Name: Cherie Francis

Table of Contents

HW4: MTS Lab

This script was created to characterize and calculate material properties of flat dog-bone samples of steel, copper, brass and aluminium. Different graphs will also be plotted to aid in this characterization.

```
clear all;
close all;
clc;
```

Initialising Variables

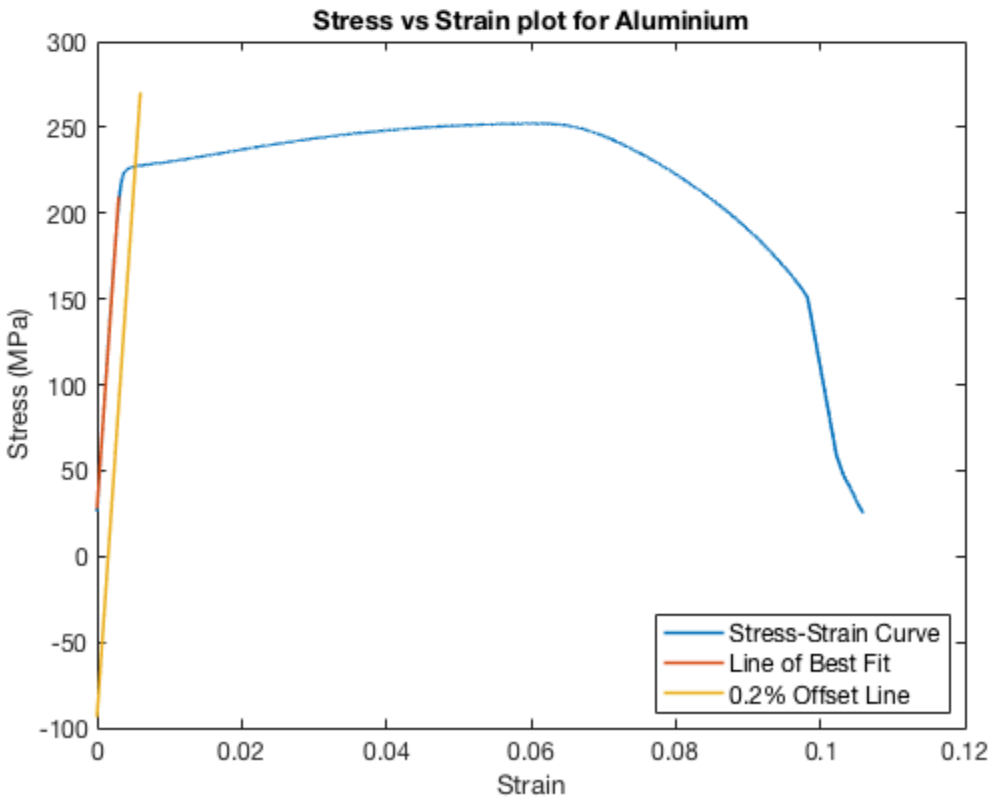
```
width = 6.35;                                   % mm
thick = 1.5875;                                 % mm
gage_length = 25;                               % mm
area = width * thick;                           % mm^2
```

Aluminium

Importing and Reading Data for Aluminium

```
filename = 'Aluminum.xlsx';
sheet = 1;
range = 'A4:D5365';

% Organising data for Aluminium into Arrays
Al_data = xlsread(filename, sheet, range);
Al_cross = Al_data(:,1);                        % mm
Al_load = Al_data(:,2);                         % kN
Al_time = Al_data(:,3);                         % s
Al_exten = Al_data(:,4);                        % mm

% Graph Plotting for Aluminium
[Al_stress,Al_strain] = str(Al_load, area, Al_exten, gage_length);
xsmooth = linspace(0,0.003,100);
```

