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Tensile Test

Engineering Science ACHA4002 & ACMA4028

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1 Introduction

The aim of this experiment was to test the tensile strengths of different materials. There were four materials in total. The first material was Mild steel, which is a basic steel alloy. The second material was a basic aluminium alloy. The next material was Duralumin, which is a high specification aluminium alloy. The final material was PVC, which is a common thermoplastic. With this experiment, the materials strengths and how they responded under a load would be understood. The test itself takes the materials to their limit until they snap by adding tensile load. From this the stress, strain and the extension of the material can be found (Engineering Science Guidance Notes, TecQuipment Ltd, 2012).

2 Experimental Procedure

The first step in the experiment procedure was to set up the tensile tester kit supplied by TecQuipment. This kit included a work panel and the tensile tester itself.

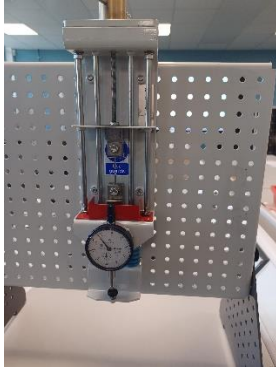


Figure 1 - The tensile test kit set up

As seen in figure 1, the tensile tester has several features on it. The dial indicator on the front of the equipment showed how much the load nut, situated on top of the tester, had been moved. This had to be zeroed before each material was tested to make sure the reading was accurate. The load nut on top of the tester was used to extend the material, with each full turn equalling 1mm of pull. The materials were placed between the two chucks on the vice.

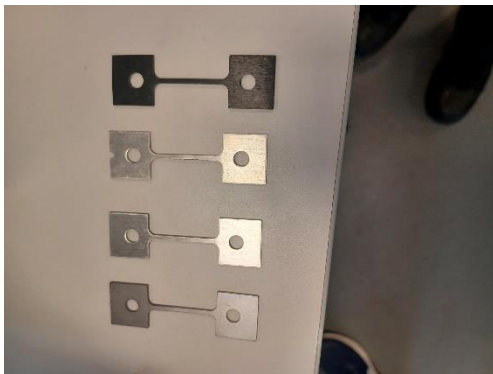


Figure 2 - Materials from top to bottom: PVC, Duralumin, Aluminium and Mild steel

Before each material was tested the dimensions, which included the overall length and cross-sectional area of the material, were measured with a vernier calliper. Once these had been noted, the material would then be placed in between the two chucks of the tensile tester and fitted between two fixings. Once the dial indicator was then set at zero, the load nut was turned until there was tension on the material. To start with, the load nut was turned by 0.2mm increments up until the dial indicator was at 5mm. From here the load nut was turned at 1mm increments until the dial indicator was at 10mm, which from there stepped up to 10mm increments at a time. This would then

continue until the material had snapped. Once the material was destroyed, it was removed from the chucks, the new length of the material was measured with vernier callipers.

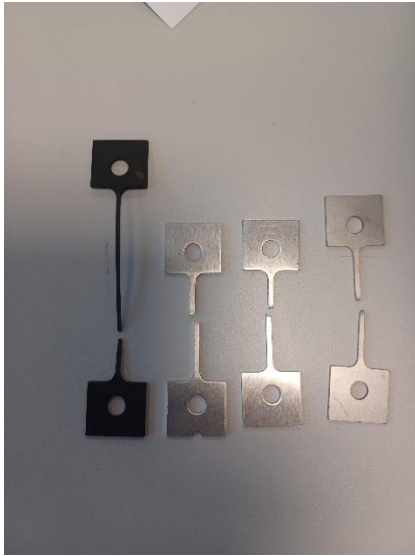


Figure 3 - All specimens after the tensile test

3 Results

Load nut movement (mm)	Steel dial indicator (mm)	Aluminium dial indicator (mm)	Duralumin dial indicator (mm)	PVC dial indicator (mm)		
0	0	0	0	0		
0.2	0.08	0.17	0.17	0.06		
0.4	0.25	0.24	0.35	0.13		
0.6	0.45	0.52	0.54	0.19		
0.8	0.63	0.7	0.73	0.23		
1	0.81	0.87	0.9	0.25		
1.2	1	1	1.1	0.2		
1.4	1.2	1.24	1.28	0.18		
1.6	1.38	1.41	1.45	0.15		
1.8	1.56	1.58	1.65	0.13		
2	1.75	1.75	1.83	0.13		
2.2	1.93	1.89	2.02	0.15		
2.4	2.12	2	2.2	0.14		
2.6	2.31	2.09	2.39	0.14		
2.8	2.49	2.2	2.57	0.14		
3	2.66	2.26	2.74	0.14		
3.2	2.84	2.38	2.92	0.15		
3.4	3	2.43	3.1	0.14		
3.6	3.14	2.51	3.28	0.14		
3.8	3.25	2.58	3.46	0.15		
4	3.37	2.61	3.64	0.14		
4.2	3.5	2.67	3.82	0.14		
4.4	3.62	2.7	4	0.14		
4.6	3.74	2.7	4.16	0.14		
4.8	3.85	2.76	4.32	0.13		
5	3.96	snapped	4.46	0.13		
6	4.43		4.75	0.12		
7	4.77		4.92	0.11		
8	5	snapped		0.12		
9	5.24			0.14		
10	5.3			0.11		
20	snapped			0.11		
30				0.08		
40			snapped			
50						
60						

