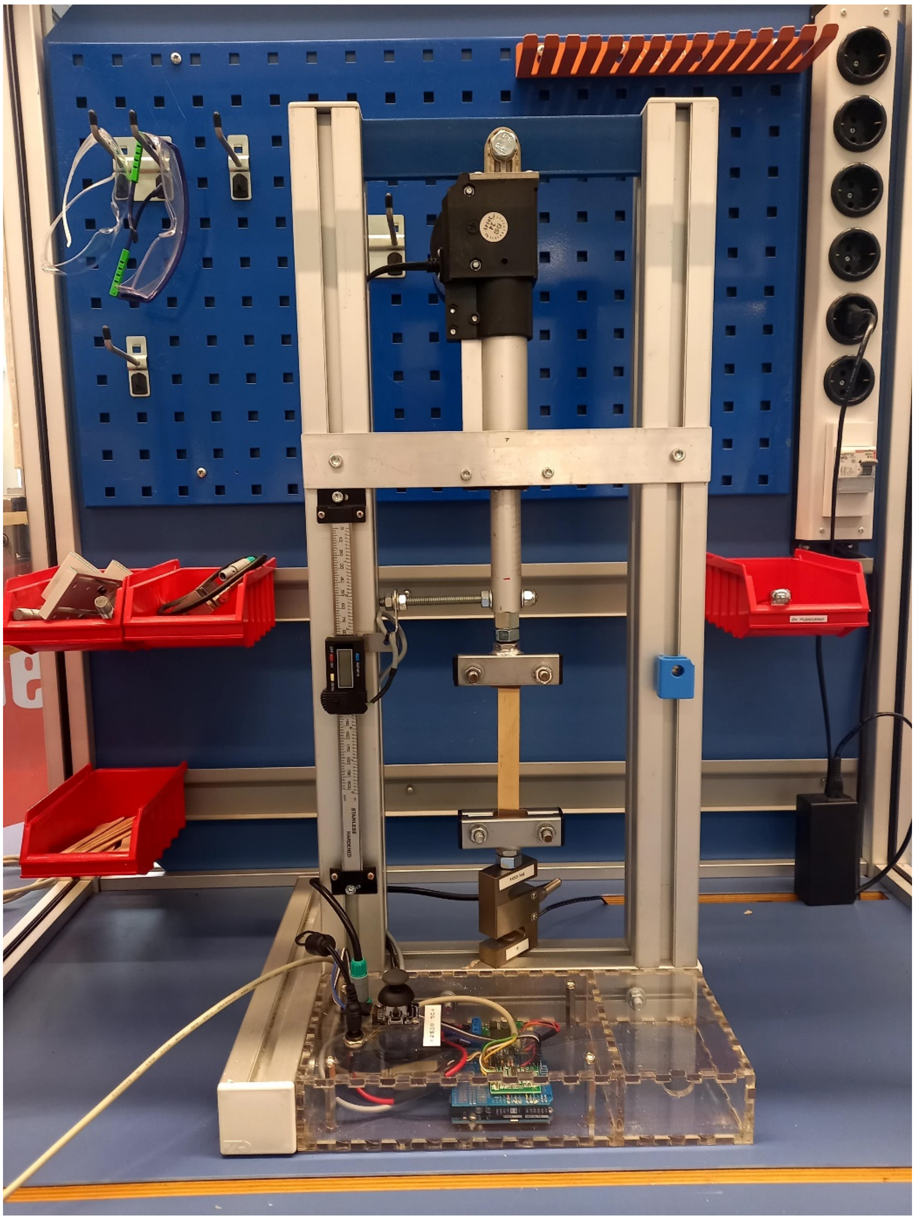
JUNE 23, 2023



MASCHA SLINGERLAND - IO
TU DELFT

Contents

The LETT

The LETT (Low-End Tensile Tester) is a tensile test machine, especially built for education purposes at IDE, TU Delft. The machine can be used to do tensile tests, 3-point bending tests and compression tests to determine material properties such as the Young's modulus and the tensile strength.

