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Tensile Test

Engineering Science ACHA 4002 & ACMA4028

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1 Introduction

The aim of this report is to understand the strength of materials and their reaction when loads are applied during the tensile test. Determine the materials' yield strength, tensile strength, and elongation and evaluate and interpret the data.

2 Experimental Procedure

The first procedure is to assemble the provided tensile test kit.

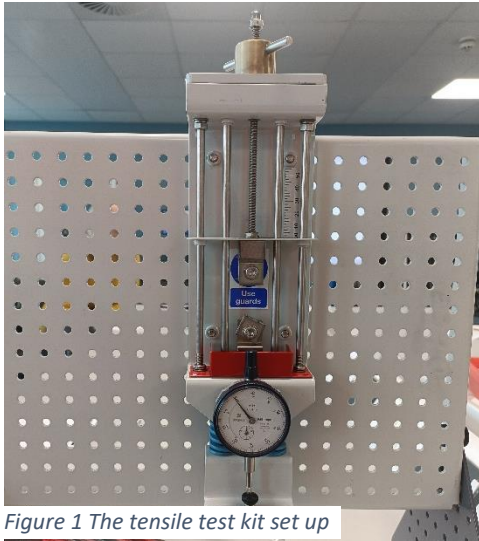


Figure 1 The tensile test kit set up

All that must be installed is the tensile tester onto the work panel. The load nut, located on top of the device; has a notch and pulls the top chuck 10mm upwards for every completed turn. It has 10 marks indicating 0.1mm per increment. The next step is to remove the Allen screw on the top and bottom chuck from the apparatus. Install the material specimen onto the device. The load nut may need a few turns to align the holes of the specimen with the top and bottom chuck to fit. Once the material is installed, fit in the safety guard provided with the test kit. To zero the

dial, carefully turn the load nut clockwise until the dial indicator shows movement and the notch aligns with one of the 10 marks. Then, turn the outer bezel of the dial until the pointer is aligned with the 0 mark. The testing kit is now set to produce data for that specimen.

For the experiment, record the material specimen's original cross-sectional area and length before fitting it onto the apparatus. Once installed, turn the load nut 1 increment clockwise, forcing the top chuck to pull on the specimen by 0.1mm. Then, record the produced value from the dial indicator. Repeat this procedure until the material specimen fractures. Afterwards, remove the specimen from the device and press the broken ends together to determine the new length. Install a different material specimen to start the procedure again.

For this test, 4 materials are used for this experiment. They are:

- Steel
- Duralumin
- Aluminium
- PVC plastic

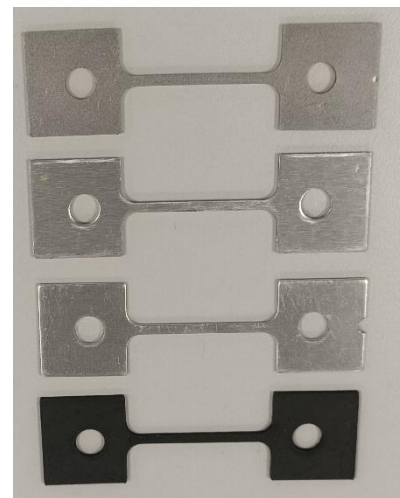


Figure 2 Material Specimens. (Top to bottom)

3 Results

3.1 Steel Specimen Results

Table 1 shows the results obtained after the experiment for the steel specimen.

Elongation = 7.3mm

Elongation % = 23.55%

Load Nut Movement (mm)	Dial Indicator (mm)
0	0.00
0.2	0.17
0.4	0.35
0.6	0.54
0.8	0.73
1.0	0.92
1.2	1.11
1.4	1.29
1.6	1.47
1.8	1.67
2.0	1.85
2.2	2.04
2.4	2.22
2.6	2.41
2.8	2.58
3.0	2.76
3.2	2.93
3.4	3.09
3.6	3.23
3.8	3.35
4.0	3.48
4.2	3.60
4.4	3.73
4.6	3.84
4.8	3.95
5.0	4.06
6.0	4.56
7.0	4.90
8.0	5.14
9.0	5.27
10.0	5.35

Table 1 Results for Steel Specimen

3.2 Duralumin Specimen Results

Table 2 shows the results for Duralumin after the testing.

