Optimizing Cost of a Tubular Column Under Pressure Using Gekko. (adapted from "Engineering and Optimization Theory and Practice Fourth Edition, Rao")

A general diagram of the system is given below.

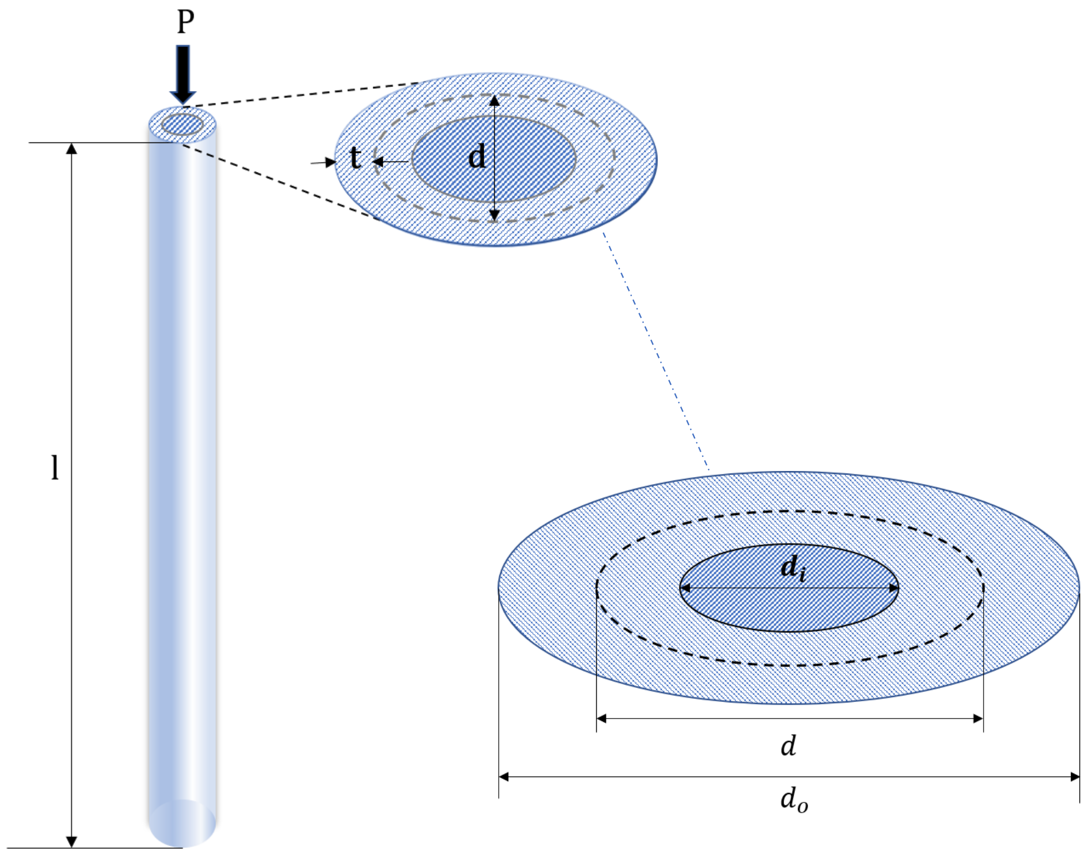

Figure 1

Figure 2

P is the compressive load of 2300 kg_f. The material used to make the column has a module of elasticity (E) of 0.65x10^6 and a weight density (ρ) of 0.0020 kg_f/cm^3. The column has a yield stress (σ_y) of 450 kg_f/cm^2 and a length (l) of 300 cm.

The objective is to optimize the cost of building the column, using variables *d*, the mean diameter of the column (cm), and *t*, the thickness of the column (cm). Due to available materials the diameter must be ≤ 14.0 cm and ≥ 2.0 cm. Similarly, the thickness must be ≤ 0.8 cm and ≥ 0.2 cm. Safety requires that the induced stress is less than the yield stress and that the induced stress is less than the buckling stress. The cost of the column is equal to the expression 5W + 2d with W being the weight in kilograms force.

Note: $W = \rho\, l\, \pi \frac{d_o^2 - d_i^2}{4}$

$d_o = d + t$

$d_i = d - t$

Induced stress $= \frac{P}{\pi\, d\, t}$

Buckling stress = Euler buckling load/ cross sectional area $= \frac{\pi^2 E I}{l^2} \frac{1}{\pi d t}$

I is found using the model below.

I = second moment of area of the cross section of the column.

$= \frac{\pi}{64}(d_0^4 - d_i^4)$

See https://apmonitor.com/me575/index.php/Main/TubularColumn for additional information.