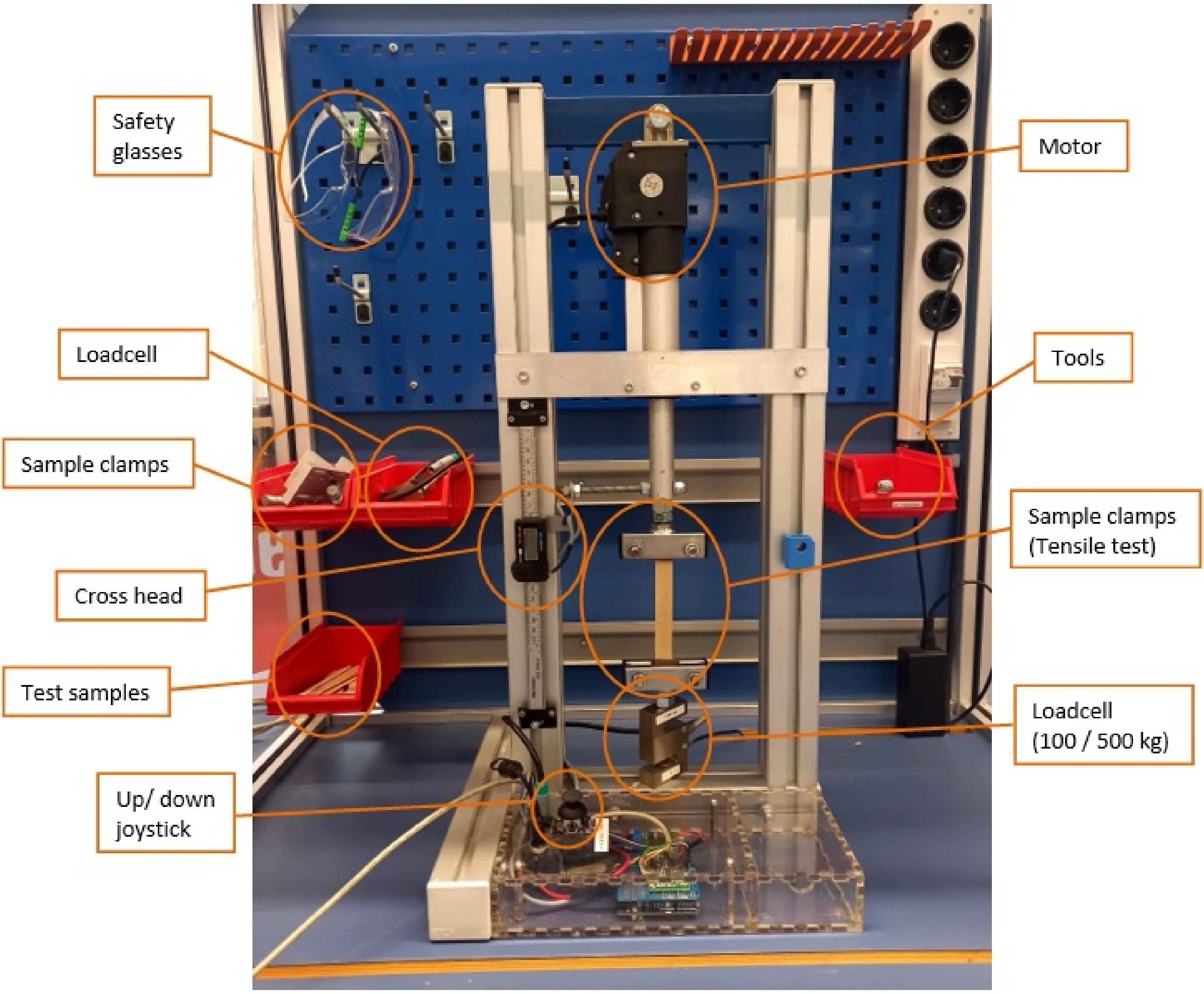


Figure 1: LETT

The motor drives the top-clamp in the Z-direction while the Loadcell measures the force and the Cross head measures the Z-travel.

