



Guide Use of the Tensile Testing Machine

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Introduction

The tensile test is one of the destructive testing methods in which a specimen is subjected to a uniaxial tensile force until it reaches the point of failure, while elongation is simultaneously recorded alongside the applied force (load). The results obtained from this test are typically used to select a material for quality control purposes and to predict how a material will respond to other types of forces. The engineering stress-strain curve is plotted based on the values of applied force and elongation, resulting in a stress/strain curve that illustrates the material's behavior under tension. The data derived from this test is utilized to determine the mechanical properties of the material.

- Terms and Definitions

In this guide, the following terms and definitions apply:

- **Initial Length (L_0)**

The initial distance between gauge marks in the central section of the specimen, in millimeters.

Note: The initial length values specified for various specimen types in different sections of this guide represent the maximum initial length.

- **Thickness (h)**
The smaller initial dimension of the rectangular cross-section in the central section of the specimen, in millimeters.
- **Width (b)**
The larger initial dimension of the rectangular cross-section in the central section of the specimen, in millimeters.
- **Cross-Sectional Area (A)**
The product of thickness and width of the specimen ($A = bh$), in square millimeters.
- **Test Speed (V)**
The rate at which the jaws of the grips move apart, in millimeters per minute.
- **Stress (σ)**
The force perpendicular to the unit area of the original (initial) cross-section at the initial length, in megapascals.
Note: To distinguish it from the true stress applied to the actual cross-section of the specimen, this is often referred to as "engineering stress."
- **Yield Stress (σ_y)**
The stress at the yield strain, in megapascals.
Note: This stress may be lower than the maximum stress applicable to the specimen (see curves b and c in Figure 1).
- **Strength (σ_m)**
The first maximum stress observed during the tensile test, in megapascals.
This maximum may occur at the point where the specimen yields or fractures.
- **Stress at x% Strain (σ_x)**
The stress (in megapascals) at which the strain reaches a specified value of x%.
Note: Stress at x% strain is useful, for example, when the stress/strain curve lacks a yield point (see curve d in Figure 1).
- **Breaking Stress (σ_b)**
The stress (in megapascals) at which the specimen breaks, i.e., the highest stress value on the stress-strain curve just before fracture, immediately prior to the load drop caused by the onset of cracking.
- **Strain (ϵ)**
The increase in length divided by the original initial length, expressed as a percentage or dimensionless.
- **Yield Strain (ϵ_y)**
The first increase in strain without an increase in stress during the tensile test, expressed as a percentage or dimensionless (see curves b and c in Figure 1).
Reminder: Refer to Informative Annex A for computer-controlled determination of yield strain.
- **Breaking Strain (ϵ_b)**
If fracture occurs before yielding, the strain (dimensionless or as a percentage) at the last recorded point before the stress drops to a value less than or equal to 10% of the strength is recognized as the breaking strain (see curves a and d in Figure 1).

- **Strain at Strength (ϵ_m)**

The strain (dimensionless or as a percentage) corresponding to the strength stress.

- **Crosshead of the Machine**

The part of the tensile testing machine on which the jaws and grips are mounted.

- **Nominal Strain (ϵ_t)**

The displacement of the crosshead divided by the grip distance, expressed as a percentage or dimensionless.

Note 1: This property is used for strains beyond the yield point or when an elongation measuring device (extensometer) is not available.

Note 2: It may be calculated based on the crosshead displacement from the start of the test or based on the increase in crosshead displacement after the yield strain, in which case a length gauge is used (preferred for multi-purpose specimens).

- **Nominal Strain at Break**

The nominal strain at the last recorded point before the stress drops to a value less than or equal to 10% of the strength, if fracture occurs after yielding.

Reminder 1: Values are expressed dimensionless or as a percentage.

Reminder 2: See curves b and c in Figure 1.

- **Modulus**

The slope of the stress/strain curve (σ/ϵ) within the strain range between $\epsilon_1 = 0.05\%$ and $\epsilon_2 = 0.25\%$.

Reminder 1: Values are expressed in megapascals.

