

# STUDENT FEEDBACK FORM (JOSHUA WITNEY)

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

| Generic Assessment Criteria                                                                                                                                                                                                                                                                                                                                                                            | Marks available | Marks awarded |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|
| <b>1. Engagement with Literature Skills</b>                                                                                                                                                                                                                                                                                                                                                            |                 |               |
| Engagement with a range of literature, including sources retrieved independently. Some good points were raised, but generally your work needed more to be more focused in attempting to focus on the practical use of the information covered. Nevertheless, you did cover sufficient research to allow for the evaluation of results but more detailed needed for a full consideration of the topics. | 20              | 11            |
| <b>2. Knowledge and Understanding Skills</b>                                                                                                                                                                                                                                                                                                                                                           |                 |               |
| Knowledge of the basic underlying concepts and principles is accurate with some good understanding of the field of study. However, your research needed further depth and scope and at times the terminology used was somewhat confused. You need to develop a more concise and technical style of writing and avoid the use of inappropriate terms.                                                   | 30              | 17            |
| <b>3. Cognitive and Intellectual Skills</b>                                                                                                                                                                                                                                                                                                                                                            |                 |               |
| A reasonable attempt at the evaluation of the underlying concepts and principles. You did interpret the data correctly, and you demonstrated an ability to use evidence to support the argument. Some areas of the evaluation were underdeveloped (I would have liked to have seen more on flexural rigidity, for example) and some confusion was also evident.                                        | 20              | 10            |
| <b>4. Practical Application Skills</b>                                                                                                                                                                                                                                                                                                                                                                 |                 |               |
| A good and appropriate application of basic methods, materials, tools, and/or techniques. Clear appreciation of the context of the application. Good set of calculations, and reasonable values of E and G obtained. Minor issues identified. Beam stress included. I would have liked to have seen more on the practical application of the work covered. Some presentational issues noted.           | 15              | 10            |
| <b>5. Transferable Skills for Life and Professional Practice</b>                                                                                                                                                                                                                                                                                                                                       |                 |               |
| Coherent, organised and accurate work in a suitable structure. Work is well written but overly descriptive at times. Referencing was mostly provided but needs to be improved. Summary also needed to be more concise and include the main results (see my comments in the report). You also need to ensure you use the correct tense and person is always used. Contents page was missing.            | 15              | 8             |

|                                                                                                                                                                                                            |                                                        |          |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|----------|-----------|
| <b>Assessment Mark</b> (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed. ) | <b>Late Submission Penalties (tick if appropriate)</b> | <b>%</b> | <b>56</b> |
|                                                                                                                                                                                                            | Up to 1 week late (40% Max)                            |          |           |
|                                                                                                                                                                                                            | Over 1 week late (0%)                                  |          |           |

# **Technical report**

## **Investigation into elastic constant**

**An engineering report that consists of technical diagrams, graphs, calculations all to support mechanical testing on elasticity of materials.**