The machine can be setup for test till failure, for testing creep and relaxation and for cyclic tests.

You can setup a measurement by choices in hardware, the loadcell and the clamps, and choices in the software, see the next Paragraphs.

Keep the window down during the tests as protection against splinters. If you really need the window to be open during the experiment wear safety glasses and make sure the people around you are safe.

Setting up the hardware of the LETT machine

To setup the hardware you can choose the load cell and the clamps.

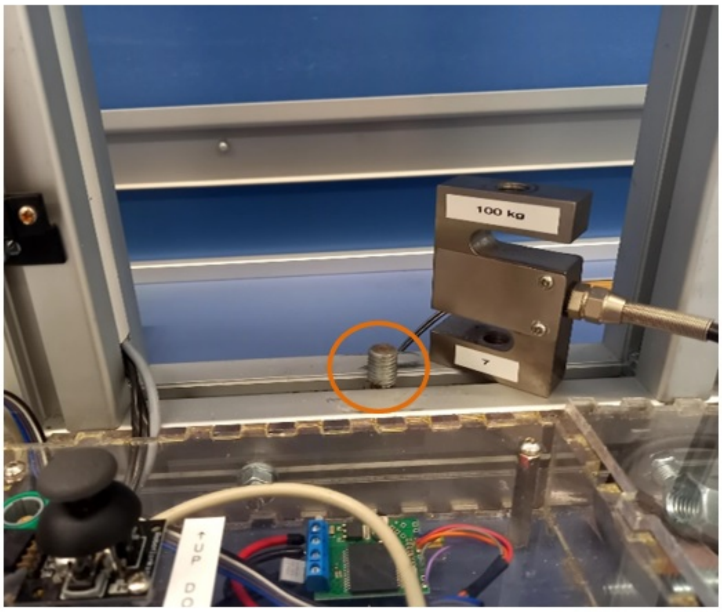
If you need to move the clamps in order to (dis)connect hardware, first connect the LETT with the USB to your laptop and use the joystick to move up and down.

Choose the force sensor

There are 2 options:

- **a.** 100 kg / 1000 N
- **b.** 500 kg / 5000 N

The force gauge can be fixated on the M13 bolt end in the bottom of the LETT, hand tight. The sensor doesn't have to be aligned with the machine.



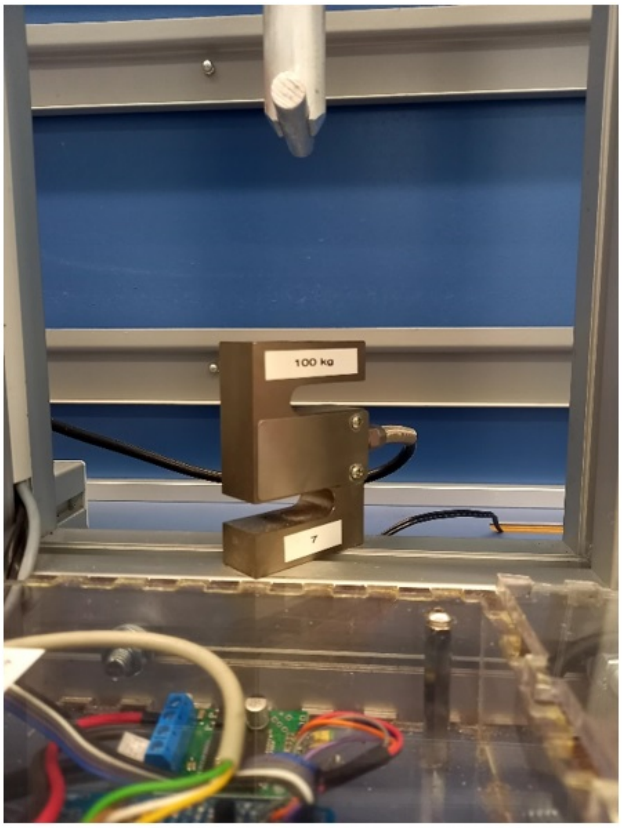


Figure 2: Force sensor connection

Choose the clamps

The clamps can be changed by loosening the M13 fixation nuts that holds the clamp to both the top end of the machine and the force gauge with a spanner size 19, hand tight.

