INSTRON OPERATION – METHODS 45 AND 46

This document offers a step-by-step procedure for performing the types of tensile tests done in laboratory sessions of ENG-45. It is assumed that you are already familiar with tensile testing in general. Also, your work must be done under the supervision of your instructor. Finally, it is important that you read through the whole procedure before starting a test.

About the Instron 4204

The Instron 4204 is a computer controlled electro-mechanical testing system capable of performing a variety of tests based on tension and compression. The load frame is a tension/compression type employing a moving (screw-driven) crosshead. It is rated for forces up to 50 kN, crosshead speeds from 0.05 to 500 millimeters per minute and crosshead travel of up to 1.170 meters. The system is controlled from the control panel and a computer. The computer provides automated control, data acquisition and analysis.

Figure 1 Instron 4204 universal testers in the materials science teaching laboratories.

Method 45

Test method number 45 defines complete set of testing and data acquisition parameters for the types of tensile tests done in ENG-45. Briefly, it defines a tensile test which is conducted in displacement control using a crosshead speed of 2.54 millimeters per minute, assumes you are testing a 25.4 mm long rectangular specimen, and starts out recording data at a rate of 20 samples per second but drops to 1 sample per second after one minute.

Method 46

Test method number 46 defines complete set of testing and data acquisition parameters for the types of tensile tests done in ENG-45. Briefly, it defines a tensile test which is conducted in displacement control using a crosshead speed of 5.08 millimeters per minute, assumes you are testing a 58 mm long cylindrical specimen, and starts out recording data at a rate of 20 samples per second but drops to 1 sample per second after one minute.

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Safety Issues

Hazards associated with mechanical testing of materials include machine movement which creates pinch and crush zones, high forces which make these pinch and crush zones potentially very dangerous and stored elastic energy which can result in flying debris following sudden failure of the specimen or the machine. The operator of these machines must be constantly on the alert for all of these hazards. In particular, be very careful when moving the crosshead, especially when working in confined spaces such as when installing the grips and specimen. And be sure to take full advantage of all of the safety features of these machines. For instance, always set the crosshead travel limit switches before starting a series of tests. Also, when working in a group, make sure that all activities are coordinated and that everyone knows what the other people are doing. Finally, learn how to use the equipment properly and never use it for purposes for which it was not designed. If you have any questions or concerns regarding the operation of this equipment please talk to your instructor.

Procedure for Conducting the Tensile Test

1. Inspect the System

- Inspect the system to make sure that it is ready to be used. There should be no evidence of damage or misuse. It should be clean, and all of the parts and tools should be available.
- Check the installation of the grips.
- A copy of the operating manual should be close by.

2. Turn on the System

- Turn on the power to the Instron console and load frame, the computer, the computer's monitor and the printer.
- Allow the system to warm up for at least 30 minutes in order to ensure accurate readings.

3. Calibrate the System

The testing machine must be calibrated before testing the first specimen. The following procedure calibrates the load cell and defines the starting position of the crosshead.

- The grips, but not the specimen, should already be installed.
- Press "IEEE" on the Instron's control panel to disable off computer control. The red "IEEE" LED should turn off.
- Press "Load Cal" on the Instron's control panel. The red "Load Cal" LED should come on. When the load calibration is complete the number "50.00" should be displayed in the console's main readout. This mean's the system has found a 50 kN load cell.
- Press ENTER on the Instron's console. The red "Load Cal" LED should turn off.
- Install a specimen in the upper grip. If you are testing cylindrical specimen (method 46) you should also attach the lower grip to the specimen, but this grip should hang free.
- Using the Instron's jog controls on the load frame move the crosshead so that the free end of the specimen is positioned in the lower grip.
- Press "G.L. Reset" on the Instron's control panel. The red "At G.L." LED should turn on and the LCD display of extension should display ".00". (This step causes the console to record the current position of the crosshead. This position will be used in measuring displacement during your tests. G.L. refers to the gage length of the specimen.)
- Press "IEEE" on the Instron's console to re-enable computer control. The red "IEEE" LED should turn on.
- Tighten the lower grip.

4. Set the Crosshead Travel Limit Switches
The crosshead travel limit switches provide an important safety function which protects both the operator and the machine.

