

STUDENT FEEDBACK FORM (KIERAN JONES)

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
1. Engagement with Literature Skills		
Limited engagement with a suitable range of literature but some reasonable points were raised. Generally, your work needed more depth and scope. Without a detailed and structured literature review, you left yourself with too little to discuss. This is something you will need to improve upon next time. Try to ensure you present your research in coherent and structured manner. You need to plan out your work beforehand.	20	8
2. Knowledge and Understanding Skills		
Knowledge of the basic underlying concepts and principles is evident but also some confusion appears to be present. The structure of the report is an issue here. Your research needed further depth and scope. Tended to the descriptive, be more critical in your tone. Errors in terminology noted.	30	12
3. Cognitive and Intellectual Skills		
Reasonable attempt at the evaluation of the underlying concepts and principles. You did interpret the data correctly (see below), and you did not demonstrate an ability to use evidence to support the argument. Some points of interest were identified. Structural issues noted throughout which prevented a coherent approach.	20	10
4. Practical Application Skills		
Reasonable application of basic methods, materials, tools, and/or techniques. Appreciation of the context of the application is present but the calculations of E were not correct. Presentation of data was poor. Beam stress was not included. I would have liked to have seen more on the practical application of the work covered. Also, further reference to expected values of E and G would have helped.	15	8
5. Transferable Skills for Life and Professional Practice		
Work is too descriptive with grammatical errors noted. Contents page needed to be developed. Referencing was included but only to a limited extent. Summary was not fully developed. This is important and it needs to include the main aims, the results and the conclusions. Remember to use the correct tense and person throughout. Also, always ensure that appropriate technical language is always used.	15	7

Assessment Mark (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.)	Late Submission Penalties (tick if appropriate)	%	45
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

Investigation into Elastic Constants

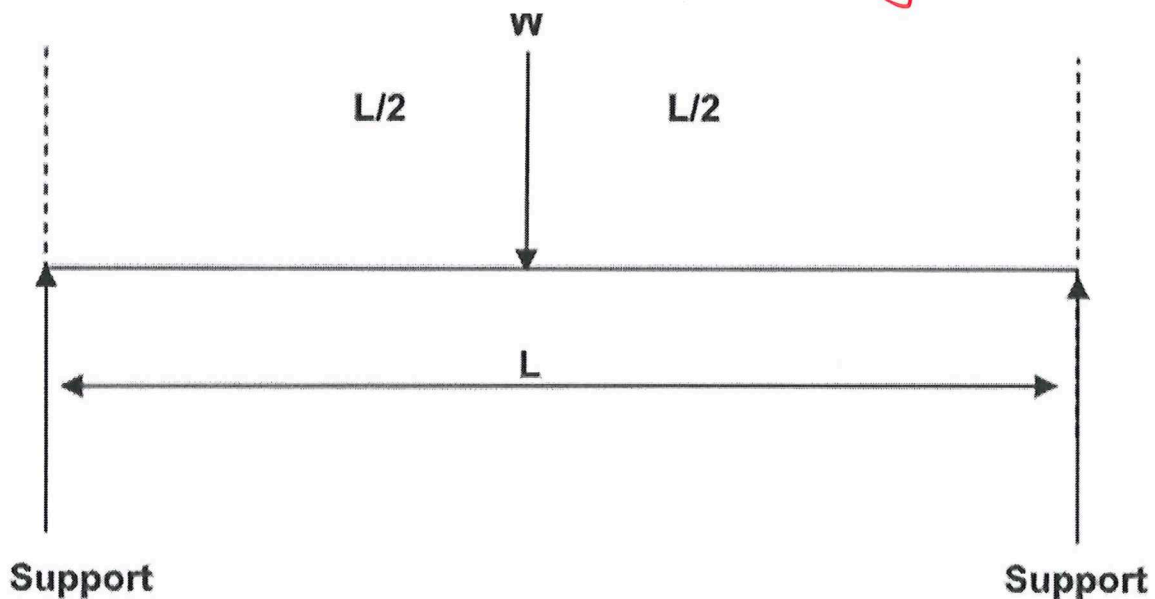
By Kieran Jones

Remember to use third person

Summary

In this report I will be carrying out two different tests and recording the results. The tests were carried out to find the elasticity of a material when a load is applied. In the first test I looked at how to work out the modulus of elasticity of an aluminium beam when different loads were applied to the centre of the beam. In the second test I looked at how to work out the modulus of rigidity when torque is applied to the beam. I have gathered all my results in placed them into tables, as well as graphs with line of best fit. This report will explain in detail the theory behind how I come up with the results

You needed to confirm your main results and conclusions in the summary also.



