ENGINEERING

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STRUCTURES

This mobile revision pdf is based on detailed work found in the STRUCTURES and FORCES section.
Tap on the green link button below to go to the complete website section

Tap the blue button to view PROPERTIES covered by this Revision PDF

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STRUCTURES

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UNDERTSANDING FRAMES

Many structures are based on a frame. Two examples are shown below. We use frames every day, for example, a stool is a frame on which we sit.
Buildings are based on frames and this is why they can be built very high.
Everywhere we look in towns and cities we see examples of structures based on frames

Tap the image for more information

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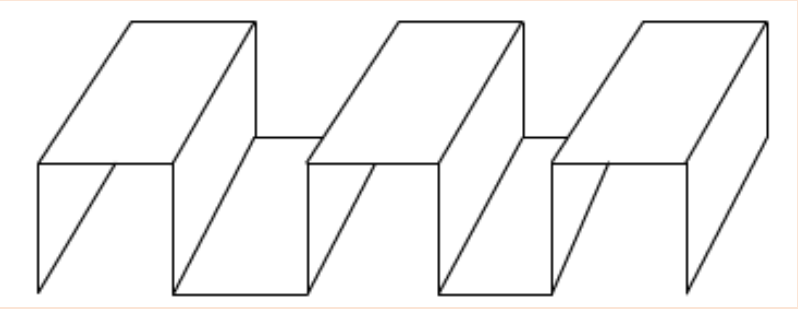
UNDERSTANDING FRAMES

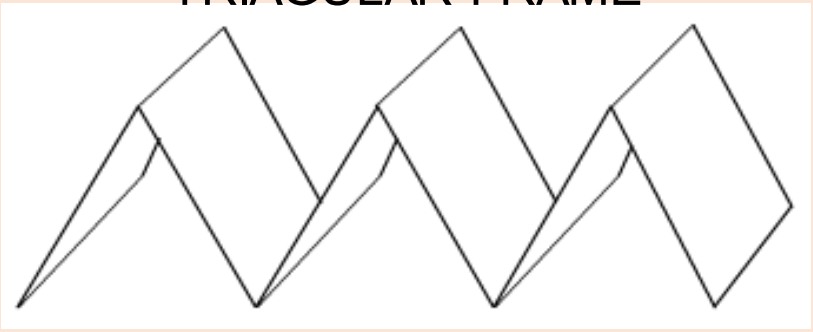
Below are two examples of frames that you can make from card or even paper. Make both and then, press down lightly with one hand. You will probably find that they can take some pressure from above, but the triangular frame is the strongest.

Tap the image for more information

SQAURE FRAME



TRIAGULAR FRAME



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UNDERSTANDING FRAMES

Glue a piece of card on the top and bottom of the frame. This will make the frame even more ‘rigid’. To test the strength of each frame, place a book on the top and if it survives place more books on top. The triangulated frame should be the strongest

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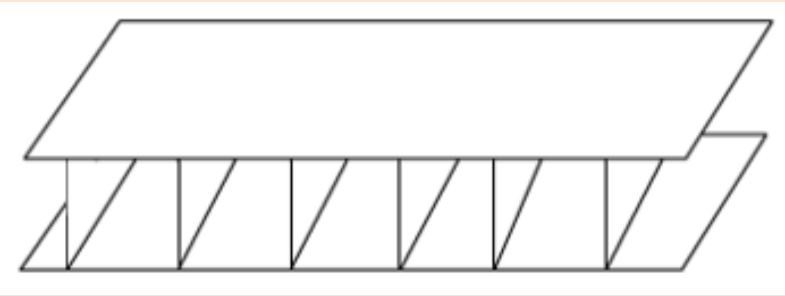

