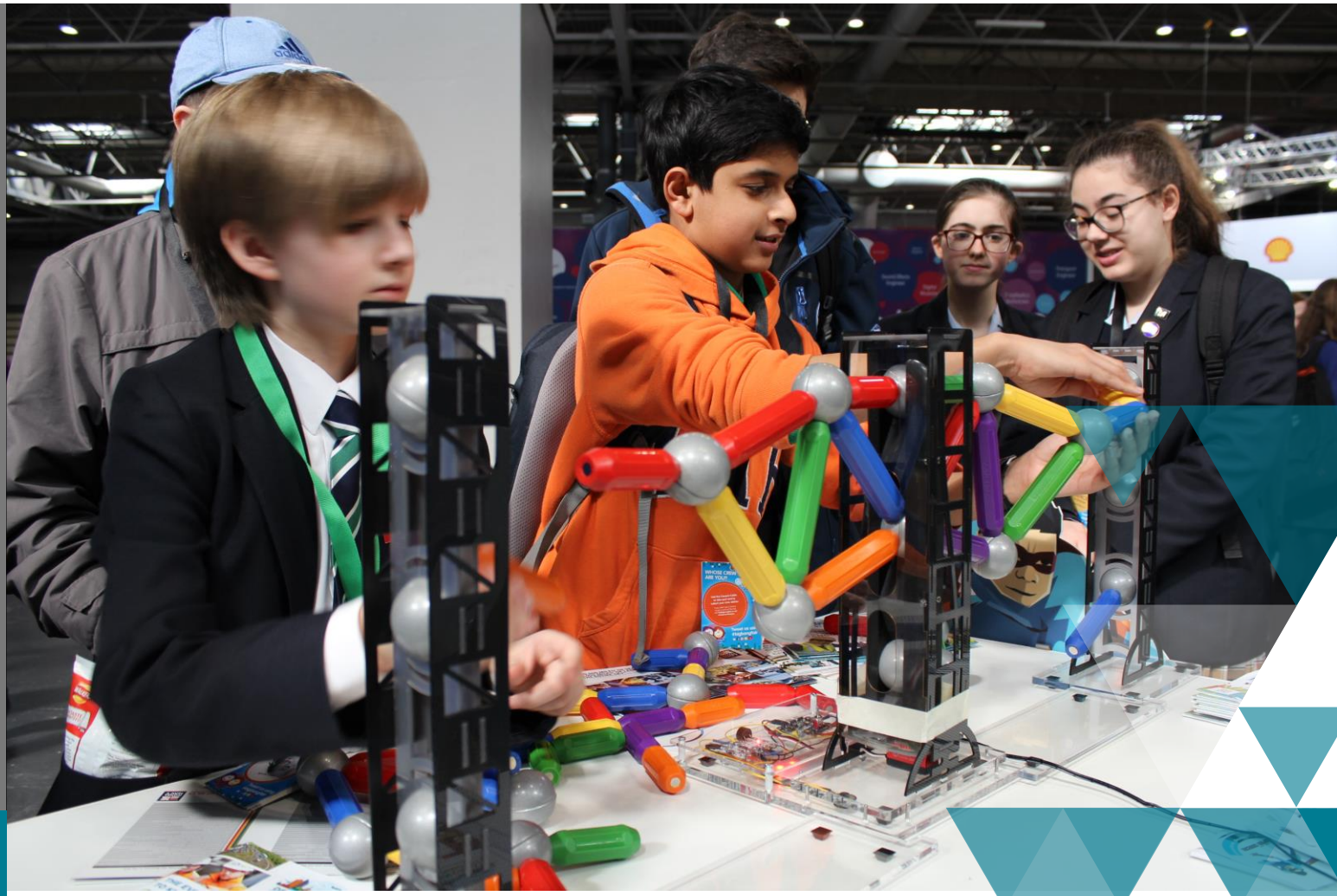
ice
Institution of Civil Engineers

North East



# Paper tube bridges

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# Contents

# Paper tube bridges

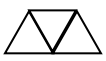
## Introduction

This is a hands-on design, make and test activity. Pupils will use sheets of paper, masking tape and nuts and bolts, to create a bridge which is tested for strength.

The activity helps students to appreciate the role of civil engineers and provides a great understanding of the forces that need to be managed in order to build a safe structure.

When working with schools or with other young people, either on or off their own premises, no ICE North East activity will be delivered without the attendance of a class teacher/full time member of staff or the adult responsible for the group/individual.

