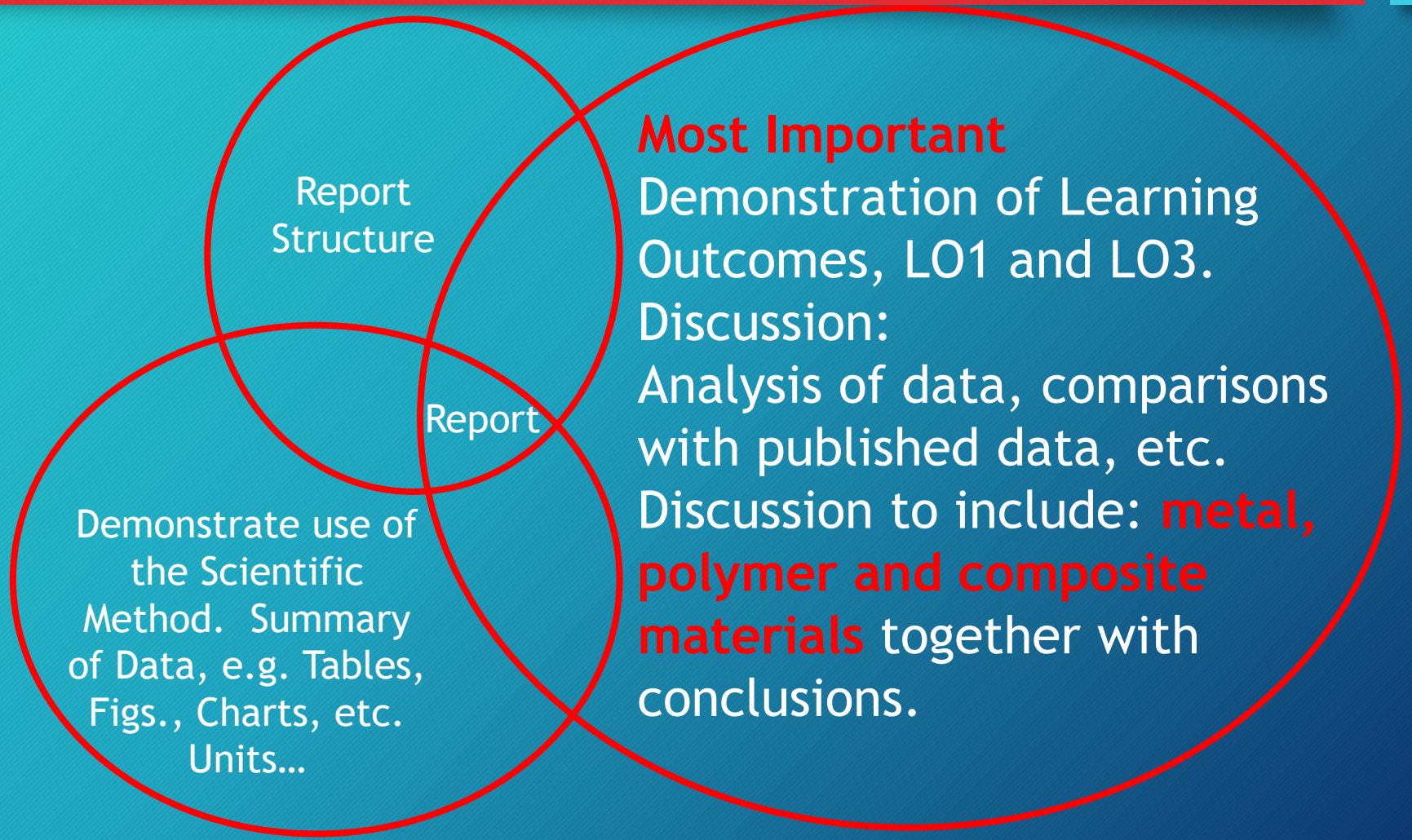
Engineering Science - Laboratory Tests

Assignment 2

Ingredients of a Good Report



Assignment Brief and Guidance

Scenario

You work as a materials engineer and have been tasked with investigating issues with products manufactured by your company. These products are made from polymer, composite and metal components.

Materials are failing in service, but your manager is not sure of the reason for this and has hypothesised that this could be due to degradation caused by fatigue, creep or other means. It has been suggested that types of hysteresis should be considered and/or that there are issues with the specification of materials being used.

Assignment Brief and Guidance

Task

Part 1:

You have been given samples of metals together with polymer and composite materials. You have access to tensile testing equipment, hardness testing equipment and dye penetrant testing equipment (destructive/non-destructive tests).

You are required to carry out tests on these materials and present a formal laboratory report.

By comparing and contrasting results obtained in your testing with theoretical material properties you should be able to draw appropriate conclusions. To do this the laboratory report must be structured to follow a formal scientific method thus ensuring your analysis can be relied upon to be scientifically sound.