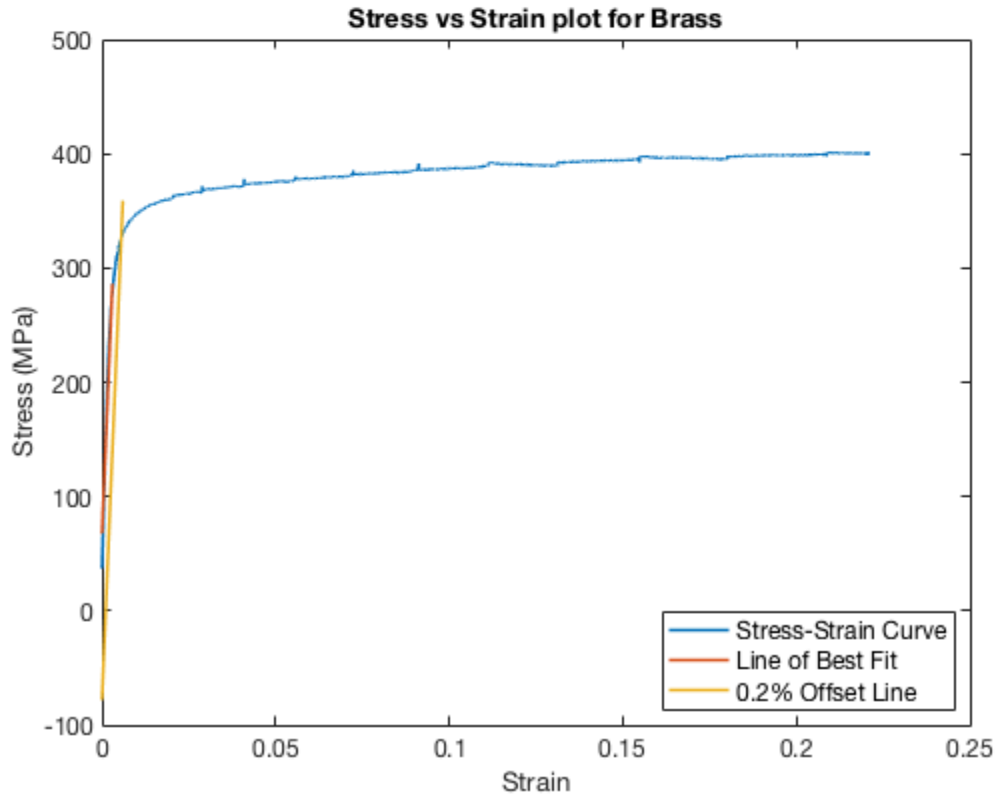
```
pal = polyfit(Al_strain(1:389),Al_stress(1:389),1);
al_fit = polyval(pal, xsmooth);

% To obtain 0.002 elongation
xsmooth2 = linspace(0,0.006,100);
pal2 = polyfit(Al_strain(1:389)+0.002,Al_stress(1:389),1);
al_fit2 = polyval(pal2, xsmooth2);

figure();
plot(Al_strain,Al_stress,'LineWidth', 1.5);
hold on;
plot(xsmooth, al_fit, 'LineWidth',1.5);
plot(xsmooth2, al_fit2,'LineWidth',1.5);
title('Stress vs Strain plot for Aluminium','FontSize',16);
xlabel('Strain','FontSize',14);
ylabel('Stress (MPa)','FontSize',14);
legend({'Stress-Strain Curve','Line of Best Fit','0.2% Offset
 Line'},'FontSize',12,'Location','southeast');
set(gca,'FontSize',12);

% Finding Modulus, UTS and Elongation at Break
[al_uts,al_break,al_mod] = maxstr(Al_stress,Al_strain,pal)
```



Brass

Importing and Reading Data for Brass

```
filename1 = 'Brass.xlsx';
range1 = 'A4:D13429';

% Organising data for Brass into Arrays
Br_data = xlsread(filename1, sheet, range1);
Br_cross = Br_data(:,1);                              % mm
Br_load = Br_data(:,2);                               % kN
Br_time = Br_data(:,3);                               % s
Br_exten = Br_data(:,4);                              % mm

% Graph Plotting for Brass
[Br_stress,Br_strain] = str(Br_load, area, Br_exten, gage_length);
pbr = polyfit(Br_strain(1:462),Br_stress(1:462),1);
br_fit = polyval(pbr,xsmooth);

% To obtain 0.002 elongation
pbr2 = polyfit(Br_strain(1:462)+0.002,Br_stress(1:462),1);
br_fit2 = polyval(pbr2, xsmooth2);

figure();
plot(Br_strain,Br_stress,'LineWidth', 1.5);
hold on;
plot(xsmooth, br_fit, 'LineWidth',1.5);
plot(xsmooth2, br_fit2,'LineWidth',1.5);
title('Stress vs Strain plot for Brass','FontSize',16);
xlabel('Strain','FontSize',14);
ylabel('Stress (MPa)','FontSize',14);
legend({'Stress-Strain Curve','Line of Best Fit','0.2% Offset
 Line'},'FontSize',12,'Location','southeast');
set(gca,'FontSize',12);

% Finding Modulus, UTS and Elongation at Break
[br_uts,br_break, br_mod] = maxstr(Br_stress,Br_strain,pbr)


br_uts =

  401.6491


br_break =

    0.2208


br_mod =

   72.8557
```