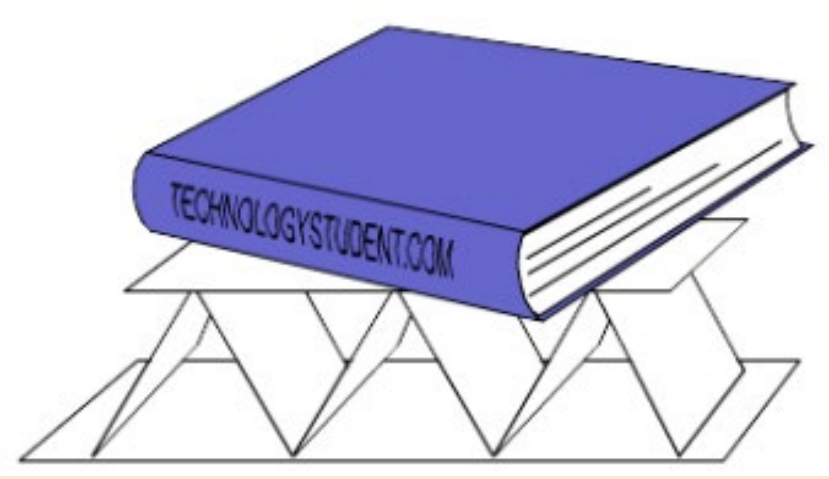

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WHAT IS TRIANGULATION?

Folding a simple art straw into a triangular shape and then attempting to break it, gives us some idea of the strength of **triangulation**. This is why this 'shape' is popular for building structures, from large to small, permanent to temporary.
A triangular form is one of the strongest shapes known to man. It is not surprising then, that 'triangulation' is used in the construction of buildings and structures.

Tap the image for more information

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TRIANGULATION
THE EIFFEL TOWER

The Eiffel Tower is one of the most famous structures in the world. It was named after Alexandre Eiffel whose team of engineers designed it. It cost £260,000 to build in 1889. It displays the strength of TRIANGULATION.

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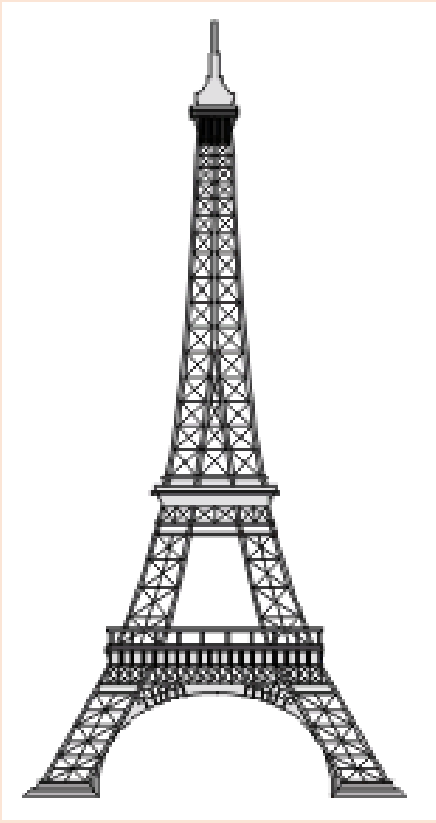

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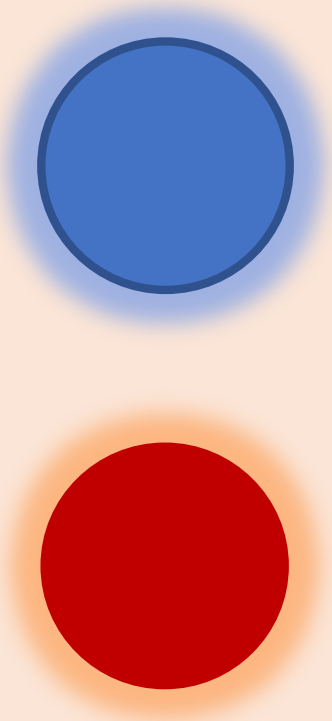
EXAMPLES OF TRIANGULATION

Tap the buttons for more examples of triangulation



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BEAMS AND SECTIONS

Beams are used to 'span' distances, such as the distance between two walls. How well the beam works, depends the material it is made from and its shape. In some buildings you can easily see the steel girders, that hold the roof up. These are made from different 'sections' or shapes and some are named below.

