Mechanical Laboratory 2

Lab 4: Charpy Impact Testing

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MMAE-419-L01

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EXPERIMENTAL SETUP AND PROCEDURE:

Two materials, 1018HR carbon steel and 1045HR carbon steel, were tested to find DBTT (ductile to brittle transition temperature) and FATT (fracture appearance transition temperature) of each. Specimens of both metals had dimension of 10mm x 10mm x 55mm with 45° and 2mm deep notch in the middle (Figure 1). Samples were tested at different temperatures, while cold, hot and at room temperature. First step was to prepare samples that were to be tested meaning hot specimens were heated in furnace, while cold were cooled down with use of dry ice. Temperature of each sample was tracked with thermocouple that was connected to multimeter. When specimens were ready and on desired temperature, Charpy machine (Figure 2) was loaded and scale that read energy was reset. Student than place specimen, that is either hot, cold or at room temperature, in Charpy machine by using tongs. When it is assured that sample is placed property (Figure 3) than student hit release knob and pendulum hummer hits sample. Sample is than collected and fracture surface is examined, visually and with use of microscope to determine how dull or reflective fracture surfaces are.

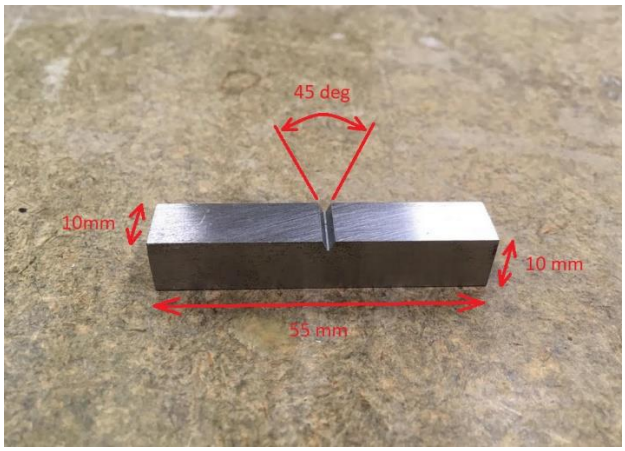

Figure 1. Specimen Dimensions

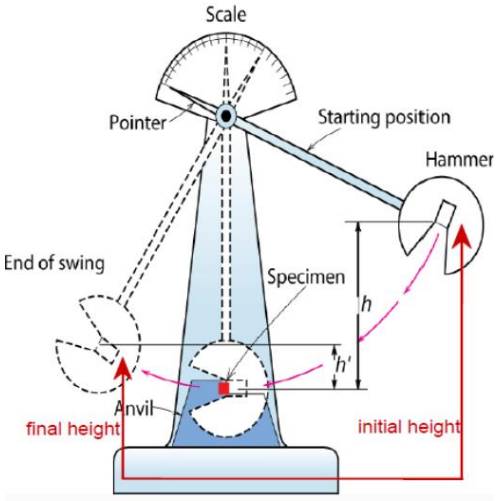

Figure 2. Charpy Impact Testing Setup

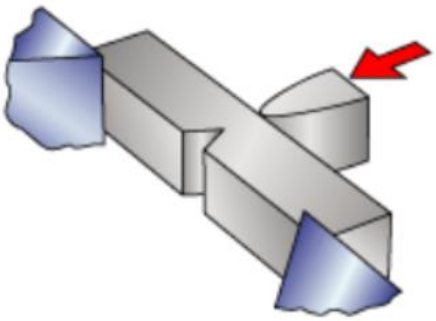

Figure 3. Position of the Specimen

Figure 4. Tested samples fracture surfaces

ANALYSIS OF DATA:

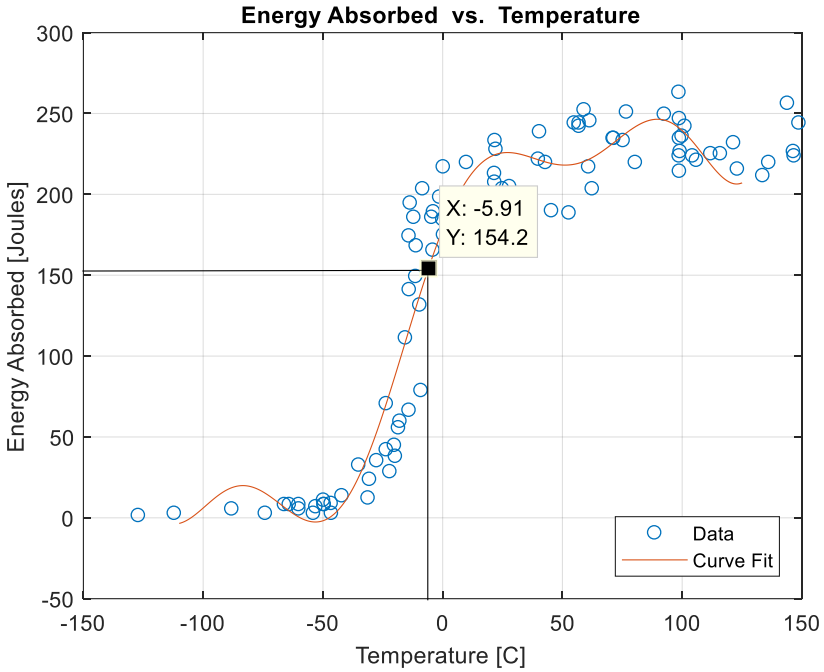

Figure 5. Charpy impact energy vs. test temperature for 1018HR carbon steel

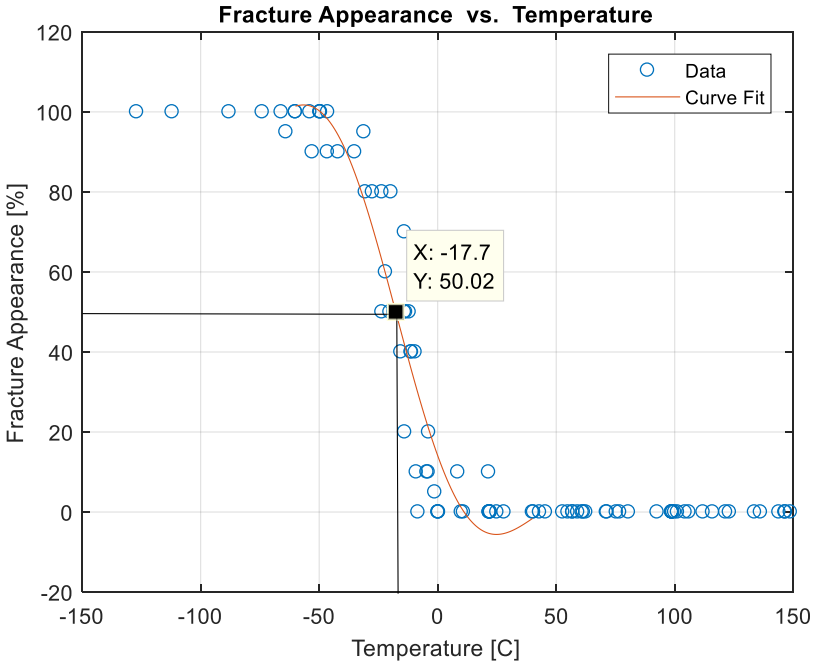

Figure 6. Fracture appearance vs. test temperature for 1018HR carbon steel

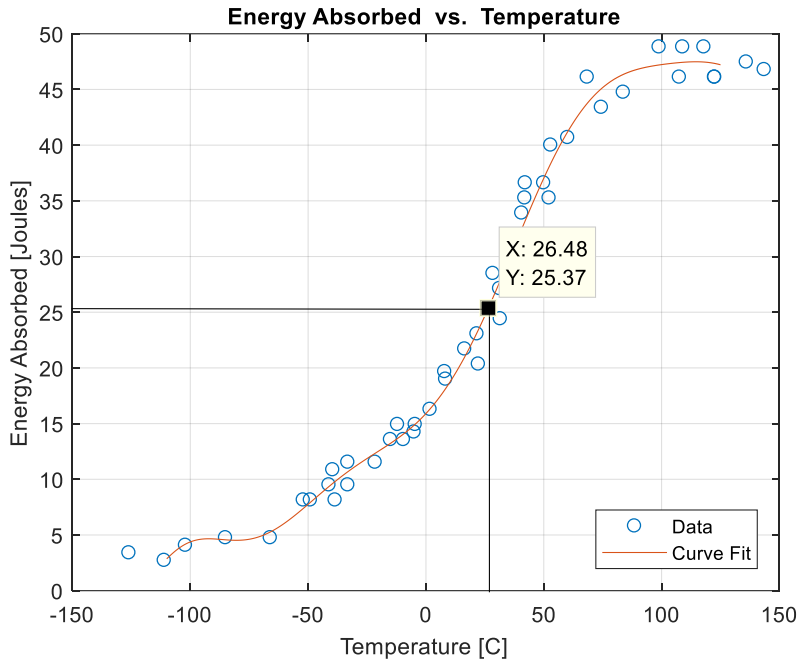

Figure 7. Charpy impact energy vs. test temperature for 1045HR carbon steel

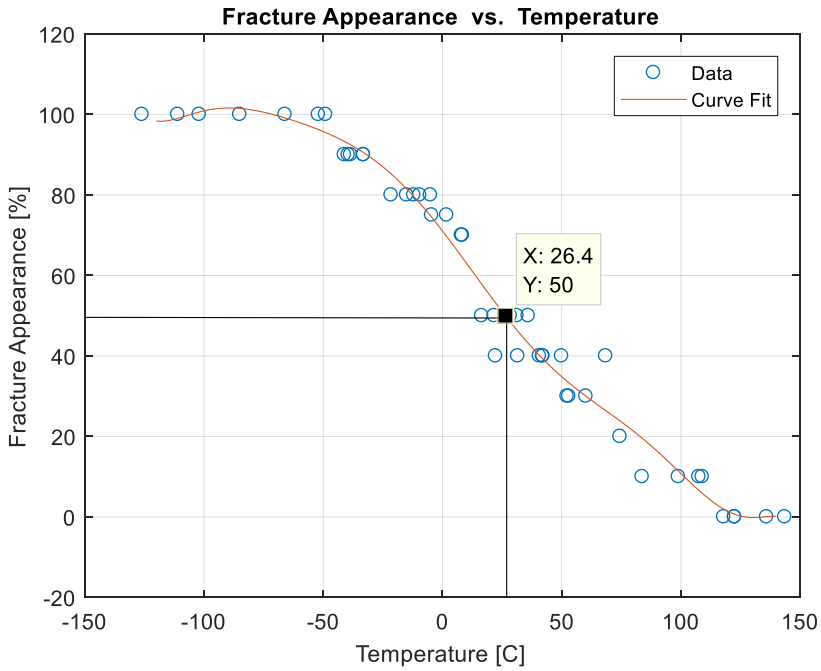

Figure 8. Fracture appearance vs. test temperature for 1018HR carbon steel

Table 1. Ductile Brittle vs. Fracture Appearance Transition Temperatures

MATERIAL	DBTT [°C]	FATT [°C]
1018HR carbon steel	-5.91	-17.7
1018HR carbon steel	25.37	26.40

For 1018HR carbon steel first values of energy absorbed vs. test temperature was plotted using MATLAB and then fitted curve through (Figure 5). Similarly, for 1045HR carbon steel values of energy absorbed vs. test temperature was plotted (Figure 7). Ductile-to-brittle transition temperature was found by first finding average value of energy (from upper shelf to lower shelf), and corresponding temperature is our DBTT for both materials (Table 1). Average values of energy for 1018HR carbon steel and for 1018HR carbon steel were found to be 154.2[J] and 25.37[J] respectively. Values of fracture appearance vs. test temperatures were plotted using MATLAB and then curve was fitted trough data points for both metals (Figures 6 and 8). Temperature that correspond to 50% fracture appearance was recorded and that is our FATT (fracture appearance transition temperature). Fracture method is much less accurate because it is more relaying on visual approximation. Temperatures below transition temperature will limit materials ability to deform and absorb impact without fracturing. Transition temperature tells us what is minimum temperature for material before it becomes brittle.

REFERENCES:

Mechanical Behavior of Materials 4th Ed. by Norman E. Dowling (Pearson, 2013 ISBN 0-13-139506-8)

Dr. Murat Vural, MMAE 419 Impact Testing Handout, IIT, Chicago