You should ensure that your report includes the following elements:

- Graphical representations of the quantitative data gathered, using appropriate software.
- The SI units used including prefix notation, symbols and derived units.
- Full citation/references using the Harvard referencing system.

Assignment Brief and Guidance

Part 2:

Your manager wants you to write a formal report on the potential in service conditions that may have caused material failure and the structural properties of the metals as well as polymers and composites that you have been investigating (from Part 1).

You should consider the effect of degradation on the appearance of these materials and gather qualitative feedback from colleagues on the potential causes of failure. This feedback/data will be presented, using appropriate graphical software within your report.

Your report should reflect on the application of the scientific method (demonstrated in your laboratory report) for the testing you carried out. There should also be an analysis of all the graphical data presented (qualitative and quantitative information from Part 1 and Part 2).

You should ensure that your report includes the following elements:

- An explanation and comparison of the types of degradation including elastic and magnetic hysteresis.
- A description of the structural properties linked to their respective material properties.
- The SI units used including prefix notation, symbols and derived units.
- Full citation/references using the Harvard referencing system.

Demonstrate the Learning Outcomes

LO1 Examine scientific data using both quantitative and computational methods.		**D1** Analyse scientific data using both quantitative and qualitative methods.
P1 Describe SI units and prefix notation. **P2** Examine quantitative and qualitative data with appropriate graphical representations.	**M1** Explain how the application of scientific method impacts upon different test procedures.	
LO3 Explore the characteristics and properties of engineering materials.		**D3** Compare and contrast theoretical material properties of metals and non-metals with practical test data.
P6 Describe the structural properties of metals and non-metals with reference to their material properties. **P7** Explain the types of degradation found in metals and non-metals.	**M3** Review elastic and electromagnetic hysteresis in different materials.	

Demonstrate this in your calculations.

To express multiples and subdivisions of SI units concisely, the following prefixes are used with them:

Multiplication Factor	*Prefix*	*Symbol*
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10^{1}	deca	da
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

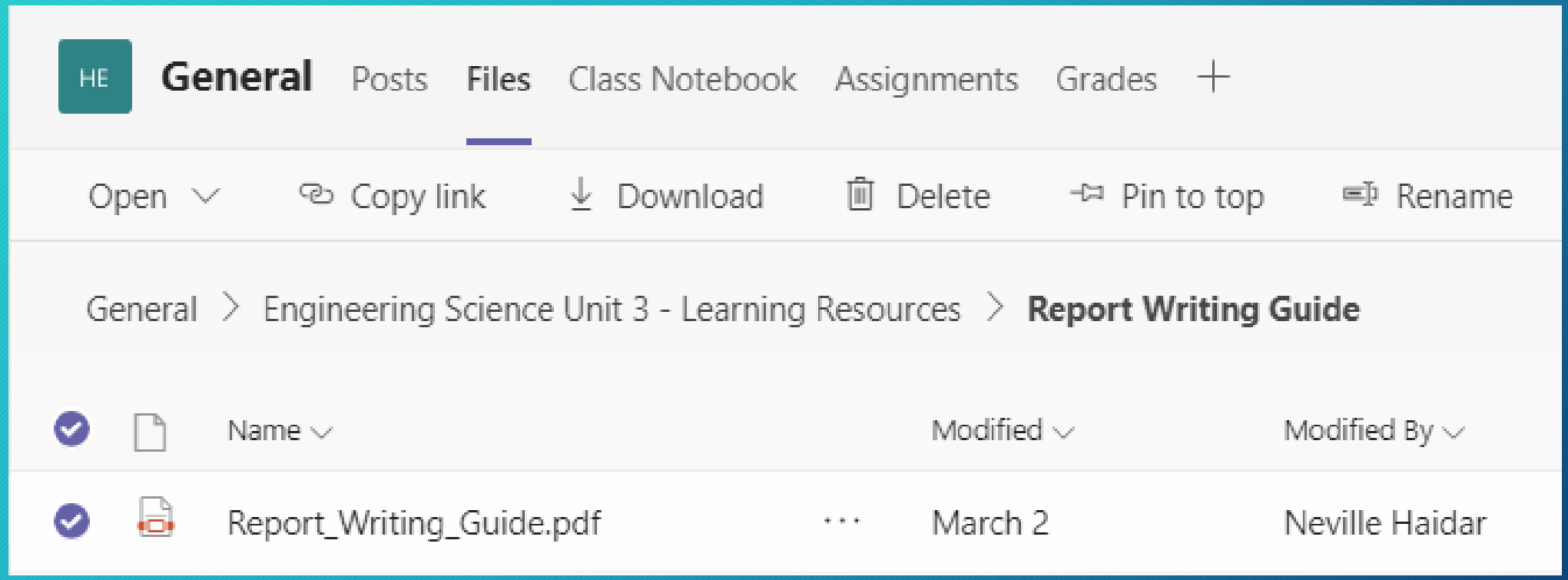
The multiplication factors preferred in SI are those increasing in steps of 10^{3}. Thus the use of hecto, deca, deci and centi should be avoided if possible.