Limited detail

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Reasonable structure but you needed a section numbering system also.

Introduction

This report will show the results gained from carrying out tests on different beams where different loads were applied to test the elasticity of the material. To perform these tests a beam was placed on two supports and a load was added in the middle of the beam, which will give your readings that allows you to calculate the modulus of elasticity. This report will give you information on the methods that are used to complete the tests. I have gathered all my results and placed them into tables, as well as graphs with line of best fit. This report will explain in detail the theory on how I come up with the results.

*Better to bullet point of list
as below.*

Objective

My main objective is to investigate the elasticity of a material and the effects that a load has on determining the deflection and modulus of rigidity. With these results I am able to create a line graph showing the line of best fit.

- To find young's modulus of the bar that was used for test 1
- To find the modulus of rigidity of the 2 materials used in test 2

Background

The tests that I have carried out will be practical and I will provide calculations to show the load a certain material can withstand without failing. These calculations are vital in many different applications. Establishing the maximum deflection of a beam when applying a certain load is important so that the size and shape of the material can be designed accordingly so that beam will not be able to reach the maximum deflection and therefore the beam will not fail in a real-life environment.

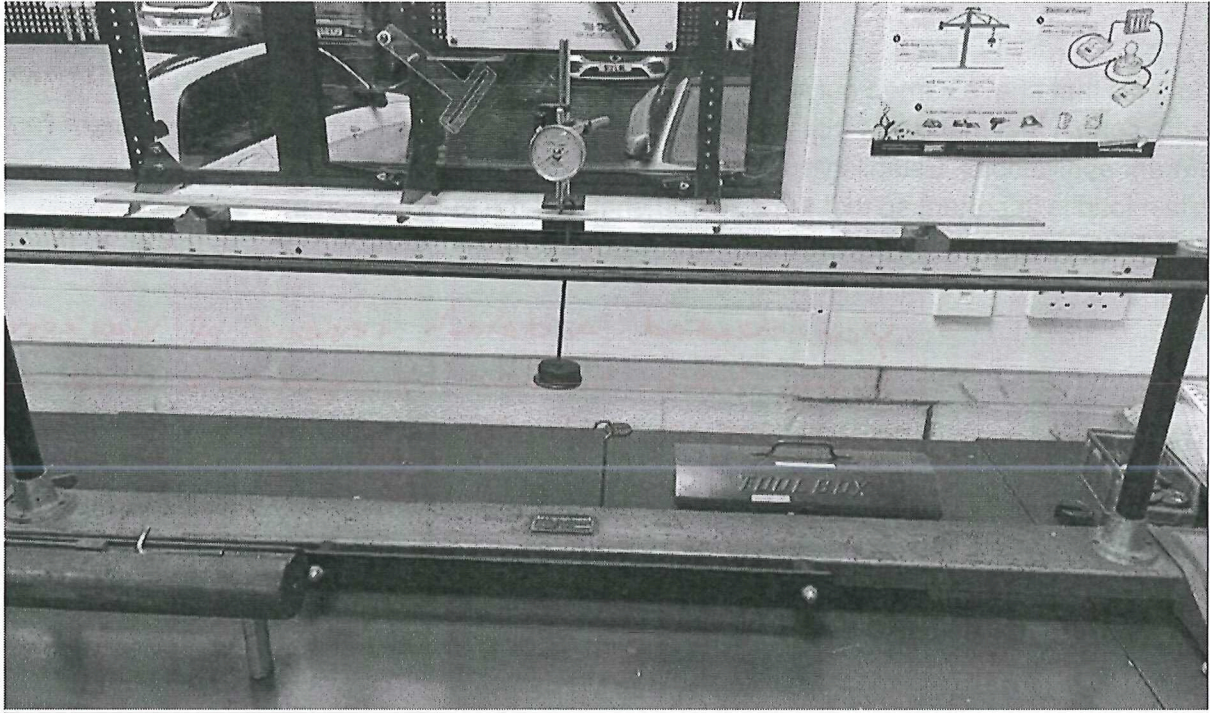
You needed a detail review of background theory here. Without it, you will find evaluating your result difficult.

