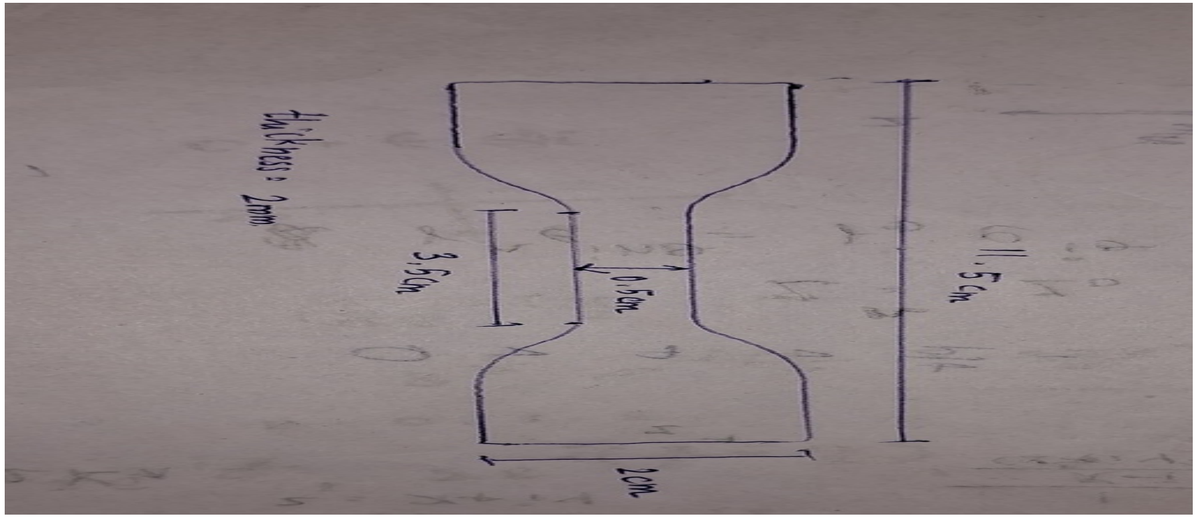
AS2070 PROJECT
GROUP H

Failure Analysis: The Role of Surface Roughness

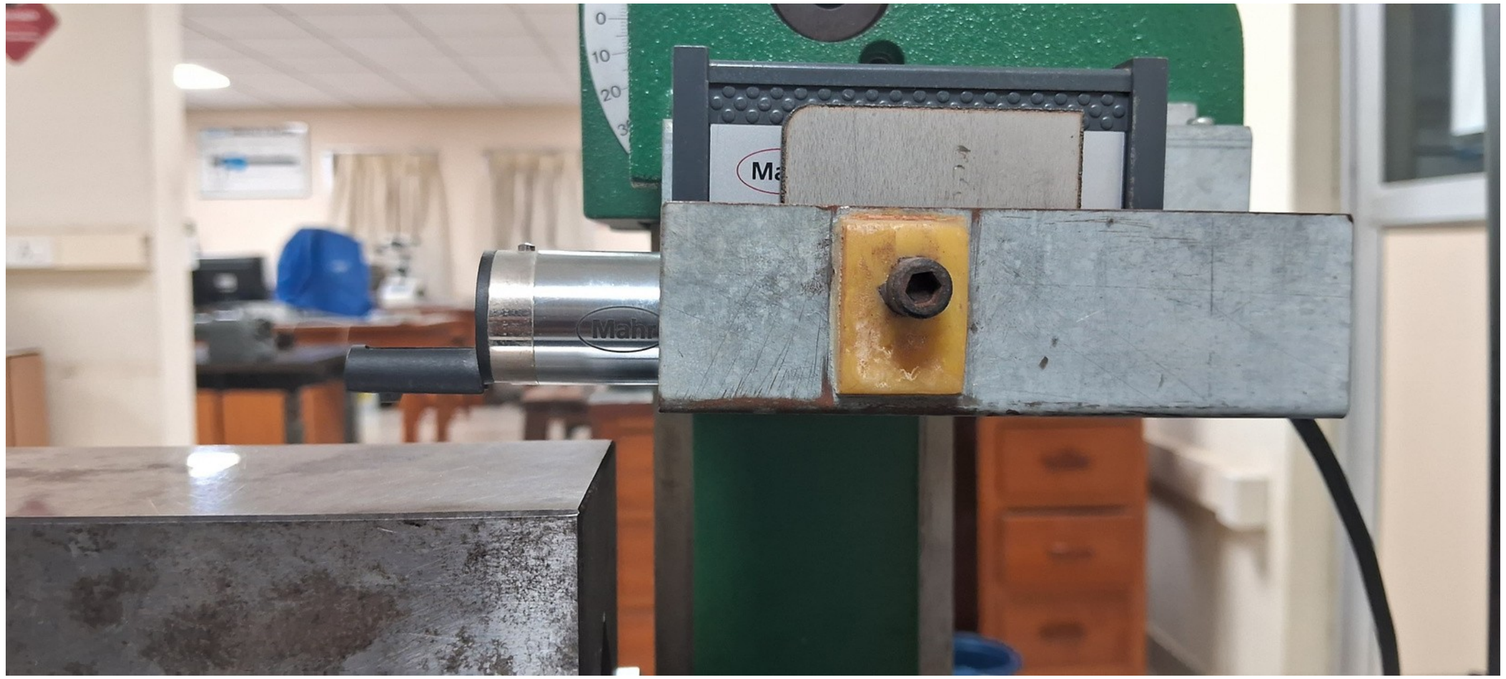
Dog-bone specimen

- We chose this sample because it is the most preferred sample for UTM testing.
- The dimensions used are standard testing dimensions for Aluminium (ASTM 6384)
- The dimensions of the sample are:



Profilometer

- A profilometer is an instrument used to measure surface roughness by capturing the texture and contours of a surface.
- A microscopic tip, in contact with the surface, is moved along the X axis. The vertical movement of the tip, due to the surface relief, is captured and amplified.
