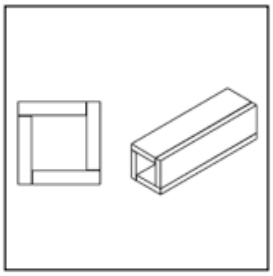
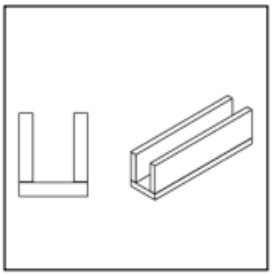
Bridge building knowledge base

Beams and channels

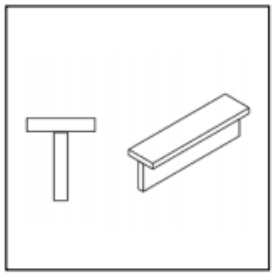
Below are some examples of beam and channel shapes. These excel in different areas, so feel free to experiment and see which types will suit your bridge designs.



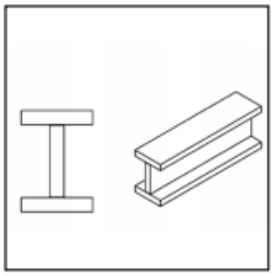
square channel



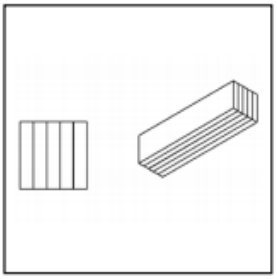
Parallel flange channel



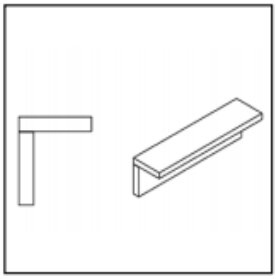
T beam



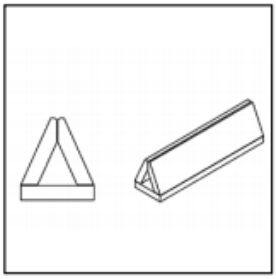
I beam



Square/rectangular member



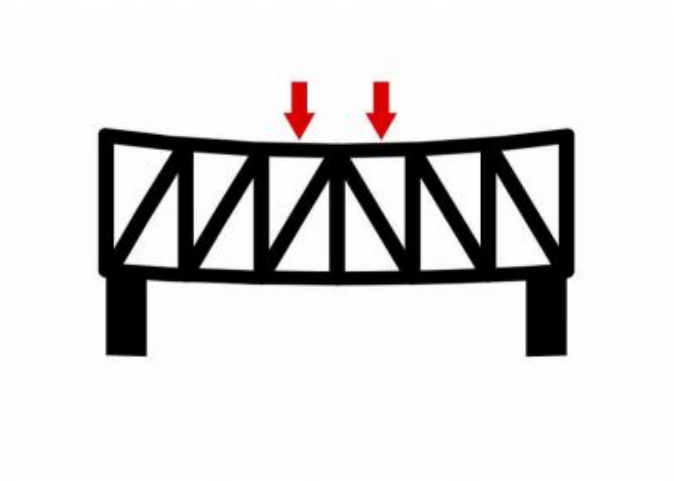
equal/unequal angle

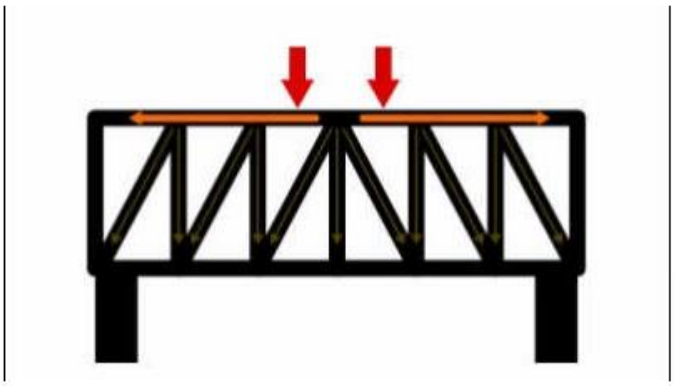


triangular cross section

Forces

When constructing your bridge, pay attention to how the load is being distributed amongst all the members. Is your bridge symmetrical? Is the force being distributed evenly? Sometimes it might also help to draw diagrams to help visualise force flow. Below are some examples of force flow:





Construction Tips

- To improve the strength of your bridge, and also make it easier to plan and design construction, try designing a wireframe of your bridge first using AutoCAD, SketchUp Make or SketchUp Free. This will ensure you don't run out of materials and help you plan the structure of your bridge before you build it

- Pay attention to the *joints* between the timber elements. This is critical to the bridge achieving its capacity. Bridges most often fail here because of lack of glue or inadequate contact between the two surfaces

- Think about the forces in each *member*. Will it be in *tension* or *compression*? In other words, are the *members* being stretched or crushed? Picture how the bridge will *deflect* (refer to Figure 5) – this will help you visualise the forces in the *members*. Long *members* in *compression* have a tendency to *buckle*. A *member* that is long will *buckle* and therefore fail more easily than a short *member* of the same cross section

  You can try this out with a ruler. Carefully push on both ends of a plastic 30cm ruler and see how it bends as you apply force. Now get a friend to gently support the centre of the ruler with a finger on both sides, and again carefully push on the ends of the ruler. Notice how the ruler resists more force. If you have long *compression members* in your bridge, consider reducing their unsupported lengths by connecting them to cross *members* or *bracing.* A *member* that is in *tension* will most likely fail at its *joints*

- Think about where the maximum forces are going to be applied, and how this might affect your construction method. Remember all the pieces provided are shorter than the distance the bridge needs to *span*

- Think about the most efficient use of the materials supplied. The aim is to use all the materials provided in your bridge design, except for these guidelines and the tube of glue itself

- If you use the string to supplement the strength of balsa wood *tension members*, try *tensioning* the string. *Untensioned* string adds no benefit. You can *tension* the string by gently applying a *compression* force to your *tension members* while fixing the string in place until the glue dries. Remember to only apply a force to your *members* once they have already been glued in position. Failure at supports is common due to the *shear forces* present. Your design needs particular attention in these areas to make them strong and stable. The ability to resist *shear forces* depends on the amount of material used. Two pieces of balsa wood will have twice the strength to resist *shear force* than a single piece

- Be as accurate as possible keeping symmetry about the *longitudinal axis* of the bridge (parallel to the direction of the *span*). This will help the bridge load evenly, and prevent twisting of the bridge as well as assisting in maintaining stability

- Don't forget to take visual appeal, workmanship and creativity into account when designing and constructing your bridge– points will be awarded for these three categories.