Figure 4 - Raw data from tensile test experiment

4 Analysis

There were several steps needed to calculate the stress and strain for each material. Firstly, to calculate the force applied to each object, the dial indicator reading had to be multiplied by 1000 (Engineering Science Guidance Notes, TecQuipment Ltd, 2012). From here, the stress and strain could be found. As the width and depth of each material had been measured, multiplying the two values gave the cross-sectional area of each material. To calculate the stress, the force was divided by the cross-sectional area and given in KN/m^2 , as seen in figure 5-8 below. To calculate strain, first the extension was needed. To find this, the dial indicator value was taken away from the load nut movement. This value was then plugged into the strain equation, where the extension was divided by the original length of the material. The extension was also divided by 1000 so that it was in base units of meters.

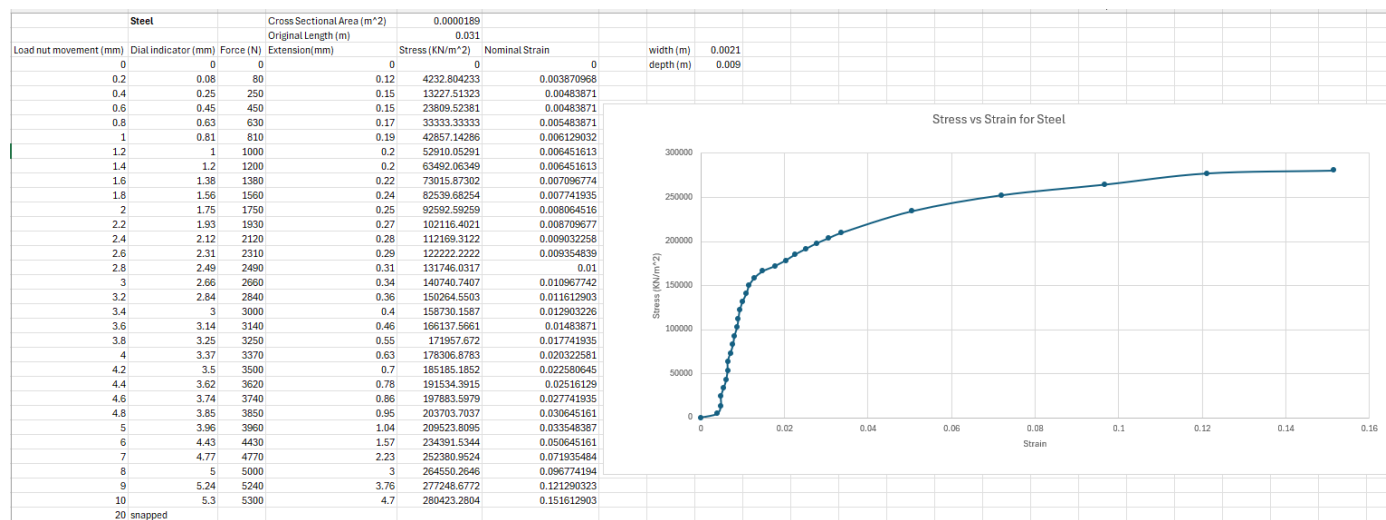


Figure 5 - Graph and calculations for Mild steel

For Mild steel, the yield point on the graph was 171957.67KN/m^2 , and the tensile stress was 280423.28KN/m^2 .

