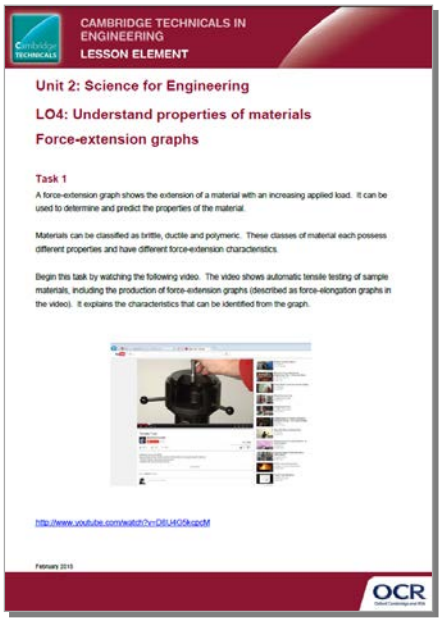
Unit 2: Science for Engineering

LO4: Understand properties of materials - Force-extension graphs

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Force-extension Graphs' *activity which supports OCR Level 3 Cambridge Technicals in Engineering Level 3.*


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 2: Science for Engineering

LO4: Understand properties of materials

Force-extension graphs

Task 1

A force-extension graph shows the extension of a material with an increasing applied load. It can be used to determine and predict the properties of the material.

Materials can be classified as brittle, ductile and polymeric. These classes of material each possess different properties and have different force-extension characteristics.

Begin this task by watching the following video. The video shows automatic tensile testing of sample materials, including the production of force-extension graphs (described as force-elongation graphs in the video). It explains the characteristics that can be identified from the graph.

http://www.youtube.com/watch?v=D8U4G5kqzdM

February 2015

OCR

The Activity:

In this activity learners are required to investigate force-extension graphs and the key characteristics they illustrate regarding the properties of a material.

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

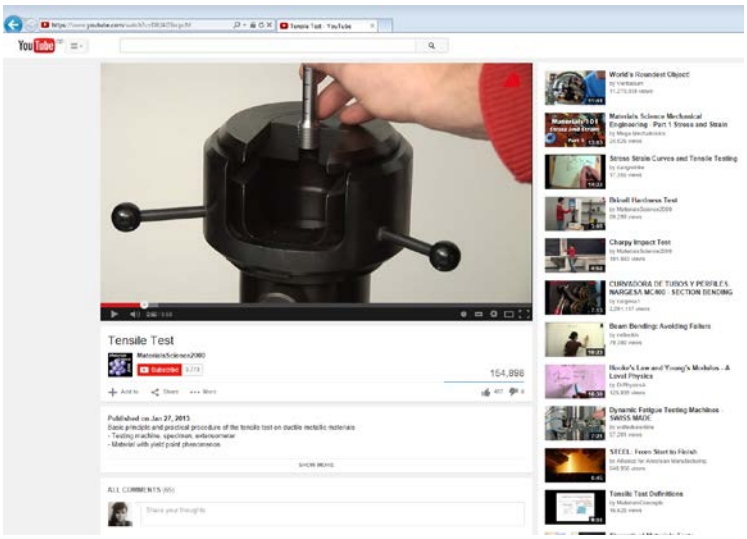
2 hours

April 2015

Activity 1

In this activity learners are required to investigate force-extension graphs and the key characteristics they illustrate regarding the properties of a material.

Learners are first directed to watch a YouTube video showing tensile testing being performed. Teachers may select other video sources, or could demonstrate tensile testing practically if access to resources is available.



http://www.youtube.com/watch?v=D8U4G5kcpcM

Learners are tasked to complete the following table. Required information can be obtained from the video. Further research could be undertaken if required.

