

This handout will help you to fulfill the IRP requirements for the Physical Science Unit on Materials and Structures. It will provide some organizational features, background material and some suggestions as to how to ensure your students get the most out of the experience.

It is not a recipe for building a winning bridge. It does not have detailed lesson plans but it does contain a possible schedule for a one month experience culminating with the Popsicle Bridge Building Contest to be held in Capilano Mall outside WalMart on March 1st 2009.

The object of the contest is to build the strongest bridge possible with up to 100 popsicle sticks and white glue. The bridge must be capable of transporting a Matchbox or HotWheels car from end to end. The rules give the complete specifications for the bridge and must be complied with if the bridge is to be entered into the competition.

Official popsicle bridge building kits with 125 popsicle sticks and glue pack will be available from Kids Books in Edgemont Village and cost \$5 for an individual kit and \$50 for a class set of 25 kits. E-mail popsicleengineer@gmail.com to order a teachers' kit or to request more information. There will be an additional grade 3 class competition for those for classrooms that enter at least 10 bridges on competition day - the three classes with the greatest number of entrants will win a "pizza day" for their entire class. Children must attend with their own bridges, as the event can only be a success with the participation of the contestants. Each kit is registered so the purchase price can be returned at the test site. Further details and full rules at:

www.apeg.bc.ca/services/branches/seatosky/popsicle.html

Extra materials the teacher would need to supply would include large sheets of drawing paper for planning bridges, paint brushes for applying glue, small containers (medicine cups?) for the glue/water mixture, rulers and extra sticks for practicing with. Build on waxed paper to prevent the sticks from being stuck to the building surface. Use small plastic spring clamps (Canadian Tire), Bulldog clips or clothespins to clamp the sticks together when drying.

A downloaded, printed and enlarged set of rules should be posted within the classroom. Charts for keeping track of the number of sticks used are useful to have and prevent disqualification by an extra stick or three. Make a timeline/schedule and prepare a countdown calendar so the students can see how many days are left until the bridges need to be finished. It is suggested you leave a few days for a final inspection and/or repair. Count the sticks again!

A diagram made life-sized to show the maximum and minimum sizes for the bridges may be a useful tool. A life-sized test bed (actual measurements from the rules) could be constructed out of corrugated cardboard to allow students to quickly check their bridge for size.

You will need to decide whether your students will work as individuals or in pairs when building bridges. There is little doubt that there is much to be gained when students are paired and need to communicate orally as they proceed with a project. Bear in mind that you will need to enter a minimum of **ten** bridges to be considered for the class contest.

As the bridges are built a bit at a time, set aside a regular building time and post the schedule. Glue needs time to dry properly and the bridges cannot be built in only one or two sessions. A shorter construction period each day is required rather than a longer lesson once or twice a week. Have adequate storage space for the bridges under construction and have a discussion of the importance to not touch any bridges that are not your own. Have some signs posted prominently as reminders for both your students and visitors.

See if a parent can help with the organizing of the safe delivery of the bridges to Capilano Mall on the day of the testing. Remind students that every bridge will be broken during the testing but the ultimate load will be recorded and will be available on the web. You will need to register your grade three class as above, purchase the bulk kits and enter at least ten bridges to possibly win one of three pizza lunches for your class!

The IRP requirements for the unit on Materials and Structures are as follows:

Students will describe shapes that are part of natural and human-built structures (e.g. domes, arches, pyramids, triangles, cylinders, spheres, ovoids, cubes). (A)

Students will compare the effects of different materials, shapes and forces on the strength and stability of different structures. (B)

Students will conduct investigations into ways to improve the strength and stability of structures. (C)

Vocabulary: strength, balance, structure, materials, force, gravity, tension, compression, flexible, dome, arch, triangle, pyramid, cylinder, load, fasteners, design, construction

Have your students look at pictures of structures with shapes as in A above. There are many sources for these pictures and the Internet or local library allows access to many of them. Modern architecture and time-tested architecture should be represented in the samples and students could certainly research and present examples they find as well.