Equipment

The equipment that was used is the torsion test rig and the beam rig. Materials used were an aluminium beam, as well as 70/30 brass steel rod and 0.4% carbon steel rod.

Method

Test 1



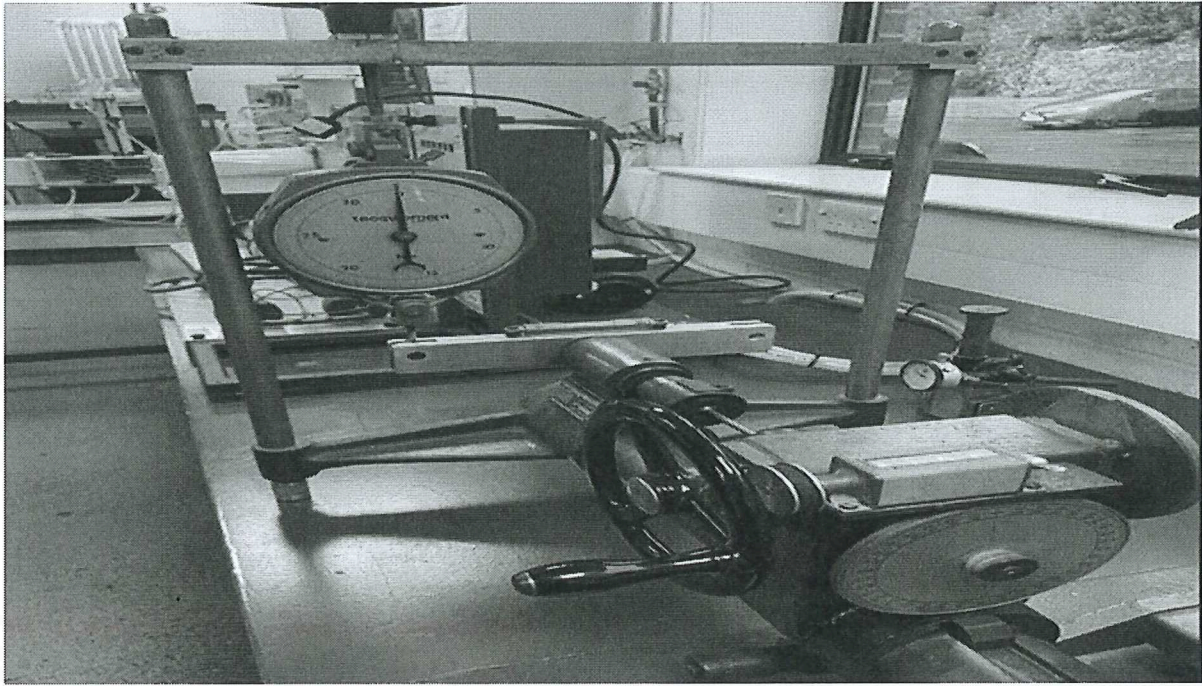
Remember to use third person

For the first test we applied different loads onto the centre of the supported aluminum I beam and measured the deflection of the beam on the gauge on the testing rig, as you can see on the image below. Then proceeded to measure the deflection of the beam on the gauge. Begin by gathering all equipment needed in the test. Place the aluminum bar in the centre of the testing rig sitting on the 2 supporting beams.

- Place the starting load of 0.25 lbs onto the hook of the testing rig and record the deflection from the gauge provided.
- Continue applying the load of 0.10 lbs onto the hook and record the results.
- Repeat the process until the load is 0.75 lbs. ✓
- Record all results in a table and plot a graph with a line of best fit.
- Finally, convert the load from Lbs to Kg by dividing each value by 2.205.

"When under stress, materials will first exhibit elastic properties: the stress causes them to deform, but the material will return to its previous state after the stress is removed" (INSTRON 2024)

Test 2



Place the first beam onto the testing machine ensuring it is safe and secure. Apply the first torque of 0.4Nm by turning the wheel on the testing machine and record the angle of twist from the gauge provided.