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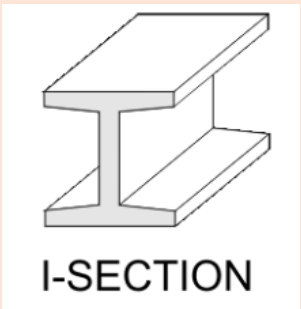

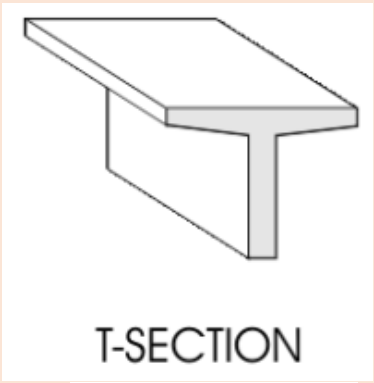

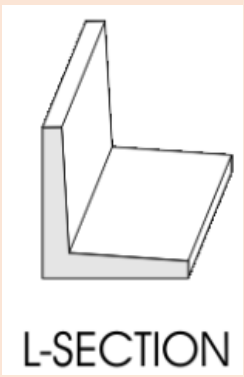

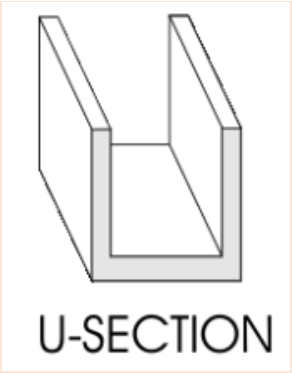

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STRENGTH

If you use metals or plastics, as part of a practical project, a knowledge of the shape or 'section' of lengths of metals is important. The diagrams below show examples of solid lengths and also tubes. Sections are important when building structures.

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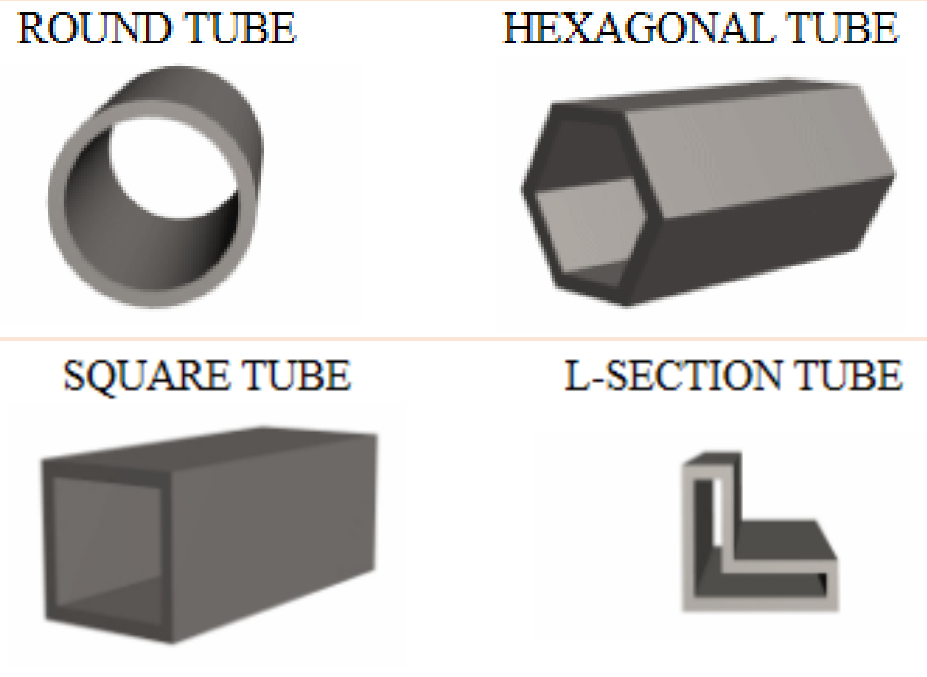

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INTRODUCTION TO STRUCTURES

When walking through a town / city, we inevitably pass by a variety of structures. These range from homes and houses, to high rise buildings, stadiums, railway stations and many more. There are five main forms of structural frames: Plain Frame, Structural Frame, Space Frame. Monocoque and Semi-Monocoque

Tap the image for more general information

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PLANE FRAME STRUCTURES

These are structures created in two dimensions. An example is seen opposite. This is a flat wooden frame, holding bricks in position, whilst the cement dries. This is a typical construction technique. Once the brick work is set in position, the plain frame structure can be removed, leaving the brick arch firmly and permanently in place.