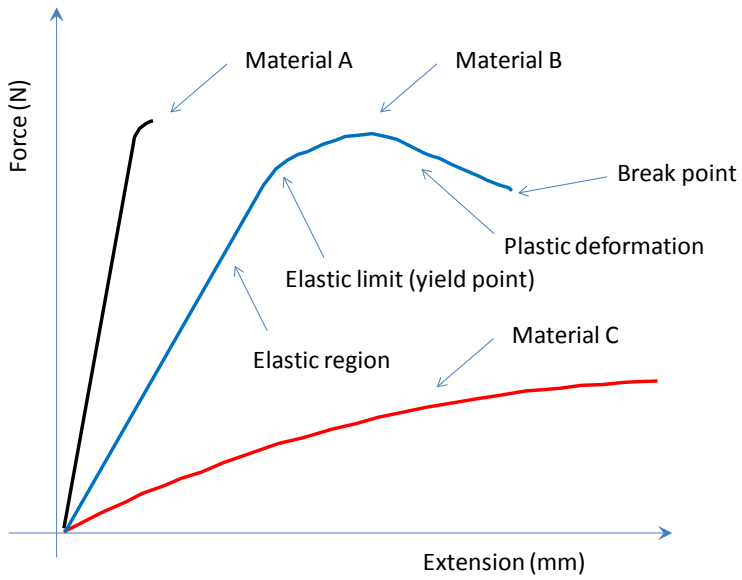
Term	Explanation
Force-extension or force-elongation graph	A force-extension (or force-elongation) graph is used to describe the properties of a material when in tension. It is the result of tensile testing.
Extensometer	An extensometer is a device that is used to measure changes in the length of an object.
Gauge length	Gauge length is the length marked on the parallel portion of a tensile test piece from which the elongation is measured.
Yield Point	The yield point is the stress beyond which a material becomes plastic – the point between the elastic and plastic regions.
Elastic behaviour	Elastic deformation or behaviour is deformation that disappears upon removal of the external forces causing the alteration and the stress associated with it.
Plastic behaviour	Plastic deformation or behaviour is a permanent deformation or change in shape of a solid body without fracture under the action of a sustained force.
Breaking point	The breaking point is the point at which the sample fractures.
Tensile strength	The tensile strength of a material is the applied force/original cross sectional area. In the video three values are defined: maximum elastic limit, lower yield point and maximum force.
Permanent strain after fracture	The permanent strain after fracture is the percentage elongation after fracture of the material. It is the change in length/original length.

Activity 2

In Activity 2 learners are required to identify the force-extension characteristics for different types of material: brittle, ductile and polymeric. These are shown on the graph below.

1. Material A is brittle, Material B ductile and Material C polymeric. Learners should also label the graph as shown below.

2.



3. Learners are also required to complete the following table to identify examples of materials, and their properties as indicated by the force-extension graph.

Material	Type of material (brittle/ductile/ polymeric)	Examples of this type of material	Properties (referring to force-extension graph)
Material A	Brittle	• Cast Iron • Glass • Concrete	• A brittle material deforms under load and breaks without significant deformation (often suddenly). • Brittle materials absorb relatively little energy prior to fracture. • Brittle materials can often withstand a large force. • Brittle materials often have no plastic deformation.
Material B	Ductile	• Copper • Steel	• A ductile material is easily stretched without breaking or lowering in strength. • Ductile materials can also often withstand large forces. • Ductile materials have defined areas of elastic and plastic deformation. • Materials that are highly ductile can be drawn into long thin wires without breaking.
Material C	Polymeric	• Plastics • Rubber • Elastomers	• Polymeric materials have no elastic (linear) region on force-extension graph. • Polymeric materials tend not to obey Hooke's Law i.e. there is no linear region on the force-extension diagram. • Due to their internal composition of long polymer chains the force-extension graph for polymeric materials often exhibits hysteresis (when loading and unloading).

Further work:

Teachers could task learners to research and identify the connection between Hooke's Law/Young's Modulus and the tensile properties of materials.

Teachers might set further examples of identifying key properties and values from force-extension graphs, including the calculation of stress and strain in the material.

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