Elongation = 1.9mm

Elongation % = 6.11%

Load Nut Movement (mm)	Dial Indicator (mm)
0	0.00
0.2	0.18
0.4	0.26
0.6	0.55
0.8	0.83
1.0	1.02
1.2	1.20
1.4	1.39
1.6	1.57
1.8	1.75
2.0	1.94
2.2	2.12
2.4	2.30
2.6	2.48
2.8	2.66
3.0	2.85
3.2	3.03
3.4	3.22
3.6	3.40
3.8	3.58
4.0	3.75
4.2	3.91
4.4	4.07
4.6	4.20
4.8	4.32
5.0	4.39
6.0	4.58

Table 2 Results for Duralumin Specimen

3.3 Aluminium Specimen Results

Table 3 shows the results obtained from the aluminium specimen.

Elongation = 2.7mm

Elongation % = 8.71%

Load Nut Movement (mm)	Dial Indicator (mm)
0	0.00
0.2	0.18
0.4	0.33
0.6	0.43
0.8	0.51
1.0	0.69
1.2	0.86
1.4	1.03
1.6	1.21
1.8	1.38
2.0	1.50
2.2	1.62
2.4	1.72
2.6	1.82
2.8	1.90
3.0	1.96
3.2	2.01
3.4	2.10
3.6	2.17
3.8	2.18
4.0	2.22
4.2	2.23
4.4	2.24
4.6	2.25

Table 3 Results for Aluminium Specimen

3.4 PVC Specimen Results

Table 4 shows the results for the PVC specimen after the test.

Elongation = 15mm

Elongation % = 48.54%

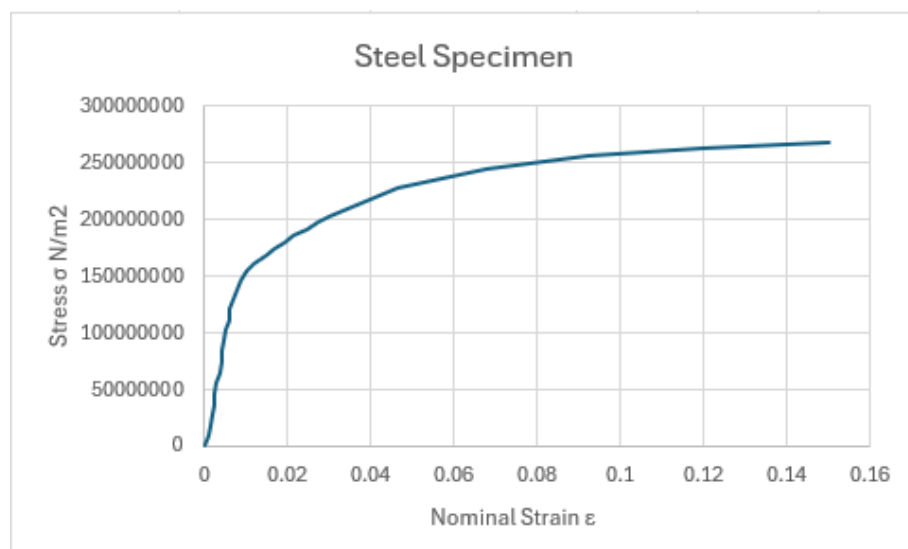
Load Nut Movement (mm)	Dial Indicator (mm)
0	0.00
0.2	0.06
0.4	0.13
0.6	0.18
0.8	0.21
1.0	0.10
1.2	0.08
1.4	0.08
1.6	0.08
1.8	0.08
2.0	0.09
2.2	0.09
2.4	0.08
2.6	0.09
2.8	0.11
3.0	0.09
3.2	0.08
3.4	0.09
3.6	0.09
3.8	0.10
4.0	0.08
4.2	0.08
4.4	0.09
4.6	0.10
4.8	0.09
5.0	0.11
6.0	0.14
7.0	0.12
8.0	0.10
9.0	0.10
10.0	0.08