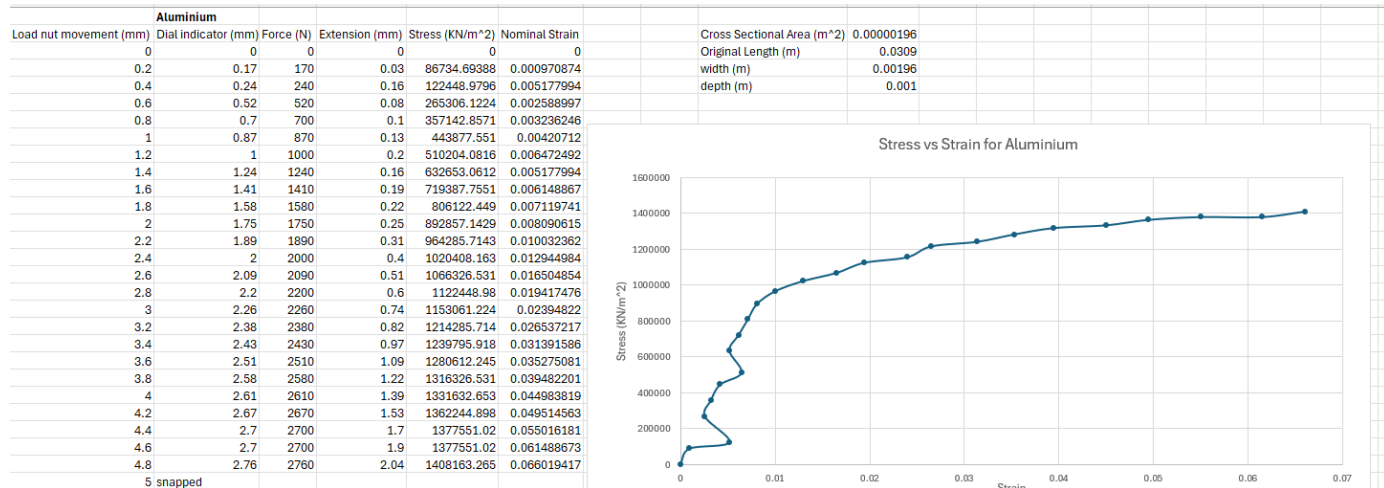


Figure 6 - Graph and calculations for Aluminium

For Aluminium, the yield point was 964285.71KN/m², and the tensile stress was 1408163.27KN/m².

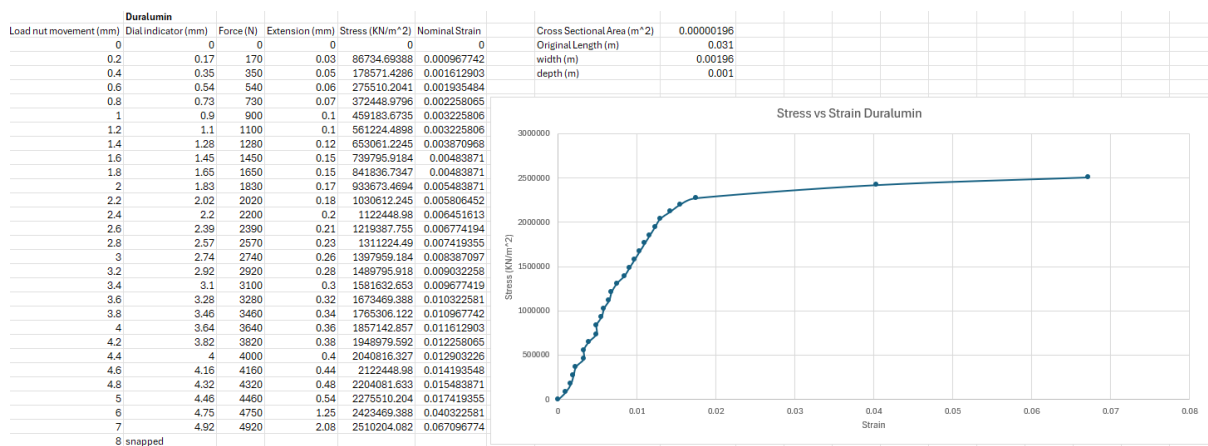


Figure 7 - Graph and calculations for Duralumin

For Duralumin, the yield point was 2040816.33KN/m², and the tensile stress was 2510204.08KN/m².