- The heights and depths of the surface is plottted along the x-axis and the roughness is measured as the average of this measurement.



Roughness measurement

- The roughness is measured in terms Ra (Roughness average).
- Ra is the average of the absolute values of the surface height deviations measured from the mean surface over a specified sampling length.
- A low Ra value means a smoother surface.
- A high Ra value means a rougher surface.

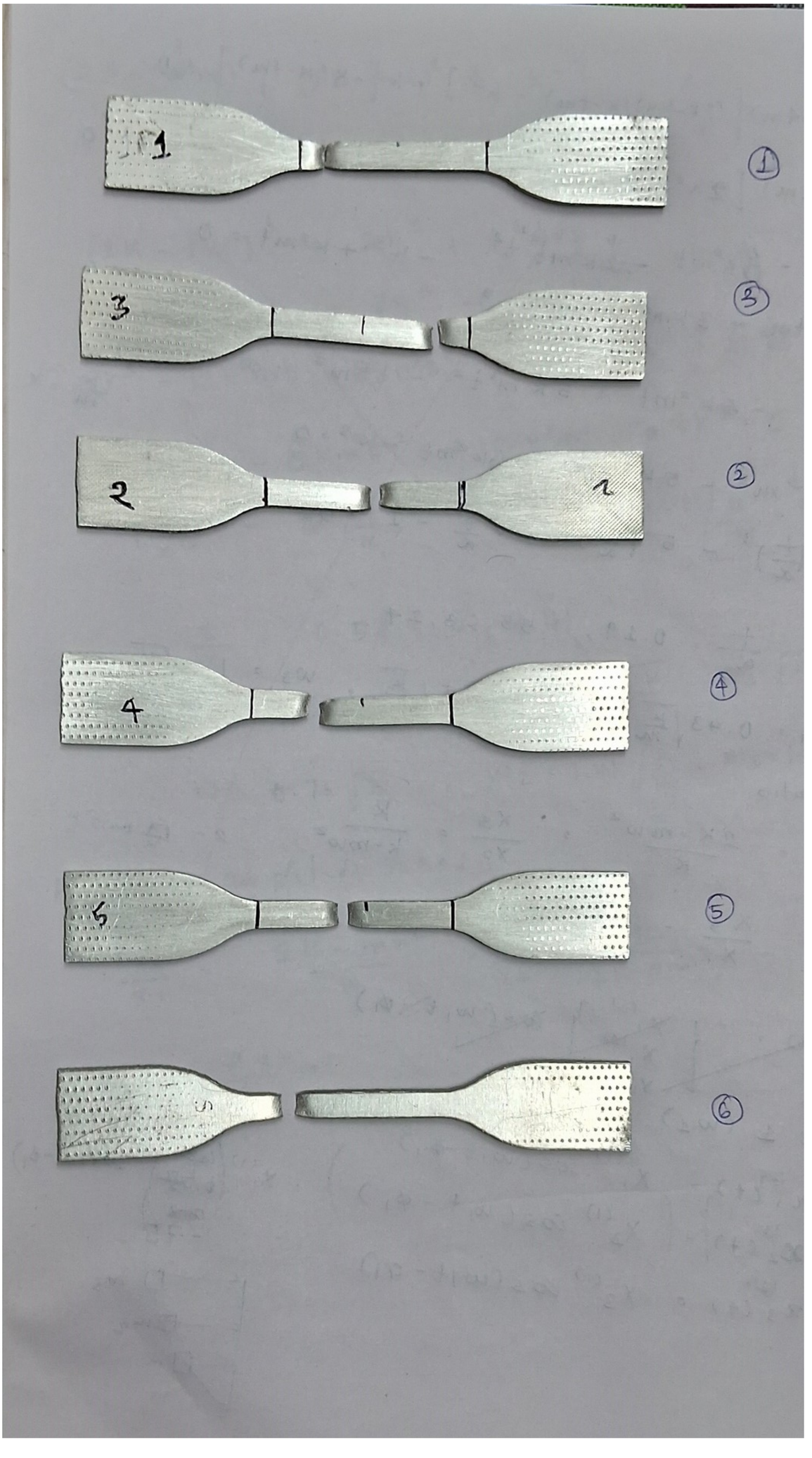
$$Ra = \frac{1}{L} \int_0^L |y(x)| \, dx$$

