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Tensile Test

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1 Introduction

The purpose of this paper is to explain the process of carrying out a tensile test on different materials. This is very important for engineers to understand what happens to different materials they may use. The four materials used in this experiment were Steel, Aluminium, Duralumin (Alloy) and PVC. This report will show the results, in the form of tables and graphs, to give clear representation of how each material reacted while tested. This test is destructive, meaning that each sample will be broken to find the results needed. Information will be researched to gain knowledge in order to improve the experiment and to gain more reliable and accurate results. By doing this precisely, it will help in further research to know the strength and stiffness of the materials included.

2 Experimental Procedure

This is the procedure that explains how the experiment was carried out in the university. It is important to follow the same procedure for each material test to ensure the results gathered are as accurate as humanly possible.

- Firstly, the equipment needed is unpacked and laid out to make sure all parts are present and are in good shape for it to be installed on to the back plate as seen in figure 1-1.



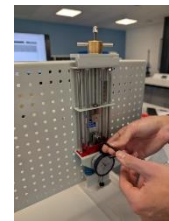
Figure 1-1

- Measure all materials before and after testing for base length and final length as this is important to know to find out elongation percentage (Figure 1-2).

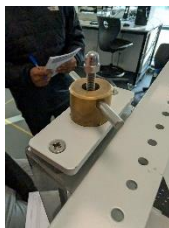


Figure 1-2

- Figure 1-3 and figure 1-4 show the process of setting up the tester with each sample being secured in the top and bottom chucks, it is important to make sure the nuts holding the sample are tight and secure.

*Figure 1-3**Figure 1-4*

- Once the material is secure, place the guard over the tester and begin testing procedure.
- Turn the top load nut to apply the load to the material that is currently in the tester (figure1-5)

*Figure 1-5*

- One person must keep an eye on the DTI gauge which shows the extension of the material in mm and measure the result as accurately as possible.
- Turn the load nut in 0.2mm increments until 5.00 mm is reached then increase to one full turn until 10.00mm after this, a full 10 turns should now be used up to 60.00mm.
- Keep turning the load nut until the material snaps and record the final reading on the DTI into the table provided (figure 1-6)

*Figure 1-6*

- Remove guard and take out material and measure the new length of each material.
- Repeat all steps for all materials provided in the kit.

3 Results

Below are the results for the tensile test. To find these results, three equations were used to find Stress, Strain and young's modulus.

$$\sigma = F \div A$$

Above is the equation for stress which is the force divided by the area of the material.

$$\varepsilon = \text{change in length } (l) \div \text{original length}(L)$$

This is the equation for strain which is a ratio for the two distances, and is shown as a small number ($\mu\text{E}=\text{x}10^{-6}$).

And finally, young's modulus which is - $E = \sigma \div \varepsilon$ this is used to find the stiffness of the material.

Steel was the first material that was tested. The results seen in figure 3-1 show that an error in recording data must have happened since the results were not in the linear fashion as shown by other tests carried out on the same material (CMRP, 2024). This anomaly may have happened due to the results being read from a small DTI gauge attached to the test equipment. The result anomalies can be put down to human error in reading the numbers on said DTI and copying them down incorrectly. Steel should be a linear test as can be expected from a material known for its strength. Never the less, the data recorded shows that the steel material reached its peak elastic region at around 152.77 N/mm² and its young's modulus was calculated to be 20,086 N/mm². The material specimen started at 30.9mm in length and ended up at 38.7 giving it a percentage of 25.24%.

