

3D Signpost - Pre-Analysis & Start-Up

Authors: Rajesh Bhaskaran and Vincent Prantil

Problem Specification

1. Pre-Analysis & Start-Up

2. Geometry

3. Mesh

4. Physics Setup

5. Numerical Solution

6. Numerical Results

7. Verification & Validation

Exercises

Comments

Pre-Analysis & Start-Up

Pre-Analysis

This problem requires a relatively straightforward application of linearly superposed solutions from individual loadings. A simple spreadsheet can be prepared to give the results for the stresses associated with the separate loadings experienced by the signpost. An example is given here for the case of a solid post with a diameter of 1.12 feet:

F25		f _x		=H19*(E21+C21)						
	A	B	C	D	E	F	G	H	I	J
1	Project 3: Designing a steel sign post									
2										
3	Definitions	$\sigma_{axial} = \frac{P}{A}$ $\sigma_{max \ bending} = \frac{Mc}{I}$ $\sigma_{max} = \sigma_1 + \sigma_2 = \frac{P}{A} + \frac{Mc}{I}$ $\tau_{max \ lateral} = \frac{2V}{A}$ $\tau_{max \ torsion} = \frac{Tc}{J}$								
4	P = Axial load									
5	V = Lateral load									
6	M = Bending moment									
7	T = Torsion									
8	do = External diameter									
9	di = Internal diameter									
10	A = Area									
11	I = Moment of Inertia about the neutral axis									
12	J = Polar Moment of Inertia									
13	c = Centroid referenced from the extreme compression fiber (equal to outer radius)									
14	σ_{max} = Normal stress produced by the combined effects of axial load and bending moment									
15	τ_{max} = Shear stress produced by the lateral load									
16							wind x	wind y	weight sign	
17	Data	x1	z1	b2	h1	h2	Wx2	Fy1	Wz1	Unit Wt Steel
18	Units	ft	ft	ft	ft	ft	k/ft	k	k/ft	k/ft^3
19	Value	6	4	13	28	8	0.70	8.00	0.90	0.49
20	Units	in	in	in	in	in	k/in	n/a	k/in	k/in^3
21	Value	72	48	156	336	96	0.0583	n/a	0.0750	0.000284
22										
23	Reactions	Vx = Ax	Vy = Ay	Vresult	P = Az	Mx	My	Mresult	T = Mz	
24	Units	kip	kip	kip	kip	kip*in	kip*in	kip*in	kip*in	
25	Value	-12.6	-8.00	14.93	29.08	3072	-4502	5450	-576	
26										
27	Property	d _o	d _i	wall thick	A	I _x	J	c	Wt Post	
28	Units	in.	in.	in.	in. ²	in. ⁴	in. ⁴	in.	kip	
29	Value	13.44	0.00	6.720	141.87	1601.6	3203.3	6.720	17.38	
30										
31	Stress	σ_{axial}	$\sigma_{bending}$	max σ_z	$\tau_{lateral}$	$\tau_{torsion}$	max τ			
32	Units	ksi	ksi	ksi	ksi	ksi	ksi			
33	Value	0.20	22.87	23.07	0.21	1.21	1.42			
34	Allowable Stress	25.00			16.00					
35										

Note that the formula for the moment about the x-axis is highlighted and shown in the formula bar above the spreadsheet. Not surprisingly, the stresses are quite low as solid posts are almost never used in practice. You may wish to begin with this case of an over-designed signpost. The tutorial contains geometry files for both solid and hollow poles. Then you will want to consider hollow poles and compare results as you attempt to optimize the post's load-carrying capacity:

35						
36	RESULTS SUMMARY					
37						
38	Record your results (numbers, not formulae) below.					
39		d_o	d_i	t	max σ_z	max τ
40		in.	in.	in.	ksi	ksi
41	Option 1					
42	Option 2					
43	Option 3					
44	Option 4					
45	Option 5 (Solid)	13.44	0.00	6.72	23.07	1.42

You will want to continue and re-design lighter hollow posts which sustain higher stresses, but remain in the elastic regime.

Start-Up

Launch ANSYS Workbench and start a "Static Structural" analysis in the project page as shown in the video below.

[Go to Step 2: Geometry](#)

[Go to all ANSYS Learning Modules](#)