Good Practice and Tips

- Label/number all figures and tables, for referencing, comparison and discussion purposes.
- Define any abbreviations used in the report, i.e. where applicable.
- Always include the CORRECT Units, e.g. in calculations, tables, figures, etc.
- Avoid using ‘I or we’.

Good Practice – Follow Report Structure

Report Structure – Refer to Report Writing Guide. A copy of this is located, as follows.



Tests Performed

1. Tensile Test
2. Vickers Hardness Test
3. Dye Penetrant Test, i.e. Inspection

Test 1 - Tensile Test

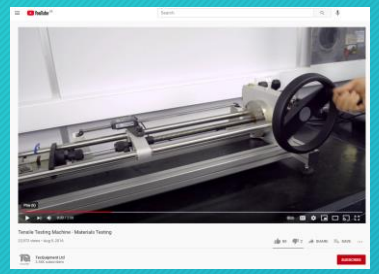
- The tensile test is a standard method for determining the mechanical properties of a material.
- The objective of this test is applying increasing forces to metal test specimens, while measuring the corresponding elongations and therefore determining the **materials' strength characteristics**.

Test 1 - Apparatus

- Tensile testing machine.
- Mild steel (0.1% Carbon), Copper and Brass samples.
- Computer software for post-processing test data.

Test 1 - Apparatus

College's tensile testing machine is shown opposite, i.e. with samples tested below.



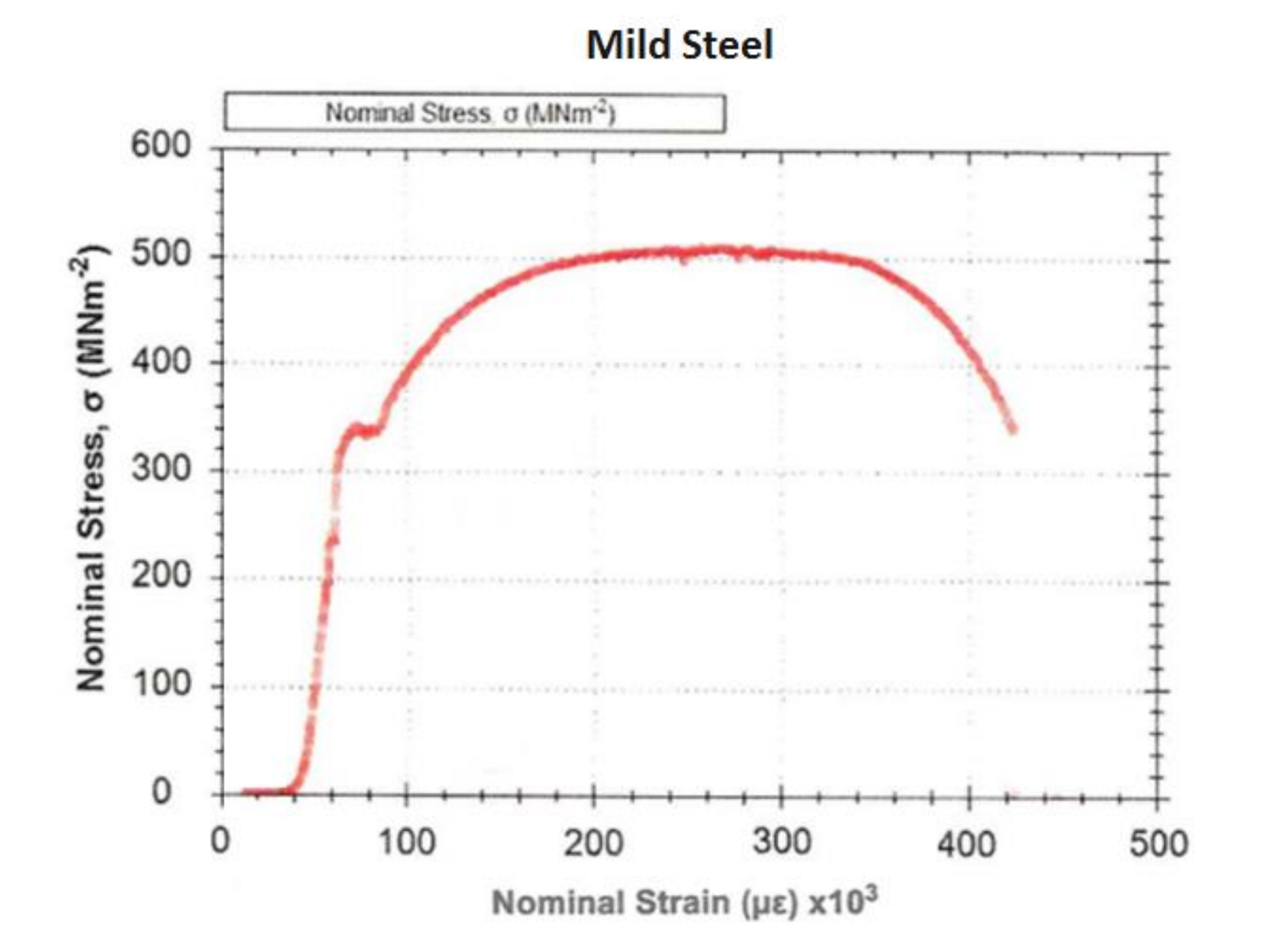
A link to a similar test is provided below.