Table 1-1 shows data gathered from steel tensile test

Load Measurements (N)	Displacement (mm) (Steel Force (N))	Extension (mm)	Stress (N/mm ²)	Strain	Original Length (mm)	Final Length (mm)	Elongation %
0	0	0	0	0	30.9	30.7	25.2471846
0.2	0.17	0.03	9.44444444	0.00097087			
0.4	0.35	0.05	19.44444444	0.00161812			
0.6	0.53	0.07	29.44444444	0.00226537			
0.8	0.71	0.09	39.44444444	0.00291262			
1	0.89	0.11	49.44444444	0.00355987			
1.2	1.07	0.13	59.44444444	0.00420712			
1.4	1.25	0.15	69.44444444	0.00485437			
1.6	1.43	0.17	79.44444444	0.00550162			
1.8	1.61	0.19	89.44444444	0.00614887			
2	1.79	0.21	99.44444444	0.00679612			
2.2	1.97	0.23	109.444444	0.00744337			
2.4	2.15	0.25	119.444444	0.00809062			
2.6	2.33	0.27	129.444444	0.00873787			
2.8	2.51	0.29	139.444444	0.00938512			
3	2.69	0.31	149.444444	0.01003237			
3.2	2.87	0.33	159.444444	0.01067962			
3.4	3.05	0.35	169.444444	0.01132687			
3.6	3.23	0.37	179.444444	0.01197412			
3.8	3.41	0.39	189.444444	0.01262137			
4	3.59	0.41	199.444444	0.01326862			
4.2	3.77	0.43	209.444444	0.01391587			
4.4	3.95	0.45	219.444444	0.01456312			
4.6	4.13	0.47	229.444444	0.01521037			
4.8	4.31	0.49	239.444444	0.01585762			
5	4.49	0.51	249.444444	0.01650487			
5.2	4.67	0.53	259.444444	0.01715212			
5.4	4.85	0.55	269.444444	0.01779937			
5.6	5.03	0.57	279.444444	0.01844662			
5.8	5.21	0.59	289.444444	0.01909387			
6	5.39	0.61	299.444444	0.01974112			

Table 1-2 shows graph created from Stress and Strain calculated results

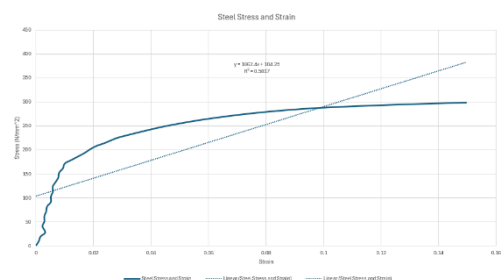
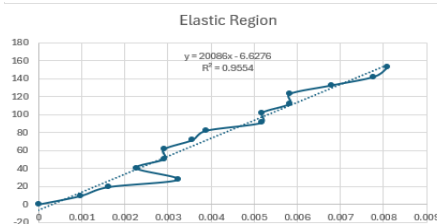


Table 1-3 shows the graph of the elastic region of steel to provide the Young's modulus



Aluminium was the second material tested, and the raw data was collected as seen in figure 3-3 and converted into a stress against strain graph. The graph in figure 3-4 shows that aluminium is not a very strong material as the elastic region is quite small. It did not take much effort to go beyond this region and enter the plastic region. The aluminium was at the peak of the elastic region at around 84.21 N/mm² giving its young's modulus to be 20,722N/mm² for this specimen. The elongation was also measured before and after testing. The piece of material used started at 30.9mm and after testing reached 33.7mm giving this elongation as a percentage it would be 9.06%.