Table 4 Results for PVC Specimen

4 Analysis

4.1 Steel Specimen

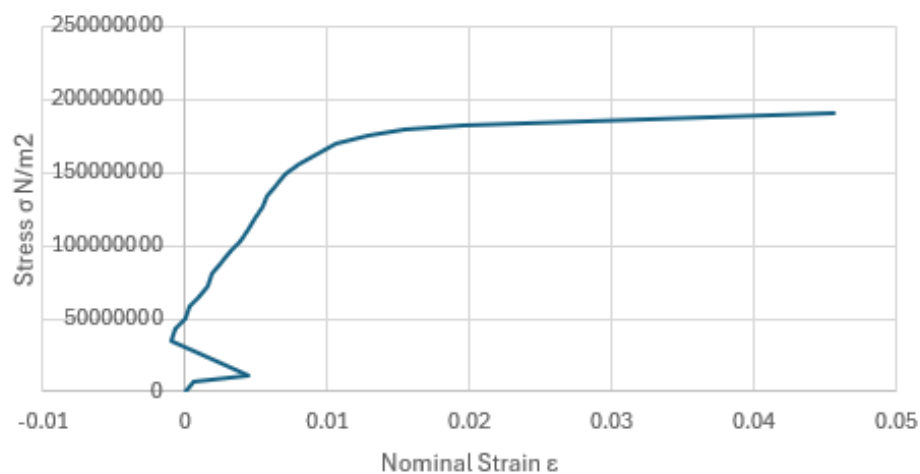
Load Nut Movement (mm)	Dial Indicator (mm)	Force (N)	Extension (mm)	Stress σ N/m ²	Nominal Strain ϵ
0	0	0	0	0	0
0.2	0.17	17	0.03	8500000	0.000967742
0.4	0.35	35	0.05	17500000	0.001612903
0.6	0.54	54	0.06	27000000	0.001935484
0.8	0.73	73	0.07	36500000	0.002258065
1	0.92	92	0.08	46000000	0.002580645
1.2	1.11	111	0.09	55500000	0.002903226
1.4	1.29	129	0.11	64500000	0.003548387
1.6	1.47	147	0.13	73500000	0.004193548
1.8	1.67	167	0.13	83500000	0.004193548
2	1.85	185	0.15	92500000	0.00483871
2.2	2.04	204	0.16	102000000	0.00516129
2.4	2.22	222	0.18	111000000	0.005806452
2.6	2.41	241	0.19	120500000	0.006129032
2.8	2.58	258	0.22	129000000	0.007096774
3	2.76	276	0.24	138000000	0.007741935
3.2	2.93	293	0.27	146500000	0.008709677
3.4	3.09	309	0.31	154500000	0.01
3.6	3.23	323	0.37	161500000	0.011935484
3.8	3.35	335	0.45	167500000	0.014516129
4	3.48	348	0.52	174000000	0.016774194
4.2	3.6	360	0.6	180000000	0.019354839
4.4	3.73	373	0.67	186500000	0.021612903
4.6	3.84	384	0.76	192000000	0.024516129
4.8	3.95	395	0.85	197500000	0.027419355
5	4.06	406	0.94	203000000	0.030322581
6	4.56	456	1.44	228000000	0.046451613
7	4.9	490	2.1	245000000	0.067741935
8	5.14	514	2.86	257000000	0.092258065
9	5.27	527	3.73	263500000	0.120322581
10	5.35	535	4.65	267500000	0.15



