

Measuring Strain

Theoretical Reference

Upon the application of a transverse load upon the cantilever, the upper portion of the beam undergoes tensile strain while the lower part undergoes a compressive strain.

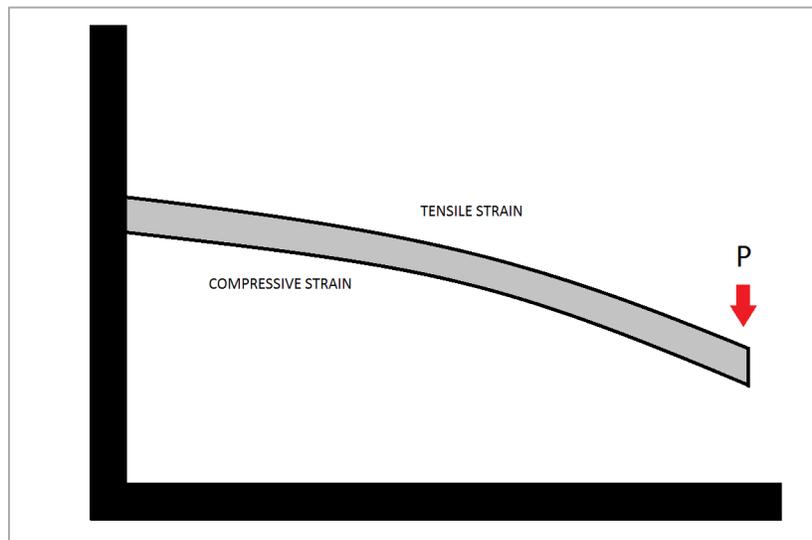


Figure: Deformation of cantilever under load

This means that the upper portion of the beam attains a length greater than the initial beam length while the lower portion has a lesser length than the initial beam length.

These strains are produced as a result of the application of bending moment on the cross-section of the beam.



Figure: A small section of the beam before and after bending moment is applied

The strains so produced can be calculated by using the bending moment formula.

$$\frac{M}{I} = \frac{\sigma_{max}}{y_{max}} = \frac{E}{R}$$

Where,

M = applied bending moment at the cross-section

I = Area moment of inertia of the cross-section

σ_{max} = Maximum stress in the cross section due to bending moment

y_{max} = Maximum distance from the neutral axis

E = Young's modulus

R = Radius of curvature of the bending arc

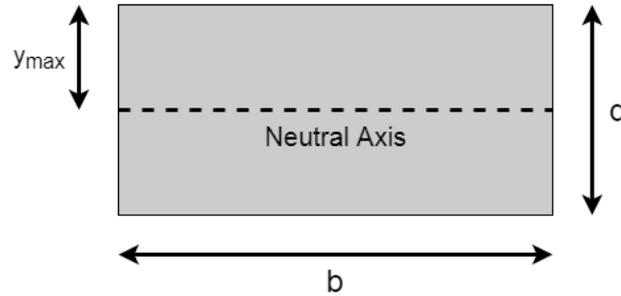


Figure: Cross-section of the beam

The bending moment acts along the neutral axis. The magnitude of bending moment on any cross-section in the cantilever at distance of x mm from the point of concentrated load application is given by:

$$BM = P \cdot x$$

Where,

P = Magnitude of applied load

X = distance of point of load application from the point of scrutiny

Hence, the bending strain at any point on the cantilever is given by:

$$\frac{Px}{EI} = \frac{\sigma_{max}}{E y_{max}}$$

Hence,

$$\frac{Px}{EI} \times \frac{d}{2} = \epsilon$$

Where,

ϵ = Strain

d = thickness (refer to above figure)

Hence the bending strain at the top/bottom surface of the beam is:

$$\epsilon = 6 \times \frac{Px}{Ebd^2}$$

Compose Implementation

We are using the bending strain (ϵ) equation, to calculate the strain value and the same is written in oml language for this we must just initialize some variable and constants as follows:

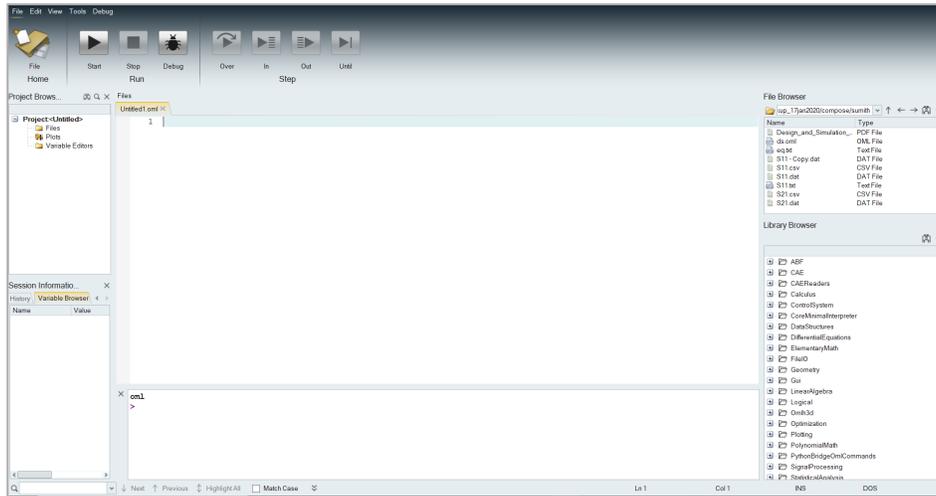
```
% To calculate the strain value
clc;close all;clear all;
p = input('enter the magnitude of applied load = ');%enter the value in
grams
x = 0.26;% The position of strain gauge from the point of load
E = 193*10^9; % Young's modulus
b = 0.036; % beam width(m)
d = 0.001; % thickness of beam(m)

p1 = (p*9.8)/1000; % p value will be in grams, to convert to newton
multiply by 9.8/1000
strain = 6*((p1*x)/(E*b*d^2))
```

Step 1: Launch Compose



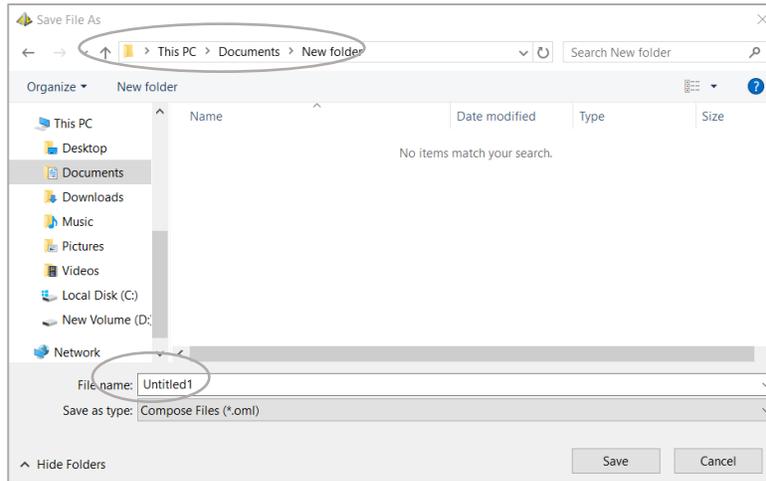
Double click on the icon. This launches the Altair Compose MATH GUI in the Authoring Mode and by default a file named Untitled1.oml exists in the Editor Window.



Step 2: Save File and Enter the Basic Commands



1. "Save file" by selecting single folder icon as shown. . Select the location where the file as to be saved.



2. Type “clc”, “close all” and “clear all” in the editor window to close all plots opened, clear all variables, and remove previous command.

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

Step 3: Initialize Variable

Load value has to be entered by the user. The position of the strain gauge from the point of load, Young's modulus, beam width and the thickness of beam value are constant.

```
p = input('enter the magnitude of applied load = '); %enter the value in grams
x = 0.152;% The position of strain gauge from the point of load
E = 193*10^9; % Young's modulus
b = 36*10^-3; % beam width(m)
d = 1*10^-3; % thickness of beam(m)
```

Step 4: Strain (ϵ) equation

The load value entered by the user will be in grams, multiply that value by 9.8/1000 to convert the value to newton.

```
p1 = (p*9.8)/1000; % p value will be in grams, to convert to newton multiply by 9.8/1000
strain = 6*((p1*x)/(E*b*d^2))
```

Step 5: Run File



Run the file by clicking on the start button in the Editor toolbar

Result

Enter the applied load value as 31.8 and press enter, this gives the strain value

```
> enter the magnitude of applied load = 31.8  
strain = 4.0906114e-05
```