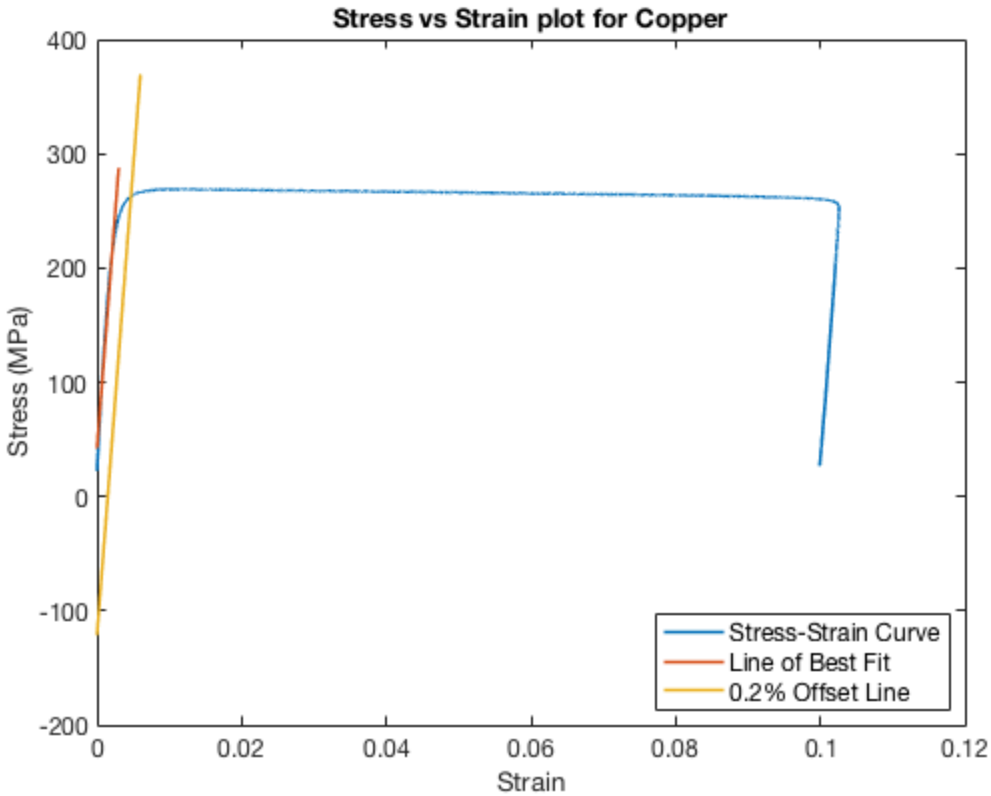
Copper

Importing and Reading Data for Copper

```
filename2 = 'Copper.xlsx';
range2 = 'A4:D8171';

% Organising data for Copper into Arrays
Cu_data = xlsread(filename2, sheet, range2);
Cu_cross = Cu_data(:,1);                              % mm
Cu_load = Cu_data(:,2);                               % kN
Cu_time = Cu_data(:,3);                               % s
Cu_exten = Cu_data(:,4);                              % mm

% Graph Plotting for Copper
[Cu_stress, Cu_strain] = str(Cu_load, area, Cu_exten, gage_length);
pcu = polyfit(Cu_strain(1:400),Cu_stress(1:400),1);
cu_fit = polyval(pcu,xsmooth);

% To obtain 0.002 elongation
pcu2 = polyfit(Cu_strain(1:400)+0.002,Cu_stress(1:400),1);
cu_fit2 = polyval(pcu2,xsmooth2);

figure();
plot(Cu_strain,Cu_stress,'LineWidth', 1.5);
hold on;
```

```
plot(xsmooth,cu_fit,'LineWidth',1.5);
plot(xsmooth2,cu_fit2,'LineWidth',1.5);
title('Stress vs Strain plot for Copper','FontSize',16);
xlabel('Strain','FontSize',14);
ylabel('Stress (MPa)','FontSize',14);
legend({'Stress-Strain Curve','Line of Best Fit','0.2% Offset
 Line'},'FontSize',12,'Location','southeast');
set(gca,'FontSize',12);

% Finding Modulus, UTS and Elongation at Break
[cu_uts,cu_break,cu_mod] = maxstr(Cu_stress,Cu_strain,pcu)
```

```
cu_uts =

  268.8778


cu_break =

    0.0999


cu_mod =

   81.8555
```



