Stress & Shear MATLAB Learning Tool

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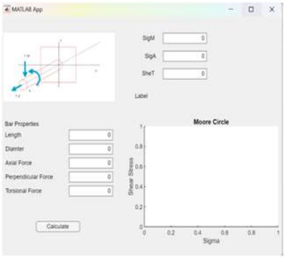
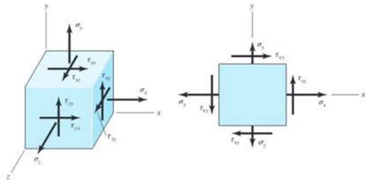
Abstract

This study introduces a MATLAB-based learning tool to enhance engineering students' understanding of stress and shear forces in cantilever cylindrical beams. Utilizing graphical methods, including Mohr's Circle, the tool allows users to input beam parameters, triggering calculations for axial stress, bending moment, and shear stress. While successful, potential enhancements such as unit flexibility and support for different beam types are identified, offering valuable insights for further development.



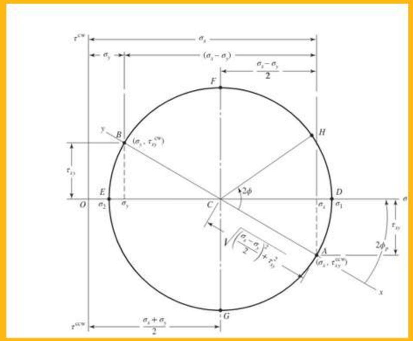
Stress & Shear

Stress and shear are fundamental mechanical concepts representing internal forces within structural elements. Stresses are perpendicular to the face of the stress element we are observing while shear stresses are parallel to the face of the stress element



Mohr's Circle

Mohr's Circle is a graphical representation used to analyze and visualize stress components acting on a material at different orientations. It aids engineers in understanding normal and shear stresses and is valuable for identifying principal stresses and maximum shear stresses. By providing a clear visual representation, Mohr's Circle enhances the interpretation of complex stress states and assists in making informed decisions in structural analysis and design.

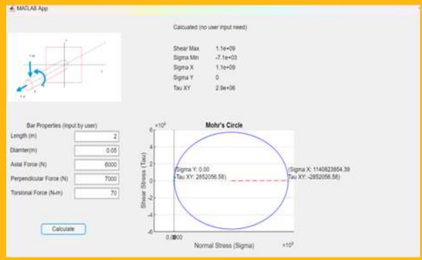


MATLAB APP CODE

```
function Calculations(app)
    %General Stress Calcs
    c = app.D/2;
    I = (pi/64)*app.D^4;
    A = (pi*app.D^4)/4;
    J = (pi/32)*app.D^4;
    app.SigM = ((app.FM*app.L)*c/I);
    app.SigA = (app.FA/A)/(10^6);
    app.ShearT = (app.T*(app.D/2)/J);
    app.SigX = (app.SigA+ app.SigM);
    app.SigY = 0;

    % Moores Circle Calcs
    app.Center = (app.SigX + app.SigY) / 2;
    app.Rad = sqrt(((app.SigX - app.SigY) / 2)^2 + app.ShearT^2);

    % Plot Moores Circle
    theta = 0:0.01:2*pi;
    sigmaX = app.Center + app.Rad * cos(theta);
    tau = app.Rad * sin(theta);

    % Plot Mohr's Circle
    plot(app.UIAxes, sigmaX, tau, 'b'); % Plot Mohr's Circle
    title(app.UIAxes, 'Mohr''s Circle');
```

```
% Plot Moores Circle
theta = 0:0.01:2*pi;
sigmaX = app.Center + app.Rad * cos(theta);
tau = app.Rad * sin(theta);

% Plot Mohr's Circle
plot(app.UIAxes, sigmaX, tau, 'b'); % Plot Mohr's Circle
title(app.UIAxes, 'Mohr''s Circle');
xlabel(app.UIAxes, 'Normal Stress (Sigma)');
ylabel(app.UIAxes, 'Shear Stress (Tau)');
grid(app.UIAxes, 'on');

% Plot calculated stress and shear point
hold(app.UIAxes, 'on');  % Allow multiple plots on the same axes
plot(app.UIAxes, app.SigY, app.ShearT, 'go', 'MarkerSize', 4);  % Green circle marker
plot(app.UIAxes, app.SigX, (-1*app.ShearT), 'go', 'MarkerSize', 4);  % Green circle marker
```

Results



Further Direction

Unit Flexibility: Users can seamlessly choose metric and imperial units for personalized calculations.

Versatile Support: Introducing support for various beam types and customization of supports, such as fixed and roller end supports, enhances the application's adaptability for a more comprehensive exploration of stress and shear forces in structural engineering.

References

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Moebs, William, et al. "12.3 Stress, Strain, and Elastic Modulus - University Physics Volume 1." *OpenStax*, OpenStax, openstax.org/books/university-physics-volume-1/pages/12-3-stress-strain-and-elastic-modulus. Accessed 1 Apr. 2023.

Mohr's Circle - Illinois Institute of Technology, web.iit.edu/sites/web/files/departments/academic-affairs/Academic%20Resource%20Center/pdfs/Mohr_Circle.pdf. Accessed 1 Dec. 2023.

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