UTM

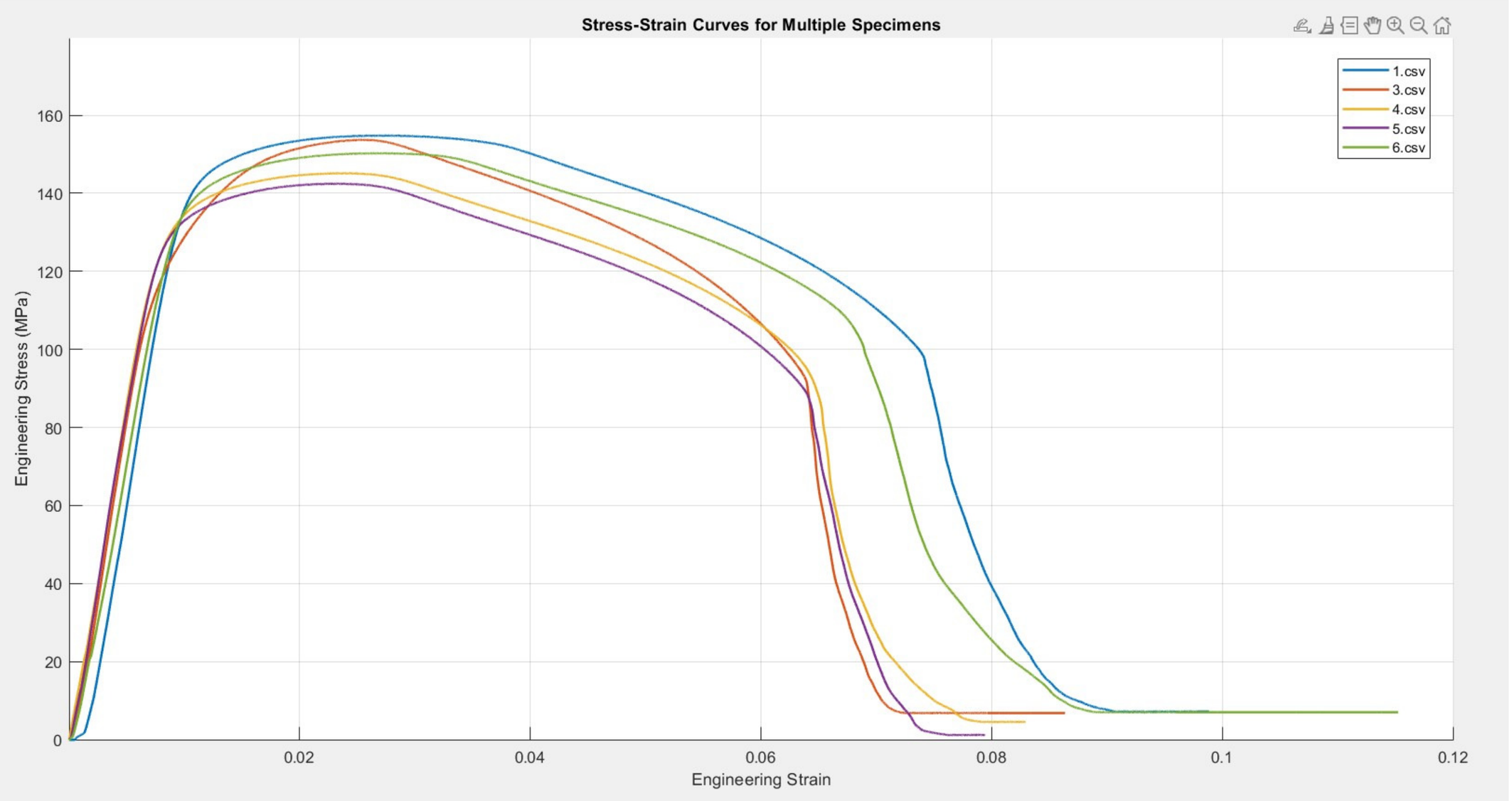
- The Universal Testing Machine (UTM) is a versatile device used to test the mechanical properties of materials, including tensile strength, compressive strength, flexural strength, and more.
- The samples that we prepared are loaded onto the clamps and applied load till it fails.
- The UTM clamps are called the cross-heads and their speed is called cross head speed.
- This speed is maintained constant (~5mm/min) and the load is varied accordingly
- We get the load applied at each strain and from this we generate the stress strain plot.

