

## SCIENCE WORKSHEET

In this session, we are going to be learning about Science, Technology, Engineering and Maths (STEM) topics and science skills connected to railway and transport infrastructure careers.

**You will learn to:**

- Understand more about the roles and skills associated with a large engineering project.
- Understand how the idea of forces can be applied to structures such as tunnels.
- Construct and test a model to explore ideas about structures.

In this session, you will strengthen your STEM skills by building tunnel structures. We are going to think about your *STEMPowers*. These are the skills that we will be using.

a) Evaluate your own *STEMPowers* on the grid below.

<i>STEMPower</i>	Low						High
Creativity							
Teamwork							
Communication							
Problem solving							
Investigation							
Determination							
Respect							

b) Which *STEMPower* is your strongest? Explain your answer.

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c) Which of your *STEMPowers* would you most like to improve today? How could you do that?

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## Engineering Challenge: Tunnel Structures

There are three ways of building tunnels. They are either excavated using tunnel boring machines, mined by diggers, or built using a technique called 'cut and cover'. Cut and cover tunnels are constructed by removing the land above the tunnel route, constructing the tunnel structure and then replacing the land over the top. The tunnel structure is built of reinforced concrete, to help resist the forces acting upon the tunnel and to prevent collapse.

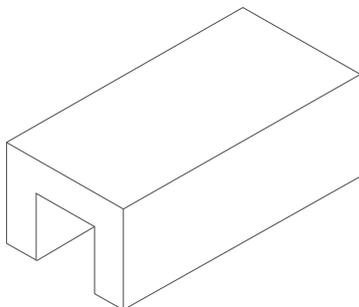
### Challenge 1: Tunnel Forces

All structures must be built to resist forces that would otherwise make them collapse. Match the force to its description below:

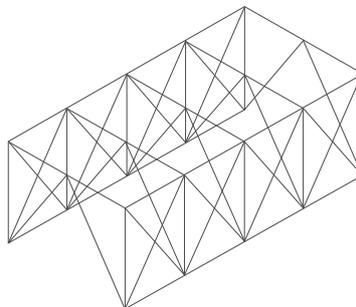
<b>Compression</b>	<b>Forces that stretch</b>
<b>Tension</b>	<b>Forces that twist</b>
<b>Bending</b>	<b>A combination of compression and tension</b>
<b>Shearing</b>	<b>Forces that cut and tear</b>
<b>Torsion</b>	<b>Forces that squash</b>

### Types of Structure

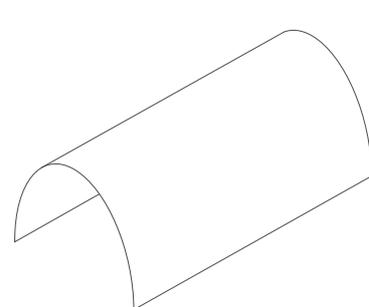
You can build different types of structures to resist or oppose the forces acting upon them. Mass structures are solid and heavy, whilst frames are lightweight and flexible and composed of members joined at either end. Shell structures resist forces using their outside skin.



**Mass**



**Frame**



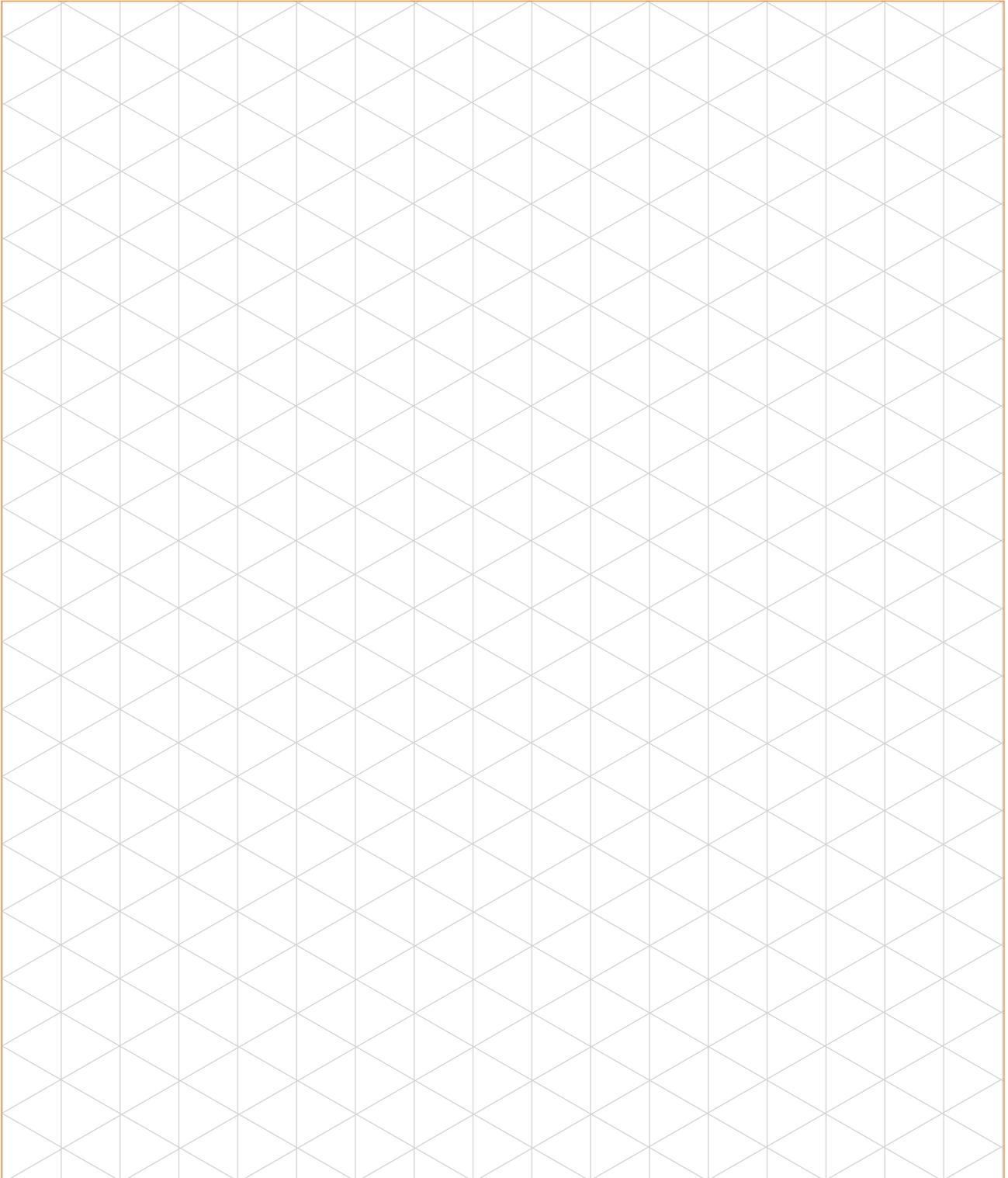
**Shell**

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### Challenge 2: Designing a Tunnel Structure

Together with your team, you must design a prototype tunnel structure to span 400mm through the cut and cover. Your tunnel structure should be strong and lightweight, using as few materials as possible to resist the earth pressure acting upon it.

Sketch your design below.



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Tunnel structure weight: .....

a) How well did your tunnel structure work?

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b) What would you improve about your tunnel structure?

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c) What were the challenges when designing and building your tunnel structure?

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d) How did you ensure that your tunnel prototype was sustainable?

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### Reflection

• Which *STEM*Powers have you improved the most?

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- Which *STEM*Powers do you think are the most important?

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- Are you likely to consider a STEM career in the future?

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- Identify particular progress you have made.

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