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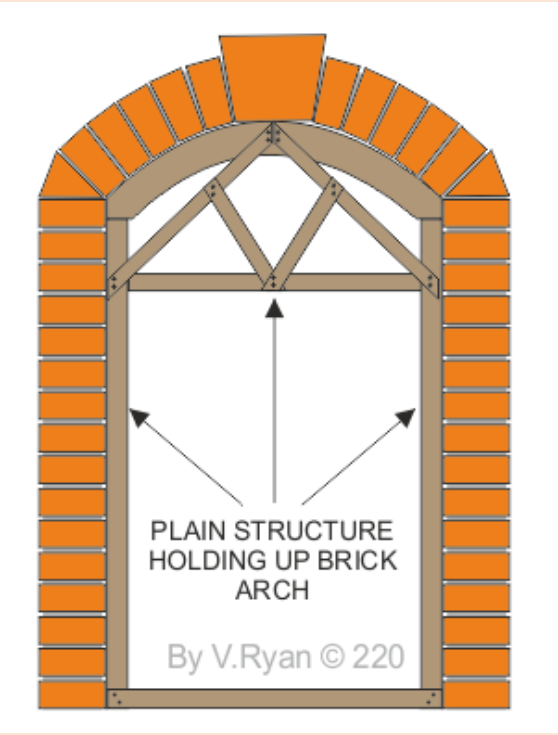

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STRUCTURAL FRAMES

These are three dimensional structures, often composed of girders, beams and columns. They are characterised by having columns to hold up sections of the structure. The steel structure of a stadium may have many anchor points to the ground. The roof of many sporting stadiums, are held in position, by this type of structure (see below)

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WHAT IS A SPACE FRAME STRUCTURE?

A space frame structure is three dimensional, based on an interlocking geometrical pattern. It is lightweight and capable of taking high loads (heavy weights) and withstanding structural stress. They span large areas and are often built up from triangulated or hexagonal elements, forming a matrix. Tensile and compressive forces are spread / distributed, throughout the matrix.

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MONOCOQUE STRUCTURES

A ‘monocoque’ structure does not rely on a frame for strength / structural integrity. It relies on the outer skin / shell, to counter stresses and loads. For example, the carbon fibre reinforced bodywork, of a modern Formula One racing car, is an example of this type of structure. The bodywork is one piece and does not require internal strengthening, through the inclusion of a frame. The monocoque increases the safety of the car, as it is less likely to break apart in the event of a crash.

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SEMI-MONOCOQUE STRUCTURES

Modern passenger jets are referred to as monocoques, although they rely on both the skin / shell and the formers, which form a skeleton. This type of structure is more accurately referred to as a **semi-monocoque**.

A plane is an excellent example of this type of structure.

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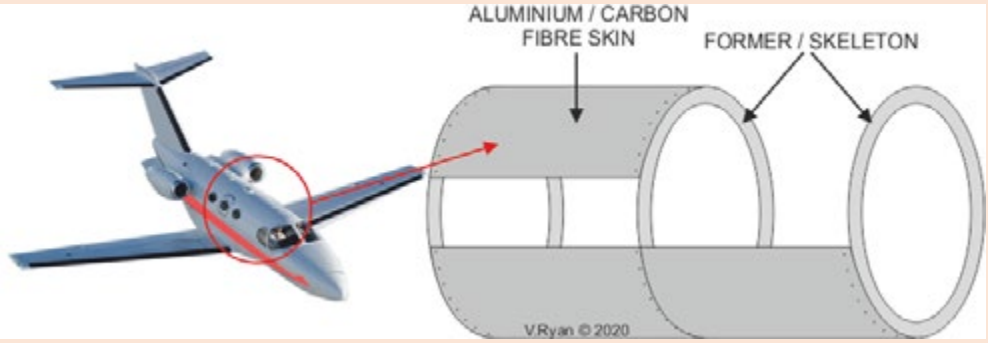

