

Ropes and lines

What is rope made from?

What is rope used for on a boat?

What makes rope so strong?

How is rope made?

Curriculum Areas

Key stage 3 Science

Key stage 3 Design and Technology

Key stage 3 History

Learning Objectives:

1. The difference between synthetic and natural fibre rope.
2. How ropes are made.
3. What affects the properties of rope?

Some boats have hundreds of different bits of rope, for example a **square rigged sailing ship**. Sailors have different names for each rope or line depending on what its job is.



Many young people go to sea each year with youth organisations. One of the first things that they have to do is to “learn the ropes”. But what are ropes used for? Watch the two video clips and jot down some ideas on the next page.

[Video clip one, yacht ropes click here.](#)

[Video clip two, dinghy and windsurfing ropes click here.](#)



Before the invention of **synthetic fibres** (man-made fibres), rope was made from plant material. These are called natural fibre ropes. Some traditional boats still use natural fibre ropes. Each natural fibre rope has its own advantages. For example **coir rope** floats; it is made from coconut husks. **Flax rope** is very strong when it is new. Flax rope is made from Phormium plants and was a big export industry for New Zealand to the British Navy in the 19th century

Can you think of any major disadvantages of natural fibre ropes?



This is a photograph of some ***hemp rope***. It is made from *Cannabis sativa* plants, grown for the strong fibres in the plants stem. Each natural material gives different properties to the rope. Hemp rope does not stretch as easily as coir rope.

Why are stretchy ropes no good for hoisting sails up the mast?

To make a traditional laid rope the fibres first get twisted into yarn.



The yarn gets twisted into a strand.



Finally the three strands get twisted into a rope.



Some synthetic rope is still made in a similar way – except the fibres are far longer.

Why will this make the rope stronger and last longer?

If you try and twist laid rope the wrong way it may start to come unlaid.



In the video clip you will have seen that rope is often made today using machines that plat the strands together. This is sometimes called **braided rope**.



Can you think of any advantages of braided rope?

Very often braided rope is made with an easy to handle outside surface called the **rope mantle** platted around a **rope core** in the middle.

The rope core can be made of very strong fibres. Sometimes ropes can be made with a fat outer mantle for the part that the sailor has to pull on, but tapering down to a lightweight and thin, but very strong core, that goes to the sails. This is particularly useful for controlling lightweight racing sails.



If you want to see more footage of rope being made and tested click [here](#)

Make and test your own rope

You will need: some Newzealand flax leaves (these are often planted outside DIY stores) or nettle stems, a supermarket carrier bag, some weights, some string, and a science lab clamp stand.

You must take care not to drop any masses and to wear safety goggles

You can make your own natural fibre rope by cutting three very thin strips off the side of a New Zealand flax plant leaf and weaving them together into a 3 strand braided rope. You can do the same thing to make a 3 strand braided synthetic rope out of a supermarket carrier bag.

Why not test the properties of your ropes?

There are two properties that you can test.

Stretchiness

To measure this you will have needed to make your plats out of very thin slithers of plant or plastic. (You may find it easier to test the material properties on a 5mm x 200mm strip of leaf and a similar strip cut out of the bag.)

Using a felt tipped pen put two marks 50mm apart on both bits of rope. Hang the rope from a science lab clamp stand. The best way to do this is to tie a loop of string to either end of your home made rope. One end loop is to go on the clamp stand; the other end is to hang masses on.

As you add each weight measure how far apart the marks are. If you take the weight off does the rope go back to the previous length?

Breaking Strain

This is best done as a teacher led demonstration behind a safety screen. New Zealand flax fibres are very strong!



Match the rope to the job

Synthetic ropes and lines are made from lots of different types of plastic fibres. In this exercise you will need to match the type of fibre the rope is made of to the best use for it at sea.

Type of rope	Properties
Polypropylene 	Floats and 10mm line has a breaking strain of 1.11 tonnes
Nylon 	Slightly stretchy and good at absorbing shocks. 10mm diameter rope has a breaking strain of 2.16 tonnes
Polyester 	Soft to handle, easy to splice and relatively low stretch. 10mm diameter rope has a breaking strain of 3 tonnes.
Dyneema 	Lightweight, very low stretch and very strong. 9mm diameter rope has a breaking strain of 12.74 tonnes! It can be used on its own, but is often used with a mantle made from a more comfortable to handle material for situations where sailors need to pull on it with their hands.

Complete the table below with a type of rope or line to use for each job onboard.

Discuss with the person sitting next to you why you made your choices of rope.

Job onboard boats	Rope or line to use
Handling sails, for example pulling the sails in to go faster.	
Mooring a boat or to use as a tow line to pull another boat.	
As a rope to pull the sails up by winch on a racing yacht, or to replace heavy metal wires with a lighter alternative.	
For safety lines to throw to someone who has fallen in the sea.	

Knotty knots

Why not have a go at learning some useful knots. You will need some short bits of rope. Can you match the job on a boat to the best knot use?

To help you here is a list of possible knots

Figure of eight knot; **Clove hitch;** **Reef knot;** **Bowline;**
Round turn and two half hitches; **Rolling hitch.**

Job on boat	Knot to use	Sketch of the knot
To tie around a bundle of sails		
To stop the end of a rope going through a pulley block		
To tie a towline onto a dinghy, with a knot that can be undone easily when you have finished towing the boat.		

Job on boat	Knot to use	Sketch of the knot
To tie a rope to a post		
To make a loop in the end of the rope to use as a mooring line		
To tie a rope onto another rope, so that you can slide the knot along one of the ropes, for example to help winch another rope in.		

Did you know that a knot in a rope can nearly halve a ropes breaking strain?

This is because knots put very tight bends in the rope, stretching the outside fibres.

For this reason the best way to put a loop in the end of a mooring rope or towing rope is to use a **Splice** (the rope is woven back into itself to make a loop). Some rope makers at the boat show sell ropes with spliced loops already in the ends of each mooring line.

At the Boat Show

See if you can find any rope making machines at the show.

Look at boat exhibitors around the show and match these types of ropes to what they are used for. **Note these ropes come in all different colours. The pictures are just a guide.**

Polyester braid on braid rope



Nylon Dock line



Synthetic hemp (this is polypropylene rope made to look like hemp)



Natural fibre rope



Dyneema rope



Multiplat rope