4.2 Duralumin Specimen

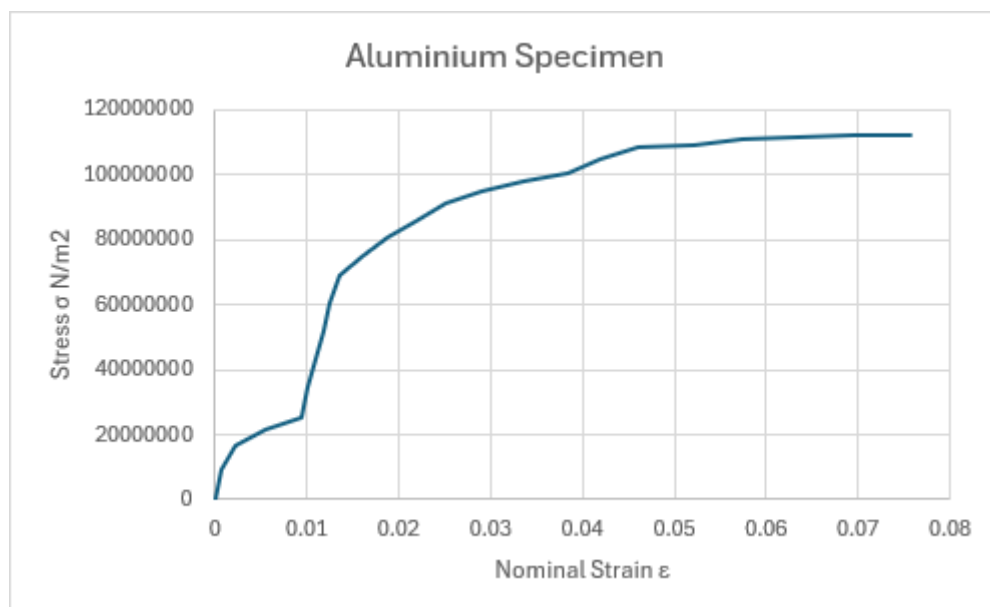
Load Nut Movement (mm)	Dial Indicator (mm)	Force (N)	Extension (mm)	Stress σ N/m ²	Nominal Strain ϵ
0	0	0	0	0	0
0.2	0.18	18	0.02	7500000	0.000643087
0.4	0.26	26	0.14	10833333.33	0.004501608
0.6	0.55	55	0.05	22916666.67	0.001607717
0.8	0.83	83	-0.03	34583333.33	-0.00096463
1	1.02	102	-0.02	42500000	-0.000643087
1.2	1.2	120	0	50000000	0
1.4	1.39	139	0.01	57916666.67	0.000321543
1.6	1.57	157	0.03	65416666.67	0.00096463
1.8	1.75	175	0.05	72916666.67	0.001607717
2	1.94	194	0.06	80833333.33	0.00192926
2.2	2.12	212	0.08	88333333.33	0.002572347
2.4	2.3	230	0.1	95833333.33	0.003215434
2.6	2.48	248	0.12	103333333.3	0.003858521
2.8	2.66	266	0.14	110833333.3	0.004501608
3	2.85	285	0.15	118750000	0.004823151
3.2	3.03	303	0.17	126250000	0.005466238
3.4	3.22	322	0.18	134166666.7	0.005787781
3.6	3.4	340	0.2	141666666.7	0.006430868
3.8	3.58	358	0.22	149166666.7	0.007073955
4	3.75	375	0.25	156250000	0.008038585
4.2	3.91	391	0.29	162916666.7	0.009324759
4.4	4.07	407	0.33	169583333.3	0.010610932
4.6	4.2	420	0.4	175000000	0.012861736
4.8	4.32	432	0.48	180000000	0.015434084
5	4.39	439	0.61	182916666.7	0.019614148
6	4.58	458	1.42	190833333.3	0.045659164

