is really designed for this. Unfortunately, it is quite expensive (the recently redesigned model is upwards of $1300, which is really outrageous.) I was fortunate to find one on the web for $150. It was missing a few parts, which were easy to fabricate. You may not be so lucky.

The next best option is to use a free weight design. The bridge is placed between two tables. A hanger bracket connecting the bridge to the free weights is attached to a basket type holder. The weights can be loaded in increments. Weights are usually available from the PE Department. If this method is used, some padding to protect the floor is recommended. A variation on this approach is to use a pail and add sand in increments. This is not recommended since multiple transfers of sand are required and sand particles tend to spread in the room.

The free weight equipment is easier to see than describe. A quick search of youtube will provide all the ideas you need to find an easy to construct system. Two links to get you started:

http://www.youtube.com/watch?v=PXG6CjFX6kc

http://www.youtube.com/watch?v=clOXmFdVHLw

Pitsco now makes a Balsa Truss Tester ($79) which works with both a hanging weight (as well as their expensive instrument, which may be the most economical compromise. This can be used to test trusses and compared with the simulations. However building and evaluating just a truss is not as satisfying as testing a bridge, even if some precision is lost.