

BEng Engineering Programmes

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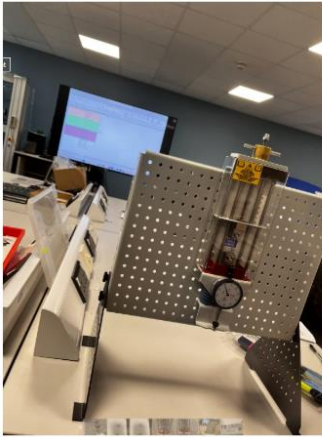
## **Tensile Test**

### **Introduction-**

Tensile stress is a key area in material science and engineering (Emmens, 2011) as it determines how material will react under stretching forces. According to Clinton (2018) when a material is subjected to tensile stress, it may elongate and if the stress exceeds a certain threshold, the material may break or fail. The aim of this assignment is to analyse the test to understand how tensile testing is used to test how materials react after being put under tension. During the test four different types of materials were used such as Steel, duraluminium, aluminium and PVC. Yield testing was used to determine the strength of the four materials. According to, The yield strength is the amount of stress a material can withstand before it begins to deform permanently.

### **Experimental Procedure-**

This experiment was conducted through testing different specimens' strength and elasticity such as, Steel, Duralumin, Aluminium, and PVC. The purpose of this experiment was to gradually apply a force to the material until it snapped, while having to record the dial indicator and then calculate the Force, extension, stress and nominal strain. The equipment we used and needed was a tensile tester, and a dial indicator which was used to measure the extension of the material as pictured below;



Once the kit was all setup, we had to set the dial indicator to zero for accurate readings when applying the force. We started off by going up 0.2 mm per rotation recording the measurement after each rotation. During this process the materials will elongate under pressure which at some point it will hit its breaking point. At this point we recorded where it snapped so we could then measure the new length of the material and compare the differences of all materials.

## Results-

## Lab Results- Raw Data

| Steel                                                              |                        |                     | Aluminium                                                          |                        |                     |
|--------------------------------------------------------------------|------------------------|---------------------|--------------------------------------------------------------------|------------------------|---------------------|
| Material                                                           | Steel                  |                     | Material                                                           | Aluminium              |                     |
| Original cross-sectional area (mm <sup>2</sup> or m <sup>2</sup> ) | 1.782 mm <sup>2</sup>  |                     | Original cross-sectional area (mm <sup>2</sup> or m <sup>2</sup> ) | 1.94 mm <sup>2</sup>   |                     |
| Original length (mm)                                               | 30.9 mm                |                     | Original length (mm)                                               | 30.06 mm               |                     |
| Load (N)                                                           | Load Not movement (mm) | Dial Indicator (mm) | Load (N)                                                           | Load Not movement (mm) | Dial Indicator (mm) |
| 0                                                                  | 0                      | 0                   | 0                                                                  | 0                      | 0                   |
| 0.2                                                                |                        | 0.105               | 0.2                                                                |                        | 0.14                |
| 0.4                                                                |                        | 0.35                | 0.4                                                                |                        | 0.32                |
| 0.6                                                                |                        | 0.53                | 0.6                                                                |                        | 0.5                 |
| 0.8                                                                |                        | 0.715               | 0.8                                                                |                        | 0.67                |
| 1                                                                  |                        | 0.9                 | 1                                                                  |                        | 0.85                |
| 1.2                                                                |                        | 1.08                | 1.2                                                                |                        | 0.97                |
| 1.4                                                                |                        | 1.275               | 1.4                                                                |                        | 1.13                |
| 1.6                                                                |                        | 1.44                | 1.6                                                                |                        | 1.32                |
| 1.8                                                                |                        | 1.63                | 1.8                                                                |                        | 1.49                |
| 2                                                                  |                        | 1.815               | 2                                                                  |                        | 1.63                |
| 2.2                                                                |                        | 1.99                | 2.2                                                                |                        | 1.76                |
| 2.4                                                                |                        | 2.19                | 2.4                                                                |                        | 1.88                |
| 2.6                                                                |                        | 2.35                | 2.6                                                                |                        | 2.01                |
| 2.8                                                                |                        | 2.53                | 2.8                                                                |                        | 2.12                |
| 3                                                                  |                        | 2.7                 | 3                                                                  |                        | 2.26                |
| 3.2                                                                |                        | 2.87                | 3.2                                                                |                        | 2.32                |
| 3.4                                                                |                        | 3.01                | 3.4                                                                |                        | 2.41                |
| 3.6                                                                |                        | 3.14                | 3.6                                                                |                        | 2.5                 |
| 3.8                                                                |                        | 3.27                | 3.8                                                                |                        | 2.55                |
| 4                                                                  |                        | 3.41                | 4                                                                  |                        | 2.61                |
| 4.2                                                                |                        | 3.54                | 4.2                                                                |                        | 2.66                |
| 4.4                                                                |                        | 3.65                | 4.4                                                                |                        | 2.88                |
| 4.6                                                                |                        | 3.75                | 4.6                                                                |                        | 2.73                |
| 4.8                                                                |                        | 3.88                | 4.8                                                                |                        | 2.78                |
| 5                                                                  |                        | 3.98                | 5                                                                  |                        | SNAPI               |
| 6                                                                  |                        | 4.46                | 6                                                                  |                        |                     |
| 7                                                                  |                        | 4.85                | 7                                                                  |                        |                     |
| 8                                                                  |                        | 5.1                 | 8                                                                  |                        |                     |
| 9                                                                  |                        | 5.28                | 9                                                                  |                        |                     |
| 10                                                                 |                        | 5.39                | 10                                                                 |                        |                     |
| 20                                                                 |                        | SNAPI               | 20                                                                 |                        |                     |
| 30                                                                 |                        |                     | 30                                                                 |                        |                     |
| 40                                                                 |                        |                     | 40                                                                 |                        |                     |
| 50                                                                 |                        |                     | 50                                                                 |                        |                     |
| 60                                                                 |                        |                     | 60                                                                 |                        |                     |