It is important to allow students to experience some basic understandings of shapes that are both strong and able to withstand being deformed by forces. A fairly simple way to do this is to construct structures with 4cm pieces of chenille (pipe cleaners - cut with strong scissors or kitchen shears) used to join straight, plain plastic soda straws from the dollar store.

With these elements you can build squares, triangles, tetrahedrons, cubes and rectangles easily and by cutting the straws you can add in triangular bracing. By using modelling clay to hold straws to the desk you can fix structures to a surface and further check stability by loading the structures and pushing them sideways to see if they can withstand lateral forces. (B & C)

When you are confident your students have enough information and ideas you can enter into having your students practice construction techniques followed by the testing and building of various elements such as beams, sticks connected at an angle, cross bracing, etc) they will use when they build bridges. Practice with extra popsicle sticks you buy at the dollar store. Use only the 100 best from your registration package for your contest bridge.

*****Resist the urge to get building the bridges before the students practice building.*****

- Avoid 'bad' popsicle sticks. Check your sticks over for flaws before you use them.
- Overlap sticks enough to make the joint stronger than one stick and then add a clamp.

- White glue can be thinned with water to improve its ability to fully contact and soak into the wood in the popsicle sticks to make a stronger joint. Glue has no strength by itself. Please note that despite all of the warnings about using only white glue, there is little advantage at all to using crazy glue and the like. In almost every case where a bridge has had time to dry, and historically always with the strongest bridges, it is the popsicle sticks that fail first - not the glue joints.
- Glue is best applied with a small paint-brush as too much glue can weaken the structures. Generally, if glue is oozing out there is probably too much in the joint. Excess glue can be wiped away with a wet paper towel.
- Allow joints to dry overnight. Remember that if a bit of time is available each day for construction then students can keep the excitement going throughout the experience.
- Introduce the system you will use for keeping track of how many sticks are used and have your students begin the process with their test structures.
- Student journals with simple diagrams are useful and could allow you to introduce the element of measurement in cm of course. Things to measure would be height, width, length, length of overlap, etc.

When you feel the students can effectively join sticks together, it is time to plan the bridge and make a life-sized drawing of a side and a top view making sure it is both long and wide enough but not too long, wide or high. In other words, make sure the rules are followed!

Beam building - Beams are the main structural components of any bridge and do the dual job of spanning a gap and carrying the load to the other structural elements.

Truss building - The bridges that seem to do well use an inverted truss construction that hangs below the bridge deck. This allows the loading plate for the testing apparatus to be placed easily and allows for lateral bracing (side to side) to be installed easily. Truss diagrams and much more may be found at:
<http://www.garrettsbridges.com/design/trussdesign>

Designing and drawing the bridge - Your students should plan their bridge with some rough sketches. When they have decided upon a design they can make life-sized side-view and top view drawings. Have them use rulers and pencil so they can rub out any errors.

It is important that the bridge be symmetrical from one end to another in order to have the load evenly distributed. Each side must be exactly the same to prevent any twisting when the two-sided bridge is under load. Avoid any lean from side to side when viewed from an end. Bridges that lean will twist and then fail quite quickly.

Once the drawing has been done then the bridge can be laid out (no glue) to see how many sticks it will need to make each side. Remember do not cut or split the popsicle sticks.