https://www.youtube.com/watch?v=NR1O_L5MLjA

Test 1 - Experiment

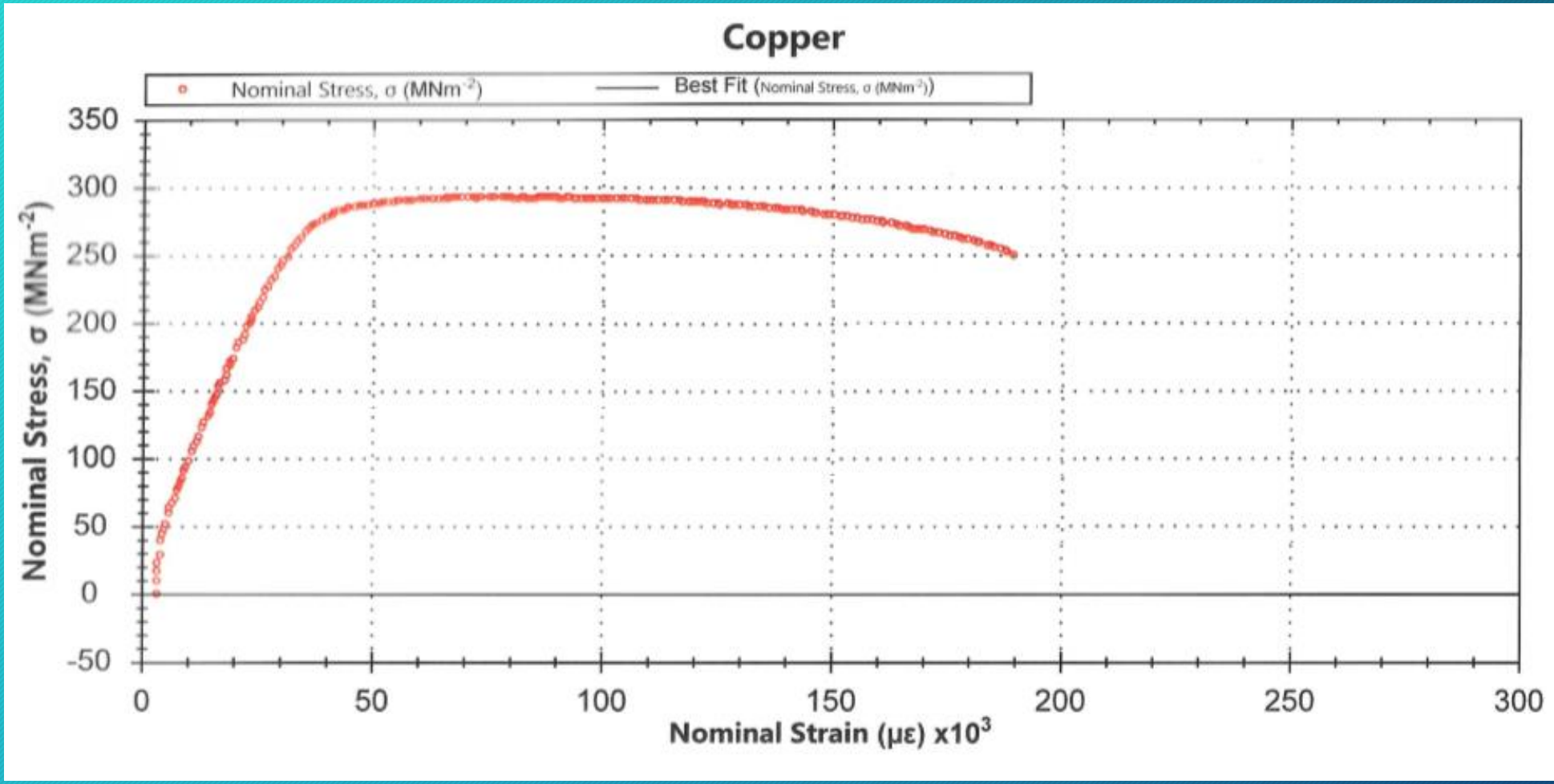
- A sample of a material is clamped between two jaws and (instrumentation zeroed) and gradually pulled it apart.
- In this tensile test experiment the sample is elongated incrementally and sample's elongation and corresponding applied *load* (force) recorded.
- The load (force) and elongation values are converted to *stress* and *strain* respectively and a graph for *stress vs strain* is generated, i.e. using the computer software.