| Duralumin                                                          |                        |                     |
|--------------------------------------------------------------------|------------------------|---------------------|
| Material                                                           | Duralumin              |                     |
| Original cross-sectional area (mm <sup>2</sup> or m <sup>2</sup> ) | 1.9 mm <sup>2</sup>    |                     |
| Original length (mm)                                               | 31 mm                  |                     |
| Load (N)                                                           | Load Not movement (mm) | Dial Indicator (mm) |
| 0                                                                  | 0                      | 0                   |
| 0.2                                                                |                        | 0.16                |
| 0.4                                                                |                        | 0.26                |
| 0.6                                                                |                        | 0.35                |
| 0.8                                                                |                        | 0.485               |
| 1                                                                  |                        | 0.66                |
| 1.2                                                                |                        | 0.83                |
| 1.4                                                                |                        | 1.06                |
| 1.6                                                                |                        | 1.25                |
| 1.8                                                                |                        | 1.43                |
| 2                                                                  |                        | 1.6                 |
| 2.2                                                                |                        | 1.77                |
| 2.4                                                                |                        | 1.95                |
| 2.6                                                                |                        | 2.12                |
| 2.8                                                                |                        | 2.31                |
| 3                                                                  |                        | 2.48                |
| 3.2                                                                |                        | 2.65                |
| 3.4                                                                |                        | 2.81                |
| 3.6                                                                |                        | 2.99                |
| 3.8                                                                |                        | 3.18                |
| 4                                                                  |                        | 3.36                |
| 4.2                                                                |                        | 3.53                |
| 4.4                                                                |                        | 3.7                 |
| 4.6                                                                |                        | 3.87                |
| 4.8                                                                |                        | 4.05                |
| 5                                                                  |                        | 4.22                |
| 6                                                                  |                        | 4.78                |
| 7                                                                  |                        | 5                   |
| 8                                                                  |                        | 5.13                |
| 9                                                                  |                        | SNAPI               |
| 10                                                                 |                        |                     |
| 20                                                                 |                        |                     |
| 30                                                                 |                        |                     |
| 40                                                                 |                        |                     |
| 50                                                                 |                        |                     |
| 60                                                                 |                        |                     |