Steel

Importing and Reading Data for Steel

```
filename3 = 'Steel.xlsx';
range3 = 'A4:D4610';

% Organising data for Steel into Arrays
St_data = xlsread(filename3, sheet, range3);
St_cross = St_data(:,1);                        % mm
St_load = St_data(:,2);                         % kN
St_time = St_data(:,3);                         % s
St_exten = St_data(:,4);                        % mm

% Graph Plotting for Steel
[St_stress,St_strain] = str(St_load, area, St_exten, gage_length);
pst = polyfit(St_strain(1:135),St_stress(1:135),1);
st_fit = polyval(pst,xsmooth);

% To obtain 0.002 elongation
pst2 = polyfit(St_strain(1:135)+0.002,St_stress(1:135),1);
st_fit2 = polyval(pst2,xsmooth2);

figure();
plot(St_strain,St_stress,'LineWidth', 1.5);
hold on;
```

```
plot(xsmooth, st_fit, 'LineWidth',1.5);
plot(xsmooth2, st_fit2,'LineWidth',1.5);
title('Stress vs Strain plot for Steel','FontSize',16);
xlabel('Strain','FontSize',14);
ylabel('Stress (MPa)','FontSize',14);
legend({'Stress-Strain Curve','Line of Best Fit','0.2% Offset
 Line'},'FontSize',12,'Location','southeast');
set(gca,'FontSize',12);

% Finding Modulus, UTS and Elongation at Break
[st_uts,st_break,st_mod] = maxstr(St_stress,St_strain,pst)
% These values won't display but they're shown in the attached
 document
```

Functions

Definition of function designed to find stress and strain values for each material

```
function [stress, strain] = str(load, area, exten, gage_length)
    stress = (load ./ area) .* 1000;            % MPa
    strain = exten ./ gage_length;              % no units
end

% Function to find modulus, ultimate tensile strength and elongation
% at break for each material
function[max_stress,end_strain,mod] = maxstr(stress, strain,p)
    max_stress = max(stress);                   % MPa
    end_strain = strain(end);
    mod = p(1)/1000;                            % GPa
end
```

```
al_uts =

  252.2483


al_break =

    0.1059


al_mod =

   60.7056
```

Published with MATLAB® R2020a

Name: Cherie Francis
Assignment: MTS Lab

Q1. The machine is used to stretch specimens placed within the upper and lower grips until they break, i.e., until they reach material failure. For operation, one must first reset interlocks. To do this, grip controls should be in the neutral position in the control pad and the hydraulic pump, turned on. Afterwards, adjust the space between the upper and lower crossheads on the machine appropriately using the specimen. The software can then be run, and the upper and lower grips will stretch the specimen until it breaks.

Results for questions 3-6

Material	Modulus, E (GPa)	Yield Stress (MPa)	Ultimate Tensile Stress, UTS (MPa)	Elongation at Break
Aluminium	60.7056	226	252.2483	0.1059
Brass	72.8577	325	401.6491	0.2208
Copper	81.8555	261	268.8778	0.0999
Steel	125.1573	333	356.3647	0.2224

Q7. The larger a material's modulus of elasticity, E, the stiffer the material, or the more resistance it has to being deformed by applied loads. From the results achieved, it can be inferred that steel is the stiffest material, followed by copper then brass, and aluminium has the least resistance to applied loads, therefore it's deformed more easily under applied loads.

This helps us to understand why the yield stress for each material is ranked a similar order. The material with the highest modulus has the highest yield stress because it was able to withstand a greater load than the other materials before it's unable to return to its original dimensions after being stretched. The opposite goes for the material with the lowest yield stress, aluminium. However, brass has a higher yield stress than copper, but a lower modulus. This result might be due to the range of points on the stress-strain curves for brass and copper, where the line of best fit was taken.

For the ultimate tensile stress however, brass had the highest, followed by steel, copper then aluminium. Since brass had the highest UTS, this means that it could withstand the maximum amount of stress before failure, while aluminium withstood the lowest, although the UTS for copper was relatively close in value to it. Brass' UTS was intermediate compared with the other materials. This implies that copper and aluminium withstood the least amount of stress in comparison to brass and steel, which are the two alloys in this sample.

As for the elongation at break, which is the final strain of each material before they break into two, steel possessed the highest value, followed by brass, aluminium then copper. In this case, final strain for the two alloys were very close, as well as the values found for copper and aluminium. The elongation at break of brass and steel differed by 0.0016, while that of aluminium and copper differed by 0.006. From the results obtained, it was be concluded that brass and steel withstand deformation more than copper and aluminium without breaking.