# Activity Instructions

| Session part | Tips / resources needed |
|---|---|
| **Learning outcome(s)** | Produce a stable and strong paper bridge.<br>Appreciation of the role of Civil Engineers in society |
| **Age group** | For age 8 and above |
| **Activity length** | 2 hours - whole class in groups of 4 |
| **Risk assessment** | See below. |
| **Resources required (provided by ICE)** | 200 No. M4 20mm bolts (slot head) and bolts (10 per group – bagged)<br>30 No. split A4 9mm rolling dowels (2 per group plus spare)<br>8 No. paper punches (1 per group)<br>8 No. rolls Masking Tape (1 per group)<br>200 No. sheets A4 plain paper (20 sheets per group plus spare)<br>8 No. Screwdrivers (1 per group)<br>Laptop and projector (optional) |
| **Resources required** | 1 No. screen or blank wall (optional for projector above) |
| **Space required** | Classroom |
| **Activity plan / introduction** | Short (5 to 10 min) introduction to Civil Engineering and the role it plays in the everyday life of society (use elements of "What is Civil Engineering?" presentation). |
| **Main activity** | Show how paper can be strong under different conditions:<br>• Sheet vs. tube<br>• Tension, compression & bending<br>Demonstrate how to roll the tubes.<br>Construct a triangle and talk through geometry.<br>Teams to assign roles ("taper", "roller", "puncher" and "fastener" and cf. Civ. Eng.)<br>Develop into a 3 triangle element  <br>Construct an exact replica<br>Join together at top, adding bottom members and bracing to form rigid structure. Show why diagonal members are so critical.<br>Talk about overuse of materials – not replicating top members.<br>Bolts and nuts not to be fastened until entire structure complete. |
| **Summary** | Test strength with weights (either students own or a prepared model) |
| **Assessment criteria** | Were students able to construct a simple 3 triangle bridge?<br>Do students have a better understanding of the Civil Engineering profession? |

## At the end of the session…

After your civil engineering education activity ICE would be grateful if could complete a short online evaluation for us please. In order to be prepared for the questions on it would be useful to note down the following info before you leave the classroom:

**Date**……

**The name of school** (or STEM Fair)…….

**Postcode** (or town/area if not known)…….

**Age of students/year group(s)** (most probably 16-17 yrs)……..

**Number of students** who took part …… and

an estimate of the number of **girls**…….

an estimate of the number of **black or minority ethnic** (BAME) students…….

You can find the survey at **surveymonkey.co.uk/r/ICEambassador**

The information and feedback you give ICE in the survey helps us improve coordination in their educational activities. **Thank you!**

# More resources on civil engineering for teachers/students

After the session has finished we hope that you'll find the teacher(s) / students are keen to know more about civil engineering. Here is a handy list of resources to direct them to:

Careers advice for becoming a civil engineer: **ice.org.uk/beacivilengineer**

Careers and activity resources on our website: **ice.org.uk/educationresources**

Civil engineering project case studies: **ice.org.uk/what-is-civil-engineering/what-do-civil-engineers-do**

Civil engineer (people) case studies: **ice.org.uk/what-is-civil-engineering/who-are-civil-engineers**

Info about all types of engineering careers (not just civil)**:** Tomorrow's Engineers **tomorrowsengineers.org.uk**