- Repeat the process by increasing the torque by 0.4Nm each time using the turning wheel and recording the angle of twist until you have reached 1.6Nm.
- Repeat this process for each bar used in testing.
- Record results in a table.
- Convert the angle of twist from degrees to radians. You do this by multiplying the degrees by $\pi/180$. With these results, plot a graph with a line of best fit.

"The definition of Modulus of Rigidity:

the ratio of shear stress to the displacement per unit sample length (shear strain)" (Engineering toolbox)

✓ use standard convention.

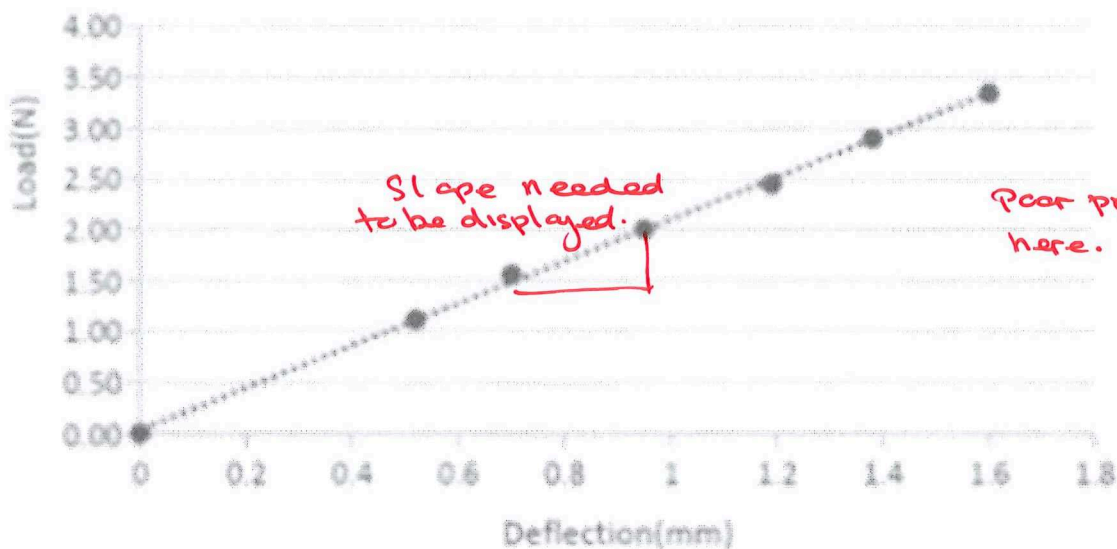
Results

Below are the results that I have recorded from the test and have been placed into a table and created a line graph that has been plotted to show the line of best fit.

Load(lbs)	Load(Kg)	Load(N)	Deflection(mm)
0	0.000	0.00	0
0.25	0.114	1.11	0.52
0.35	0.159	1.56	0.7
0.45	0.204	2.00	0.95
0.55	0.250	2.45	1.19
0.65	0.295	2.89	1.38
0.75	0.341	3.34	1.6

Always label all tables and graphs

Load vs Deflection



As you can see from the table above, the load increases as well as the deflection; it is almost directionally proportional to the load added. You must be aware that when

undertaking this test in a work environment there can be some factors that affect the results from being perfect.