Written by- Joshua Witney

Module code: SGDM4008

Word count: 2221

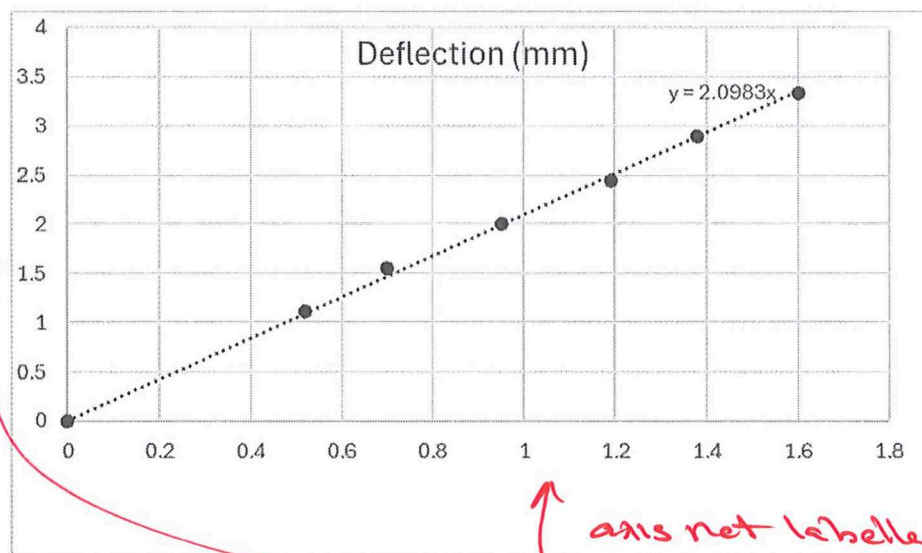
Date submitted: 10/12/24

## Summary

*Remember to use third person*

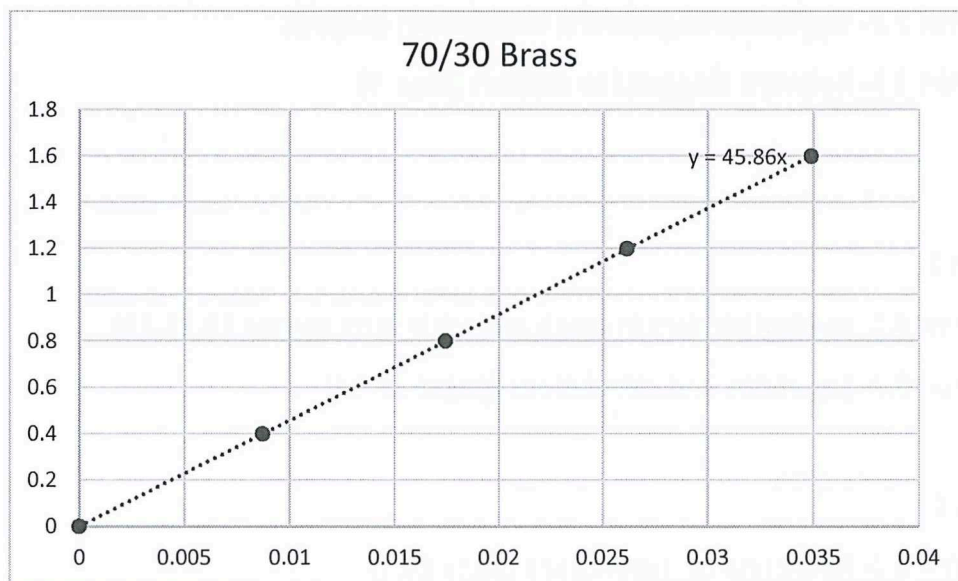
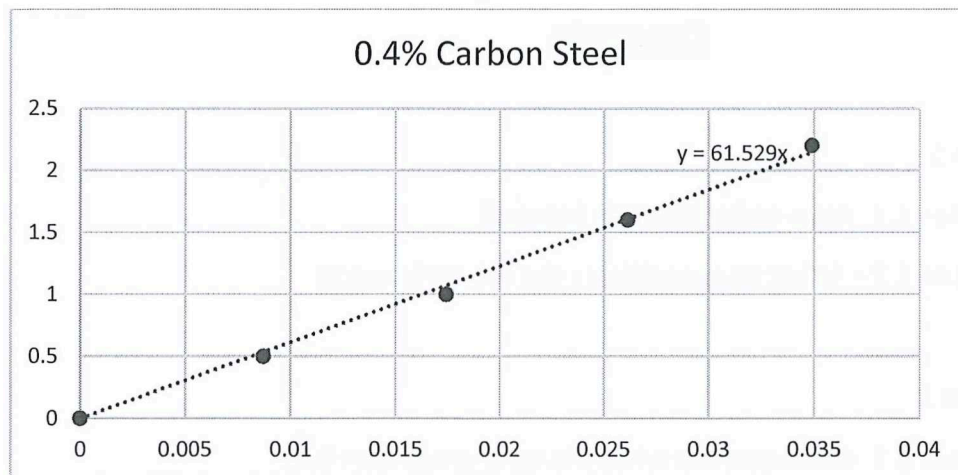
In this report I have set out to investigate the elasticity of materials when subjected to different loading methods. This is performed by using mechanical testing equipment. The two tests I have set out to gather relevant data for this report is; **Loading an Aluminium beam with a number of different loads and measuring the deflection that takes place** and also a **Torsion Test on a torsion test rig, to test two types of materials (0.4% carbon steel and 70/30 brass ) where a Torque value is applied and a angle of twist is recorded.** I carried out extensive research gathering significant knowledge on the two tests and what to expect to see, how it relates to the properties of the materials used and how designers/engineers use this information to aid their work. Below you can see the results in graphical form on how the beam deflected and the torsion test on the two materials.

### Deflection on a beam



*axis not labelled - unclear what is being plotted.*

### Torsion test on 0.4% carbon steel and Brass



You started off in a reasonable manner (although it was somewhat descriptive) but your summary did not present the results or the main conclusions.