- **a.** Tensile test (spanner 13)
- **b.** Tensile test for small samples (spanner 13)
- **c.** 3-point bending test (Allen key 3)
- **d.** Compression test (not jet available)

a. In the **tensile test setup**, align the clamps such that the sample will be straight; make sure that the M8 nuts are on the front to change samples easily.

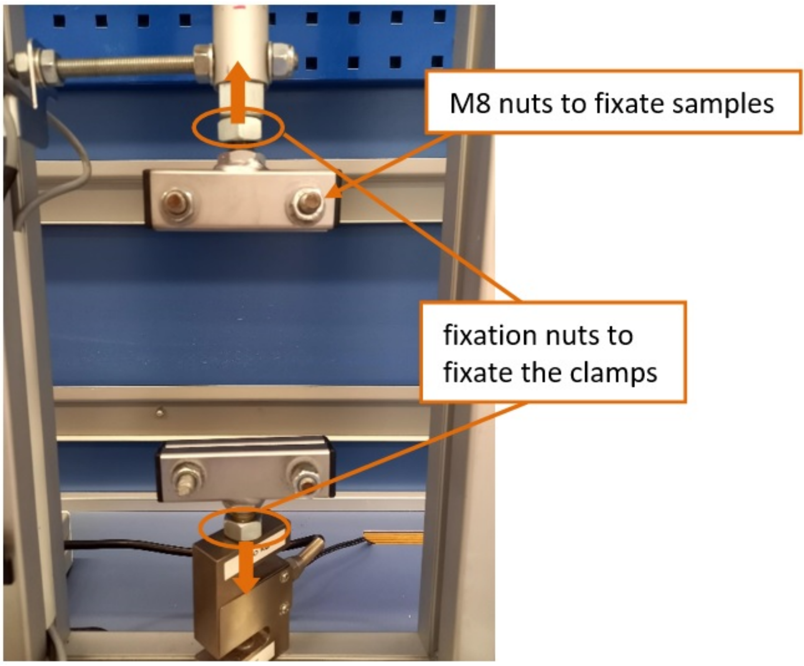


Figure 3: Tensile Test clamps

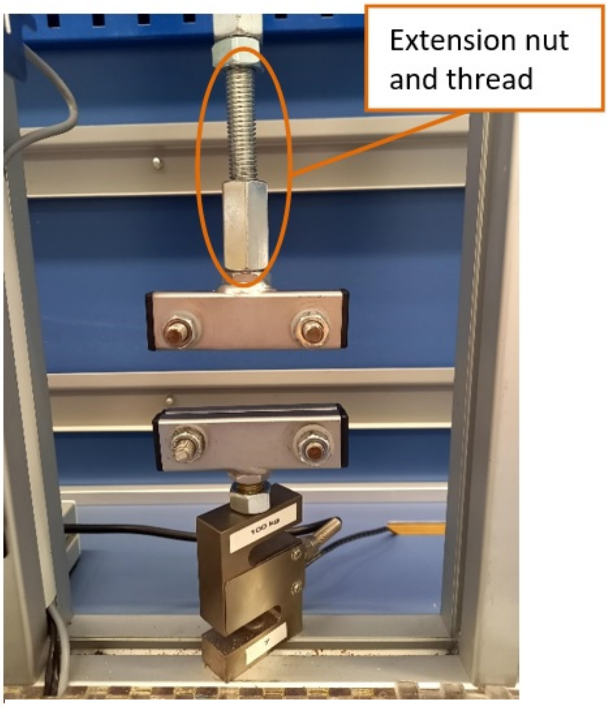


Figure 4: Tensile Test for small samples

b. In the **tensile test setup for small samples**, align the clamps such that the sample will be straight; make sure that the M8 nuts are on the front to change samples easily. Fixate the extension nut and thread hand tight.