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WOOD BEAM BRIDGES

Throughout history, people have built bridges. The early bridges were tree trunks laid across the banks of streams. Stone slabs were then used and eventually wooden frames and finally steel.
A simple solution to crossing a small stream, still used today, is to lay a wooden beam across it

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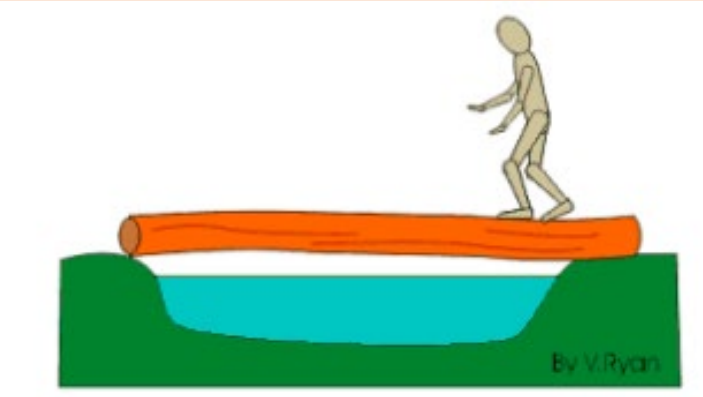

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WOOD FRAME BRIDGES

Wood frames are stronger than the simple beam bridge and weigh less. In the early days of bridges, they were made from wood grown locally. Today these types of bridges are still popular. The term 'triangulation' is used to describe the use of triangles, arranged together to form a frame.

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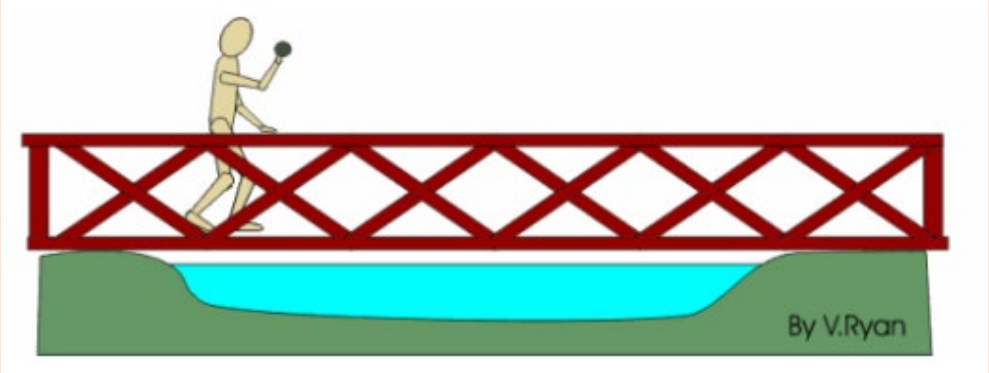

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THE STONE SLAB BRIDGE

This is a stone beam bridge. A slab of stone is laid across a stream. The stone slabs are selected for their shape/form. They must be flat and also wide enough for one or two people to pass over the gap. Sometimes the stone needs to be shaped a little, by the use of a stone chisel. Even the best stone slabs may need some shaping.

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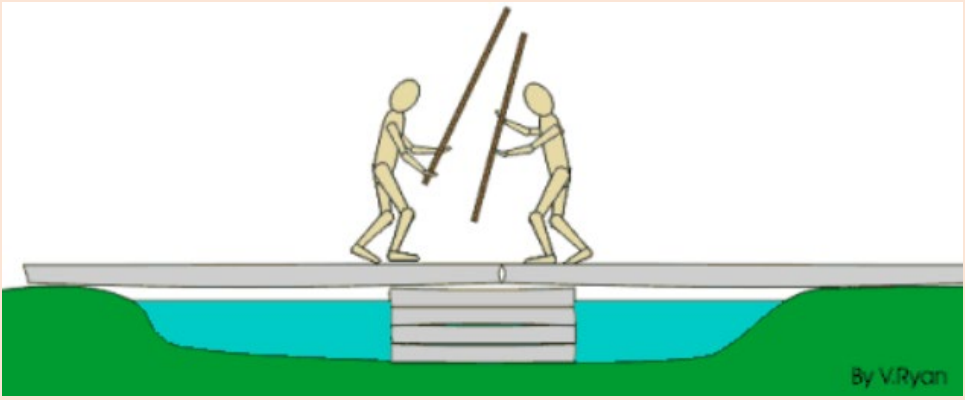

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THE STONE ARCH BRIDGE

The Arch Bridge is very common. They were built with stone before iron and steel bridges were introduced. A good example is seen in the picture below. The Romans used arch bridges throughout Europe and many of them are still standing today, as they are very strong.

