TEAM ASSIGNMENT COVER SHEET

Student Name	Student Number	Student submitting work
Asad Rizwan Shaikh	8113257	Discussion
Mark Joy Binsu	8197088	Discussion
Taha Yaseen Parker	8243578	Results, Polishing Discussion

Subject number and name	ENGG103 – Materials in Design
Subject coordinator	Mr. Mohammad Yousuf
Title of Assignment	Experiment 3 – Torsion Test
Date and time due	November 5, 2023, 23:59:59
Lab Number	3

Student declaration and acknowledgement (must be read by all students)

By submitting this assignment online, the submitting student declares on behalf of the team that:

1. All team members have read the subject outline for this subject, and this assessment item meets the requirements of the subject detailed therein.
2. This assessment is entirely our own work, except where we have included fully documented references to the work of others. The material contained in this assessment item has not previously been submitted for assessment.
3. Acknowledgement of source information is in accordance with the guidelines or referencing style specified in the subject outline.
4. All team members are aware of the late submission policy and penalty.
5. The submitting student undertakes to communicate all feedback with the other team members.

Results

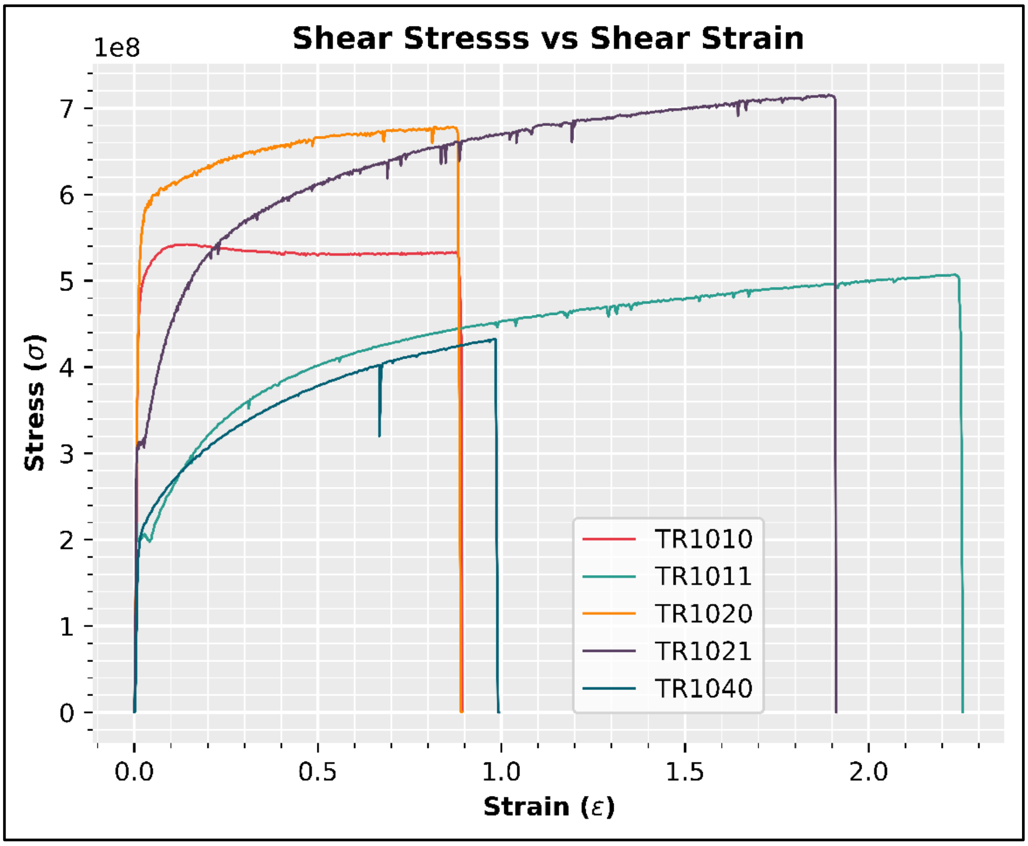

Figure 1 – Shear Stress vs Shear Strain for all materials

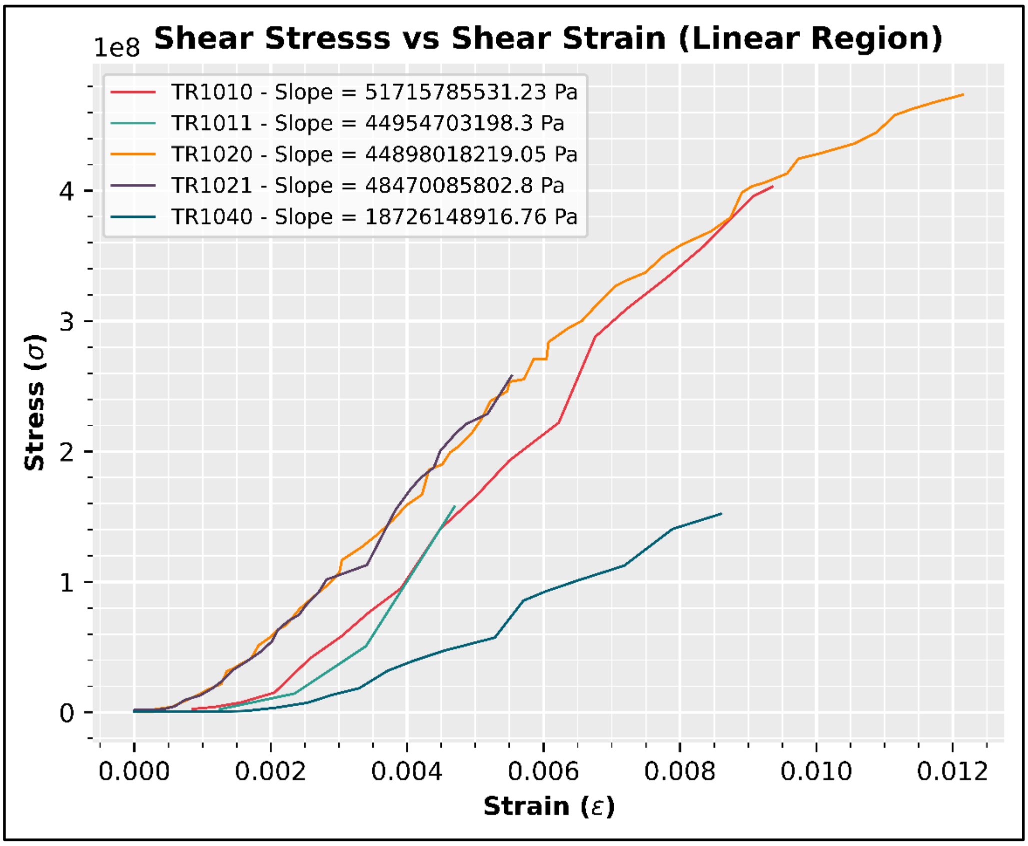

Figure 2 – Linear region of all materials with slopes

Material	Experimental Shear Modulus (GPa)	Theoretical Shear Modulus (GPa)
TR1010 – 0.15% Carbon Steel (as drawn)	51.7158	79
TR1011 – 0.15% Carbon Steel (normalised at 900° C)	44.9547	79
TR1020 – 0.4% Carbon Steel (as drawn)	44.8980	79
TR1021 – 0.4% Carbon Steel (normalised at 860° C)	48.4701	79
TR1040 – CZ121 Brass (60% Copper, 40% Zinc)	18.7261	40

Table 1: *Experimental Shear Modulus vs Theoretical Shear Modulus*

Discussion

Question 1

Provide a comprehensive discussion of your results, show their significance and importance.

The objective of this experiment was to explore the relationship between shear stress and shear strain between different materials at different temperatures and obtain the material's shear modulus (G) value (Shear Modulus = Shear Stress / Shear Strain). Shear modulus is a measure of the deformation of a solid when in shear (or when twisting). The obtained experimental values were then compared to the theoretical values for shear modulus.

Example Result:

TR1010 – 0.15% Carbon Steel (as drawn):

- Experimental Shear Modulus: 51.7158 GPa
- Theoretical Shear Modulus: 79 GPa

Significance: There is a substantial difference between the experimental and predicted (theoretical) shear moduli. This suggests that the 0.15% Carbon Steel is more ductile, less stiff, and less resistant to shear deformation, contrary to theoretical predictions. This might be the result of things like processing conditions, microstructure, or material impurities.

This relationship of a higher theoretical value than experimental value for shear modulus is seen with TR1020 – 0.4% Carbon Steel and TR1040 – CZ121 Brass as well. Furthermore, it is evident that the normalization process (annealing) on the 2 carbon steel materials does not have an affect on the relationship between the theoretical and experimental values.