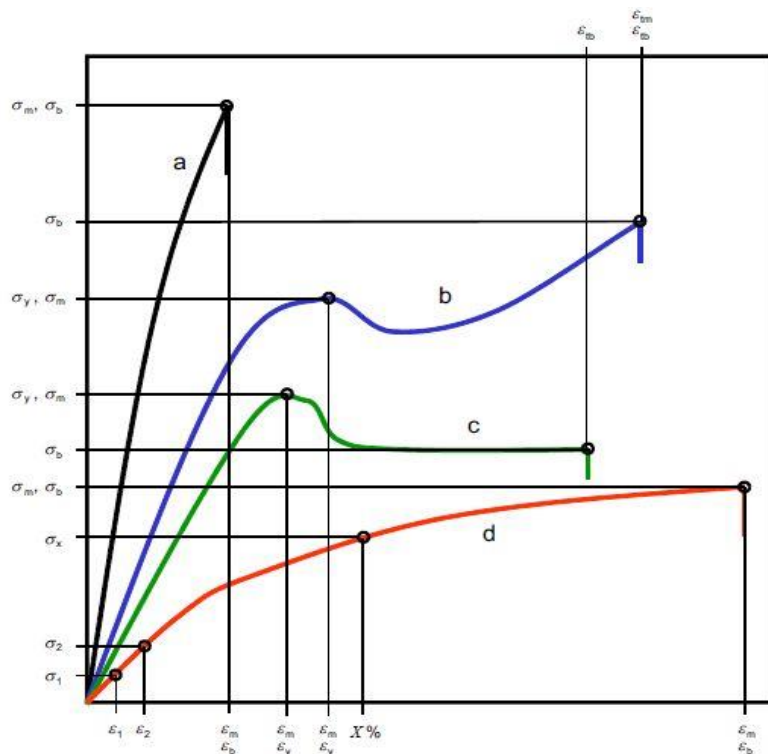
Reminder 2: It may be calculated as a chord modulus or as the slope of the linear least squares regression line within this range (see curve d in Figure 1).

Reminder 3: This definition does not apply to films.

- **Poisson's Ratio**

The ratio of the strain $\Delta\epsilon_n$ in the direction perpendicular to the tensile axis to the strain $\Delta\epsilon_t$ in the tensile direction, with a negative sign.

Reminder: Values are expressed dimensionless.



2- Main Menu and Software Submenus

The main menu consists of four sections: **File**, **Hardware**, **Test**, and **Report**, each with submenus offering various functionalities:

- **File:**

The File menu includes practical options such as archiving tests for later retrieval in the program for data analysis, opening previously archived tests, creating a new test, converting test outputs to files compatible with other software for better data analysis, and more.

- **New:** Create a new test.
- **Open:** Open previously saved test outputs for review.
- **Save:** Save the test.
- **Save as:** Save with a new name.
- **Close:** Close the test.
- **Print:** Print the test report.
- **Print preview:** Preview the printout.
- **Export to:** Convert outputs to files such as PDF, images, etc.
- **Print setting:** Print settings.
- **Exit:** Exit the software.

- **Hardware:**

The Hardware settings menu includes submenus for checking hardware connections and establishing communication, with an option to calibrate the load cell if needed, and another option to calibrate the extensometer when necessary.

- **Hardware Setting:**

- **Comport:** In this menu, you can view and adjust settings related to system-device communication (device connection port).
- **Up Load Cell & Down Load Cell:** Here, you can select the capacity of the load cell depending on whether an upper, lower, or both load cells are designated for the machine.
- **Down Over Load:** Set the maximum allowable force based on one or two times the load cell capacity.
- **Load Cell Calibrate:** Load cell calibration menu.
On the right side of this menu, first verify the load cell type (upper or lower) and its capacity. During calibration with a reference load cell, enter the actual force value in the designated field to calibrate the load cell within a range below or above 50% of its capacity.
- **Encoder Calibrate:** Extensometer encoder calibration.
First, select the extensometer type at the top of the window (External or Internal). During verification or calibration, enter the readings from a reference such as a gauge block or a suitable ruler in the Target field, then click Calib to calibrate the extensometer displacement accordingly.

- **Test:**

The Test menu includes submenus for specifying the method or procedure of the test and adding or removing tests.