| PVC                                                                |                        |                     |
|--------------------------------------------------------------------|------------------------|---------------------|
| Material                                                           | PVC                    |                     |
| Original cross-sectional area (mm <sup>2</sup> or m <sup>2</sup> ) | 1.9 mm <sup>2</sup>    |                     |
| Original length (mm)                                               | 31.1 mm                |                     |
| Load (N)                                                           | Load Not movement (mm) | Dial Indicator (mm) |
| 0                                                                  | 0                      | 0                   |
| 0.2                                                                |                        | 0.01                |
| 0.4                                                                |                        | 0.14                |
| 0.6                                                                |                        | 0.21                |
| 0.8                                                                |                        | 0.26                |
| 1                                                                  |                        | 0.34                |
| 1.2                                                                |                        | 0.35                |
| 1.4                                                                |                        | 0.22                |
| 1.6                                                                |                        | 0.17                |
| 1.8                                                                |                        | 0.16                |
| 2                                                                  |                        | 0.15                |
| 2.2                                                                |                        | 0.16                |
| 2.4                                                                |                        | 0.15                |
| 2.6                                                                |                        | 0.16                |
| 2.8                                                                |                        | 0.17                |
| 3                                                                  |                        | 0.14                |
| 3.2                                                                |                        | 0.18                |
| 3.4                                                                |                        | 0.18                |
| 3.6                                                                |                        | 0.18                |
| 3.8                                                                |                        | 0.17                |
| 4                                                                  |                        | 0.16                |
| 4.2                                                                |                        | 0.16                |
| 4.4                                                                |                        | 0.19                |
| 4.6                                                                |                        | 0.15                |
| 4.8                                                                |                        | 0.16                |
| 5                                                                  |                        | 0.15                |
| 6                                                                  |                        | 0.15                |
| 7                                                                  |                        | 0.16                |
| 8                                                                  |                        | 0.17                |
| 9                                                                  |                        | 0.15                |
| 10                                                                 |                        | 0.15                |
| 20                                                                 |                        | SNAPI               |
| 30                                                                 |                        |                     |
| 40                                                                 |                        |                     |
| 50                                                                 |                        |                     |
| 60                                                                 |                        |                     |

The tables above show the initial data we recorded whilst taking out the tensile test. As you can see from the table of results Steel and PVC both snapped at the same point which was ten rotations on the dial indicator. This is because steel has a higher tensile strength than aluminum and duralumin, which essentially means that steel can withstand heavier loads which makes it the perfect material to use when it comes to withstanding heavy forces.

(Engineering discoveries, 2019)

PVC also outperformed aluminum and duralumin because of the flexibility of PVC. This suggests that PVC can stretch freely without instantly snapping under stress. During the test PVC also showed elastic deformation, which meant that it would almost instantly go back to its original length. Evidently our group had to quickly record each of the results before it went back to its shape.