Table 1-4 shows the data table for Aluminium

Load/Displacement (mm)	Displacement (mm) (Displacement)	Force (N)	Extension (mm)	Stress (N/mm ²)	Strain (mm/mm)	Original Length (mm)	Final Length (mm)	Elongation %
0	0	0	0	0	0	30.9	30.9	0.000000
0.2	0.05	16	0.05	51.780000	0.001618			
0.4	0.10	32	0.10	103.560000	0.003236			
0.6	0.15	48	0.15	155.340000	0.004854			
0.8	0.20	64	0.20	207.120000	0.006472			
1.0	0.25	80	0.25	258.900000	0.008090			
1.2	0.30	96	0.30	310.680000	0.009708			
1.4	0.35	112	0.35	362.460000	0.011326			
1.6	0.40	128	0.40	414.240000	0.012944			
1.8	0.45	144	0.45	466.020000	0.014562			
2.0	0.50	160	0.50	517.800000	0.016180			
2.2	0.55	176	0.55	569.580000	0.017798			
2.4	0.60	192	0.60	621.360000	0.019416			
2.6	0.65	208	0.65	673.140000	0.021034			
2.8	0.70	224	0.70	724.920000	0.022652			
3.0	0.75	240	0.75	776.700000	0.024270			
3.2	0.80	256	0.80	828.480000	0.025888			
3.4	0.85	272	0.85	880.260000	0.027506			
3.6	0.90	288	0.90	932.040000	0.029124			
3.8	0.95	304	0.95	983.820000	0.030742			
4.0	1.00	320	1.00	1035.600000	0.032360			
4.2	1.05	336	1.05	1087.380000	0.033978			
4.4	1.10	352	1.10	1139.160000	0.035596			
4.6	1.15	368	1.15	1190.940000	0.037214			
4.8	1.20	384	1.20	1242.720000	0.038832			
5.0	1.25	400	1.25	1294.500000	0.040450			
5.2	1.30	416	1.30	1346.280000	0.042068			
5.4	1.35	432	1.35	1398.060000	0.043686			
5.6	1.40	448	1.40	1449.840000	0.045304			
5.8	1.45	464	1.45	1501.620000	0.046922			
6.0	1.50	480	1.50	1553.400000	0.048540			
6.2	1.55	496	1.55	1605.180000	0.050158			
6.4	1.60	512	1.60	1656.960000	0.051776			
6.6	1.65	528	1.65	1708.740000	0.053394			
6.8	1.70	544	1.70	1760.520000	0.055012			
7.0	1.75	560	1.75	1812.300000	0.056630			
7.2	1.80	576	1.80	1864.080000	0.058248			
7.4	1.85	592	1.85	1915.860000	0.059866			
7.6	1.90	608	1.90	1967.640000	0.061484			
7.8	1.95	624	1.95	2019.420000	0.063102			
8.0	2.00	640	2.00	2071.200000	0.064720			
8.2	2.05	656	2.05	2122.980000	0.066338			
8.4	2.10	672	2.10	2174.760000	0.067956			
8.6	2.15	688	2.15	2226.540000	0.069574			
8.8	2.20	704	2.20	2278.320000	0.071192			
9.0	2.25	720	2.25	2330.100000	0.072810			
9.2	2.30	736	2.30	2381.880000	0.074428			
9.4	2.35	752	2.35	2433.660000	0.076046			
9.6	2.40	768	2.40	2485.440000	0.077664			
9.8	2.45	784	2.45	2537.220000	0.079282			
10.0	2.50	800	2.50	2589.000000	0.080900			

Table 1-6 shows the elastic region graph for Aluminium

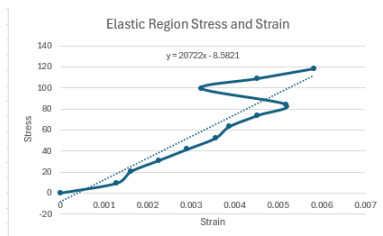
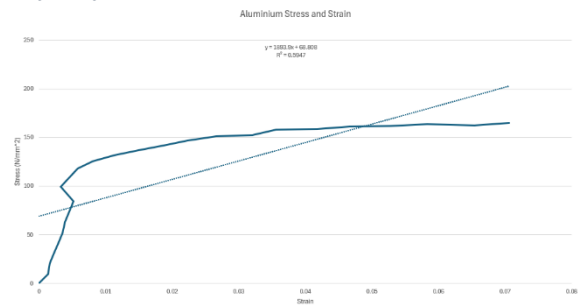


Table 1-5 Shows the Stress and Strain graph for Aluminium



Duralumin was the next specimen to be tested. Duralumin is an alloy of aluminium, copper and magnesium and is described as being strong and having more tensile strength than the aluminium its alloyed with (AZO, 2013). The results show that duralumin was at the peak of its elastic region at 179.47 N/mm² and has a young's modulus of 14,966 N/mm². The length of the original specimen before testing was 30.9mm and its final length after testing was 33.2mm giving it an elongation percentage of 7.44%.