North East

# RISK ASSESSMENT FOR THE INPUT BRIDGES

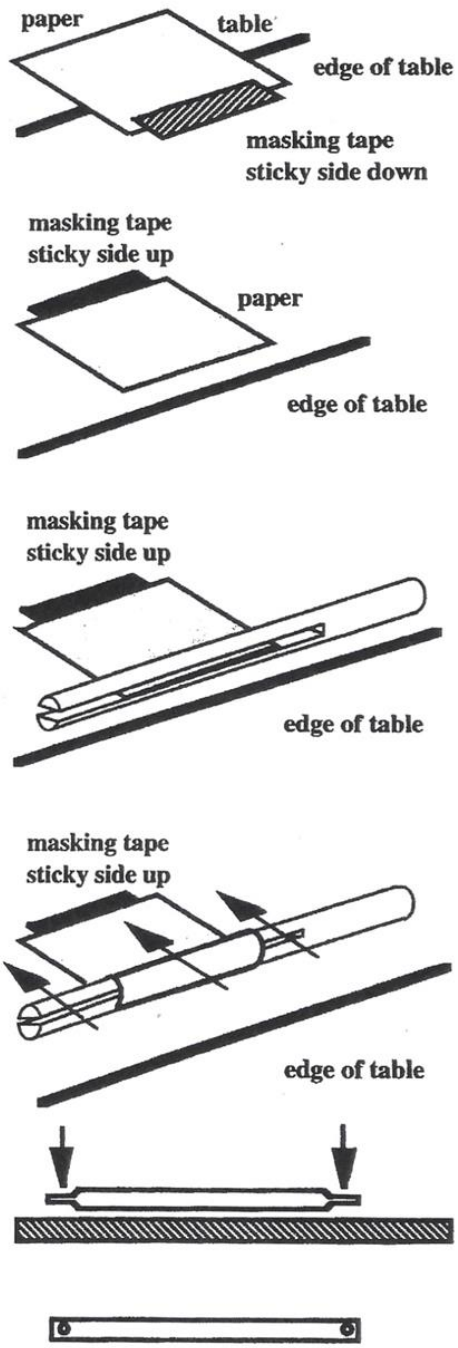
| What are the Hazards? | Who might be harmed and how? | What is ICE doing already? What further action is necessary? | How will ICE put the assessment into action? |
|---|---|---|---|
| **Creation of paper tubes** | **Children** by paper cuts<br>**Children** by catching fingers in hole punch<br>**Children** by splinters, slipping on dowels<br>**Children** by horseplay with dowels | **Children** warned<br>**Children** warned<br>All dowels checked for rough edges and splinters. Children warned.<br>Dowels to be issued singly by ambassadors and activity to be carried out at desks (i.e. no dowels on floor)<br>**Children** under close supervision.<br>**Children** warned. Repeat offenders removed from activity. | **Ambassadors** to brief children prior to commencement of construction.<br>**Ambassadors** to check dowels.<br>**Ambassadors** to maintain lookout for dowels dropped on the floor.<br>**Ambassadors** to stop unruly behaviour. **Teachers to remove children from activity if necessary.** |
| **Joining of tubes** | **Children** by swallowing nuts and bolts<br>**Children** by slipping on nuts and bolts | **Children** warned<br>Nuts and bolts to be distributed by ambassadors and kept on desks at all times. Nuts/bolts removed during construction/ demolition to be collected immediately by ambassadors.<br>**Children** under close supervision. | **Ambassadors** to brief children prior to commencement of construction.<br>**Ambassadors** to maintain lookout for nuts and bolts dropped on the floor. |
| **Testing of bridge** | **Children** by dropping weights<br>**Children** by collapse of structure | Weights to be handled by ambassadors.<br>**Ambassadors** to carry out test. Children briefed to stand well back. | **Ambassadors** to brief children to keep clear.<br>**Ambassadors** to retain possession of weights. |

**NOTES:**

The assessment methodology is strictly in accordance with the Health & Safety Executive Guidance on Risk Assessment, INDG163 (rev2) revised 06/06. Risk assessment prepared by **ICE**. This Risk Assessment does not take account of activity that would normally be expected in a classroom environment. **Outcome of assessment is that all risks are low and effectively controlled by identified arrangements. No incidents have ever been recorded as a result of using this activity by the Institution of Civil Engineers. Only experienced presenters will deliver this activity.**

**ICE makes use of photographs in publicity materials, newsletters and content on its website. All measures are taken to ensure children's names (if they appear in publication) are not represented against individuals in photographs. Schools should advise if the use of such materials is not permissible.**

# How to make a strong paper tube




Lay the piece of paper hanging slightly over the edge of the table.

Take a length of masking tape which is slightly shorter than the length of the side of the paper.

Place the masking tape, sticky side facing downwards, along the edge of the paper, half overlapping the paper. If the tape is placed on the edge overhanging the table this will prevent adhesive getting on the table surface!

Turn the paper over and place on the table with the sticky side of the masking tape facing upwards.

Take the split rod and place the edge of the paper in the split, so that the edge of the paper is just at the near edge of the split.

The split rod may be a piece of dowel, about 9mm diameter, cut along part of its length, or alternatively , two lengths of half-round section of wood bound together by adhesive tape, with a small ‘spacer’ of tape to maintain a gap at the bound end.

Grip the split rod ad roll it along the paper and over the masking tape, which will then fasten the whole roll together to make the paper tube.

Slide the tube off the split rod. Place on a flat surface and with a finger on each end, press downwards and flatten the two ends of the tube against the table.

Use the paper punch, with the flattened end inserted fully, to form the punched hole at each end. The distance between the holes is 17mm less than the length of the tube.