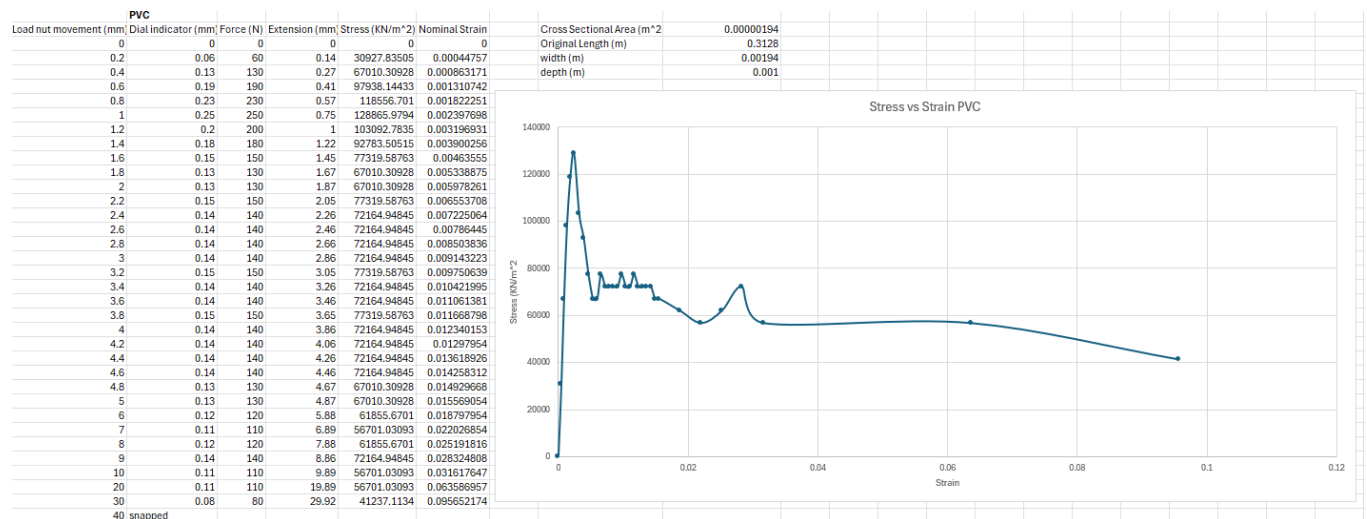


Figure 8 - Graph and calculations for PVC

For PVC, the yield point was calculated at 128865.98kN/m², and the tensile stress was 41237.11kN/m².

5 Conclusion

In conclusion, the results from the experiment were slightly off from the true values of stress of the materials. For Mild steel, the average yield stress is 250MPa (How Much Force Can Mild Steel Withstand? | Clickmetal). This converts to about 250000KN/m^2 , which is about 80000KN/m^2 higher than the value that was calculated. The tensile stress of steel is around 400MPa, which converts to 400000KN/m^2 (The Strength of Mild Steel, Austen Knapman, 2013). This is around 120000KN/m^2 higher than the calculated value. This could be due to inaccuracy's when calculating the force, which could be down to an inaccurate reading when the dial indicator was read. The cross-sectional area of the material did also change throughout the experiment, whereas in the calculation it is assumed the cross-sectional area is the same up until the destructive point.

For Aluminium, the yield strength varies greatly depending on the type of alloy that is used. It can range from 30 MPa to 425MPa, around 30000KN/m^2 to 425000KN/m^2 (Yield Strength of Aluminum Alloys - Al Alloy Yield Strength Chart). The calculated value from the experiment was 964285.71KN/m^2 , which is a lot higher than the average value. This could mean it is a high strength alloy. The tensile stress can vary from 90000KN/m^2 to 690000KN/m^2 (What Are the Mechanical Properties of Aluminium? - KMC Aluminium). This is again lower than the calculated value of 1408163.27KN/m^2 . This could be due to inaccuracy when reading the dial indicator and during calculations in excel.

For Duralumin, the yield stress is around 450000KN/m^2 , with tensile stress being around 730000KN/m^2 (Duralumin, ChemEurope). The value calculated is nearly triple the average yield and tensile strength, likely a miscalculation.

For PVC, the tensile strength is around 47000KN/m^2 , which was very close to the calculated value of 41237.11KN/m^2 . This could have been more accurate, but with PVC reaching plasticity quickly it meant reading the dial indicator did become a challenge.

6 Evaluation

There were a few ways errors were eliminated as much as possible. For example, there was one person always watching the dial indicator and calling out the value straight away. However, sometimes the dial indicator would slip back slightly, meaning the true value would not have been seen. One way this problem could have been solved is by having a camera as a backup where the recording could be paused the exact moment the load nut had stopped moving. This would mean a more accurate dial indicator reading could be taken.

Another way error was reduced was through having the same person measure each material for its dimensions. By doing this, the readings would be consistent throughout and there was always a second person on hand to confirm the value and that it had been measured correctly.

One other way error was reduced was by making sure there was no slack on the material before the dial indicator was set to zero. This meant that the first turn of the load nut would not pick up any slack and it would be an accurate reading on the dial indicator.

7 Further Work

One way the experiment could be improved is through the use of a bigger tensile tester. With a larger tester, larger specimens could be used. This means the limit of where the material could be tested would be greater. The measurements of the stress and strain would also be more accurate, as there would be a greater force applied to the material over a larger area. With being able to use a larger size of material, the force that can be applied would be increased exponentially, again giving a more accurate result.

Another way to improve the experiment would be to spend longer on it. Each material was only tested once, whereas if there was a longer period of time spent doing it, each material could be tested two or three times. This would give more accurate data as a mean from each data set could be taken and could give a truer value of stress and strain.

8 References

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