- With the crosshead in the "AT G.L." position set the lower crosshead travel limit to approximately 2-5 millimeters below its current position.
- Set the upper crosshead travel limit switch so that adequate extension of the specimen is possible but also so that the crosshead can not strike any other part of the system.
- Note that if either of the crosshead travel limit switches are ever tripped then the Instron may have to be turned off to reset them. This would also necessitate repeating the calibration procedure.

5. Specimen Installation
Use the following procedure when testing flat tensile specimens (method 45).

- Measure and record the length, width and thickness of the gage section of the specimen.
- Make sure that the grips are installed correctly and are empty.
- Disable computer control by pressing "IEEE" on the Instron's console. The red "IEEE" LED should go off.
- Press "Return" to move the crosshead to its starting position.
- Load the specimen into the upper grip and then in the lower grip. Make sure the specimen is straight. The easiest way to do this is to align it with the back edge of the grips. Also, make sure the grips are really tight. The specimen will get loose during a test but it should not get loose enough to slip.
- If tightening the grips creates a load on the specimen use the jog controls to carefully move the crosshead to relieve most of the load. Ideally, the load will be zero, but if this is not possible then a slight positive load is better than a slight negative load.
- If you had to use the "Jog" controls to move the crosshead then you must press the "G.L. Reset" button to reset the starting position for the computer.
- Re-enable computer control by again pressing "IEEE" on the Instron's console. The red "IEEE" LED should turn on.

Use the following procedure when testing cylindrical tensile specimens (method 46).

- Measure and record the length, width and thickness of the gage section of the specimen.
- Disable computer control by pressing "IEEE" on the Instron's console. The red "IEEE" LED should go off.
- Use the "Jog" controls to raise the crosshead to make room for the specimen and grips.
- Install the upper grip and screw in the specimen until the shoulder is flush with the end of the grip.
- Screw the lower grip until its end is nearly flush with the shoulder of the specimen and so that the holes will line up with the holes in the flange.
- Use the "Jog" control to carefully lower the lower grip into the flange until the holes line up. Insert the pin.
- Use the "Jog" control to carefully raise the crosshead to take the slack out of the grips. Ideally, the load will be zero, but if this is not possible then a slight positive load is better than a slight negative load.

- Re-enable computer control by again pressing "IEEE" on the Instron's console. The red "IEEE" LED should turn on.

6. Start the Testing Program

Start the testing software, log on and set up the test you will perform.

- Double-click the "Instron Series IX" icon to start the software.
- Log on as user "ENG-45" using the password "ENG-45".
- Click the "Test" button to start the test procedure.
- A dialog box will appear asking you to specify a sample name. With this software the sample name and file name are the same. (The file should have an MRD (Merlin Raw Data) extension.)
- Review the data on the next form that appears. Check the sample name (file name), enter your name as the operator, make sure the test mode is "Tensile" and make sure either method 45 or 46 are selected. When done, click the "OK" button.
- At this point the "Test a Sample" screen will appear.

7. Start the Test

To start the test you must first enter the specimen dimensions and then start the test.

- Select "Start Test" from the menu at the top of the screen.
- A dialog box will appear and allow you to enter the specimen's dimensions.
- Enter the specimen's length and its width and thickness if you are testing a rectangular specimen (Method 45) or its diameter it you are testing a cylindrical specimen (Method 46).
- Click the "OK" button when done.
- A warning message box with text saying "The test will now start. The crosshead will move." will appear. Click the "OK" button to start the test.

8. During the Test

- During the test the load-displacement data will be plotted on the screen and the load and extension values will be displayed at the top of the screen.
- If you wish to stop the test at any point simply click the "Stop Test" menu item.
- The test will automatically terminate after the specimen fractures.

9. Conclude the Test

When the test is complete you will need to finish up the testing program and save and/or print the report.

- Select "End Sample" when the test is done.
- Enter a comment (optional).
- Save and/or print a copy of the report for your own records. You can even print copies for everyone in your group.
- A message box will appear, asking you if you want to test another sample. Click the "No" button to return to the home screen.
- If the specimen did not fracture you should carefully tap the "jog down" button on the load frame to remove the load from the specimen before opening the grips.
- Open the grips and remove your specimen (method 45) or remove the pin to the lower grip, raise the crosshead, unscrew the lower grip from the specimen and then unscrew the specimen from the top grip (method 46).

