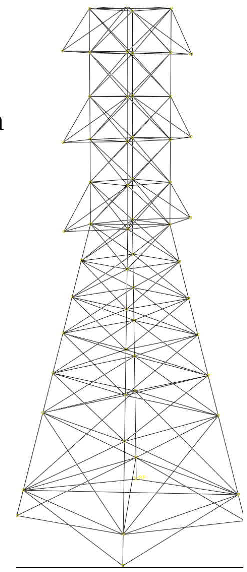
High-Tension Anchor Pylon



High-tension power lines transmit electricity over large distances and are the backbone of a national power grid. These lines are supported by transmission towers, steel lattices ranging from 15 to 370 m in height and capable of supporting both the lines and incidental environmental stresses such as ice encrustation. We will model the tension on a particular kind of high-tension tower called an *anchor pylon*, a self-supporting structure used to anchor the line and limit catastrophic damage in the event of a collapse.

A candidate anchor pylon structure is provided for you in the file `pylon.cae`. You need to assign separate properties and sections to the three beam sets. You should also define a beam orientation for each. Assume SI units.

The following sets are defined for you already:

`UprightSet`	Contains the four major uprights; use with `UprightBeam` section.
`CrossBeamSet`	Contains major horizontal trusses; use with `CrossBeam` section.
`AngleBeamSet`	Contains minor trusses; use with `AngleBeam` section.
`PylonBase`	Contains four base points; set `ENCASTRE` boundary condition.
`WireTips`	Contains six branch tips; use for wire loading.

You will create a tower mesh from a geometry with one beam element `B22H` per segment. You will then simulate arbitrarily heavy loads at several locations to find the stress distribution and the likely failure points within this model (using the von Mises stress). You should verify and report the beam orientation in a diagram in your report as well.

The tower is made of A36 steel, with E = 207 GPa, ν = 0.3, ρ = 7.85 g·cm^{-3}. (Make your unit system consistent.) You should also solve the first case again using Al 6061, with E = 69 GPa, ν = 0.33, ρ = 2.7 g·cm^{-3}, which is often used in environments where steel would be corroded.

Anchor pylons are designed as self-supporting structures which can support heavy horizontal loads. Consider the tower subjected to the following load cases:

- Balanced power lines are suspended from the end of each pylon branch (six in all) with a net downward force of (0.8 kg·m^{-1} × 500 m) × 9.8 m·s^{-2} = 3.92 kN each. (Also solve this case using Al 6061.)
- A gale-force wind of 70 mph strikes the tower. (Include the power line loads in this model.) A line load of 0.34 N should be distributed across the tower.

If, at this point, your model appears too fragile, determine suitable adjustments to render it stable (to the beam section, material, profile properties, etc., not to the geometry).

You will document your simulations in an 8–10 page report (with figures) containing sections:

- Problem description (model, grid, etc.—you should examine and report beam profiles and any necessary modifications you've made)
- Numerical values (element parameters, boundary conditions, etc.)

- Computational times (CPU time to solve)
- Observations of numerical behavior (boundary conditions, mesh behavior, etc.)
- Discussion of the results (deformation, perceived safety, etc.)

Include the following plots in your report, with data from each case as appropriate:

- Mesh of model
- Contour plot of von Mises stress projected onto (displaced) beam elements (*Main Menu→View→ ODB Display Options→Render beam profiles* with a scale factor of 1 or more.)
- Line plot of von Mises stress along an upright of anchor pylon

The report should be formatted with 1.5 line spacing, 1 inch margins on all sides, and set in 11 point serif font. All figures and tables (if any) should be numbered and have labels and captions.

Reference

Gemmill, Edwin Le Roy. (1920). *Transmission towers*. Blaw-Knox.

Jones, Kathleen F. & Kurt Z. Egelhofer. (1991). *Computer Model of Atmospheric Ice Accretion on Transmission Lines, CRREL 91–3*. U.S. Army Corps of Engineers.