The importance of this information is that it is crucial for understanding different factors that affect a material's mechanical properties. These findings suggest that the behaviour of these materials in real life can differ from the theoretical calculations and original expectations, which might have significant effects on the design and selection of materials.

Question 2

Compare the materials you obtained. Also, comment on the effect of normalization heat treatment on the samples' strength and ductility.

From our experiment, we can observe that the theoretical values of shear modulus are 40 GPa for TR1040 – CZ121 Brass and 79 GPa for the other materials. For each of our 2 materials, we have one "as drawn" and another which has undergone normalization heat treatment. We can see that for TR1011 – 0.15% Carbon Steel, we have an experimental shear modulus of 51.7158 GPa, whereas we have a shear modulus of 44.9547 GPa for the same material after undergoing the process of annealing. This difference in the values of the experimental shear modulus is due to the changes in the structure of the material after it has been annealed. This is in line with the objectives of annealing, as it aims to increase the ductility of the material at the cost of some strength.

For TR1020 – 0.4% Carbon Steel, we have an experimental shear modulus of 44.8980 GPa, however, after undergoing normalization heat treatment, the shear modulus increases to 48.4701 GPa, which is greater than its value before annealing. This is converse to what we have inspected with TR1011 – 0.15% Carbon Steel. This is unusual for steel as annealing generally tends to reduce the shear modulus in many materials, especially in metals like steel. There could be various reasons for this, such as impurities in the material among others.
Annealing or normalization heat treatment is a process that helps remove impurities and makes the material softer and more ductile as annealing alters and realigns the grains in the material using heat.

Question 3

Discuss the difference between the experimental and theoretical shear modulus and state the possible sources of errors in this experiment.

From our experiment, we can observe that our theoretical values for shear modulus are significantly higher than our values for the experimental shear modulus. This indicates that our material is less stiff and more ductile than our theoretical calculations would presume. This is mainly because we do not take the impurities and other miniature contents found within the material into account while going through with our calculations, hence giving us values for shear modulus which differ from the values gained from the experiment.

There are a few possible sources of error that can occur in this experiment. For example:

- Irregularities, impurities, and defects in the sample can introduce unexpected errors in the test.
- Our material may not be properly aligned within the apparatus before carrying out the experiment.
- Our apparatus may have minute damage which can lead to uneven loading of torsional stress on our material.
- Human faults such as not being able to conduct the test at a consistent and controlled pace.