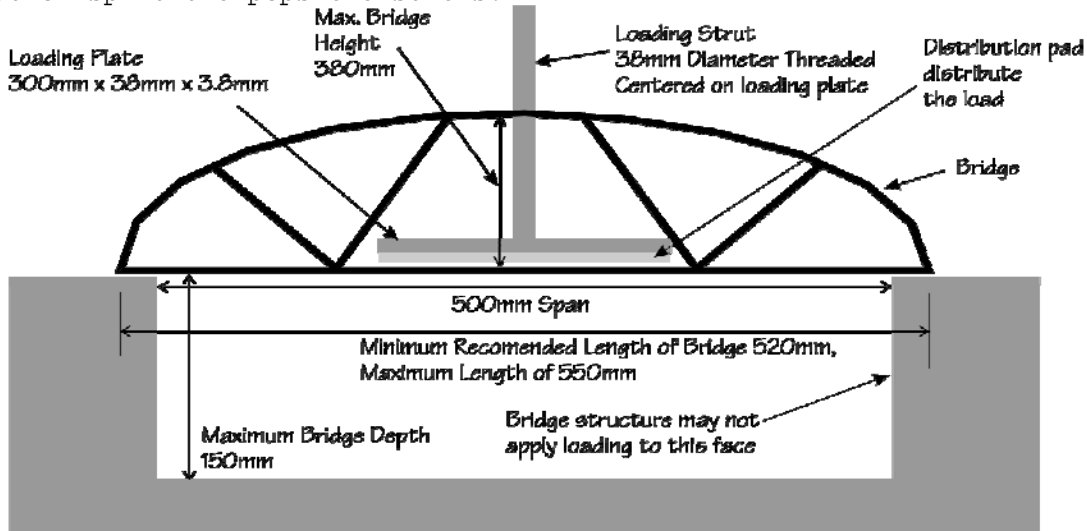


Figure 1a - Side view of Bridge in testing apparatus

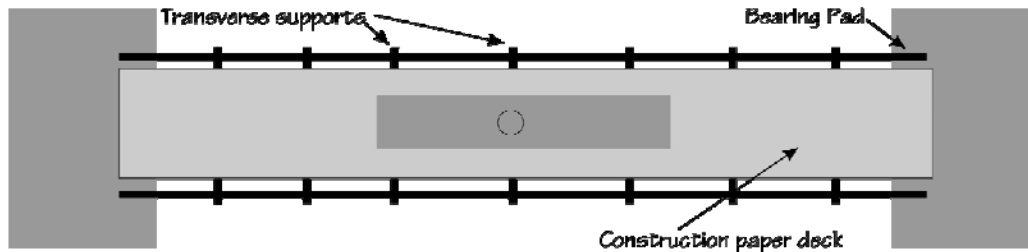


Figure 1b - Top view of bridge in testing apparatus

As you can see, your paper must be at least 60cm long and 55cm wide. White or Yellow paper large enough for the life-sized plans can be obtained from your large paper rolls. Use three short strips of tape to make a length gauge on a countertop or table. Make one strip the starting mark (0 mm), the second and third tape strips are placed 520 mm (min) and 550 mm (max) from the 0 mm tape. To help avoid disqualification, be sure each bridge's length falls between the two marks. Of course, extra sticks can be used for reinforcing weak spots.

Event Schedule

Bridges will be tested in order of their ticket number (the order that entrants picked up their kits at KidsBooks). We have two test rigs working in tandem, so we anticipate the schedule working as follows:

Ticket #	Testing Time
1 - 100	11:00 am - 12:00 pm
101 - 200	12:00 pm - 1:00 pm
201 - 300	1:00 pm - 2:00 pm

Prizes will be awarded after the last bridge is tested after 2:00pm. Treats (hot chocolate), surprise spot prizes (hats, gift certificates...), and bridges failing *dramatically* should make for a fun spectator event. We'll also have some fun activity booths around the event. For those who win a prize but are unable to return for the award ceremony, prizes can be picked up at the end of the day. If it's looking "close", you may leave a cell phone number can be left with the judges and we can contact you to let you know if you've won a top prize.

If you are a grade three teacher and want to enter your class bridges you will be able to estimate when your class bridges will be tested by their numbers. e.g. If your class has tickets 120 through 135 then the bridges will begin to be tested shortly after noon. Classes with the most bridges entered (with the child present!) will be in the running for the pizza lunches. Prizes will be given for the most number of entrants, and individual children will also be in the running for prizes for the strongest bridges.

The following event promises to be a wonderful chance for students to learn and work under the engineering expertise of professional bridge builders. It is an exceptional opportunity that could result in a great experience for budding bridge builders. Reserve a spot early to avoid disappointment.

Special Workshop!

Buckland and Taylor (yes, the internationally famous *bridge engineering firm* at #101 - 788 Harbourside Drive in North Vancouver) has volunteered to put on a bridge building workshop on:

Wednesday, February 18th at 7:00 pm.

Space is limited, so we ask that you RSVP by e-mail to CScollard@b-t.com with "Popsicle Stick Bridge Workshop" in the subject line.