

Materials Testing

There are many tests available to check how suitable a material is for a specific task. These three are commonly used to check physical performance, others are of course possible.

Tensile strength

Tensile strength tests how strong a material is when we try and stretch it.



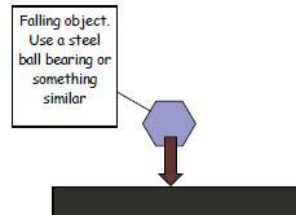
Preparing samples to test:

Once you have sourced a material learners could be asked to consider the size of test blanks. Through discussion they could come to the importance of keeping variables the same. They should also consider the size relative to the test equipment. Long cuboids (something that looks like a stick of chewing gum) work well as this makes it easy to measure width and thickness.

Space should be made for learners to make mistakes in their choices so that these can be discussed and inform next steps as this is the nature of inquiry and engineering and builds important skills.

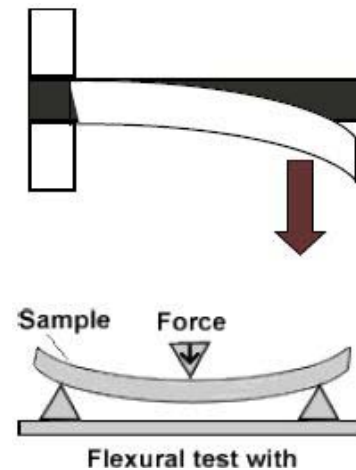
Impact test

This shows how resistant a material is to breaking if it hit something or if something hits it.



Bend or flex test

This shows how easy or hard it is to bend or flex something.



Test equipment

It may be possible for some schools to work with universities or local companies with tensile testing equipment (an Instron or similar) though the building of the test rigs would add to the challenge.

Guidance is included on how to set up simple test pieces with equipment that will be available in most schools.

An important part of testing is the accurate recording of results for analysis.

In order to involve the learners they could be asked in groups to consider what kind of information to include on a record sheet. Each group could then present their thoughts before the class come to a consensus about what will be important to include.

Preparing samples to test:

An example of a possible recording sheet which a class may come to use is included below.

Materials Testing—Recording Sheet for Tensile or Bending Strength

(tensile or bend)	Measure the width of the sample	Measure how thick the sample is	Multiply previous two columns	Enter the force needed to break the sample or bend it by a distance	Divide the test value by the cross sectional area	Once you have tested three samples, add the values together then divide by three.
↓	↓	↓	↓	↓	↓	↓
Test Type	Sample Width (mm)	Sample Thickness (mm)	Cross Sectional Area (mm ²)	Test Value	Strength (Value / mm ²)	Average Value

Impact resistance (drop test)

Impact resistance, or toughness, is very important for any material that will be used for car body panels. Foreign objects, such as, stones, branches, dirt etc, can hit the front of the car as it drives at speed along narrow twisting roads.

In industry a material used for a product would be tested using a Charpy impact test or an Izod impact test. This requires slightly more complex pendulum equipment.

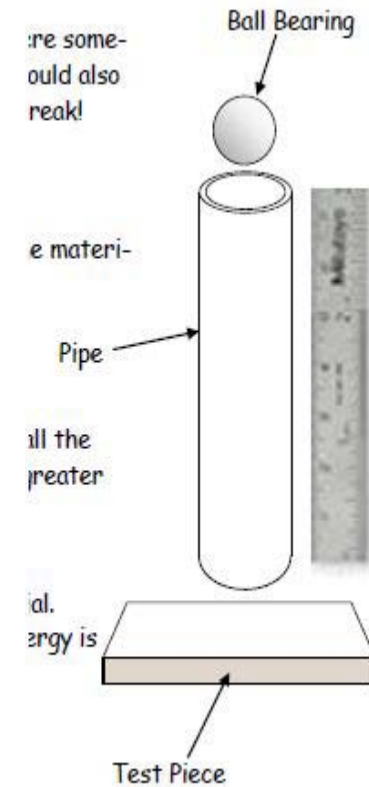
The test used must (like any) be consistent. The easiest test to do is a drop test, where something can be dropped onto a panel of material held in the correct position a set distance below. You could also drop the material from an agreed height, however, small samples, are more likely to bounce than break.

A Simple Test

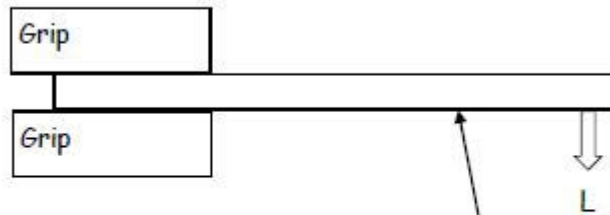
Test different materials by dropping a steel ball down a tube or pipe from increasing heights until the materials break. For example: Material A - broke at 180mm, Material B - broke at 200mm, Material C at 120mm

Learners could be asked what they think their results show and why? Which skills are being developed here and why and how might they be important? What sorts of things will we have to think about to keep the testing accurate?