$$E = \frac{L^3}{48I} \times \text{slope of graph}$$

$$E = \frac{8003}{48I} \times 2.07$$

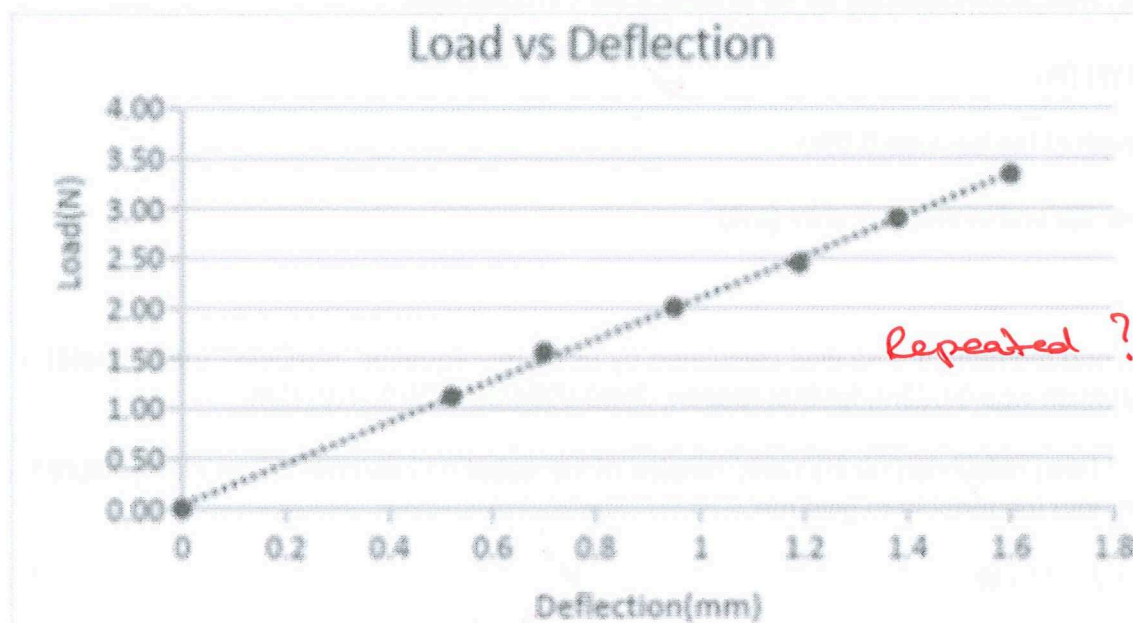
$$I = \frac{bd^3}{12}$$

$$I = 0.032 \times 0.0053 / 12$$

$$I = 333.333 \times 10^{-12} \text{ m}^4$$

$$E = \frac{8003}{48} \times 333.333 \times 10^{-12} \times 2.07$$

$$E = 15458.95 \text{ N/m}^2$$



From the results I created a graph showing the line of best fit. I used the line of best fit to calculate the slope of the graph to solve the missing part of the equation. It also demonstrates that the points follow a trend where an increase in load results in a corresponding increase in deflection.

For the second test I used two different materials to compare the modulus of rigidity between the two materials used. The materials used were a 0.4% carbon steel cylindrical rod and a 70/30 brass rod. For this test, we used the torsion formula which is:

$$T/J = \tau/r = G\theta/L$$

Reference needed.

However, we don't need to use all this equation to find the modulus of rigidity, so we just choose the two relevant equations. As we are finding the modulus of rigidity, we would use the formula $T/J = G/\theta L$ and transpose it to find G , giving us $G = (L/J) \times (T/\theta)$

My calculations for the test with the 0.4% carbon steel rod:

G = the modulus of rigidity of the material

T = torque (Nm)

Torque is set for us as it's the amount I added to the rod. I used 2.2Nm from my table.

θ = twist angle (rads)

The angle was provided by the gauge on the torsion machine, which measures the angle in degrees. Since the equation requires the angles in radians, I converted it by dividing the angle by 360 and multiplying by 2π $(2/360) \times 2\pi = 0.0349$ rads

L = length (m)

The length of the bar was 0.09m

J = polar second moment of area (m⁴)

The second moment of area was calculated by using this equation $J = \pi D^4/32$ the diameter of the rod which was 0.005m, for that reason, $J = \pi 0.005^4/32 = 61.36 \times 10^{-12} \text{m}^4$