# Analysis-

Table 1 - Steel

| Material                                                           | Steel                 |            |                |                         |                |
|--------------------------------------------------------------------|-----------------------|------------|----------------|-------------------------|----------------|
| Original cross-sectional area (mm <sup>2</sup> or m <sup>2</sup> ) | 1.782 mm <sup>2</sup> |            |                |                         |                |
| Original length (mm)                                               | 30.9 mm               |            |                |                         |                |
|                                                                    |                       | New length | 38.2 mm        |                         |                |
| Load Nut movement (mm)                                             | Dial Indicator (mm)   | Force (N)  | Extension (mm) | Stress N/m <sup>2</sup> | Nominal strain |
| 0                                                                  | 0                     | 0          | 0              | 0                       | 0              |
| 0.2                                                                | 0.165                 | 16.5       | 0.035          | 9.3                     | 0.00113        |
| 0.4                                                                | 0.35                  | 35         | 0.05           | 19.6                    | 0.00162        |
| 0.6                                                                | 0.53                  | 53         | 0.07           | 29.7                    | 0.00227        |
| 0.8                                                                | 0.715                 | 71.5       | 0.085          | 40.1                    | 0.00275        |
| 1                                                                  | 0.9                   | 90         | 0.1            | 50.5                    | 0.00324        |
| 1.2                                                                | 1.08                  | 108        | 0.12           | 60.6                    | 0.00388        |
| 1.4                                                                | 1.275                 | 127.5      | 0.125          | 71.5                    | 0.00405        |
| 1.6                                                                | 1.44                  | 144        | 0.16           | 80.8                    | 0.00518        |
| 1.8                                                                | 1.63                  | 163        | 0.17           | 91.5                    | 0.00550        |
| 2                                                                  | 1.815                 | 181.5      | 0.185          | 101.9                   | 0.00599        |
| 2.2                                                                | 1.99                  | 199        | 0.21           | 111.7                   | 0.00680        |
| 2.4                                                                | 2.19                  | 219        | 0.21           | 122.9                   | 0.00680        |
| 2.6                                                                | 2.35                  | 235        | 0.25           | 131.9                   | 0.00809        |
| 2.8                                                                | 2.53                  | 253        | 0.27           | 142.0                   | 0.00874        |
| 3                                                                  | 2.7                   | 270        | 0.3            | 151.5                   | 0.00971        |
| 3.2                                                                | 2.87                  | 287        | 0.33           | 161.1                   | 0.01068        |
| 3.4                                                                | 3.01                  | 301        | 0.39           | 168.9                   | 0.01262        |
| 3.6                                                                | 3.14                  | 314        | 0.46           | 176.2                   | 0.01489        |
| 3.8                                                                | 3.27                  | 327        | 0.53           | 183.5                   | 0.01715        |
| 4                                                                  | 3.41                  | 341        | 0.59           | 191.4                   | 0.01909        |
| 4.2                                                                | 3.54                  | 354        | 0.66           | 198.7                   | 0.02136        |
| 4.4                                                                | 3.65                  | 365        | 0.75           | 204.8                   | 0.02427        |
| 4.6                                                                | 3.75                  | 375        | 0.85           | 210.4                   | 0.02751        |
| 4.8                                                                | 3.88                  | 388        | 0.92           | 217.7                   | 0.02977        |
| 5                                                                  | 3.98                  | 398        | 1.02           | 223.3                   | 0.03301        |
| 6                                                                  | 4.46                  | 446        | 1.54           | 250.3                   | 0.04984        |
| 7                                                                  | 4.85                  | 485        | 2.15           | 272.2                   | 0.06958        |
| 8                                                                  | 5.1                   | 510        | 2.9            | 286.2                   | 0.09385        |
| 9                                                                  | 5.28                  | 528        | 3.72           | 296.3                   | 0.12039        |
| 10                                                                 | 5.35                  | 535        | 4.65           | 300.2                   | 0.15049        |
| 20                                                                 | SNAP!                 |            |                |                         |                |
| 30                                                                 |                       |            |                |                         |                |
| 40                                                                 |                       |            |                |                         |                |
| 50                                                                 |                       |            |                |                         |                |
| 60                                                                 |                       |            |                |                         |                |
| Tensile strength (N/m <sup>2</sup> )                               | 300.22                |            |                |                         |                |
| Yield Stress (N/m <sup>2</sup> )                                   | 111.67                |            |                |                         |                |
| % Elongation                                                       | 23.62                 |            |                |                         |                |