Experimental Procedure

- First, we got the raw materials - 2mm Aluminium plate and sandpaper of five different grades. In our case, we got sandpapers of grade 100, 150, 180, 320 and 400.
- We used water jet cutting to get 6 dog-bone specimens from the Al plate.
- We sanded the
  Specimen 1 with grade 100,
  Specimen 2 with grade 100, 150
  Specimen 3 with grade 100, 150, 180
  Specimen 4 with grade 100, 150, 180, 320
  Specimen 5 with grade 100, 150, 180, 320, 400
  Specimen 6 is not sanded.
- And then we took the specimens to measure their surface roughness using profilometer.
- After that we did tensile stress for each specimen in the UTM.
- With the help of Force and Stroke data from the UTM and initial dimensions of the specimens we plotted the stress-strain plot for each specimen.


1
1
3
3
2
2
2
4
4
5
5
6
6

PLOT


Stress-Strain Curves for Multiple Specimens
1.csv
3.csv
4.csv
5.csv
6.csv
Engineering Stress (MPa)
Engineering Strain
0
20
40
60
80
100
120
140
160
0.02
0.04
0.06
0.08
0.1
0.12

SOURCE OF ERROR

- Uneven surface preparation- The sanding was done with hand , which will give non uniform roughness on the specimen.
- The surface roughness was measured only at one point, so it didn’t give accurate roughness values . .
- The test specimens may have internal material defects like voids which may vary from material to material and influence mechanical behavior of surface roughness.
- Insufficient number of samples/specimens are one of the reasons for not achieving desired results/accurate trends.
- Improper attachment or environmental factors for material , humanize errors during the test may cause inaccurate values.

RESULTS AND CONCLUSIONS

- The Ultimate tensile strength values increase in the order 5 , 4 , 6 , 3 , 1 .
- That is, the UTS value increases with an increase in roughness.
- Fracture strain values increase in the order of 3,5,4,6,1
- Although we do not see a monotonic relation, the specimen with the highest roughness shows more ductility and the specimen with lowest roughness show almost lowest ductility(that is ,fractures early).
- The yield point is highest for the specimen with the highest roughness.
- These relations are opposite of what we expected . (UTS ,yield point and Fracture strain decrease with increase in roughness)
- It might be due to the direction of sanding. Instead of sanding it perpendicular to loading, we did the sanding parallel to loading.