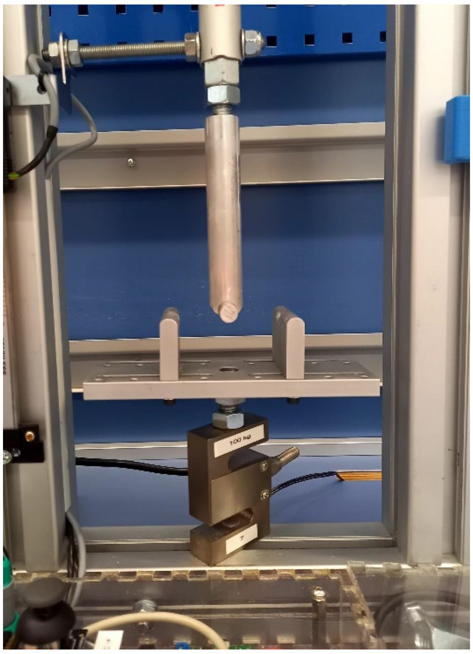


Figure 5: 3 Point Bending Test clamps

c. In the **3 point bending setup**, align the clamps such that the top support and the bottom supports are aligned and preferably aligned to the machine like in the picture. The bottom supports can be adjusted with an Allen key size 3, either to fixed positions or to slides.

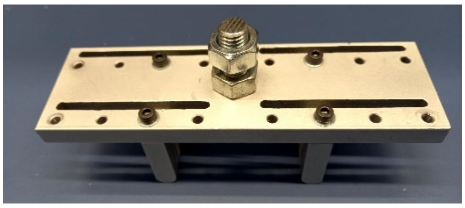


Figure 6: Adjustable bottom supports

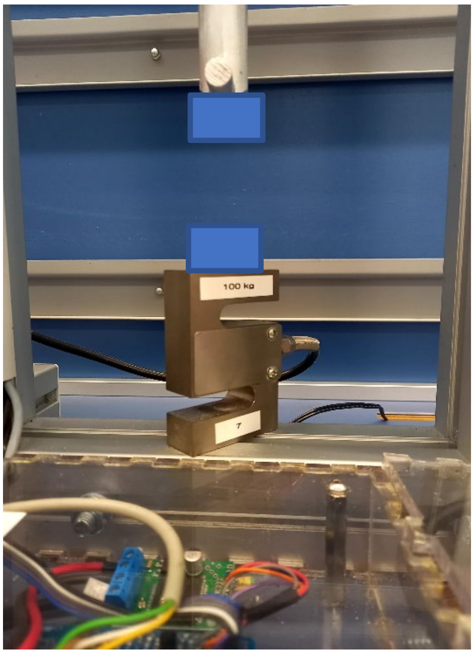


Figure 7: Compression clamps

d. The **compression grips** will be added later.

Setting up the software of the LETT machine

1. Install Java Runtime Environment from: https://www.java.com/en/download/manual.jsp
2. Download and **save** the LETT software from edu.nl/bcpk8
3. Extract the Zip-folder **LETT2023** to a suitable location.
4. Connect the LETT USB cable to your computer.
5. Open the **LETT2023.jar** file. The following window will pop up, it might take a minute:

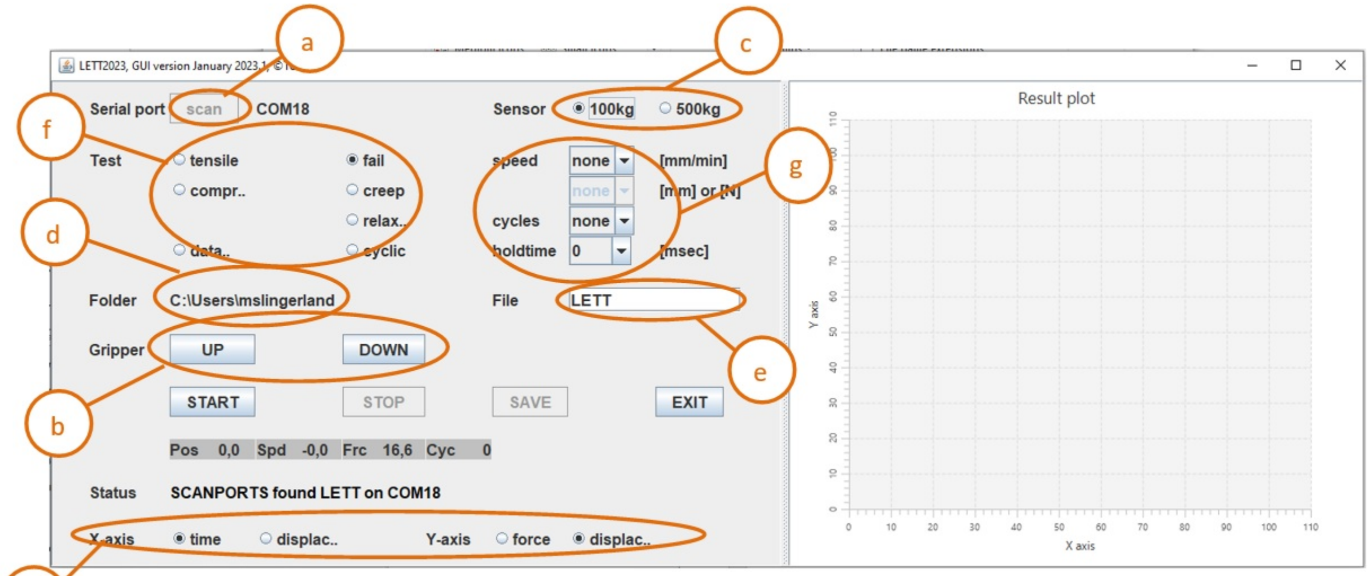


Figure 8: User Interface LETT program

a. If no port is displayed, check the connection between LETT and your computer and press the scan – button.

b. Use the “UP/DOWN” buttons to confirm a proper connection between LETT and computer.

c. Ensure that the sensor selected in the top right **(100kg or 500kg)** matches the force sensor on your LETT machine.

d. Click the bold text next to **Folder** to choose a location to save the test results. This will create a subfolder named LETTResults where tests willbe stored.

e. Choose a file name for the test results.

f. Choose the correct test:
   - *tensile* for the Tensile Test and the Tensile Test for small samples
   - *compr.* for 3-point bending and Compression
   - *fail* to test till failure
   - *creep* to apply force and measure the displacement
   - *relax.* to apply displacement and measure force
   - *cyclic* to repeat motion and measure hysteresis effects

g. Fill in the test parameters (speed, force, position, cycles and/ or holdtime).

h. Choose logical X- and Y-axis (displac. and force for testing till failure and cyclic testing, time and displac. for creep and time and force for relax.)

Preparing Your Samples

Make sure all your samples have the same dimensions, preferably in dogbone-style for tensile tests and straight/ rectangular for 3 point bending tests. Label them according to the test order.

Figure 9: Sample shapes

Measure the width and thickness of your samples and record the values in a table like Table 1.