## **Contents**

### **Introduction- Section 1**

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Section 2.2- Significant Engineering information (**page 8**)

Section 2.3- Relevant diagrams to support (**page 9**)

### **Results- Section 3**

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Section 3.2- Equations and calculations (**pages 13,14**)

### **Discussion- Section 4**

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Section 4.2- Supporting diagrams and calculations (**page 17**)

### **Conclusion- Section 5 (**page 18**)**

### **Evaluation – Section 6 - Relationship between the elastic constants (**page 19**)**

## Introduction-Section 1

This report will outline two tests that are being carried out using mechanical equipment which will enable me to find out the elasticity of materials when subjected to different loads in different ways with research and calculations to testify.

### 1.1- Aims and objectives

- The first test is to investigate the effects of loading an aluminium beam using weights and a dial test indicator to measure the deflection of the beam *→ to Calculate E for Aluminium*
- The next test I will be completing will be to investigate the effects of torsion on a cylindrical rod. *→ to Calculate G for Brass and 0.4% C Steel.*
- Next is to clearly present the data and findings so it visually evident on what has happened to the materials and what relationship they have.
- Complete research on the two tests and materials and find alternative useful information to back the report up.
- Carry out calculations to support and compare results to my experiment and research.

### 1.2- What to expect from the report

Not only will I achieve my aims and objectives in this report, I will also be discussing and reflecting on my findings, comparing them to the research and explaining the significance and importance. I will be concluding on what I have found from my values. I will evaluate on why these tests are carried out and how they are used in the engineering world to help gain control and keep structures and components safe for use.

## Theory- Section 2

## 2.1- Discussion on what the tests are (including method)

### Test 1

It is important when carrying out this test that the beam is carefully placed in the testing frame and is supported evenly. A dial test indicator is strategically placed at the point of where the deflection is going to take place. Load can now be applied in a controlled manner by slowly increasing the weight/load. Data can now be recorded. When a load is added to a beam deflection takes place which makes the beam deflect from its original position. The amount the beam will deflect all depends on the amount of load, the beams strength (i.e. material) and the beams cross section. The idea of performing these tests is to ensure that the beam is strong enough to resist certain shear forces and bending moments.<sup>1</sup> Please see figure 1, for a visual on what the test will look like.

### Test 1- Beam loading image <sup>2</sup>

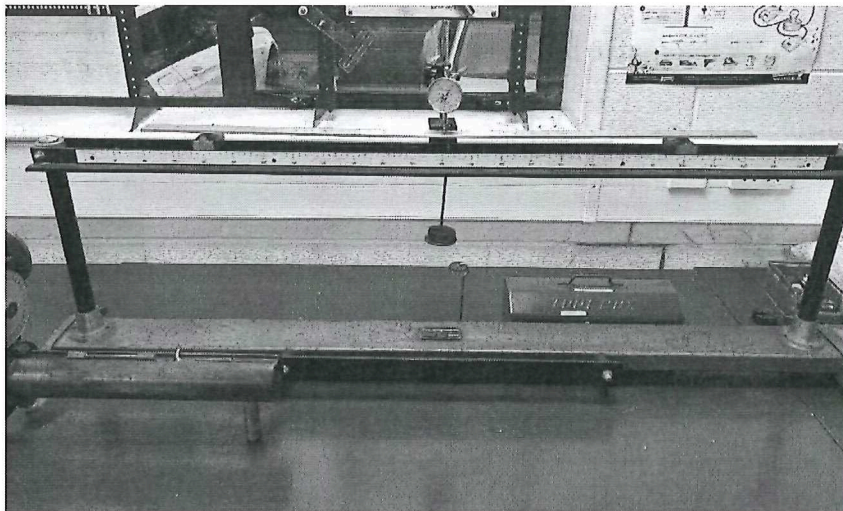


Figure 1

### Test 2

↓ Ensure Harvard is used next time

<sup>1</sup> <https://www.ilearnengineering.com/civil/what-is-the-magnitude-of-deflection-in-beams-and-how-do-we-determine-it>

<sup>2</sup> Image taken from my test in the lab

Torsion Testing is used to measure a materials reaction to torsional stress, this type of stress is a twisting rotational force when the material is fixed in place. When carrying out this test you would typically find that the material is a cylindrical rod or a tube. You would see that both sides are fixed with one end is rotated with a specific amount of torque. By preforming this you can then find out a number of properties and performances but we are focusing on one 'the modulus of rigidity'. This property will show how much the material will deform under stress, this will give the user an idea of the materials stiffness, by carrying out calculations to find the sum for the shear stress to shear strain.<sup>3</sup> Please see figure 2 for the torsion test rig using a worm wheel and drive which is measured with a torque arm and spring balance.