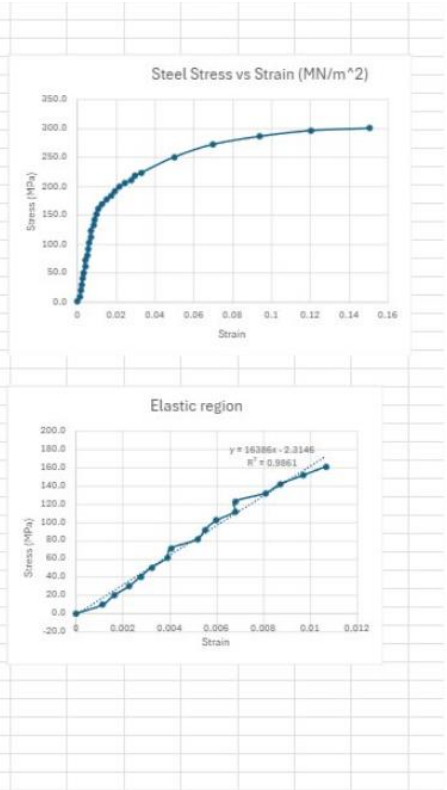


Table 2- Duralamin

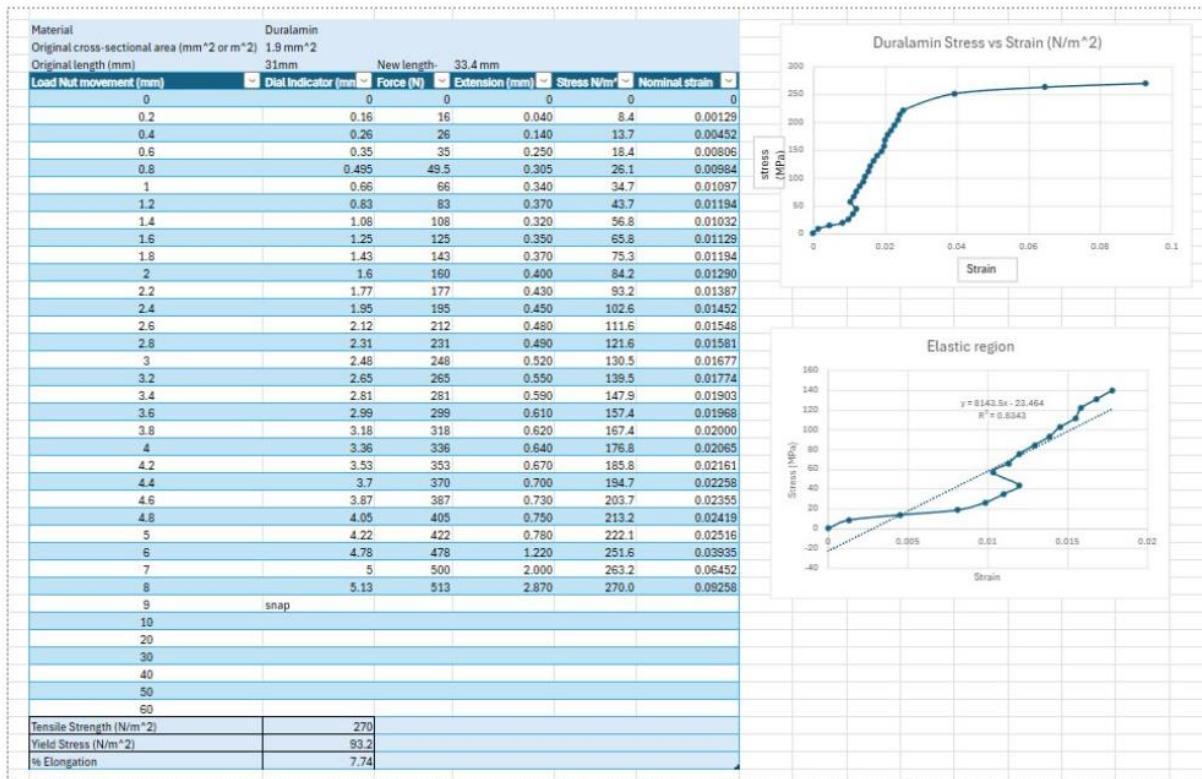


Table 3- Aluminum

| Material                                                           | Aluminium                         |           |                |                         |                |
|--------------------------------------------------------------------|-----------------------------------|-----------|----------------|-------------------------|----------------|
| Original cross-sectional area (mm <sup>2</sup> or m <sup>2</sup> ) | 1.94 mm <sup>2</sup>              |           |                |                         |                |
| Original length (mm)                                               | 30.98mm      New length- 33.14 mm |           |                |                         |                |
| Load Nut movement (mm)                                             | Dial Indicator (mm)               | Force (N) | Extension (mm) | Stress N/m <sup>2</sup> | Nominal strain |
| 0                                                                  | 0                                 | 0         | 0              | 0                       | 0              |
| 0.2                                                                | 0.14                              | 14        | 0.06           | 7.2                     | 0.00194        |
| 0.4                                                                | 0.32                              | 32        | 0.08           | 16.5                    | 0.00258        |
| 0.6                                                                | 0.5                               | 50        | 0.1            | 25.8                    | 0.00323        |
| 0.8                                                                | 0.67                              | 67        | 0.13           | 34.5                    | 0.00420        |
| 1                                                                  | 0.85                              | 85        | 0.15           | 43.8                    | 0.00484        |
| 1.2                                                                | 0.97                              | 97        | 0.23           | 50.0                    | 0.00742        |
| 1.4                                                                | 1.13                              | 113       | 0.27           | 58.2                    | 0.00872        |
| 1.6                                                                | 1.32                              | 132       | 0.28           | 68.0                    | 0.00904        |
| 1.8                                                                | 1.49                              | 149       | 0.31           | 76.8                    | 0.01001        |
| 2                                                                  | 1.63                              | 163       | 0.37           | 84.0                    | 0.01194        |
| 2.2                                                                | 1.76                              | 176       | 0.44           | 90.7                    | 0.01420        |
| 2.4                                                                | 1.88                              | 188       | 0.52           | 96.9                    | 0.01679        |
| 2.6                                                                | 2.01                              | 201       | 0.59           | 103.6                   | 0.01904        |
| 2.8                                                                | 2.12                              | 212       | 0.68           | 109.3                   | 0.02195        |
| 3                                                                  | 2.26                              | 226       | 0.74           | 116.5                   | 0.02389        |
| 3.2                                                                | 2.32                              | 232       | 0.88           | 119.6                   | 0.02841        |
