

Spaghetti Bridges

Building a bridge from spaghetti

Subject(s): Design & Technology

Approx. time: 60-90 minutes

Key words / Topics:

- > Structures
- > Bridges
- > Triangles
- > Health and safety
- > Glue

Suggested Learning Outcomes

- > To understand that triangles can be used to reinforce structures
- > To be able to safely use a glue gun
- > To be able to design and make a bridge structure

Introduction

Bridges are structures that are designed to support a load, such as the cars and lorries that need to cross above a river. The structure of a bridge has a significant affect upon its strength and its stiffness. A bridge made from square shapes can be made significantly more rigid and less likely to collapse by adding reinforcement to form triangles. This principle is widely used in civil engineering.

This activity could be used in Key Stage 2 as a stand-alone activity, as a focused task to develop skills in the use of the glue gun, or as part of a structures project investigating bridges.

Purpose of this activity

In this activity pupils develop both their skills in using a glue gun and demonstrate their understanding of how structures can be reinforced, by making a bridge from spaghetti.

Activity

1. Demonstration of using a glue gun (10-15 mins)

Outline the rules for using glue guns:

1. Always treat a glue gun as if it is hot
2. When not being used, always stand the glue gun up
3. Always use a board underneath what you are gluing
4. Only one person can use a glue gun at a time
5. Never touch anything with the hot end except for what is being glued
6. Never touch the glue – it could still be hot

Demonstrate the safe use of the glue gun to make a side

Teacher notes

The bridges are manufactured using glue guns as a team activity. Team sizes of 2-4 have been effective to complete the task in the given time. Depending upon the strengths and capabilities of the pupils, it may assist effective solutions to allow additional 'design time' of 10 minutes before starting the manufacture of the bridge.

One glue gun is required for each team. If the pupils do not have sufficient maturity to use the glue guns. The glue gun should be of the cool/low melt type to minimise risks. As for all practical activities, the school must have





of the bridge out of spaghetti, using the Bridge (handout).

2. Making a spaghetti bridge (30-45 mins)

Working in teams, pupils have 45 minutes to build a bridge from spaghetti.

Each team can only use 15 pieces of spaghetti – they can break some of it into smaller lengths if needed or to reinforce the structure. Higher ability teams could design their own bridge; lower ability teams could use the handout, sticking the sides of the structure on to the paper, then attaching the sides together.

3. Testing (20-30 mins)

Testing of completed structures, comparing which is the strongest. This involves hanging an increasing load from each bridge until it fails.

The gap for the bridges could be made by moving two desks close to each other. To test the bridges, place a strip of material over the centre of the bridge and tie this underneath the bridge. Suspend the weights from this material. Start with a low weight and increase in increments until failure.

Pupils could record the maximum values for each team in a table or on a whiteboard. During the testing they could be asked to identify how each structure could have been made stronger or taller.

a risk assessment in place for the use of this process. This can be developed from BS4135:2014, the Code of Practice for delivering Design & Technology in educational establishments, or commercial bodies such as CLEAPSS or the Design & Technology Association. If using a risk assessment obtained from a third party, it must be customised to take account of the specific environment of the school.

For the full-length pieces of spaghetti used, it can be effective to stick multiple pieces of spaghetti side-by-side, although this consumes material. If a long piece is broken, a short piece can be used as a 'splint'. If using the handout, this is not necessary as the act of sticking different sides together performs this function.

The amount of spaghetti can be increased during the competition if needed – i.e. at the half way stage teams can be issued with 3 or 5 more pieces. This can be an effective tool to see how they adapt their designs or apply their knowledge of reinforcement.

Pupils may apply excess glue in the thought that this will make the structure stronger. However, the moisture in the glue can actually weaken the spaghetti, meaning that excessive use can lead to a weaker bridge.

If using the handouts, experience indicates that pieces of paper attached to the spaghetti will not make a significant difference to the testing and can be left attached. However, multiple layers of paper, particularly when folded or overlapping and glued, may affect the testing and should be cut or carefully torn away.

For the testing, the loop of material means that the load is distributed over the structure. If the weights are applied directly to the base of the bridge, this will typically fail before the full structure.