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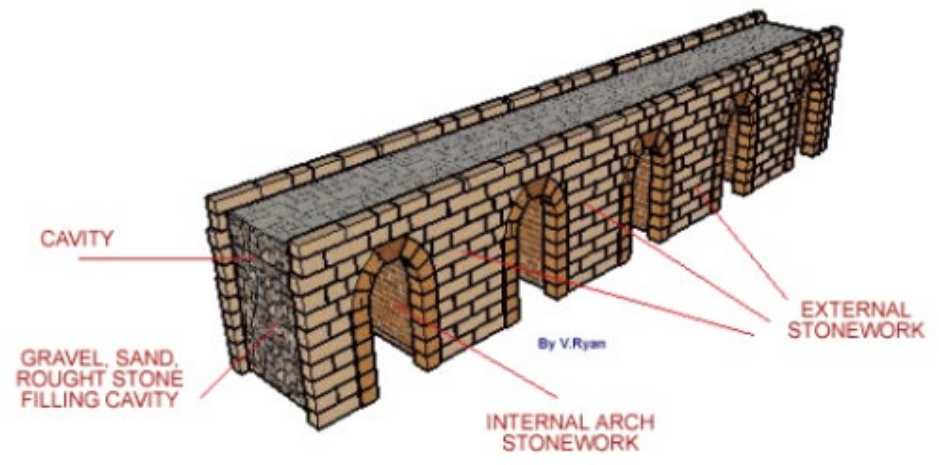
STONE ARCH BRIDGES

Tap the images for more information

ROMAN BRIDGE AND AQUEDUCT CONSTRUCTION



THE MOSTAR BRIDGE

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STONE ARCH BRIDGES

Tap the image for more information

THE LANDWASSER VIADUCT

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THE RIBBLEHEAD VIADUCT

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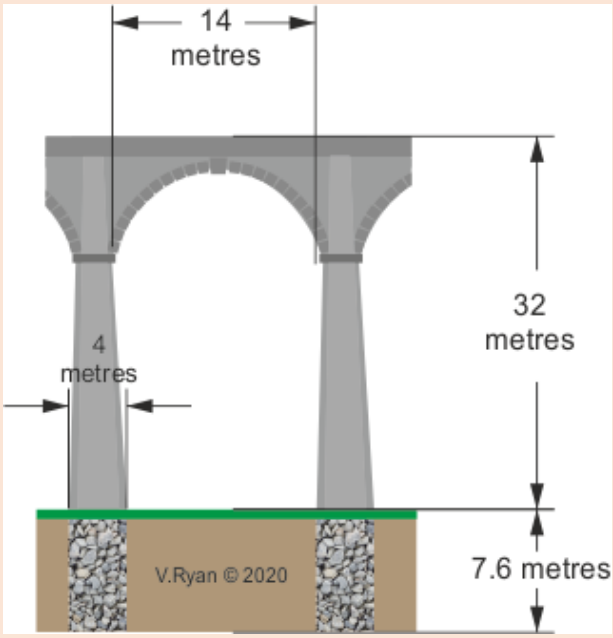

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MODERN STEEL BRIDGES

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STEEL GIRDER BRIDGE

SUSPENSION BRIDGE

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MODERN STEEL BRIDGES

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CANTILEVER BRIDGE

CABLE STAY BRIDGE

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SUSPENSION AND CABLE STAY BRIDGES

The difference between a Suspension Bridge and a Cable Stay bridge is in the way the 'deck' of each bridge is held in position (see below)

