SwiftCalcs

Randall Briggs

Brentan Alexander • 2nd

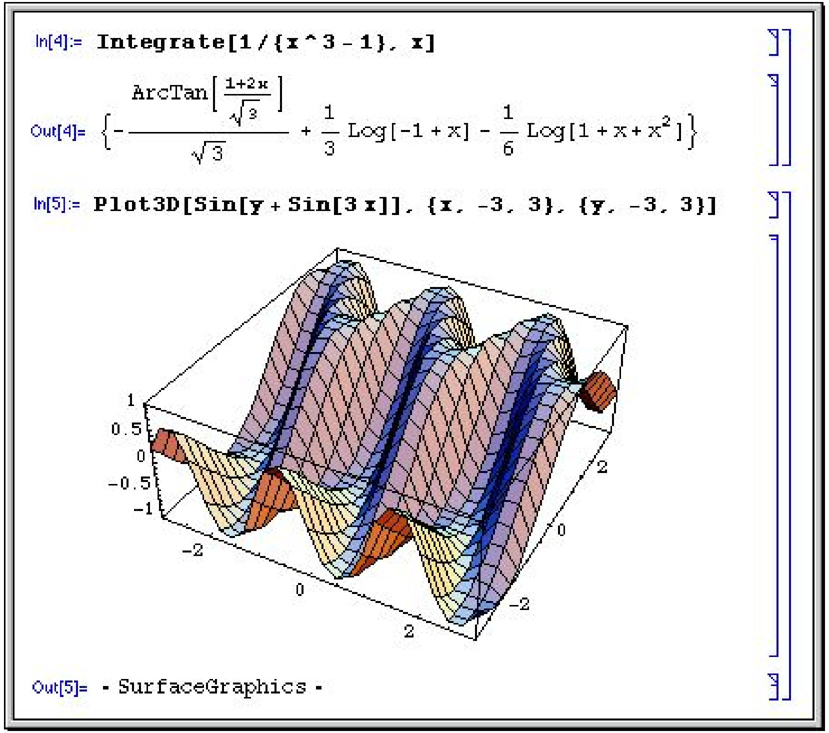
Chief Science Officer at New Energy Risk