Test 1A – Mild Steel Sample Test Results

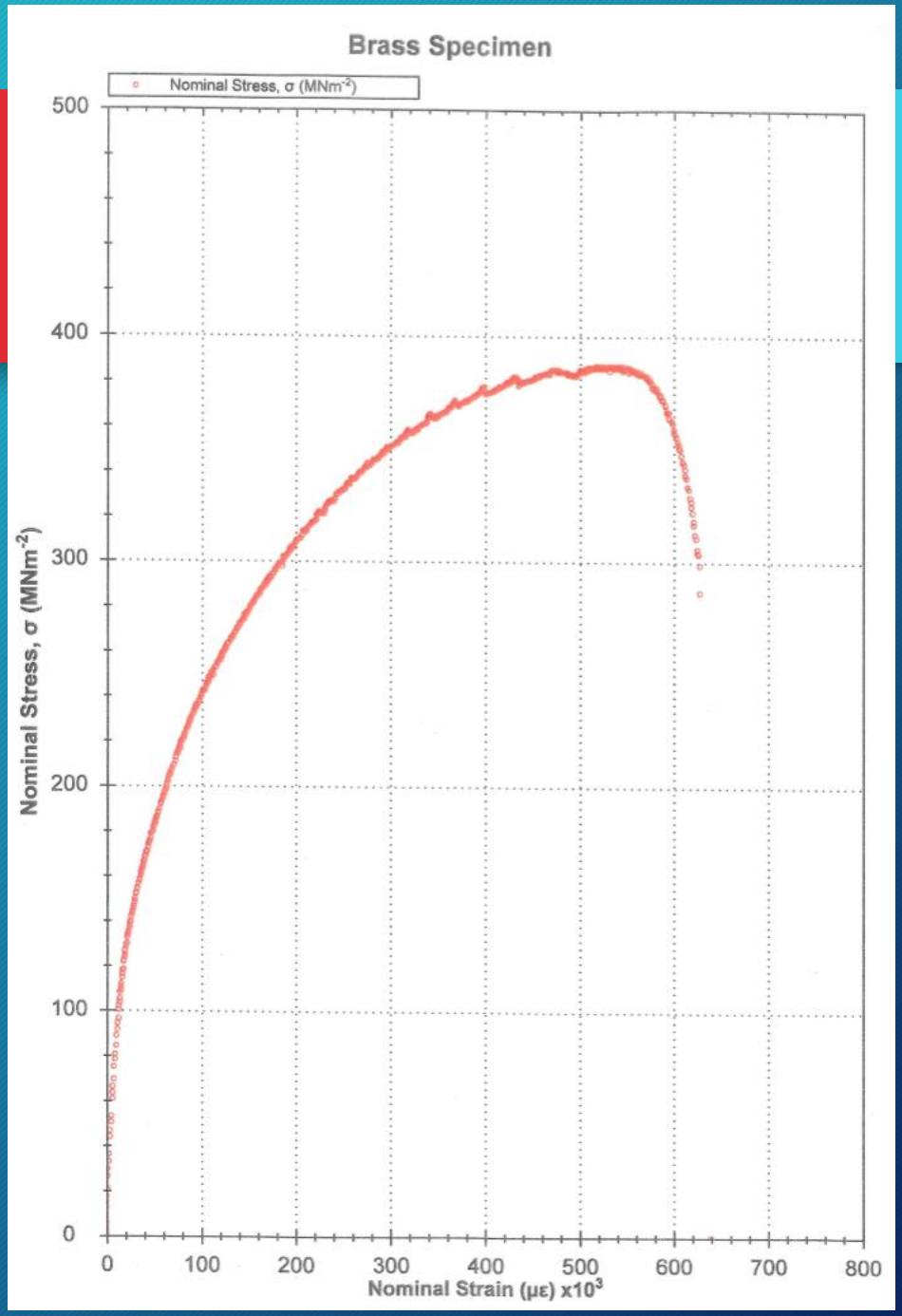


0.1% Carbon Steel Samples
- New and tested one

Test 1B – Copper Sample Test Results



Test 1C – Brass Sample Test Results



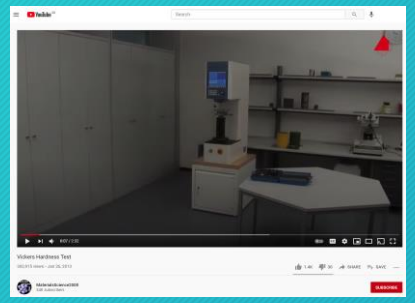
Test 2 - Vickers Hardness Test

The objective of this test is to determine the hardness of an aluminium and plastic Perspex material samples using the Vickers Hardness test.

Test 2 – Apparatus

College's universal hardness testing machine is shown opposite.

Aluminium and plastic Perspex samples used.



