



SUPER POWER: Tensile Strength!

SUPER ROPE

LAB NOTES...

What's going on?

Tensile strength is the ability to withstand being pulled without breaking. Today, you've made an experiment to test the tensile strength of paper towel material. You probably found that the single sheet broke easily and held the least amount of weight. This would be the sample with the lowest tensile strength. The doubled-up paper towel should have been able to take about twice as much weight than the single paper towel as they share the load evenly. Your twisted rope however should have been able to take even more weight than the doubled-up paper towel, even though it was made from the same number of strands. This is because twisting strands of a material around each other maximises its axial stiffness which means that the force isn't pulling straight down on the twisted paper towel strands like the other samples but instead it pulls them slightly sideways. This means that the overall twisted two strand structure can lift more weight than two untwisted strands. We use twisted rope for all sorts of pulling and lifting tasks because they are so strong and flexible.

TO MAKE YOUR SUPER TWISTED ROPE...

BUILD TIME
15
MINS

1. Watch the video of Nanogirl making her super twisted rope!
2. Measure and cut five strips 2cm wide from your paper towel.
3. Take one strip and put it to one side. This will be our 'baseline' measurement.
4. Take another two strips and lay them one on top of the other. Tape the top and bottom edges together. Put to one side.
5. Take the last two strips and fold each in half lengthways.
6. Tape the two strips together at the top to a table.
7. Twist the two strands around each other to make a twisted rope. Tape together the bottom end when finished, then remove the top from the table and tape.
8. Measure and cut three 5cm sections from one end of a tick or skewer.
9. For each of your three paper towel samples fold one end over the stick and tape in place to make a pocket that holds the stick.
10. Cut three 20cm long pieces of string. Tie onto the ends of each skewer to make a handle.
11. If you have a plastic bucket with a handle you can use that, or you can make one by cutting the top off an empty plastic bottle, punching two holes opposite each other in the side then tying 30cm of string through to make a handle.
12. Open up the middle of a paperclip to make a hook at each end.
13. Take a broom handle or wooden spoon and balance it between two chairs. If you are doing this indoors, you might need something to protect the floor, like a blanket.
14. Hook the non-skewer ends of the paper towel samples over the handle and tape in place.
15. Start with the single paper towel. Hook one end of the paper clip into the little loop of string hanging from the skewer, and hook the bucket handle into the other end.
16. Add your weights one by one into the bucket until the sample breaks! Count how many weights it took to break the single sheet of paper towel, then move onto the doubled-up paper towel, and finally the twisted rope.

YOU WILL NEED

- 1 x sheet paper towel
- Ruler.....
- Pencil
- Scissors
- Tape.....
- String.....
- Skewer or stick
- Empty plastic bottle.....
OR small plastic bucket with handle
- 1 x paper clip
- Some heavy weights.....
(e.g. small rocks, marbles etc)
- Something long and straight.....
(e.g. broom handle)
- (Optional) a mat, cushion or blanket...
(to protect the floor!)

How much weight can your twisted rope take without breaking?

Look at your broken paper towel samples. Did they all break in the same place along the strip? Why do you think that is?

Try using three strands to braid/ plait a rope, instead of twisting. Does this change how much weight it can hold?

Does using more strands make a rope stronger?

What other materials can you make a twisted rope from, and which one has the highest tensile strength?