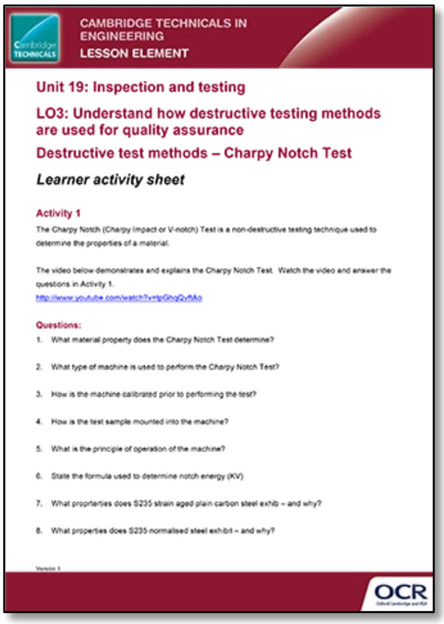
Unit 19: Inspection and testing

LO3: Understand how destructive testing methods are used for quality assurance

Destructive test methods – Charpy Notch test

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Destructive test methods – Charpy Notch test' *activity which supports Cambridge Technicals in Engineering Level 3.*


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 19: Inspection and testing

LO3: Understand how destructive testing methods are used for quality assurance

Destructive test methods – Charpy Notch Test

Learner activity sheet

Activity 1

The Charpy Notch (Charpy Impact or V-notch) Test is a non-destructive testing technique used to determine the properties of a material.

The video below demonstrates and explains the Charpy Notch Test. Watch the video and answer the questions in Activity 1.
http://www.youtube.com/watch?v=tpGhqQvftAo

Questions:

1. What material property does the Charpy Notch Test determine?
2. What type of machine is used to perform the Charpy Notch Test?
3. How is the machine calibrated prior to performing the test?
4. How is the test sample mounted into the machine?
5. What is the principle of operation of the machine?
6. State the formula used to determine notch energy (KV)
7. What proprterties does S235 strain aged plain carbon steel exhib – and why?
8. What properties does S235 normalised steel exhibit – and why?

Version 1

The Activity:

In Activity 1 learners are to watch a video showing an impact test being performed using a Charpy Impact (Notch) Test machine.

For Activity 2 learners have been set the task of investigating the toughness properties of a range of metals.

Suggested timings:

1 hour

Activity 1

In Activity 1 learners are to watch a video showing an impact test being performed using a Charpy Impact (Notch) Test machine. The video explains how the machine operates, how the machine is calibrated, how tests are peformed and shows tests on sample materials. It also explains that material toughness may vary with temperature.

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

This activity could be used as a class-based teaching resource.

Learners are are tasked to answer the following questions.

Answers to questions:

1. What material property does the Charpy Notch Test determine?
   The Charpy Notch (Charpy Impact or V-notch) Test is used to determine the toughness of the sample of a material under impact testing.

2. What type of machine is used to perform the Charpy Notch Test?
   The machine consists of a mass at the end of a pendulum. The machine is adjusted and calibrated prior to use and measures the energy absorbed by the test material.

3. How is the machine calibrated prior to performing the test?
   The pendulum is lifted to the starting position and the drag indicator adjusted. The pendumum and mass is released without a sample in the machine. When the friction is correctly compensated, then the machine will indicate zero impact energy.

4. How is the test sample mounted into the machine?
   The sample is machined to shape with a v-shaped notch. The tester places the specimen on a supported in the lower part of the machine, and adjusts its position with a centering device.

5. What is the principle of operation of the machine?
   The machine works on the principle that the pendulum strikes the test piece, and that the test piece absorbs energy. The amount of energy absorbed by the piece can be read from a dial indicators.

The pendulum only has potential energy in its starting position. At its first reversal point the pedulum also has only potential energy. The energy absorbed by the test piece is called notch impact energy (KV) which is the difference between the starting and the first reversal potential energy's.

6. State and explain the formula used to determine notch energy (KV)
   KV = mgH (starting energy of pendulum) – mgh (first reveral energy of pendulum)

7. What proprterties does S235 strain aged plain carbon steel exhib – and why?
   The sample absorbs 13 joules of energy. The specimen shows very little plastic deformation – it is brittle. It therefore absorbs little energy before fracture.