A link to a similar test is provided below.

http://www.youtube.com/watch?v=7Z90OZ7C2jI

Test 2 – Experiment

- Two samples were inspected for any visible damage, i.e. none were found.
- Each sample was fitted on the universal hardness testing machine together with the diamond indenter.
- The scale was zeroed and recommended load selected.
- The load was applied for a timed 10 seconds in order to create the indentation.
- A microscope was employed to measure the size of the indentation, using the integrated scale.

Test 2A – Aluminium Sample Hardness Results

720 - 98 = 622

622 x 0.002 = 1.244 mm

1.244 = 35.9 HV

Aluminium Sample

Test 2B - Plastic Perspex Sample Hardness Results

720 - 30 = 690

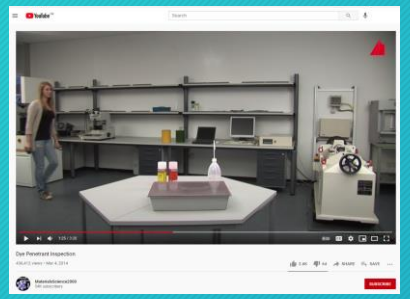
690 x 0.002 = 1.38 mm

1.38 = 29.2 HV

Plastic Perspex Sample

Test 3 – Dye Penetrant Test

The objective of this test (inspection) is to investigate the structural integrity and presence of any cracks in metal parts/specimens using Dye Penetrants.



A link to a similar test is provided below.

https://www.youtube.com/watch?v=xEK-c1pkTUI

Test 3 – Apparatus

Cleaner, Penetrant and Developer spray cans used are shown opposite.

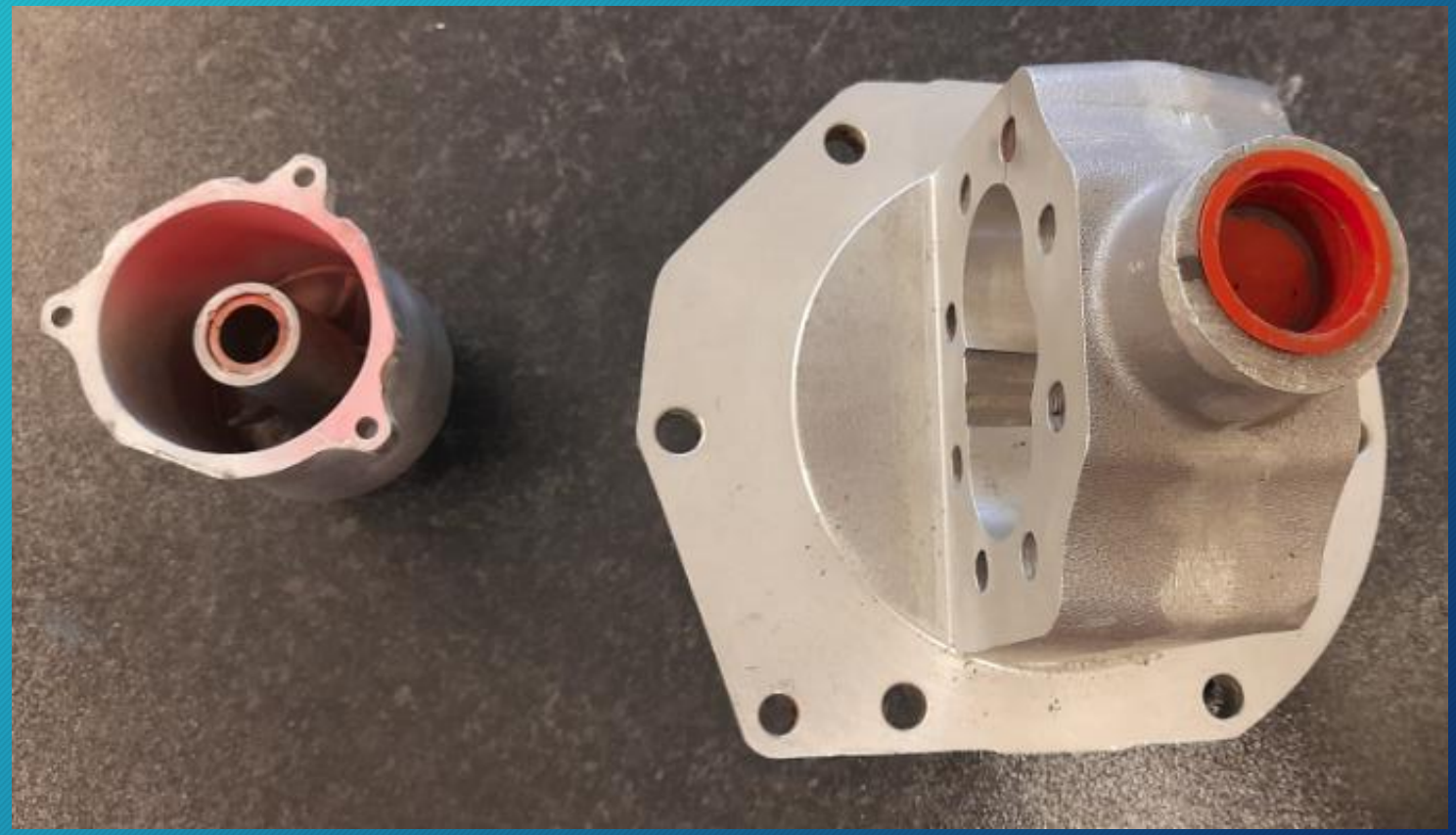
A tissue roll for cleaning surfaces.