| 3.4                                                                | 2.41                              | 241       | 0.99           | 124.2                   | 0.03196        |
| 3.6                                                                | 2.5                               | 250       | 1.1            | 128.9                   | 0.03551        |
| 3.8                                                                | 2.55                              | 255       | 1.25           | 131.4                   | 0.04035        |
| 4                                                                  | 2.61                              | 261       | 1.39           | 134.5                   | 0.04487        |
| 4.2                                                                | 2.66                              | 266       | 1.54           | 137.1                   | 0.04971        |
| 4.4                                                                | 2.68                              | 268       | 1.72           | 138.1                   | 0.05552        |
| 4.6                                                                | 2.73                              | 273       | 1.87           | 140.7                   | 0.06036        |
| 4.8                                                                | 2.75                              | 275       | 2.05           | 141.8                   | 0.06617        |
| 5                                                                  | SNAP!                             |           |                |                         |                |
| 6                                                                  |                                   |           |                |                         |                |
| 7                                                                  |                                   |           |                |                         |                |
| 8                                                                  |                                   |           |                |                         |                |
| 9                                                                  |                                   |           |                |                         |                |
| 10                                                                 |                                   |           |                |                         |                |
| 20                                                                 |                                   |           |                |                         |                |
| 30                                                                 |                                   |           |                |                         |                |
| 40                                                                 |                                   |           |                |                         |                |
| 50                                                                 |                                   |           |                |                         |                |
| 60                                                                 |                                   |           |                |                         |                |
| Tensile Strength (N/m <sup>2</sup> )                               | 141.75                            |           |                |                         |                |
| Yield Stress (N/m <sup>2</sup> )                                   | 90.7                              |           |                |                         |                |
| % Elongation                                                       | 6.97                              |           |                |                         |                |

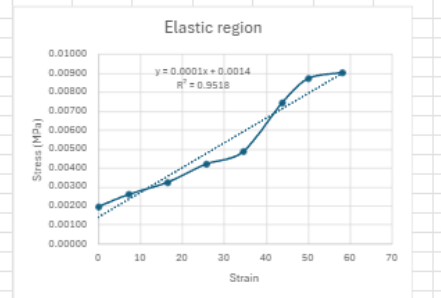
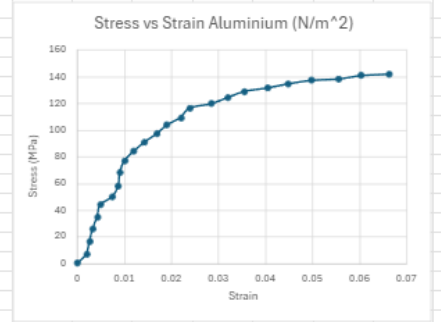
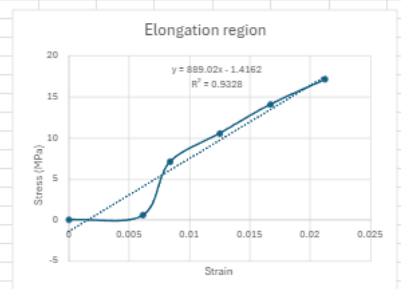
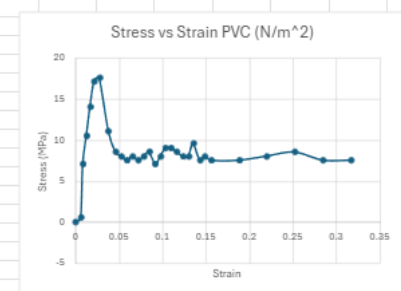