Table 1-7 shows the data table for Duralumin

Load/Displacement (mm)	Displacement (mm) (Displacement)	Force (N)	Extension (mm)	Stress (N/mm ²)	Strain (mm/mm)	Original Length (mm)	Final Length (mm)	Elongation %
0	0	0	0	0	0	30.9	30.9	0.000000
0.2	0.17	17	0.17	54.692575	0.005498			
0.4	0.35	34	0.35	109.385150	0.010996			
0.6	0.53	51	0.53	164.077725	0.016494			
0.8	0.71	68	0.71	218.770300	0.021992			
1.0	0.89	85	0.89	273.462875	0.027490			
1.2	1.07	102	1.07	328.155450	0.032988			
1.4	1.25	119	1.25	382.848025	0.038486			
1.6	1.43	136	1.43	437.540600	0.043984			
1.8	1.61	153	1.61	492.233175	0.049482			
2.0	1.79	170	1.79	546.925750	0.054980			
2.2	1.97	187	1.97	601.618325	0.060478			
2.4	2.15	204	2.15	656.310900	0.065976			
2.6	2.33	221	2.33	711.003475	0.071474			
2.8	2.51	238	2.51	765.696050	0.076972			
3.0	2.69	255	2.69	820.388625	0.082470			
3.2	2.87	272	2.87	875.081200	0.087968			
3.4	3.05	289	3.05	929.773775	0.093466			
3.6	3.23	306	3.23	984.466350	0.098964			
3.8	3.41	323	3.41	1039.158925	0.104462			
4.0	3.59	340	3.59	1093.851500	0.109960			
4.2	3.77	357	3.77	1148.544075	0.115458			
4.4	3.95	374	3.95	1203.236650	0.120956			
4.6	4.13	391	4.13	1257.929225	0.126454			
4.8	4.31	408	4.31	1312.621800	0.131952			
5.0	4.49	425	4.49	1367.314375	0.137450			
5.2	4.67	442	4.67	1422.006950	0.142948			
5.4	4.85	459	4.85	1476.699525	0.148446			
5.6	5.03	476	5.03	1531.392100	0.153944			
5.8	5.21	493	5.21	1586.084675	0.159442			
6.0	5.39	510	5.39	1640.777250	0.164940			
6.2	5.57	527	5.57	1695.469825	0.170438			
6.4	5.75	544	5.75	1750.162400	0.175936			
6.6	5.93	561	5.93	1804.854975	0.181434			
6.8	6.11	578	6.11	1859.547550	0.186932			
7.0	6.29	595	6.29	1914.240125	0.192430			
7.2	6.47	612	6.47	1968.932700	0.197928			
7.4	6.65	629	6.65	2023.625275	0.203426			
7.6	6.83	646	6.83	2078.317850	0.208924			
7.8	7.01	663	7.01	2133.010425	0.214422			
8.0	7.19	680	7.19	2187.703000	0.219920			
8.2	7.37	697	7.37	2242.395575	0.225418			
8.4	7.55	714	7.55	2297.088150	0.230916			
8.6	7.73	731	7.73	2351.780725	0.236414			
8.8	7.91	748	7.91	2406.473300	0.241912			
9.0	8.09	765	8.09	2461.165875	0.247410			
9.2	8.27	782	8.27	2515.858450	0.252908			
9.4	8.45	799	8.45	2570.551025	0.258406			
9.6	8.63	816	8.63	2625.243600	0.263904			
9.8	8.81	833	8.81	2679.936175	0.269402			
10.0	8.99	850	8.99	2734.628750	0.274900			

Table 1-8 shows the stress and strain graph for duralumin

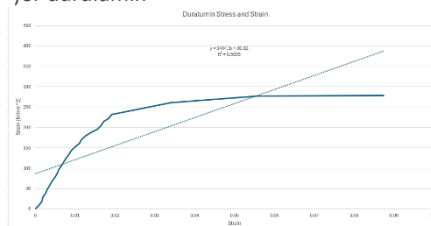
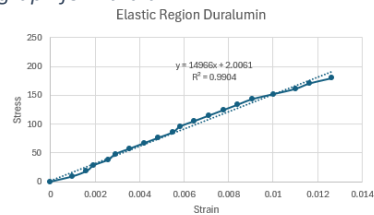


Table 1-9 shows the elastic region graph for Duralumin



Furthermore, PVC was the final material tested and the results of this showed an interesting graph as PVC is a soft material and did not stay in the elastic region for very long. It peaked at around 12.63 N/mm² thus giving it a young's modulus of 651.54 N/mm². The rest of the graph showed an interesting line as the material was trying to shrink back to its original length, giving it a 40.52 elongation percentage which takes its length from 30.6 mm to 43 mm after testing.