Duralumin Specimen



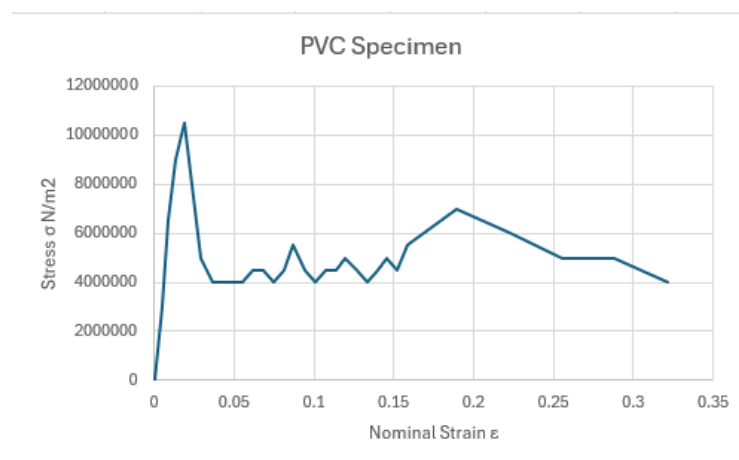
4.3 Aluminium Specimen

Load Nut Movement (mm)	Dial Indicator (mm)	Force (N)	Extension (mm)	Stress σ N/m ²	Nominal Strain ϵ
0	0	0	0	0	0
0.2	0.18	18	0.02	9000000	0.000645161
0.4	0.33	33	0.07	16500000	0.002258065
0.6	0.43	43	0.17	21500000	0.005483871
0.8	0.51	51	0.29	25500000	0.009354839
1	0.69	69	0.31	34500000	0.01
1.2	0.86	86	0.34	43000000	0.010967742
1.4	1.03	103	0.37	51500000	0.011935484
1.6	1.21	121	0.39	60500000	0.012580645
1.8	1.38	138	0.42	69000000	0.013548387
2	1.5	150	0.5	75000000	0.016129032
2.2	1.62	162	0.58	81000000	0.018709677
2.4	1.72	172	0.68	86000000	0.021935484
2.6	1.82	182	0.78	91000000	0.02516129
2.8	1.9	190	0.9	95000000	0.029032258
3	1.96	196	1.04	98000000	0.033548387
3.2	2.01	201	1.19	100500000	0.038387097
3.4	2.1	210	1.3	105000000	0.041935484
3.6	2.17	217	1.43	108500000	0.046129032
3.8	2.18	218	1.62	109000000	0.052258065
4	2.22	222	1.78	111000000	0.057419355
4.2	2.23	223	1.97	111500000	0.063548387
4.4	2.24	224	2.16	112000000	0.069677419
4.6	2.25	225	2.35	112500000	0.075806452



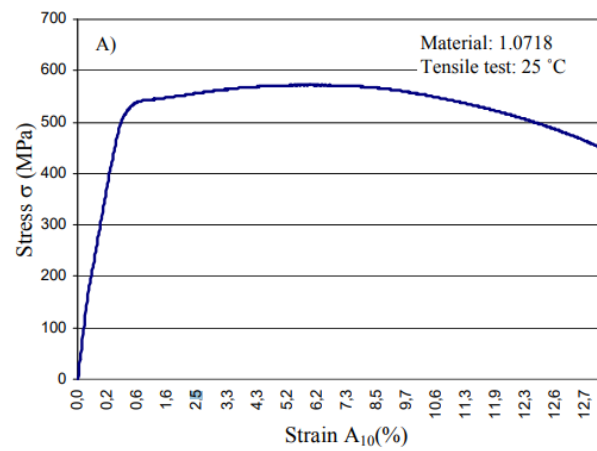
4.4 PVC Specimen

Load Nut Movement (mm)	Dial Indicator (mm)	Force (N)	Extension (mm)	Stress σ N/m ²	Nominal Strain ϵ
0	0	0	0	0	0
0.2	0.06	6	0.14	3000000	0.004530744
0.4	0.13	13	0.27	6500000	0.008737864
0.6	0.18	18	0.42	9000000	0.013592233
0.8	0.21	21	0.59	10500000	0.019093851
1	0.1	10	0.9	5000000	0.029126214
1.2	0.08	8	1.12	4000000	0.036245955
1.4	0.08	8	1.32	4000000	0.042718447
1.6	0.08	8	1.52	4000000	0.049190939
1.8	0.08	8	1.72	4000000	0.05566343
2	0.09	9	1.91	4500000	0.061812298
2.2	0.09	9	2.11	4500000	0.06828479
2.4	0.08	8	2.32	4000000	0.075080906
2.6	0.09	9	2.51	4500000	0.081229773
2.8	0.11	11	2.69	5500000	0.087055016
3	0.09	9	2.91	4500000	0.094174757
3.2	0.08	8	3.12	4000000	0.100970874
3.4	0.09	9	3.31	4500000	0.107119741
3.6	0.09	9	3.51	4500000	0.113592233
3.8	0.1	10	3.7	5000000	0.1197411
4	0.09	9	3.91	4500000	0.126537217
4.2	0.08	8	4.12	4000000	0.133333333
4.4	0.09	9	4.31	4500000	0.139482201
4.6	0.1	10	4.5	5000000	0.145631068
4.8	0.09	9	4.71	4500000	0.152427184
5	0.11	11	4.89	5500000	0.158252427
6	0.14	14	5.86	7000000	0.189644013
7	0.12	12	6.88	6000000	0.222653722
8	0.1	10	7.9	5000000	0.25566343
9	0.1	10	8.9	5000000	0.28802589
10	0.08	8	9.92	4000000	0.321035599