#### Torsion test rig<sup>4</sup>

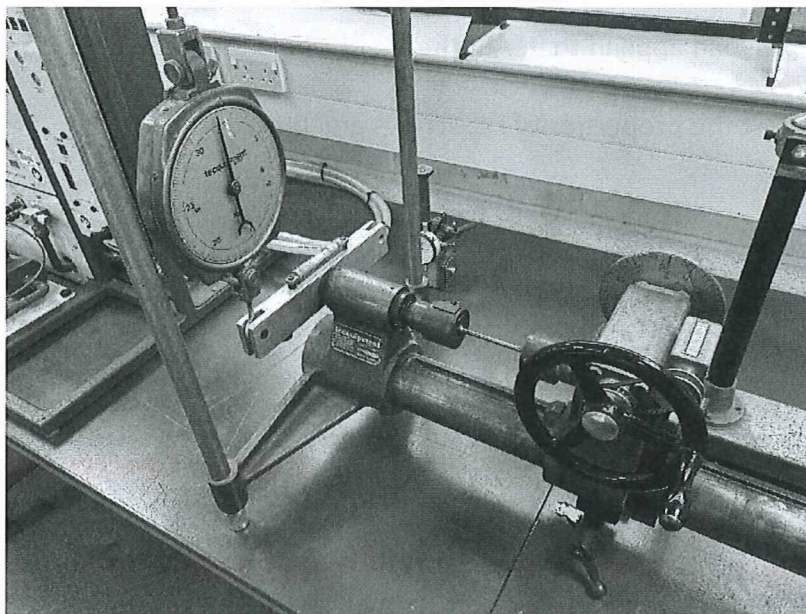


Figure 2

<sup>3</sup> <https://biopdi.com/torsion-testing/>

<sup>4</sup> Image taken while carrying out tests in lab

## 2.2- Significant engineering information

### Loading on a beam

In the engineering world the test is usually used by Architects, designers and of course engineers. One of the most common uses of this test is for buildings and structures. It is vital to know the deflection of a beam that is supporting any weight and ensuring it has a suitable safety factor. You would be able to gather information such as the weight that can be applied and how it will affect the support beams. Too much movement in beams will affect the structural integrity of the i.e. building, lifting aids, bridges etc which will immediately cause risk.<sup>5</sup>

↑ you needed to be more concise and technical.

### Torsion test rig

specific applications would be better highlighting the influence of different materials.

Torsion testing is vital information that needs to be obtained from a number of industries. In engineering you would use it for automotive applications which could be a shaft on a motor that will have a certain load applied to it. Another field would be the biomedical field where they would need to test the properties of i.e. screws and drill tool bits.

By finding this information about the materials it will enable the user to establish what materials they could use that could enhance the project, for example by completing this test on different materials it would allow them to potentially use a lighter material but would still be strong enough when certain loads are applied.<sup>6</sup>

(see comment above).

you could have introduced the other elastic constants here.

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<sup>5</sup> <https://www.ilearnengineering.com/civil/what-is-the-magnitude-of-deflection-in-beams-and-how-do-we-determine-it>

<sup>6</sup> <https://step-lab.com/torsion-test/#:~:text=This%20test%20is%20used%20to,when%20subjected%20to%20torsional%20loads.>

### 2.3- Relevant diagrams

Please see figure 3 to view a typical shear force and bending moment diagram for this beam loading test.

Beam loading shear force and bending moment diagram<sup>7</sup>

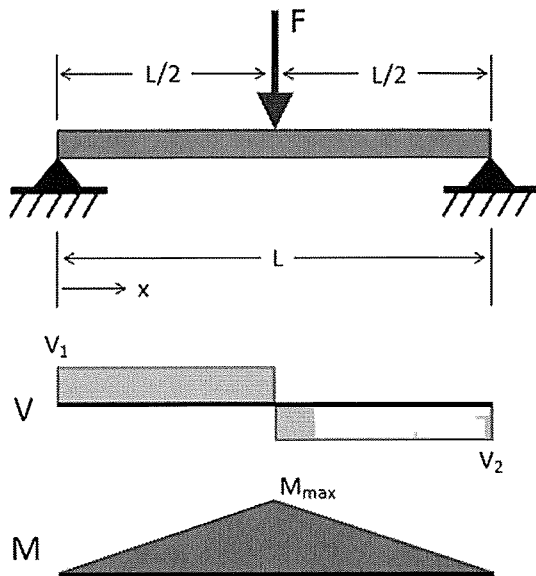


Figure 3

Please see figure 4 for a typical torque to angle of twist graph.