10. Plot the Results

You will need a copy of the load-displacement curve or stress-strain curve so that you can determine the material's basic tensile properties. To plot the results of any test whose data had been saved to disk:

- Click the "Graph" button on the home screen.
- Enter the sample name (file name) and click the "OK" button.
- A blank graph will be displayed. Select *File:Basic Graph* from the menu to refresh the graph.
- The initial graph is auto scaled. If you want to change the type of graph or scaling select *Parameters...* from the menu and change the graph setting to suit your needs. When done, select *File:Basic Graph* again to refresh the graph.
- To print the graph select *file:print plot* from the main menu.

11. Create an ASCII File of the Results (optional)

If you save the test results to a diskette you will be able to take the data with you to another machine where you can perform further analysis of the data. To create the ASCII file:

- Click the "Utilities" button on the home screen.
- Enter the sample name (file name) or press function key F2 to get a list of files.
- A DOS-style screen displaying a summary of the header from the data file will appear. (The mouse can still be used.)
- Select *File:Create ASCII File* from the menu.
- Specify the numerical precision and the type of data (header, data or both) to export. (We recommend exporting the header and the data.) Press the function key F2 to display available options.
- Press function key F10 to create the ASCII file. The exported file will have the extension MAD (Merlin ASCII Data).
- The file's extension, "MAD", can create problems in the Windows environment since MAD is also used to denote Microsoft Access Data files. It is a good idea to rename the file using a PRN or TXT extension.

12. Shut Down the System

- Exit from the testing program by click in the "Exit" button on the home screen. This will return you to Windows.
- Shut down Windows.
- Turn off the computer, the computer's monitor, the printer and the Instron.
- Return all tools and other parts to their proper place.
- Collect up all of your specimens and parts of specimens.
- Leave the equipment clean and tidy for the next person.

Sample Instron data file with the header and first 10 data points

```
    Sample id : ALUMINUM                  Test date :  30 Dec 1994
      Version : 1.08                    Version date :  30 May 1991
      Machine :  4200                     Robot used :  NO
 Report file# : 45                          Operator : Mike Meier

 X conversion :   .03937008             X A/D offset :          .0000
 Y conversion : ***********             Y A/D offset :          .0000

  Sample rate :        5.00             Extensometer : STD
2nd Sample rate :   1.00
    A/D range :   0                        Autostart : OFF
   Calib type : AUTOMATIC                   Geometry : RECTANGULAR
   Calib load :   11240.4500            Calib extens :        .0000
  Temperature :  25                         Humidity : 50
  Xhead speed :     .1000                 Units type : SI
    Test type : TENSILE                  # specimens :   1
     Bar type : E-45                     Entry dimens : YES
  Break check :    10.00000             Thresh delay :     4.49618
   Load limit : 11240.45000             Extens limit :      .98425

 Sample dimensions :
 A:      .2500   B:      .0559   C:     1.0000   D:  1.0000   E: NO
-------------------------------------------------------------------------
    Specimen # :     1                  Test end status :   10
 Maximum load :    414.305              Max load point #  :        235
   Max extens :       .140              Max extens pnt #  :        420
         | 2nd. Speed | Extn. Remv | Relx  Strt | Range  Chg  |
 Point #          ---          ---          ---          ---
 Number of points :   420
 Specimen dimensions :
A:    .2500000 B:    .0559055 C:   1.0000000 D:   1.0000000 E: NO
 Transverse gauge: ---------
 Auxiliary Specimen Inputs:
******* ******* ******* ******* ******* ******* ******* ******* *******
 Auxiliary Sample Inputs:
******* ******* ******* ******* ******* ******* ******* ******* *******

 Calculations from Instron:
   |----------- Maximum ------------|------------ Break -------------|
   |Load        Displ.     Strain   |Load        Displ.     Strain   |
    414.32     .84252E-01********** ********** ********** **********
   |----------- Peak 1 ------------|
   |Load       Displ.     Strain   |
   ********** ********** **********
-------------------------------------------------------------------------

     1,     .000060,      .000000
     2,     .000390,      .000000
     3,     .000720,      .000000
     4,     .001140,      .000000
     5,     .001470,      .000000
     6,     .001720,      .000000
     7,     .002050,      .000000
     8,     .002470,      .000000
     9,     .002720,      .000000
```