Test 3 – Samples/Parts Tested

Two welded mild steel plates, a shown below.

Test 3 – Samples/Parts Tested

- Die cast aluminium pump casing.
- Die cast aluminium hydraulic flange.



Test 3 – Experiment

1. Test specimens/parts were thoroughly cleaned with a tissue paper, using the Cleaner Spray to remove any dirt, oil, etc.
2. The Penetrant Spray was applied on the clean surface and left to dry, and excess penetrant cleaned/removed.
3. The Developer Spray was applied to reveal the locations of any cracks present.

Note The sprays were applied from 15-25 cm distance.

Test 3A – Two Welded Mild Steel Plates

Following the application of the developer no ‘obvious’ red lines were visible, thus confirming no cracks were present as shown below.

Test 3B – Pump Casing

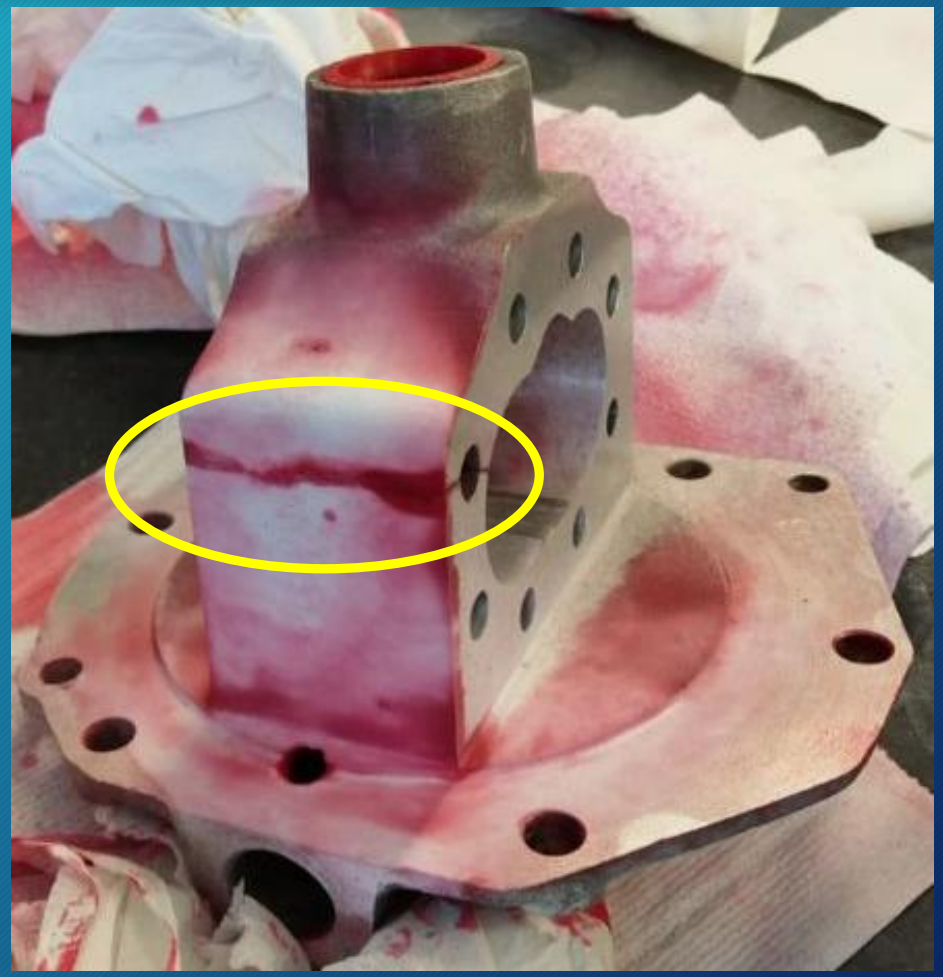
Die cast aluminium pump casing tested is shown opposite.

Following the application of the developer spray, two cracks were visible, as highlighted opposite.