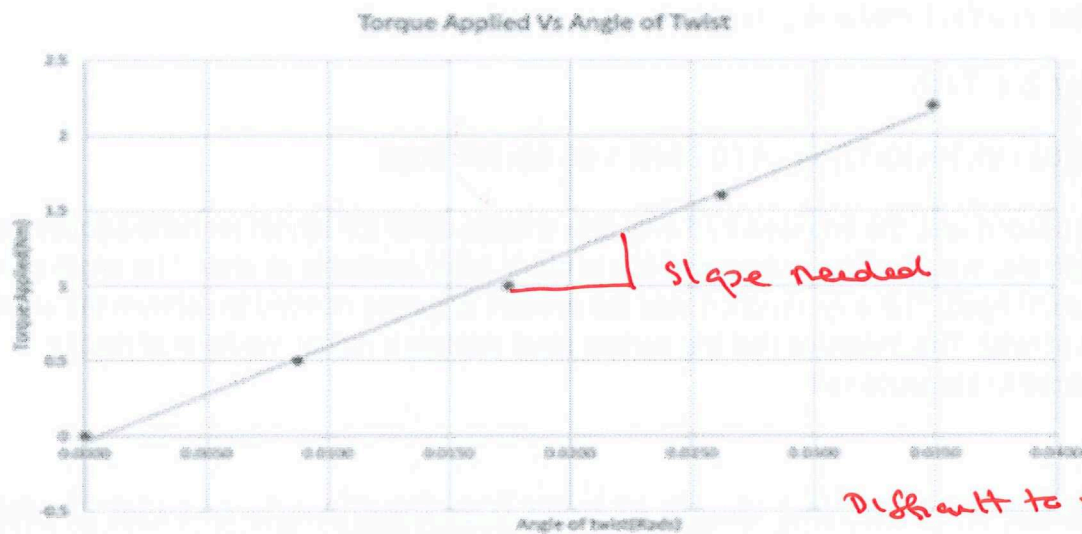
Finally, I have calculated all the parts needed of the equation I can now place all my figures together into the formula to give me.

$$G = (L/J) \times (T/\theta)$$

$$G = (0.09 / 61.36 \times 10^{-12}) \times (2.2 / 0.0349) = 92.46 \times 10^9 \text{ N/m}^2$$

↑
slope of graph.

Better to present the data
and graphs prior to the calculations



Torque Applied(Nm)	Angle of twist(Degrees)	Angle of twist (Rads)
0	0	0.0000
0.5	0.5	0.0087
1	1	0.0174
1.6	1.5	0.0262
2.2	2	0.0349

My calculations for the test including the 70/30 brass steel rod were:

T = torque (Nm)

Torque is set for us as it's the amount I added to the rod. I used 1.6Nm from my table.

θ = twist angle (rads)

The angle was provided by the gauge on the torsion machine, which measures the angle in degrees. Since the equation requires the angles in radians, I converted it by dividing the angle by 360 and multiplying by 2π $(2/360) \times 2\pi = 0.0349$ rads

L = length (m)

The length of the bar was 0.09m

J = polar second moment of area (m^4)

The second moment of area was calculated by using this equation $J = \pi D^4 / 32$ the diameter of the rod was 0.005m therefore $J = \pi 0.005^4 / 32 = 61.36 \times 10^{-12} m^4$

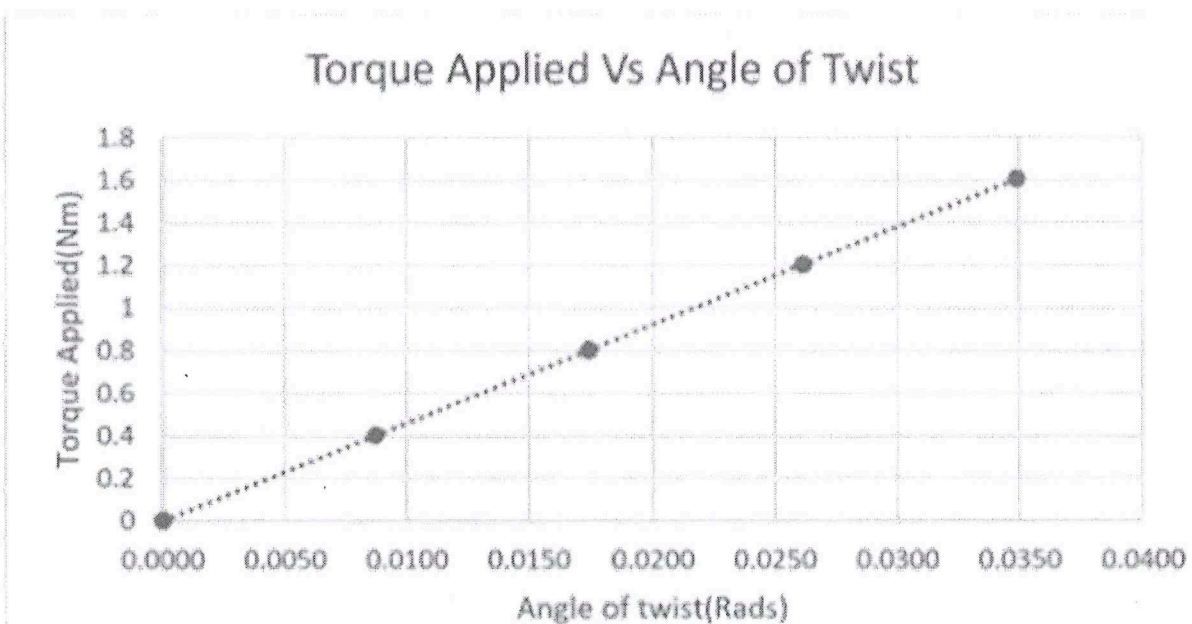
Finally, I have calculated all the parts needed of the equation. I can now place all my figures together into the formula to give me.