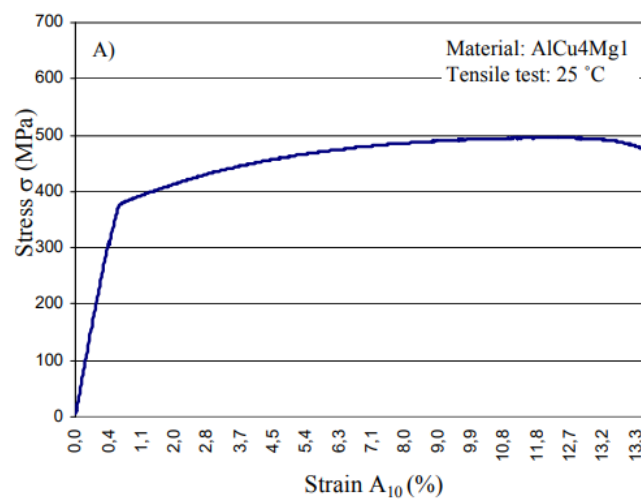
5 Conclusion

Researching the material and the stress-strain graph is required to ensure the graphs are authentic.

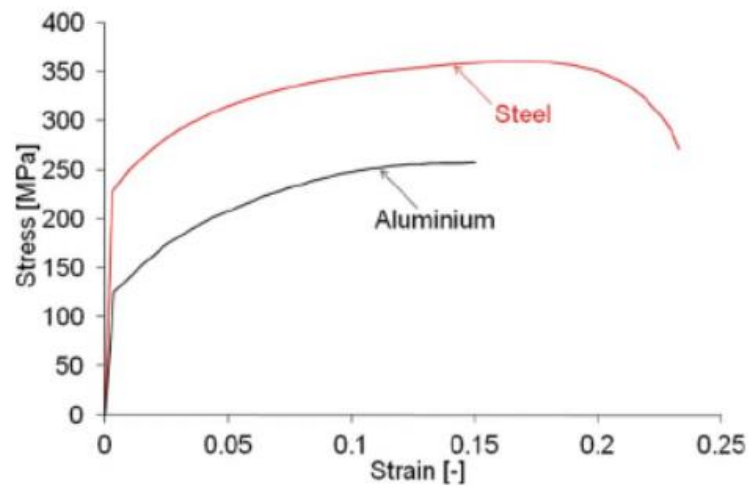


Looking at the graph above, it starts to slope down but it is very similar to the graph result obtained from the steel specimen. Produced by Professor Šircelj. (D., 2011)