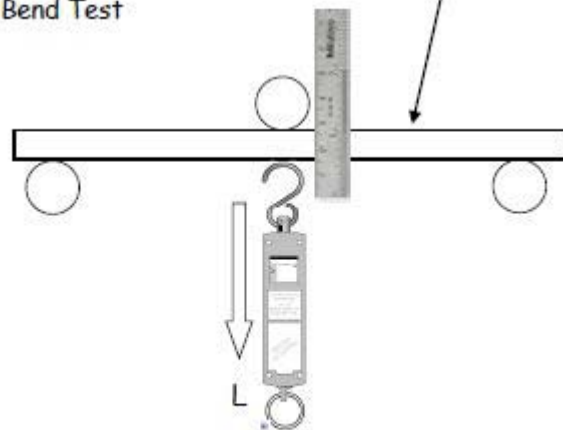
Other things that could be explored are factors such as how much energy was required to break each material. Toughness is often defined as the kinetic energy required to cause failure of a sample. How much energy is needed to break the sample. Potential energy = mass x gravitational acceleration x drop height. Kinetic energy = $\frac{1}{2} \times \text{mass} \times (\text{velocity at impact})^2$. Assume that potential energy of the ball is equal to its kinetic energy at the point of impact.



Cantilever test



3 Point Bend Test



Bend Test

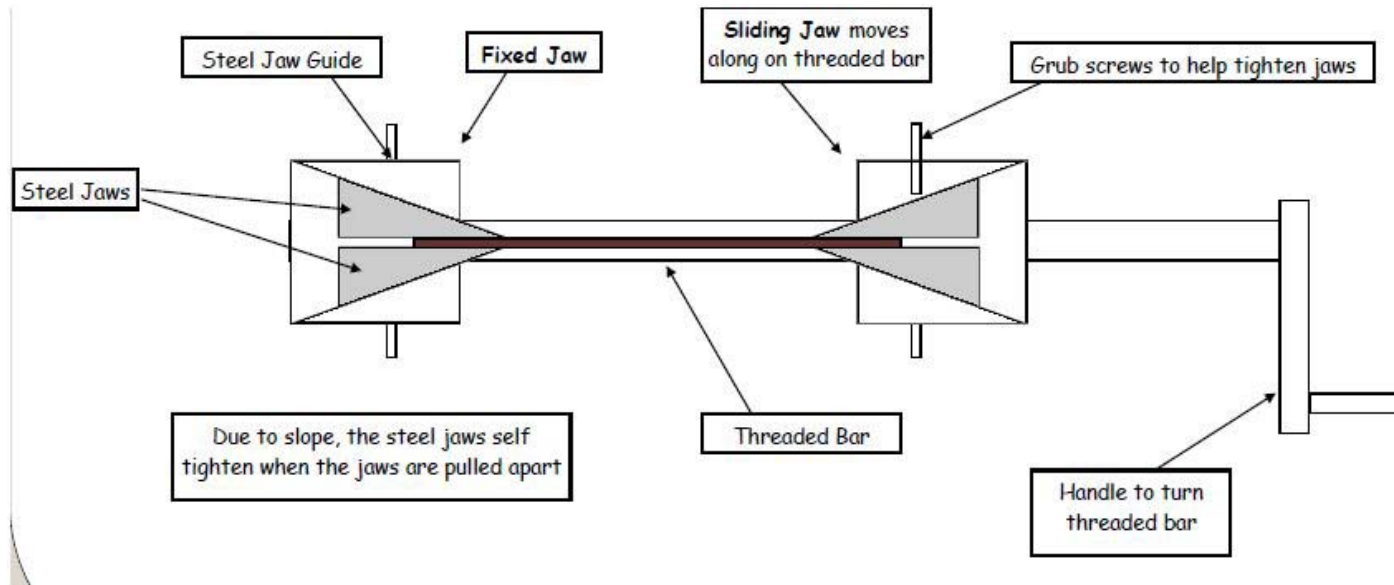
In both tests deflection for a given load (L) could be measured or how much load is needed to get a certain deflection. Since this test will most likely be used to compare materials it is simpler just to hang a specific load on a material (suspended by a piece of round bar sitting on top of the test piece) and measure deflection. This will only work if the cross sectional area of the test pieces is the same. When measuring the load needed to deflect the test piece, say 5mm, the strength can be calculated by dividing the load by the cross sectional area. A standard spring gauge can be used to measure the load.

Strength = Force = Nmm²
CSA

Tensile Test

A simple tensile test can show how much effort (Force) is required to stretch a material until it breaks or deforms beyond repair and shows how far a material can stretch before it breaks or gives up. However, it is quite a difficult test to perform as gripping the materials and stretching them requires well made and quite complex equipment.

Jaws need to be made to hold materials very tight and a system to move one jaw away from the other. Using jaws, with one fixed to end of a threaded rod and the other moving along the same threaded rod may be possible in schools. Measure how many turns it takes to break or deform the material and how far the material stretches before breaking. Also measure how much force is required to turn the threaded rod.



This is a plan view, suggesting a simple test device which can be made in a school workshop. Each school could work with the materials they have in school where possible. However, a university or business may be able to demonstrate specialist equipment to classes.