- **Test Method:** Test procedure includes:
- **File Name:** The name of the folder or sample to be tested, under which the file is saved.
- **Test Name:** The name or number of the sample being tested (e.g., the second sample out of five total samples).
- **Test Type:** The type of pre-designed test currently viewable (editable in the Setting Act section).
- **Sample:**
- **New Sample:** Click here to create required sample types. Select a name for the sample, then choose its geometric shape in Shape Type, enter dimensions such as diameter and thickness, and save it with Add New.
- After creation, the sample can be viewed and selected in the Sample section.
- **Start/Stop Rule:**
- **Auto Zero:** Choose to start the test from a geometric zero point and zero force. Enabling Auto Return After End returns the jaws to their initial position after the test ends.
- **Measure:**
In the Load section, select the desired load cell based on the type connected to the machine (if only one load cell exists, only one option is available).

In the Displacement section, select the tool measuring displacement during the test (e.g., external extensometer or the servo motor itself).

○ **Diagram:**

Determine the type of horizontal and vertical axes for test data (e.g., stress vs. strain). Save changes with Save.

○ **Add / Remove Test:** Add or remove test types in this menu.

Write the test name in the designated field and click Add to include it, or select an existing test and click Remove to delete it.

Note: To have your desired test title available in the Method and Test Type menus during testing, you must create the test beforehand as described.

● **Report:**

The Report menu includes settings for the test curve, report table items, static items, and specifying measurement units for items.

○ **Diagram Setting:** Settings for selecting the type of curve axes. With Show Grid, you can enable or disable the grid lines on the test curve.

○ **Report Table:** Manage desired parameters in the report table and prepare outputs tailored to needs for printing.

By selecting parameter categories (in the left and bottom parts of the window), choose the desired sub-items, add them with Add, then select a name or create settings and click Ok to include them in the report's displayable parameters.

In the same menu, adjust the order of parameters in the report table by selecting a parameter and using Up or Down.

○ **Report Static Items:** Maximum, minimum, and average statements that can be applied to report table parameters as needed.

○ **Units:** Define measurement units for parameters like force, displacement, etc., and specify the number of decimal places in the designated fields opposite the units.

3- Toolbox

The Toolbox includes the same frequently used tools mentioned above, designed for quick access to program menus. The program's toolbox is vertically positioned on the left side of the main screen and includes 5 options: Open File, Report Table, Method, Units, and Print Preview.

4- Manual Mode

The speed available in this section determines the rate of movement.



The manual mode buttons, designed in blue, are used to move the jaws for test preparation and to position the desired sample for conducting the test.



Start and Stop Buttons

The start and stop buttons are used to initiate the test and pause it during execution.

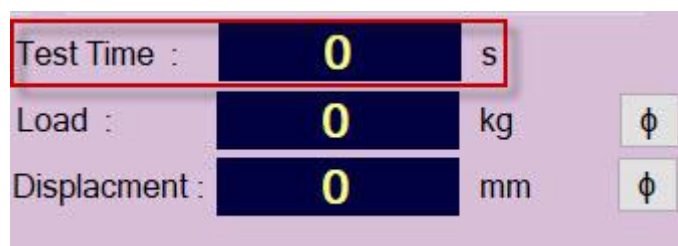
5- Status

The status display shows the device's condition and its connection to the computer, as well as various information to the user before, during, and after the test.

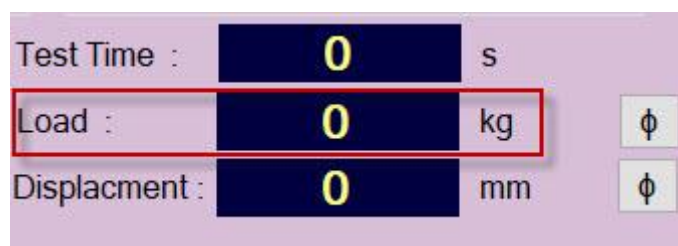
- **Disconnect:** In this state, the connection between the device and the system is severed, and the reason for the disconnection must be identified and addressed. Common causes include improper connection of the interface cable or failure to configure hardware connection settings in the software.
- **Connected:** Indicates that the connection between the device and the system is established.
- **Stop:** The connection is established, and the system is ready to perform a test, but no test is currently running.
- **Over Load:** This message appears when the applied force exceeds the capacity of the load cell.
- **Up Sensor:** Indicates reaching the maximum displacement limit upward.
- **Down Sensor:** Indicates reaching the maximum displacement limit downward.
- **Step:** Displays the various stages of test execution at any given moment.