Table 4- PVC

| Material: PVC                                                                           |                     |           |                |                         |                |
|-----------------------------------------------------------------------------------------|---------------------|-----------|----------------|-------------------------|----------------|
| Original cross-sectional area (mm <sup>2</sup> or m <sup>2</sup> ): 1.9 mm <sup>2</sup> |                     |           |                |                         |                |
| Original length (mm): 31.1 mm                                                           |                     |           |                |                         |                |
| New length: 41.88 mm                                                                    |                     |           |                |                         |                |
| Load Nut movement (mm)                                                                  | Dial Indicator (mm) | Force (N) | Extension (mm) | Stress N/m <sup>2</sup> | Nominal strain |
| 0                                                                                       |                     | 0         | 0              | 0                       | 0              |
| 0.2                                                                                     |                     | 0.01      | 1              | 0.19                    | 0.00611        |
| 0.4                                                                                     |                     | 0.14      | 14             | 0.26                    | 0.00836        |
| 0.6                                                                                     |                     | 0.21      | 21             | 0.39                    | 0.01254        |
| 0.8                                                                                     |                     | 0.28      | 28             | 0.52                    | 0.01672        |
| 1                                                                                       |                     | 0.34      | 34             | 0.66                    | 0.02122        |
| 1.2                                                                                     |                     | 0.35      | 35             | 0.85                    | 0.02733        |
| 1.4                                                                                     |                     | 0.22      | 22             | 1.18                    | 0.03794        |
| 1.6                                                                                     |                     | 0.17      | 17             | 1.43                    | 0.04598        |
| 1.8                                                                                     |                     | 0.16      | 16             | 1.64                    | 0.05273        |
| 2                                                                                       |                     | 0.15      | 15             | 1.85                    | 0.05949        |
| 2.2                                                                                     |                     | 0.16      | 16             | 2.04                    | 0.06559        |
| 2.4                                                                                     |                     | 0.15      | 15             | 2.25                    | 0.07235        |
| 2.6                                                                                     |                     | 0.16      | 16             | 2.44                    | 0.07846        |
| 2.8                                                                                     |                     | 0.17      | 17             | 2.63                    | 0.08457        |
| 3                                                                                       |                     | 0.14      | 14             | 2.86                    | 0.09196        |
| 3.2                                                                                     |                     | 0.16      | 16             | 3.04                    | 0.09775        |
| 3.4                                                                                     |                     | 0.18      | 18             | 3.22                    | 0.10354        |
| 3.6                                                                                     |                     | 0.18      | 18             | 3.42                    | 0.10997        |
| 3.8                                                                                     |                     | 0.17      | 17             | 3.63                    | 0.11672        |
| 4                                                                                       |                     | 0.16      | 16             | 3.84                    | 0.12347        |
| 4.2                                                                                     |                     | 0.16      | 16             | 4.04                    | 0.12990        |
| 4.4                                                                                     |                     | 0.19      | 19             | 4.21                    | 0.13537        |
| 4.6                                                                                     |                     | 0.15      | 15             | 4.45                    | 0.14309        |
| 4.8                                                                                     |                     | 0.16      | 16             | 4.64                    | 0.14920        |
| 5                                                                                       |                     | 0.15      | 15             | 4.85                    | 0.15595        |
| 6                                                                                       |                     | 0.15      | 15             | 5.85                    | 0.18810        |
| 7                                                                                       |                     | 0.16      | 16             | 6.84                    | 0.21994        |
| 8                                                                                       |                     | 0.17      | 17             | 7.83                    | 0.25177        |
| 9                                                                                       |                     | 0.15      | 15             | 8.85                    | 0.28457        |
| 10                                                                                      |                     | 0.15      | 15             | 9.85                    | 0.31672        |
| 20                                                                                      | SNAP!               |           |                |                         |                |
| 30                                                                                      |                     |           |                |                         |                |
| 40                                                                                      |                     |           |                |                         |                |
| 50                                                                                      |                     |           |                |                         |                |
| 60                                                                                      |                     |           |                |                         |                |
| Tensile strength (N/m <sup>2</sup> )                                                    |                     | 7.89      |                |                         |                |
| Yield stress (N/m <sup>2</sup> )                                                        |                     | 2.22      |                |                         |                |
| % Elongation                                                                            |                     | 34.66     |                |                         |                |



The results above show the different materials reacted under increasing forces, which caused the materials to elongate and stretch.

The results show that steel is the strongest material tested as it has the highest tensile and yield strength with it having a tensile strength of 300 N/m<sup>2</sup> and a yield of 3 N/m<sup>2</sup>. The

strength of the steel is also confirmed by the stress-strain graph. The graph starts to plateau around 3.2 rotations, this indicates that the material started to go into its deformation stage and could no longer go back to its original shape.