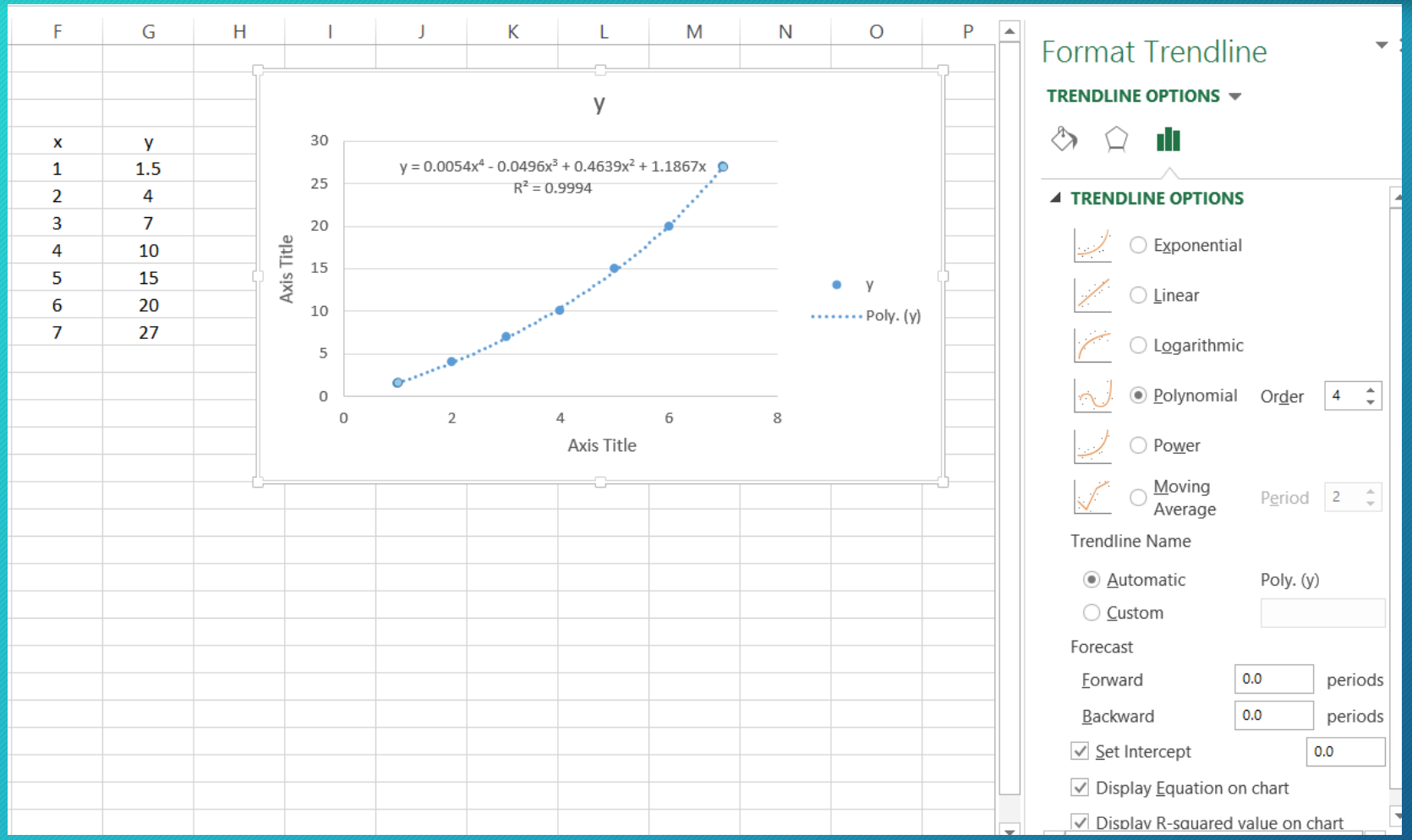
Test 3C – Hydraulic Flange

Die cast aluminium hydraulic flange tested is shown opposite.

Following the application of the developer spray, a ‘deep’ crack was visible, as highlighted opposite.



Post-Processing Data - Excel Tips, if applicable



Discussion Section

From the stress vs strain graphs, the following can be calculated:

- the *Modulus of Elasticity* (or Young's modulus).
- the *Ultimate Tensile Strength*.
- the Percentage Elongation at Failure, i.e. a measure of *ductility*.

- Discuss your tensile, hardness and dye penetrant test results, agreements/ disagreements with published data together with your observations.
- Screenshot/insert and clearly label relevant material from references used.

Re-Cap

- Conduct own investigation/research in order to ensure that you have fully delivered against the Assignment's LOs, i.e. Lecture notes may provide guidance, but not necessarily the complete/detailed information…
- Compare your findings versus published data.
- Discuss your results in a scientific manner, hence 'quantitative' and 'qualitative' graphical comparisons, where applicable.
- **Discussion and Conclusion Sections are the most important sections and findings should be compared in a scientific manner.**
- **Ensure that you work independently and reference any sources used…**

Important

Thoroughly read/digest the provided Assignment Brief and Guidance and closely follow/deliver against this.

Note: Materials to be investigated, include:

Metals, polymers and composites.