8. What properties does S235 normalised steel exhibit – and why?
   The sample absorbs 182 joules of energy. The specimen shows high plastic deformation – and does not actually break. It is highly ductile and is tough, so can absorb more energy.

9. For the Charpy Notch Test - do all materials exhibit the same proerties at different temperatures – and if not why not (hint: the video discusses BCC and FCC crystalline structures)?
   Different materials can exhibity different properties at different tempearures.
   For Body Centred Cubic (BCC) materials the properties of these materials can change with temperature, changing from brittle to ductile. These show a charaterisctic S shaped curve. At lower tenperatures they are brittle, and at higher temperatures ductile.
   For Face Centred Cubic (FCC) materials, these exhibit the same toughness across all temperatures. They do not exhibit a brittle to ductile transition.
   Learners could further investigate which materials are FCC and which are BCC.

Teachers could demonstrate the Charpy Impact Test practically if access to suitable resources is available.

Activity 2

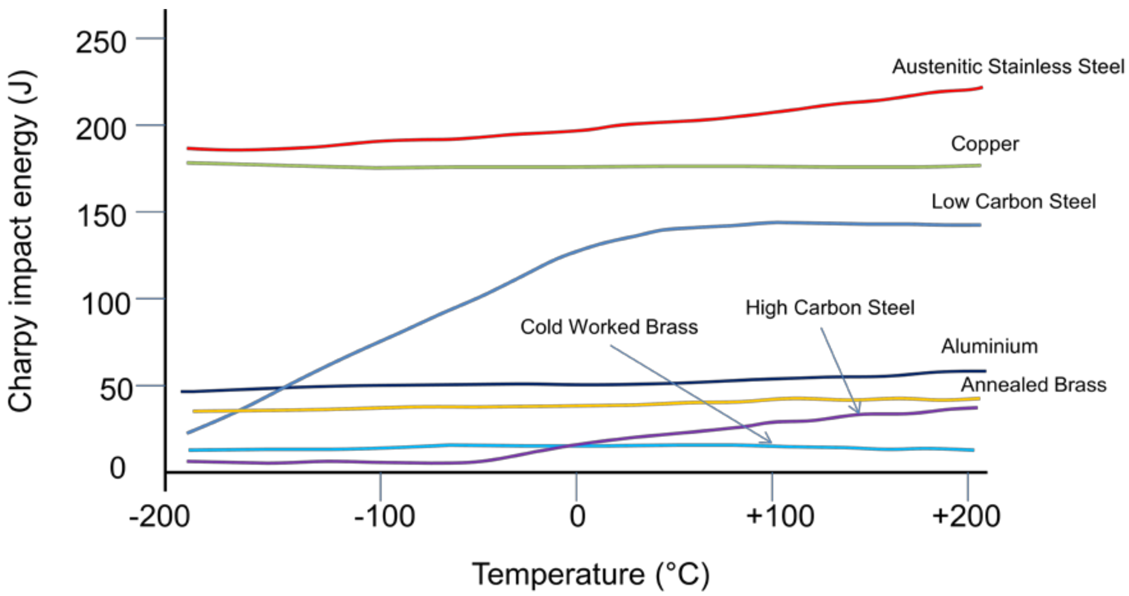
For Activity 2 learners have been set the task of investigating the toughness properties of a range of metals:

- high carbon steel
- low carbon steel
- austenitic stainless steel
- copper
- aluminium
- annealed brass
- cold worked brass

Learners might use the internet to perform their investigation.

Accurate toughness values are not required for this activity, only some appreciation of being able to order the materials in terms of their Charpy impact energy. Learners should also consider the toughness of these materials as a function of temperature.

Typical results are shown below.



It should be noted that some materials exhibit relatively constant toughness with temperature, while others exhibit a brittle/ductile transition as temperature increases.

The results above show Austenitic Stainless Steel as being the toughest material with Cold Worked Brass being the least tough.

Low carbon steel clearly demonstrates a brittle/ductile transition. Learners could investigate the reasons for this transition.

Teachers could adapt this activity in order that learners investigate the relative toughness of a different range of materials, which could include polymeric materials and composites.