Torsion test<sup>8</sup>

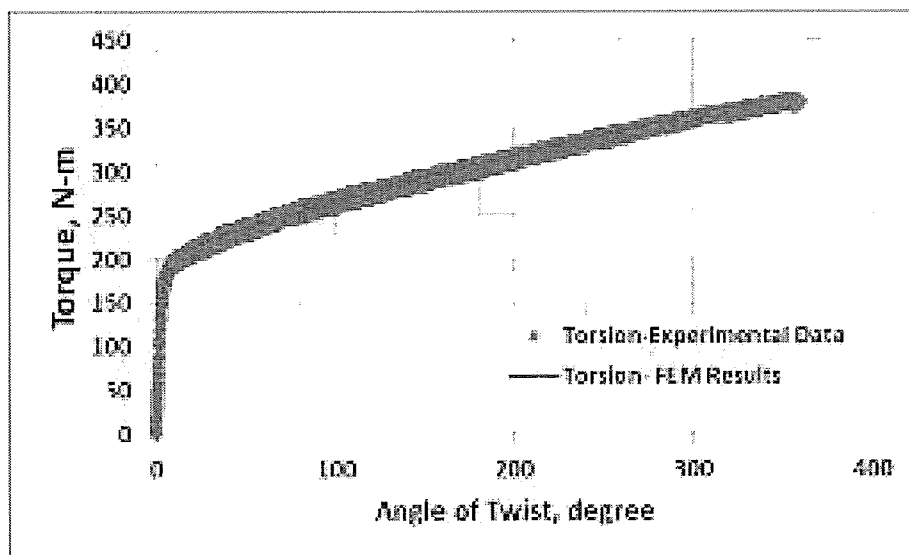


Figure 4

<sup>7</sup> <https://mechanicalc.com/reference/beam-analysis>

<sup>8</sup> [https://www.ijirset.com/upload/2013/december/61\\_Review.pdf](https://www.ijirset.com/upload/2013/december/61_Review.pdf)

## Results-Section 3

### 3.1 presenting data in graph and table form

#### Test 1

After completing the test I tabulated the results as shown below.

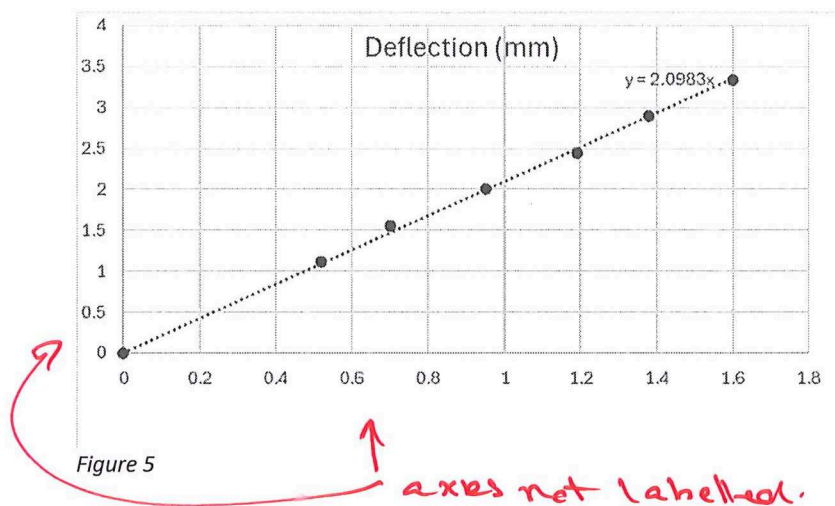
| Load (lbs) | Load (kg) | Load (N) | Deflection (mm) | Length=800mm |
|------------|-----------|----------|-----------------|--------------|
| 0          | 0         | 0        | 0               |              |
| 0.25       | 0.1135    | 1.113435 | 0.52            | Depth=5mm    |
| 0.35       | 0.1589    | 1.558809 | 0.7             |              |
| 0.45       | 0.2043    | 2.004183 | 0.95            |              |
| 0.55       | 0.2497    | 2.449557 | 1.19            |              |
| 0.65       | 0.2951    | 2.894931 | 1.38            |              |
| 0.75       | 0.3405    | 3.340305 | 1.6             |              |
|            |           |          |                 |              |

As you can see from my results I have converted from lbs to kg and to newtons. **Newtons** was the units of measurement that I wanted to use for my data. In order to complete these conversions I used the following conversion equations:

1 pound = 0. 453592 kg, therefore I multiplied my value by 0.453592

1 kg of force = 9.80665, therefore I multiplied the value by 9.80665 N

Now I was ready to produce a graph as seen below in Figure 5:



## Test 2

After completing the test on both materials I tabulated the results as shown below.