The weights typically used in science experiments are ideal, as these allow increasing weight to be stacked up. In previous classes, a starting weight of 100g has been used, with the winning designs often failing at a load between 500 and 1000 g. Ideally pupils should stay at least 2 m from the testing; further, a block of foam or padding should be put on the floor under the test, to both reduce the noise when the weight drops and to reduce weights bouncing towards anyone nearby.





Differentiation

Basic

- > The spaghetti structure on the handout could be used by pupils.
- > Small card triangles could be provided that pupils could use to reinforce the points where the spaghetti is joined

Extension

- > Pupils could design their own structures.
- > The length of the span could be set greater than one piece of spaghetti, and the amount of spaghetti increased accordingly.
- > The amount of spaghetti provided could be reduced or a further competitive element added, where the weight of the structure is also considered in the competition



Resources

1-2 packets of spaghetti
Glue guns (one per team)

Optional:
Baseboards or A3/A4 pieces of cardboard for use as baseboards when using glue guns

Required files



-  Spaghetti structures
-  Bridge (handout)

Additional websites

- > A wide range of resources to support teaching and learning about structures, including several examples of bridges and a structures project using art straws <http://www.technologystudent.com/struct1/struindex.htm>
- > Free resources on bridges by NFL Cymru <https://www.tes.com/teaching-resource/bridges-6016590> and CCEA Northern Ireland http://ccea.org.uk/sites/default/files/docs/curriculum/connected_learning/thematic_units/stem/tu_bridges.pdf
- > Presentation on types of bridges <https://www.tes.com/teaching-resource/types-of-bridges-6315251>
- > Primary area of the Design & Technology Association website <https://www.data.org.uk/for-education/primary/>
- > Primary area of the CLEAPSS website <http://primary.cleapss.org.uk/>

Related activities (to build a full lesson)

Starters (Options)

- > Building a square structure from card (see spaghetti structures activity)
- > Presenting images of various structures on the whiteboard and asking pupils to identify the triangles with them
- > Spaghetti Structures (activity)

Extension (Options)

- > Manufacture of bridge structures of alternative designs

Plenary

- > Peer review of how the bridges could have been improved





The Engineering Context



- > Triangles are widely used to reinforce many engineering structures – from bridges to the sloped roofs of houses. An understanding of how triangles are used to reinforce structures is fundamental to being able to design strong structures.

Curriculum links *[example of layout, font details in section for English National Curriculum]*

England: National Curriculum

Design & Technology Key Stage 2

Make

- > select from and use a wider range of tools and equipment to perform practical tasks [for example, cutting, shaping, joining and finishing], accurately

Technical knowledge

- > apply their understanding of how to strengthen, stiffen and reinforce more complex structures

Scotland: Curriculum for Excellence

Craft, Design, Engineering and Graphics

Design and construct models/products

- > TCH2-09a I can extend and enhance my design skills to solve problems and can construct models

Application of Engineering

- > TCH 2-12a I can extend my knowledge and understanding of engineering disciplines to create solution.

Northern Ireland Curriculum

The Arts / Art and Design Key Stage 1

Use a range of media, materials, tools and processes such as: drawing, painting, printmaking, malleable materials, textiles and three-dimensional construction, selecting which is appropriate in order to realise personal ideas and intentions, for example:

- > use modelling and construction techniques to make three-dimensional work.

Wales: National Curriculum

Design and Technology Key Stage 2

Designing

- > 6. consider the safety, reliability and sustainability of their activities/products
- > 7. evaluate their design ideas as they develop, considering the needs of the user

Making

- > 3. measure, mark out, cut, shape, join, weigh and mix a range of materials and ingredients, using appropriate tools/utensils, equipment and techniques
- > 4. find alternative ways of making if the first attempt fails

Rigid and flexible materials

- > 11. learn about the efficient use of materials
- > 12. use techniques for reinforcing and strengthening structures in their products

Range

- > tasks in which they develop and practise particular skills and techniques that can be applied in their designing and making
- > tasks in which they design and make products, focusing on different contexts and materials
- > they should be given opportunities to: be creative, be innovative, work independently and in groups.





Assessment opportunities

- > Test results on the finished bridges, pupil responses on how to improve the bridge designs.