$$G = (L / J) \times (T / \theta)$$

$$G = (0.09 / 61.36 \times 10^{-12}) \times (1.6 / 0.0349) = 66.95 \times 10^9 \text{ N/m}^2$$

In the second test, the equation had only one change since the length remained constant, the diameter was also the same, resulting in equal polar moments of area. The angle of twist was unchanged. The only variation was the amount of torque needed to achieve the same angle of twist. This indicates that the carbon steel rod has a higher modulus of rigidity compared to the brass rod.

Torque Applied(Nm)	Angle of twist (Degrees)	Angle of twist (Rads)
0	0	0.0000
0.4	0.5	0.0087
0.8	1	0.0174
1.2	1.5	0.0262
1.6	2	0.0349



Discussion

Some Confusion
noted here.

In my calculations I have outlined the maximum shear stress and bending moment. In test one, the aluminium beam had the maximum shear force of 1.67N and a maximum bending moment of 0.668Nm when the force of 3.34N was added. As a result, the stress observed in the beam was $5.01 \times 10^6 \text{ N/m}^2$. This allowed the beam to return to its original shape and size, due to the modulus of elasticity, since it did not reach the yield point of $7.0 \times 10^{10} \text{ N/m}^2$. However, even though the yield point was not exceeded, there are several methods to reduce the stress. One effective approach is to add support along the length of the beam which would minimise deflection. Another option is to use a stronger material such as a steel beam instead of aluminium. As well as, changing the size of the beam will allow you to have a larger force to be applied as the deflection and the size of the beam has a direct relationship.

Yield.

Flexural rigidity is calculated using the equation $EI = ExI$. Overall, a beam with higher flexural rigidity will bend less under any given load, meaning it is stiffer resulting in more resistance to deflection. To increase the flexural rigidity of a beam many factors can be changed to increase this value such as:

1. **Use a stronger material:** Materials like steel are stiffer than aluminium, with steel being nearly three times stiffer. Switching to steel will help reduce bending.
2. **Shorten the beam:** A shorter beam will bend less. You can shorten the beam by adding supports or redesigning it to be smaller in length.
3. **Increase the beam's second moment of area:** This helps the beam resist bending. To do this, make the beam taller instead of wider, because height has a bigger effect on stiffness.
4. **Distribute the load:** Instead of placing a heavy load at one point, spread it out along the beam. This reduces the stress at a single point. Changing the shape of the beam, like making it an I-beam, also helps by placing more material where it's needed for stiffness.

Conclusion

? | During this report I have shown that the more twist and load added to a beam, results in the beam being under more stress, therefore the modulus of elasticity increases on the beam. This is evident as when the beam is under more stress it is being forced to change its shape and structure. As more weight is added, the beam will be under more stress and therefore the modulus of elasticity will increase. Both tests were carried out in a controlled environment using the appropriate testing equipment, allowing us to have accurate answers throughout the report.

Confusing section.

References

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<https://www.instron.com/en/resources/glossary/modulus-of-elasticity>.

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Available at: [https://www.engineeringtoolbox.com/modulus-rigidity-](https://www.engineeringtoolbox.com/modulus-rigidity-d_946.html)
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