### **0.4% Carbon Steel**

| Torque (T) Applied in Nm | Angle of twist in degrees | Radians  |
|--------------------------|---------------------------|----------|
| 0                        | 0                         | 0        |
| 0.5                      | 0.5                       | 0.008722 |
| 1                        | 1                         | 0.017444 |
| 1.6                      | 1.5                       | 0.026167 |
| 2.2                      | 2                         | 0.034889 |

### **70/30 Brass**

| Torque (T) Applied in Nm | Angle of twist in degrees | Radians  |
|--------------------------|---------------------------|----------|
| 0                        | 0                         | 0        |
| 0.4                      | 0.5                       | 0.008722 |
| 0.8                      | 1                         | 0.017444 |
| 1.2                      | 1.5                       | 0.026167 |
| 1.6                      | 2                         | 0.034889 |

**Length= 90mm**

**Diameter= 6mm**

As you can see from the tables above I recorded the test in degrees of twist but actually want to have the results in **radians** for my graph.

To convert from Angle of twist to Radians I had to complete the following conversion equation:

1 degree = 0.0174533 radians, in order to complete the conversion I had to for example (using 0.5):

$(0.5\text{deg}/360)$  multiplied by  $6.28 = 0.008722$  Rads

After completing these tables and working out my conversions I could now produce my graphs in Figure 6 and 7:

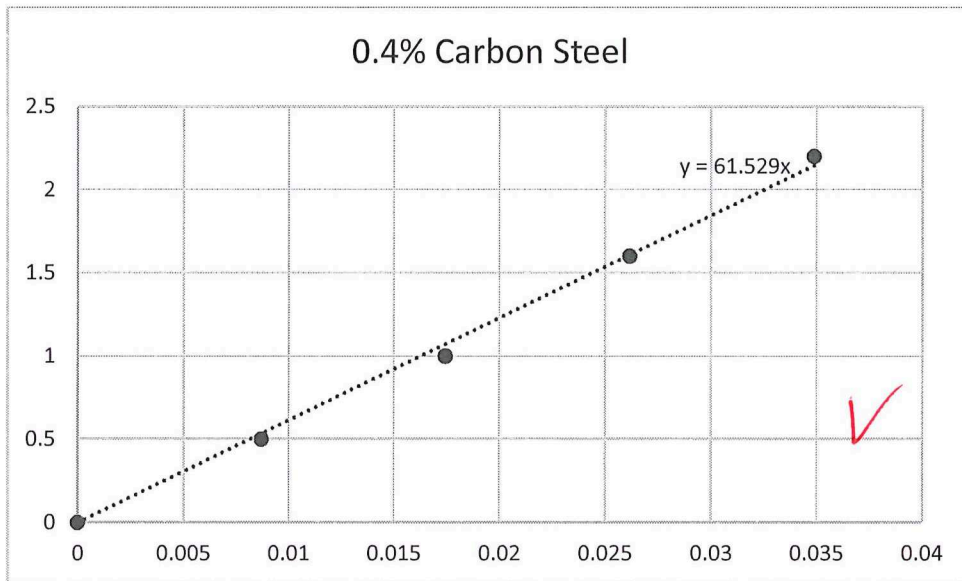


Figure 6

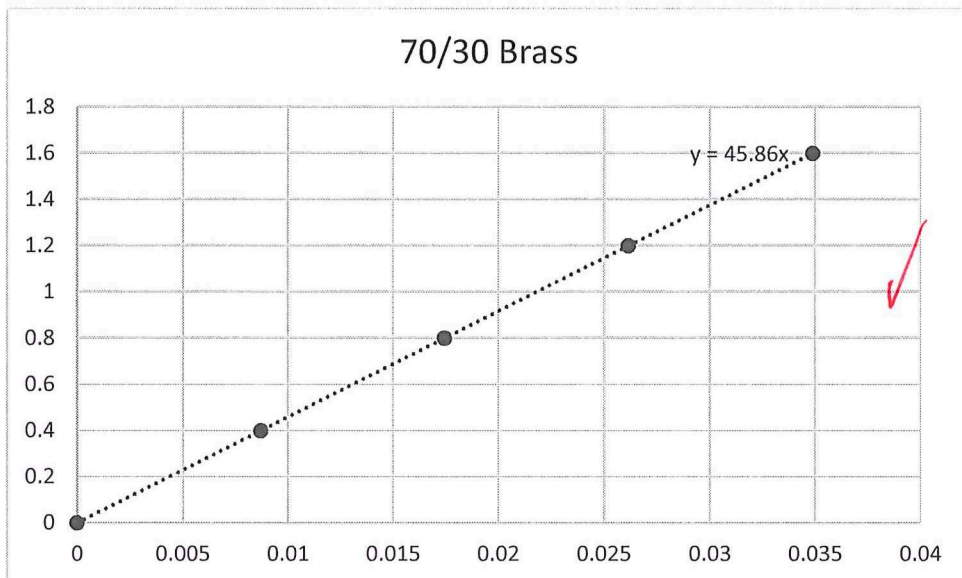


Figure 7

### 3.2 Equations and calculations

### Test 1

From producing these graphs I can now complete my calculations to find the modulus of elasticity, to complete the calculations the information I require will be

Length = 800mm

I=?

Slope of graph = 2.1

I have the Load and deflection values in my graph.

Please see figure 8 for calculations:

#### Modulus of elasticity calculations

The image shows handwritten calculations on lined paper. At the top, the word 'Beam' is written and underlined. Below it, the formula  $E = \frac{L^3}{48I} \times \text{Slope of graph}$  is written. This is followed by a substitution:  $E = \frac{(800)^3}{48I} \times 2.1$ . Then, the moment of inertia  $I$  is calculated as  $I = \frac{32 \times (5)^3}{12} = 333 \text{ mm}^4$ , with a checkmark to the right. Finally,  $E$  is calculated by substituting the value of  $I$ :  $E = \frac{(800)^3}{48 \times 333} \times 2.1 = 67267.3 \text{ N/mm}^2 = 67.27 \text{ GN/m}^2$ , also with a checkmark to the right.

$$\text{Beam}$$
$$E = \frac{L^3}{48I} \times \text{Slope of graph}$$
$$E = \frac{(800)^3}{48I} \times 2.1$$
$$I = \frac{32 \times (5)^3}{12} = 333 \text{ mm}^4$$
$$E = \frac{(800)^3}{48 \times 333} \times 2.1 = 67267.3 \text{ N/mm}^2 = 67.27 \text{ GN/m}^2$$

Figure 8

## Test 2

From the graphs I can now complete my calculations to find the modulus of rigidity (G), the information needed is:

$L = 90\text{mm}$

$J = ?$

I have the torque and twist angle in my graph.

Please see figure 9 for my calculations:

### Modulus of rigidity calculations

Carbon Steel (0.4%)

$$G = \frac{L}{J} \times \text{Slope of graph}$$
$$J = \frac{\pi D^4}{32} = J = \frac{\pi \times (0.006)^4}{32}$$
$$J = 1.27 \times 10^{-10} \text{ m}^4$$
$$G = \frac{0.09}{1.27 \times 10^{-10}} \times 61.5 = 4.36 \times 10^{10}$$

$43.6 \text{ GPa}$

Brass

$$G = \frac{L}{J} \times \text{Slope of graph}$$
$$J = \frac{\pi D^4}{32} = J = \frac{\pi \times (0.006)^4}{32}$$
$$J = 1.27 \times 10^{-10} \text{ m}^4$$
$$G = \frac{0.09}{1.27 \times 10^{-10}} \times 45.86 = 3.25 \times 10^{10}$$

$32.5 \text{ GPa}$

Figure 9

## Discussion- Section 4

In this section I will be outlining the significance of my results and comparing them to the theory and research I completed.

### 4.1 Reflection on significance

#### Test 1

From my theory it was clear that the test is carried out to not only measure the deflection of a beam but to calculate when it will fail Figure 10. This is vital in all industries because beams are typically used for support and structures. From looking at Figure 5 it clearly shows in graphical form almost a linear graph clearly showing as the weight/force increases as does the deflection proportionally. If a designer/ engineer decides the beam is not suitable they could then think of; changing the material of the beam? Or using a thicker beam? These both could increase the max stress.

No, to determine  $E$  and investigate its significance on practical situations: etc.

Flexural rigidity in beams? – it is a measure of the beams resistance to bending, it is displayed as  $(EI)$ . The larger the value of  $EI$  the less the beam will deflect. Ways to higher Flexural Rigidity is stiffer material/larger cross sectional area which will lower deflection<sup>9</sup>.

More needed here.