Table 1-10 shows the data table for PVC

Load/Displacement (mm)	Displacement (mm) (PVC)	Force (N)	Elongation (mm)	Stress (N/mm ²)	Nominal Stress	Original Length (mm)	Final Length (mm)	Elongation %
0	0	0	0	0	0	30.6	43	40.5207539
0.2	0.02	1.52	1.52	4.9349315	0.00000000			
0.4	0.03	3.03	3.03	9.8698630	0.00000000			
0.6	0.04	4.54	4.54	14.8047945	0.00000000			
0.8	0.05	6.05	6.05	19.7397260	0.00000000			
1	0.06	7.56	7.56	24.6746575	0.00000000			
1.2	0.07	9.07	9.07	29.6095890	0.00000000			
1.4	0.08	10.58	10.58	34.5445205	0.00000000			
1.6	0.09	12.09	12.09	39.4794520	0.00000000			
1.8	0.10	13.60	13.60	44.4143835	0.00000000			
2	0.11	15.11	15.11	49.3493150	0.00000000			
2.2	0.12	16.62	16.62	54.2842465	0.00000000			
2.4	0.13	18.13	18.13	59.2191780	0.00000000			
2.6	0.14	19.64	19.64	64.1541095	0.00000000			
2.8	0.15	21.15	21.15	69.0890410	0.00000000			
3	0.16	22.66	22.66	74.0239725	0.00000000			
3.2	0.17	24.17	24.17	78.9589040	0.00000000			
3.4	0.18	25.68	25.68	83.8938355	0.00000000			
3.6	0.19	27.19	27.19	88.8287670	0.00000000			
3.8	0.20	28.70	28.70	93.7636985	0.00000000			
4	0.21	30.21	30.21	98.6986300	0.00000000			
4.2	0.22	31.72	31.72	103.6335615	0.00000000			
4.4	0.23	33.23	33.23	108.5684930	0.00000000			
4.6	0.24	34.74	34.74	113.5034245	0.00000000			
4.8	0.25	36.25	36.25	118.4383560	0.00000000			
5	0.26	37.76	37.76	123.3732875	0.00000000			
5.2	0.27	39.27	39.27	128.3082190	0.00000000			
5.4	0.28	40.78	40.78	133.2431505	0.00000000			
5.6	0.29	42.29	42.29	138.1780820	0.00000000			
5.8	0.30	43.80	43.80	143.1130135	0.00000000			
6	0.31	45.31	45.31	148.0479450	0.00000000			
6.2	0.32	46.82	46.82	152.9828765	0.00000000			
6.4	0.33	48.33	48.33	157.9178080	0.00000000			
6.6	0.34	49.84	49.84	162.8527395	0.00000000			
6.8	0.35	51.35	51.35	167.7876710	0.00000000			
7	0.36	52.86	52.86	172.7226025	0.00000000			
7.2	0.37	54.37	54.37	177.6575340	0.00000000			
7.4	0.38	55.88	55.88	182.5924655	0.00000000			
7.6	0.39	57.39	57.39	187.5273970	0.00000000			
7.8	0.40	58.90	58.90	192.4623285	0.00000000			
8	0.41	60.41	60.41	197.3972600	0.00000000			
8.2	0.42	61.92	61.92	202.3321915	0.00000000			
8.4	0.43	63.43	63.43	207.2671230	0.00000000			
8.6	0.44	64.94	64.94	212.2020545	0.00000000			
8.8	0.45	66.45	66.45	217.1369860	0.00000000			
9	0.46	67.96	67.96	222.0719175	0.00000000			
9.2	0.47	69.47	69.47	227.0068490	0.00000000			
9.4	0.48	70.98	70.98	231.9417805	0.00000000			
9.6	0.49	72.49	72.49	236.8767120	0.00000000			
9.8	0.50	74.00	74.00	241.8116435	0.00000000			
10	0.51	75.51	75.51	246.7465750	0.00000000			
10.2	0.52	77.02	77.02	251.6815065	0.00000000			
10.4	0.53	78.53	78.53	256.6164380	0.00000000			
10.6	0.54	80.04	80.04	261.5513695	0.00000000			
10.8	0.55	81.55	81.55	266.4863010	0.00000000			
11	0.56	83.06	83.06	271.4212325	0.00000000			
11.2	0.57	84.57	84.57	276.3561640	0.00000000			
11.4	0.58	86.08	86.08	281.2910955	0.00000000			
11.6	0.59	87.59	87.59	286.2260270	0.00000000			
11.8	0.60	89.10	89.10	291.1609585	0.00000000			
12	0.61	90.61	90.61	296.0958900	0.00000000			
12.2	0.62	92.12	92.12	301.0308215	0.00000000			
12.4	0.63	93.63	93.63	305.9657530	0.00000000			
12.6	0.64	95.14	95.14	310.9006845	0.00000000			
12.8	0.65	96.65	96.65	315.8356160	0.00000000			
13	0.66	98.16	98.16	320.7705475	0.00000000			
13.2	0.67	99.67	99.67	325.7054790	0.00000000			
13.4	0.68	101.18	101.18	330.6404105	0.00000000			