Duralumin had the second-best tensile strength and yield which makes it the perfect material to use for something that needs good strength and high flexibility. The elongation of duralumin shows that it has a lower ductility compared to steel. Whilst being slightly weaker than steel, it still held itself together against high levels of stress and strain. The elongation of duralumin was much lower than steel, with it sitting at 7.74%. This is an important indicator of how duralumin performs and how it compares with steel and much less ductile than steel.

Aluminum was one of the strongest out of all the materials in terms of tensile and yield strength, the graph and results show that its aluminum was relatively strong but had a much lower tensile strength compared to steel and duralumin. In terms of elongation, it wasn't far off duralumin with it being 6.97%, This shows the ductility of aluminum and how low it is.

PVC was the weakest out of all the materials in terms of tensile and yield strength, it also has an extremely low resistance as shown in the graph, this makes it unsuitable for applications that require high resistance.

## Conclusion-

In this tensile test, an analysis took place of mechanical properties of four different materials steel, aluminum, duralumin, and PVC. The results for steel showed a tensile stress of 300.22 MPa and a yield stress of 111.7 MPa, both of which were lower than the typical ranges of 400 MPa to 2000 MPa for tensile stress and 250 MPa to 1500 MPa for yield stress (Callister, 2018; MatWeb, 2024). These discrepancies can likely be attributed to

several factors, including the specific type of steel used, variations in testing conditions such as temperature, and differences in strain rates applied during the test (Meyer et al., 2021).

The results for aluminum showed a tensile stress of 270 MPa and a yield stress of 93.2 MPa. While aluminum is generally less strong than steel, these results fall within the typical range of 200 MPa to 550 MPa for tensile stress and 50 MPa to 500 MPa for yield stress (MatWeb, 2024). The lower values for aluminum could be due to its inherent material properties or differences in the specific alloy tested, which can vary in strength based on its composition.

Duralumin, high-strength aluminum, showed a tensile stress of 141.75 MPa and a yield stress of 90.7 MPa. Although duralumin is typically stronger than pure aluminum, these results are on the lower end of its expected range (450 MPa to 700 MPa for tensile stress and 250 MPa to 500 MPa for yield stress) (Callister, 2018). Variations in alloy composition, testing conditions, or sample preparation could account for these lower values.

PVC showed a tensile stress of 7.89 MPa and a yield stress of 2.22 MPa, which were the lowest among the four materials tested. This is consistent with PVC's known properties as a relatively low-strength material, with typical tensile stress values ranging from 40 MPa to 70 MPa and yield stress values around 40 MPa to 70 MPa (MatWeb, 2024). PVC's performance in the tensile test reflects its more flexible nature compared to metals, which is why it has lower strength values.

These results emphasize the importance of understanding the specific properties of each material and how factors such as a composition, testing conditions, and preparation techniques can influence mechanical performance. Further testing under more controlled conditions could provide a clearer understanding of the deviations observed in this experiment and offer better alignment with the theoretical values for each material.

## Evaluation-

To eliminate as many errors as possible our group made sure that all the specimens were measured correctly using a vernier caliper. Making sure that they were measured correctly was important because we needed to use the original length to calculate the stress, if the materials got measured incorrectly it would have left our group with the incorrect data which would have made our tests unreliable to use.

We also made sure that we applied consistent loading to each rotation. Consistent loading led us to as accurate readings as possible. So, an inconsistent loading would've led to incorrect data and irregularities in the test readings.

As a group we also had to make sure that all the materials were properly in place. To do this, we tightly secured the specimen in place this ensured that we obtained the correct data for each material. If the specimen wasn't securely placed, it could have led to it twisting under the pressure which would have led to errors in the data.

## Further work-

In future, improvements could be made. This test with unlimited time and resources, we could have used a slow-motion camera to pick up on the specimen's elongation more accurately. This would have been used best on the PVC testing because the PVC had high flexibility, so it sprung back into its original shape almost instantly.

The temperature also played a key role in the findings, the temperature can affect how the material reacts under stress. So, testing the different materials in different temperatures could provide us with insightful data on how the materials react. Different temperatures would have different effects on the materials. For example, lower temperatures would decrease the resistance of the material whereas higher temperatures would increase it.

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