Value Measured	Sample 1	Sample 2	Sample 3
Width 1			
Width 2			
Width 3			
Width Avg. (*w*)			
Thickness 1			
Thickness 2			
Thickness 3			
Thickness Avg. (t)			
Gauge Length (Lo)			
Area (A=w*t)			

Table 1: Sample Dimensions

Example test: a Tensile Test till failure

1. Install the needed loadcell and clamps, see chapter 2.
2. Move the clamps with either the joystick (slowly) or the "**UP/DOWN**" buttons on the interface.
3. Place the sample on the tester:
   a. Clamp your sample to the bottom grip.
   b. (Un)screw the bottom grip until it aligns with the top.
   c. Make sure the sample is straight and clamp the top.

NOTE: If the sample slips, use sand paper between the sample and the grip.

4. Close the window as your splinter protection (if not, use safety goggles)
5. Set the test mode to **tensile** and **fail**.
6. Set test speed to **5mm/min.**
7. Change axes to **displacement** (X axis) and **force** (Y axis).
8. Begin test with "**START**" button.

(the **STOP** button is used to cancel test).

9. Repeat for all your samples.

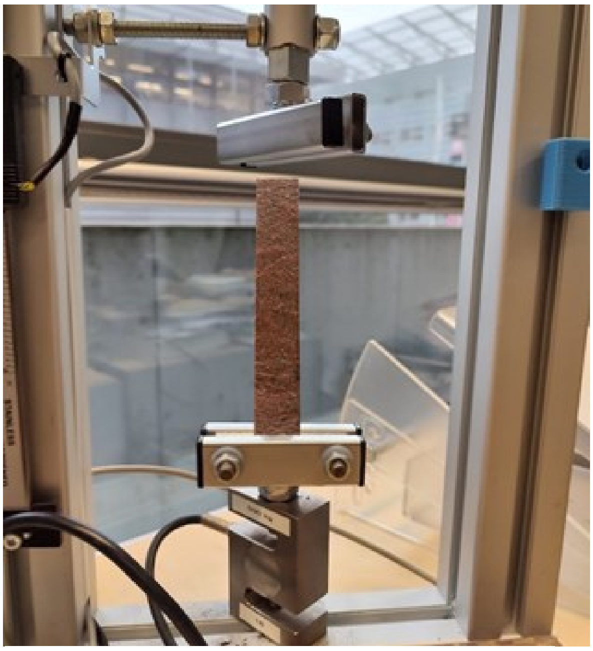


Figure 10: Clamp in the sample

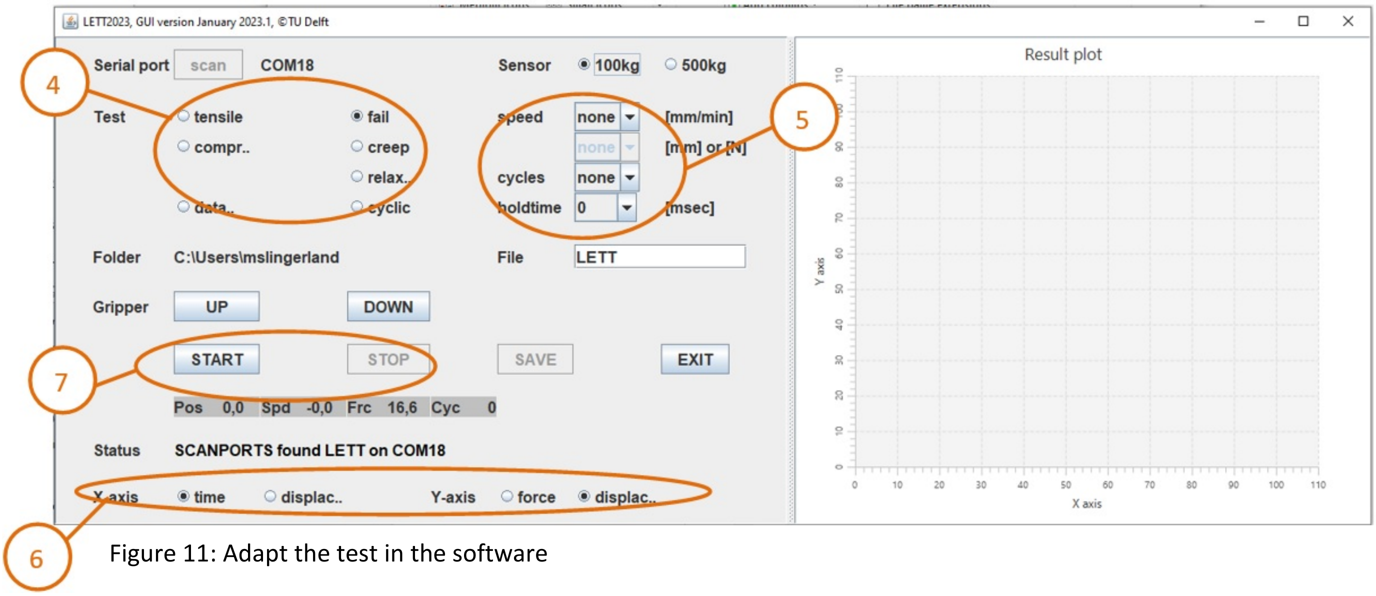


Figure 11: Adapt the test in the software

Analysis

Open the saved file from the location you saved it (C:\\Users\NAME\Documents\LETTResults) in Excel or import it into Excel. You might need to split the columns.