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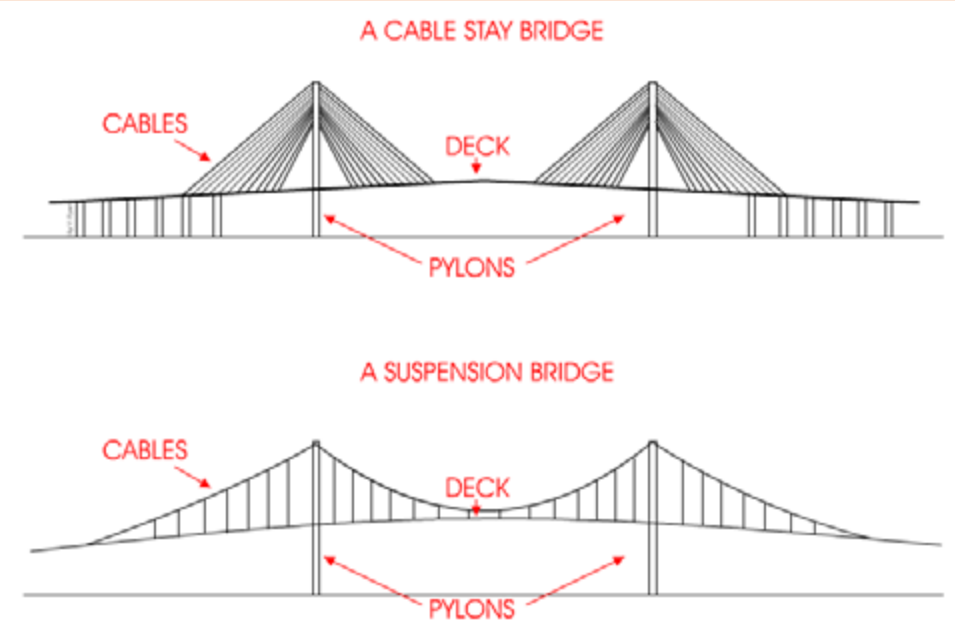

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SUSPENSION v CABLE STAY

Tap the BUTTONS for more information

CABLE STAY

SUSPENSION

THE AKASHI-KAIKYO SUSPENSION BRIDGE - JAPAN

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MAKING AND TESTING A MODEL BRIDGE

Tap the buttons for each page of instructions

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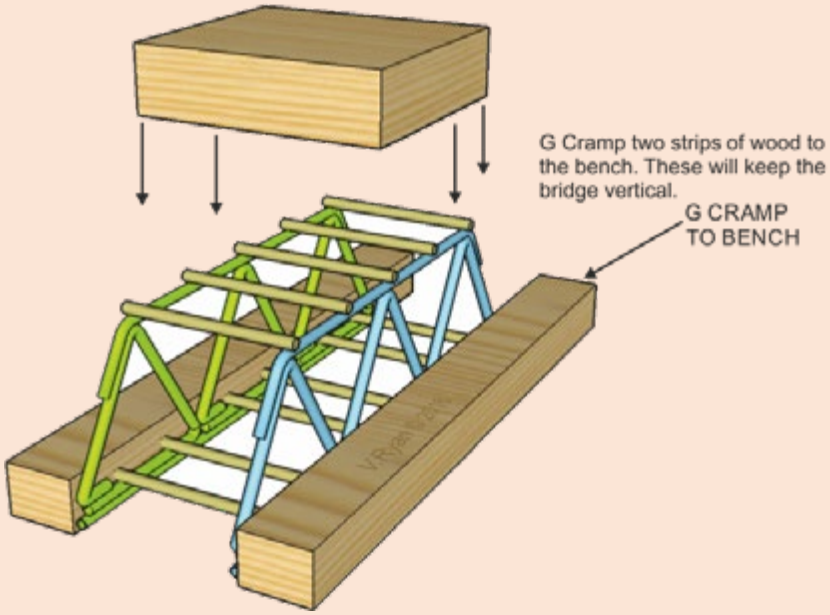

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BRIDGE DISASTERS

Tap the images for more information

THE TAY BRIDGE DISASTER

THE TACOMA NARROWS SUSPENSION BRIDGE

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TWO MORE FAMOUS STRUCTURES

Tap the images for more information

THE EIFFEL TOWER

THE EMPIRE STATE BUILDING

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