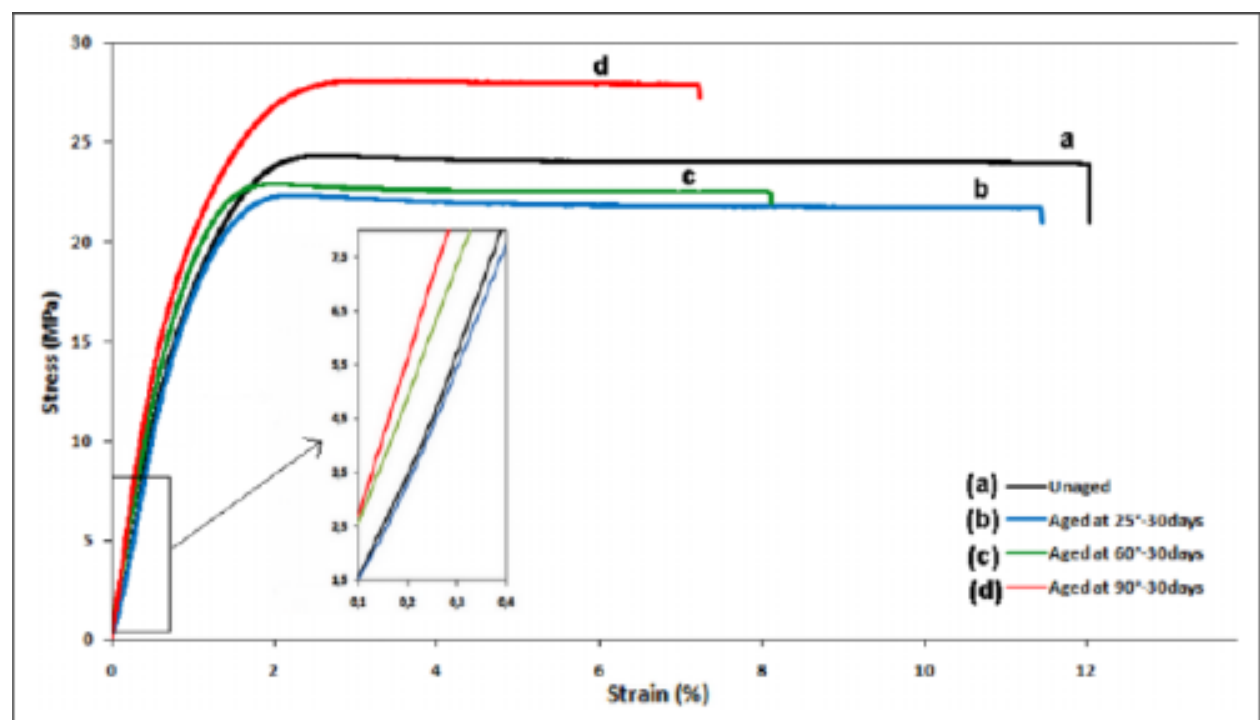
The graph obtained for duralumin is anomalous. The line shouldn't go backwards, therefore there was an error during the experiment. The graph below shows what the duralumin graph looks like. (D., 2011)



The Aluminium specimen showed an error as the graph produced shows a step at 0.1 strain then follows the trend after the graph below shows what it should look like. It follows a similar trend with steel. (Liu, Villavicencio, & Soares, 2013)



The PVC specimen graph produced an error showing a huge spike followed by several small ones afterwards. This is due to the force applied on the load nut. Force must be applied constantly to avoid spiking results. The graph below shows what the PVC line should look like. The other lines show that aged PVCs can produce different results. (Jemii, Hammiche, Boubakri, & Haddar, 2020)



6 Evaluation

What could have been done to avoid any errors during the experiment is to keep the temperature of the room the same. This affected the material specimen specifically the PVC. The PVC specimen didn't extend much compared to the PVC specimen from another group therefore producing different results. There were human errors. Particularly, in the PVC testing. The person operating the load nut must always apply a constant force to the specimen while also signalling the person recording the result when to read the indicator. The person reading the indicator may also be a human error. The pointer is constantly moving in the PVC testing making it difficult to read, therefore, having to estimate where it was. Not preparing the apparatus is also an error. Before the testing starts, the load nut must apply a small force on the specimen to avoid loose reading. So that once the experiment begins, the pointer starts to move at the first increment.

7 Further Work

To produce better results for the experiment, the test must be done 3 times on each material specimen. This is because the same material may have a different grain structure which can affect the result. Therefore, finding the average for the specimen would make the results more accurate. Another way of producing accurate results is adding an electric motor to rotate the load nut. This allows the load nut to apply constant force, especially for the PVC specimen so that the graph doesn't produce a dip in the plastic region. Adding a recording camera levelled with the dial indicator allows for accurate measurement. Attaching a sensor to the load nut wired to an LED light in the view of the camera to show when the load nut turns an increment. Furthermore, using an expensive apparatus called an extensometer will provide a further accurate result. Since it is connected directly to the specimen, this eliminates the measurement made from the chuck and the body of the apparatus used for this testing. This will provide the actual strain of the specimen.

8 Bibliography

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