Convert the obtained load-displacement data to stress-strain and plot. (More information here).

$$\boldsymbol{\sigma = \frac{F}{A}; \varepsilon = \frac{\Delta l}{l_o}}$$

in which:

σ - stress

F - force values recorded

A - cross-sectional area of sample

l_o – gauge length

ε – strain

Δl – displacement

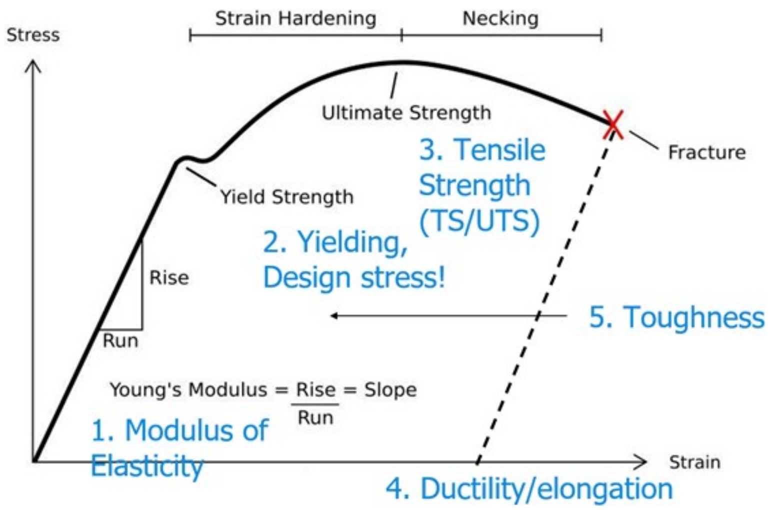


Figure 12: Charasteristics of a Tensile Curve

Use ***Figure 12*** to calculate the six major tensile properties of your curve.

1. Modulus of Elasticity or Young's Modulus (E) – the slope of the linear section of your curve.
2. Yield strength (σ_Y) – transition from elastic to plastic (permanent) deformation.
3. (Ultimate) Tensile strength – top of the curve
4. Ductility – amount of elongation at fracture.
5. Toughness – area under the curve
6. Breaking strength – end point of the curve

Youtube links

- Stress and Strain - https://www.youtube.com/watch?v=aQf6Q8t1FQE
- Material Strength, Ductility and Toughness - https://www.youtube.com/watch?v=WSRqJdT2COE
- Young’s modulus - https://www.youtube.com/watch?v=DLE-ieOVFjI
- Poisson's Ratio - https://www.youtube.com/watch?v=tuOlM3P7ygA

Literature

- Materials : engineering, science, processing and design from M.F. Ashby - https://tudelft.on.worldcat.org/v2/oclc/852806045