#### Test 2

When completing this test on two different materials it has given me an insight on why and how industries carry out the test. From the tables produced you can clearly see that 70/30 brass has less torque applied to it but achieves the same angle of twist as carbon steel. From using a metal weight calculator<sup>10</sup> I could see that both materials weigh the same at 0.02kg,

under

<sup>9</sup> <https://bjalmonte.wordpress.com/wp-content/uploads/2012/09/chapter-9-mecmat-gere7chambauer.pdf>

<sup>10</sup> <https://www.aalco.co.uk/online-tools/weight-calculator/>

this highlights as a designer you would clearly see that steel would perform better under these conditions and weighs the same.

← unclear how this relates to torsion.

## Section 4.2- Supporting diagrams and calculations

In this section I will display a shear force and bending moment diagram, this will help outline the beams Max shear force and bending moment which comes in line with deflection.

Note:

- Here I will take clockwise and anticlockwise moments
- Force = force x distance
- Upwards force = +ve / Downwards force -ve
- Bending moment clockwise +ve / Anticlockwise -ve

Please see figure 10.

Shear force and bending moment

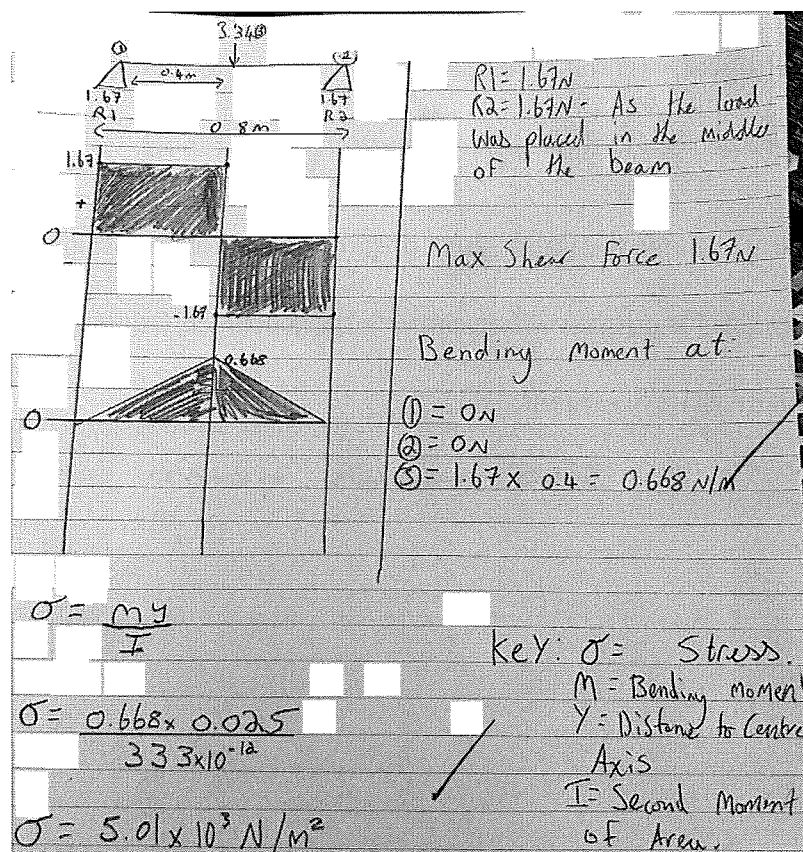


Figure 10

## Conclusion-Section 5

To bring this document to a conclusion I will first talk about the tabulated and graphical values that I gathered. You can clearly see that the results are linear and what you would expect to see, this enabled me to take a good gradient from the graphs to complete the calculations.

To back up test 1, I drew up a shear force and bending moment diagram this could also enable me to highlight the max stress that beam could withstand. From these two values I could make a good decision on whether this beam would be suitable for a job in the engineering world.

By carrying out the test 2 on two materials, my tabulated values highlighted the difference in the two materials, after carrying out research I could clearly see the importance of knowing this information as mentioned in the discussion section of the report.

In this report it clearly outlines the importance of carrying out tests on materials in making sure they are safe and fit for purpose when carrying out a project. Using diagrams and calculations it has been visually evident.

*See previous points on arms.*

## Evaluation-Section 6

To evaluate this report I will be discussing the relationship between E- modulus of elasticity and G- modulus of rigidity.

Where E measures a materials stiffness when subjected to different types of stress.

Where G measures a materials stiffness when under shearing force.

In structural engineering knowing these values it allows the engineer to predict how materials will act when subjected to axial and shear stresses.

The relationship is given by:  $G = \frac{E}{2(1+\nu)}$  <sup>11</sup>

*unclear why this has been introduced here.*

Note:

$\nu$  = poisons ratio- the lateral strain to the axial strain in a material subjected to tensile or compressive stress.

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<sup>11</sup> <https://testbook.com/mechanical-engineering/elastic-constants>