6- Display of Variable Data During Test

- **Test Time:** Shows the elapsed time since the start of the test (its unit can be changed in the Units section).

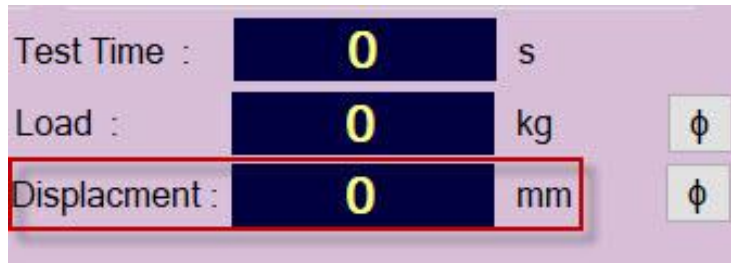


- **Load:** The amount of tensile or compressive force applied instantaneously to the sample being tested.



- **Displacement:** Displays the amount of displacement that has occurred instantaneously. When an extensometer is connected, this option shows the displacement of that device, while the **Servo** option indicates the displacement of the jaws.

If the machine lacks an extensometer, **Displacement** shows the displacement of the jaws.



- **Temperature Option:** Displays the ambient temperature.

7- Reports Table

The reports table includes parameters used for analyzing the test. The obtained values, as well as constant values such as thickness, initial length, and others, are displayed in the table.

	items	Fix Load	.Time@MaxLoad	.Lc
▶	Units	kg	s	kg
	Max			
	Min			
	Mean			

Reports Table (Continued)

- **Units Values:** Displays the measurement units of the parameters. The final report table, along with the curve, is included in the report form, and a printed version of the obtained results can be prepared.

8- Test Execution

After ensuring the device is connected to the computer and the **Hardware** section settings are configured, follow these steps to start the test:

1. To design and create the desired test, go to the **Test** menu, then to **Add/Remove Test**, write the test title, and click **Add**.
2. In the opened **Method** menu, under **Test**, and in the **Test Type** section, you will see the test title created in the first step. Click **Setting Act**.
3. In the **Steps Action** window, define the details and stages of the desired test. In the **Movement** section, you can choose the type of jaw movement, either at a specified speed or with a specified force increase rate, depending on your test type.
4. In the **Direction** section, determine the direction of the jaws' movement (upward, downward, or maintaining a specific force).
5. In the **Finishing Step** section, specify the criterion for completing this stage (e.g., reaching a certain force, time, sample rupture, or failure), then click **Add**.
6. Create all desired stages as per the mentioned steps, and finally click **Save Change**.
7. In the **Sample** section, click **New Sample**, and in the opened menu, after entering a title for your sample, specify other details such as the geometric shape of the cross-section (rectangular, cylindrical, etc.), then click **Add New** and close the menu with **Close**. If desired, you can modify the sample specifications in this section by clicking **Edit**.
8. Now, in the **Method** menu and **Sample** section, select the name of the sample you created (at this point, the sample's area and measured length will be displayed).
9. Adjust the items in the **Stop/Start Rule** section according to your needs and the provided explanations.
10. In the **Measure** section, specify the force and displacement measurement settings.
11. Define the type of horizontal and vertical axes for the test curve.
12. Click **Save New**.
13. Attach your sample (dumbbell, pipe, etc.) to the appropriate jaws.
14. Click the green **Start** button (on the software's main page). Verify the specifications displayed in the opened **Method** menu for accuracy, enter the number of the desired specimen in **Test Name**, and if everything is correct, click **Save & Start** to begin the test.
*Note: If you have multiple specimens to test, enter their number (1, 2, 3, etc.) each time in the **Test Name** section at the start of the test, then click **Save & Start**.*
15. After completing the test for each sample, you can save the results using **Save** in the desired location and name (only if the results are saved can you view that specimen's data in the reports section).
*After selecting a name, this title appears in the **File Name** section of the **Method** window.*
You can double-click on each specimen's number in the reports section at the

bottom of the page to view the curves of multiple specimens simultaneously in different colors. Additionally, by right-clicking, you can delete a specimen or change its color in the chart to a desired color.