13.6	0.69	102.69	102.69	335.5753420	0.00000000			
13.8	0.70	104.20	104.20	340.5102735	0.00000000			
14	0.71	105.71	105.71	345.4452050	0.00000000			
14.2	0.72	107.22	107.22	350.3801365	0.00000000			
14.4	0.73	108.73	108.73	355.3150680	0.00000000			
14.6	0.74	110.24	110.24	360.2500000	0.00000000			
14.8	0.75	111.75	111.75	365.1849315	0.00000000			
15	0.76	113.26	113.26	370.1198630	0.00000000			
15.2	0.77	114.77	114.77	375.0547945	0.00000000			
15.4	0.78	116.28	116.28	380.0000000	0.00000000			
15.6	0.79	117.79	117.79	384.9452050	0.00000000			
15.8	0.80	119.30	119.30	389.8904105	0.00000000			
16	0.81	120.81	120.81	394.8356160	0.00000000			
16.2	0.82	122.32	122.32	399.7808215	0.00000000			
16.4	0.83	123.83	123.83	404.7260270	0.00000000			
16.6	0.84	125.34	125.34	409.6712325	0.00000000			
16.8	0.85	126.85	126.85	414.6164380	0.00000000			
17	0.86	128.36	128.36	419.5616435	0.00000000			
17.2	0.87	129.87	129.87	424.5068490	0.00000000			
17.4	0.88	131.38	131.38	429.4520545	0.00000000			
17.6	0.89	132.89	132.89	434.3972600	0.00000000			
17.8	0.90	134.40	134.40	439.3424655	0.00000000			
18	0.91	135.91	135.91	444.2876710	0.00000000			
18.2	0.92	137.42	137.42	449.2328765	0.00000000			
18.4	0.93	138.93	138.93	454.1780820	0.00000000			
18.6	0.94	140.44	140.44	459.1232875	0.00000000			
18.8	0.95	141.95	141.95	464.0684930	0.00000000			
19	0.96	143.46	143.46	469.0136985	0.00000000			
19.2	0.97	144.97	144.97	473.9589040	0.00000000			
19.4	0.98	146.48	146.48	478.9041095	0.00000000			
19.6	0.99	147.99	147.99	483.8493150	0.00000000			
19.8	1.00	149.50	149.50	488.7945205	0.00000000			
20	1.01	151.01	151.01	493.7397260	0.00000000			
20.2	1.02	152.52	152.52	498.6849315	0.00000000			
20.4	1.03	154.03	154.03	503.6301365	0.00000000			
20.6	1.04	155.54	155.54	508.5753420	0.00000000			
20.8	1.05	157.05	157.05	513.5205475	0.00000000			
21	1.06	158.56	158.56	518.4657530	0.00000000			
21.2	1.07	160.07	160.07	523.4109585	0.00000000			
21.4	1.08	161.58	161.58	528.3561640	0.00000000			
21.6	1.09	163.09	163.09	533.3013695	0.00000000			
21.8	1.10	164.60	164.60	538.2465750	0.00000000			
22	1.11	166.11	166.11	543.1917805	0.00000000			
22.2	1.12	167.62	167.62	548.1369860	0.00000000			
22.4	1.13	169.13	169.13	553.0821915	0.00000000			
22.6	1.14	170.64	170.64	558.0273970	0.00000000			
22.8	1.15	172.15	172.15	562.9726025	0.00000000			
23	1.16	173.66	173.66	567.9178080	0.00000000			
23.2	1.17	175.17	175.17	572.8630135	0.00000000			
23.4	1.18	176.68	176.68	577.8082190	0.00000000			
23.6	1.19	178.19	178.19	582.7534245	0.00000000			
23.8	1.20	179.70	179.70	587.6986300	0.00000000			
24	1.21	181.21	181.21	592.6438355	0.00000000			
24.2	1.22	182.72	182.72	597.5890410	0.00000000			
24.4	1.23	184.23	184.23	602.5342465	0.00000000			
24.6	1.24	185.74	185.74	607.4794520	0.00000000			
24.8	1.25	187.25	187.25	612.4246575	0.00000000			
25	1.26	188.76	188.76	617.3698630	0.00000000			
25.2	1.27	190.27	190.27	622.3150685	0.00000000			
25.4	1.28	191.78	191.78	627.2602739	0.00000000			
25.6	1.29	193.29	193.29	632.2054794	0.00000000			
25.8	1.30	194.80	194.80	637.1506849	0.00000000			
26	1.31	196.31	196.31	642.0958904	0.00000000			
26.2	1.32	197.82	197.82	647.0410959	0.00000000			
26.4	1.33	199.33	199.33	651.9863014	0.00000000			
26.6	1.34	200.84	200.84	656.9315069	0.00000000			
26.8	1.35	202.35	202.35	661.8767124	0.00000000			
27	1.36	203.86	203.86	666.8219179	0.00000000			