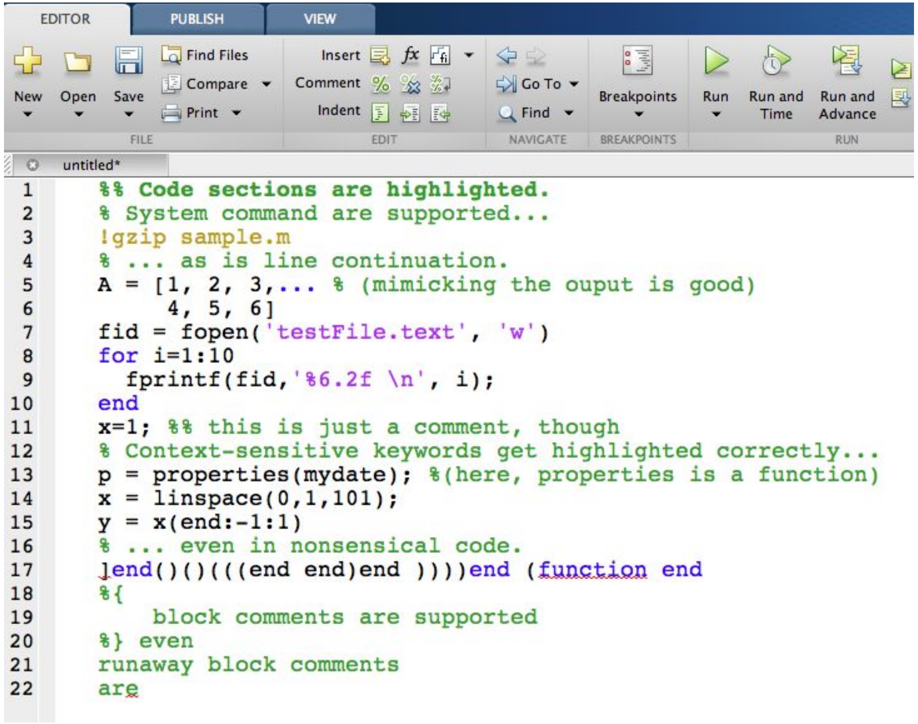
New Energy Risk • Stanford University

San Francisco Bay Area • 393

Wolfram Mathematica

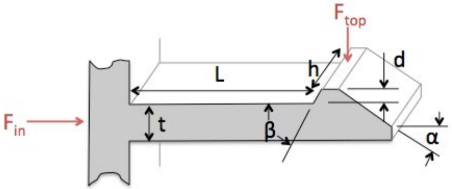
MATLAB





SWIFT CALCS

To determine the appropriate thickness for this feature, we first start with inputs that define other aspects of the geometry and the material of choice:



We are seeking to solve for the beam thickness *t* based on the other known variables.

Inputs

1 $L \equiv$ 10.5 mm

2 $d \equiv$ 490 μm

3 $h \equiv$ 9 mm

For the angles of the entry plane, we have changed the unit to 'degrees' instead of radians:

4 $\alpha \equiv$ 43 deg

Our desired assembly force:

5 $F_{in} \equiv$ 60 N

Friction:

6 $\mu \equiv 0.41$

Maximum Allowable Strain for Nylon:

7 $\epsilon_{max} \equiv 10\%$

Modulus for Nylon:

8 $E \equiv 2{,}400$ MPa

Calculation

Our first step is to convert the push force into the deflection force. This is done using simple geometry and friction calculations:

9 $F_{top} \equiv F_{in} \cdot \frac{1 - \mu \cdot \tan(\alpha)}{\mu + \tan(\alpha)}$

→ 27.6 N

To calculate the strain, we need to know the deflection magnification factor *Q*. This factor is a function of the beam aspect ratio *L/t* and has a non-standard form. We will fit a curve to data from experiments to determine this factor as a function of the aspect ratio *r*. Note this data is for the case where the beam component is anchored in a mass of plastic much larger than itself, and it therefore is considered infinitely stiff:

10 $r \equiv [2 \ldots 11]$

11 $Q \equiv [\,1.6 \;\; 1.4 \;\; 1.3 \;\; 1.25 \;\; 1.22 \;\; 1.2 \;\; 1.185 \;\; 1.177 \;\; 1.173 \;\; 1.17\,]$

12 $Q_{fit}(x) \equiv$ regression $x_{data} \equiv r$

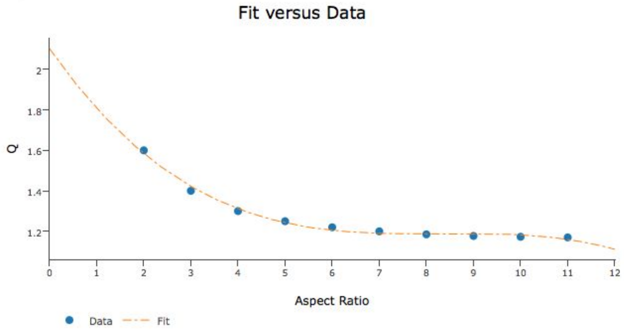
$y_{data} \equiv Q$

polynomial order 3

Polynomial Regression

→ $function(x) \Rightarrow -0.00161655012 \cdot x^3 + 0.04025 \cdot x^2 - 0.332784965 \cdot x + 2.10198485$

13 plot



Next we write the equation for strain at the beam base based on the known deformation:

14 $\epsilon_1(t) \equiv 1.5 \cdot \frac{t \cdot d}{L^2 \cdot Q_{fit}\left(\frac{L}{t}\right)}$

Finally, we can also relate strain at the beam base to our desired force:

15 $\epsilon_2(t) \equiv F_{top} \cdot \frac{6 \cdot L}{h \cdot t^2 \cdot E}$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