

Appendix A: Equilibrium Program for Single Strut – Symmetric Bar

Mathematica Code

Input and initial guesses for moment (gm) and shear force (gq):

(*Equilibrium, clamped buckled strut, $y_1=x, y_2=y, y_3=\theta, y_4=\text{moment}$, includes shear force q which is not zero; m in leftBC is moment at $s=0$, $p=p_0$ (larger than $39.48 = 4\pi^2$) This file has been revised to work in Mathematica 5

Can be used as single strut of two strut symmetric model*)

```
Clear[pi, gm, gq, m, q, po]
pi = N[ $\pi$ ];
po = 40;
gm = 2.04;
gq = -0.00001775;
```

Equilibrium equations and boundary conditions for $s=0$:

```
de[y3_, y4_, q_] := {y1'[t] = Cos[y3[t]], y2'[t] = Sin[y3[t]], y3'[t] = y4[t], y4'[t] = -po*Sin[y3[t]] + q*Cos[y3[t]]};
leftBC[m_] := {y1[0] = 0, y2[0] = 0, y3[0] =, y4[0] = m};
```

Solution for m and q :

```
endpt[m_?NumberQ, q_?NumberQ] :=
  First[NDSolve[{y1'[t] == Cos[y3[t]], y2'[t] == Sin[y3[t]], y3'[t] == y4[t], y4'[t] == qCos[y3[t]] - po*Sin[y3[t]],
    y1[0] == 0, y2[0] == 0, y3[0] == 0, y4[0] == m}, {y1, y2, y3, y4}, {t, 0, 1}, MaxSteps -> 2000]];
(*soln*)
endpt[gm, gq]
f2[m_?NumberQ, q_?NumberQ] := y2[1] /. endpt[m, q];
f3[m_?NumberQ, q_?NumberQ] := y3[1] /. endpt[m, q];

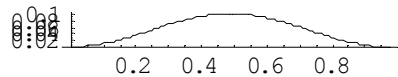
rts = FindRoot[{f2[m, q] == 0, f3[m, q] == 0}, {m, gm}, {q, gq}, AccuracyGoal -> 6, MaxIterations -> 2000]
rts
{m -> 2.03769296908383`, q -> -3.187838279412406`*^-7}

endpt[m/.rts, q/.rts]
m = m/.rts
q = q/.rts
2.03769296908383`
-3.187838279412406`*^-7
```

Create plot of strut in deformed state:

```
{yy1[t_], yy2[t_], yy3[t_], yy4[t_]} = {y1[t], y2[t], y3[t], y4[t]} /. First[soln]
```

```
ParametricPlot[Evaluate[{yy1[t], yy2[t]} /. soln /. rts], {t, 0, 1}, PlotRange -> All, AspectRatio -> Automatic, PlotPoints -> 100]
```



Create table of x and y values of strut:

numbers=TableForm[Table[Evaluate[{yy1[t]/.soln/.rts,yy2[t]/.soln/.rts}],{t,0,1,0.05}],TableHeadings→{None,{"x","y"}}]

x	y
-1.08857 × 10 ⁻²¹	3.58458 × 10 ⁻²⁶
0.0499153	0.00252384
0.0993624	0.00982297
0.148057	0.0211281
0.196003	0.0352938
0.243491	0.0509423
0.290978	0.0665909
0.338925	0.0807566
0.387619	0.0920617
0.437067	0.0993608
0.486982	0.101885
0.536897	0.0993608
0.586344	0.0920617
0.635038	0.0807566
0.682985	0.0665909
0.730473	0.0509423
0.77796	0.0352938
0.825907	0.0211281
0.874601	0.00982298
0.924048	0.00252384
0.973964	-6.79633 × 10 ⁻¹⁰