shows Duralumin being able to handle a lot more N/mm^2 of stress while aluminium and PVC not being able to handle as much.

5 Further work

To improve this experiment further given unlimited time, resources and manpower, digital gauges could have been used to mitigate human error of reading results. Motors would have been a good addition to accurately apply a certain amount of turns to the top load nut. In addition, more time and materials could have been used to provide more accurate results as the experiment could be repeated multiple times to then remove any anomalies in the recorded data. Using a UTM (Universal Testing Machine) would improve the results due to it being all machine based. The results would be more accurate and reliable and eliminating all human error is crucial for industries to gain accurate results of materials. These machines apply a constant force which humans struggle to do (ZWIC/ROEL, 2024). If this was used instead of turning the load nut by hand, the results would have been more accurate and reliable for all materials thus giving out precise information to be used. Further more machines are not always the answer, a balance of both is required to improve scientific results, it is difficult to know when a machine is making accurate decisions and end up producing worse results (ESMT, 2023).

6 References

AZO materials, 2013. *Duralumin - Chemical Composition, Mechanical Properties and Common Applications* [online] available at: <https://www.azom.com/article.aspx?ArticleID=8073> [accessed on 6th December]

Chicago metal rolled products (CMRP), 2024. *Exploring the Stress / Strain Curve for Mild Steel* [online] Available at: <https://www.cmvp.com/blog/faq/analysis-design/exploring-stress-strain-curve-mild-steel.html> [Accessed 6th December 2024]

European school of management and technology (ESMT), 2023. *Machines can make better decisions than humans, but how do we know when they're actually accurate?* [online] available at: <https://phys.org/news/2023-06-machines-decisions-humans-theyre-accurate.html#:~:text=Machines%20can%20make%20better%20decisions%20than%20humans%2C%20but,worse%2C%20according%20to%20new%20research%20by%20ESMT%20Berlin>. [Accessed on 5th December 2024]

Zwic/Roel, 2024. *Tensile Test* [online] available at: <https://www.zwickroell.com/industries/materials-testing/tensile-test/> [accessed on 4th December 2024]

