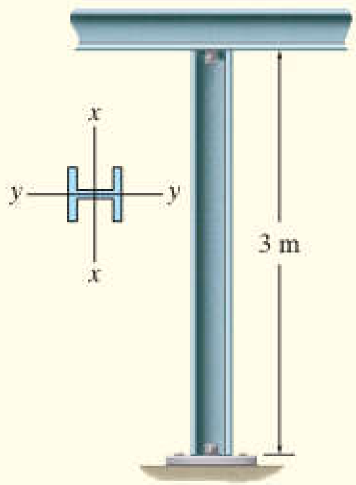
Buckling Examples

Problem #1

The A992 steel W200 × 46 member shown in Fig. 13–8 is to be used as a pin-connected column. Determine the largest axial load it can support before it either begins to buckle or the steel yields.



The properties of the section are as follows:

$A_{cs} = 5890\ \text{mm}^2$ $\quad E = 200\ \text{GPa}$ $\quad F_y = 345\ \text{MPa}$

$I_x = 45.5 \cdot 10^6\ \text{mm}^4$ $\quad L_b = 3\ \text{m}$

$I_y = 15.3 \cdot 10^6\ \text{mm}^4$

The buckling load is calculated as follows:

$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

$$\boxed{P_{cr\_buckle} = \frac{\pi^2 \cdot E \cdot I_y}{L_b^2} = 3.3557\ \text{MN}}$$

This is the load required to prevent buckling.

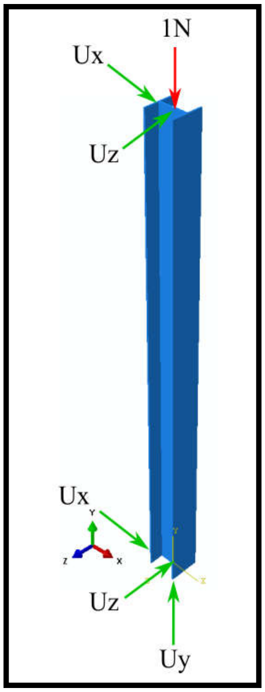
Now, let us check the compressive load required to prevent Yielding.

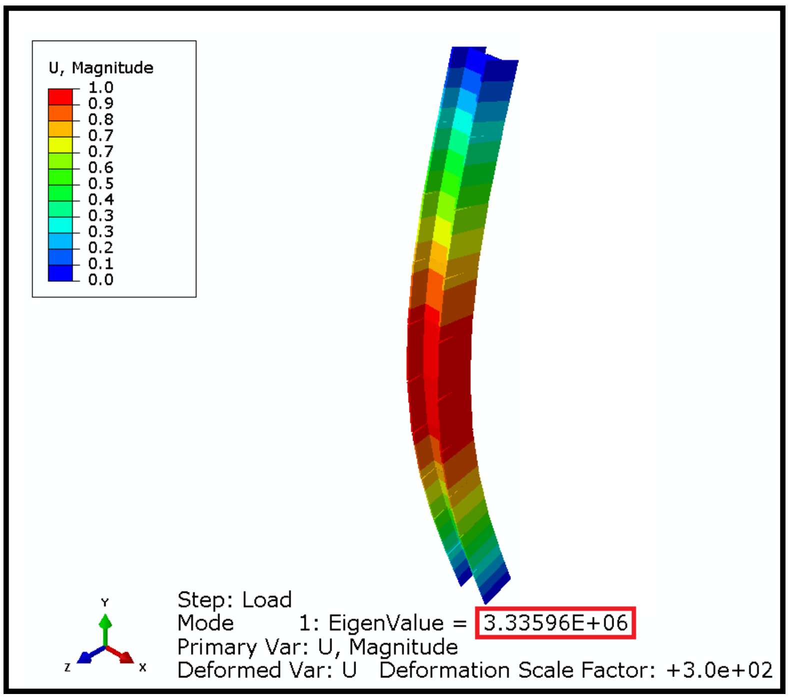
$$\boxed{P_{cr\_yield} = F_y \cdot A_{cs} = 2.032\ \text{MN}}$$

Thus we see that the beam will yield before it will buckle !

I have solved the problem using Abaqus.
A unit load was applied at the top. This causes the eigenvalue to be the buckling load.

$P_{applied} = 1\ \text{N}$





According to Abaqus, the eigenvalue is, $\boxed{\lambda = 3.3359 \cdot 10^{6}}$

To obtain the bucklign load, we multiply this eigenvalue with the load that was applied.

$\boxed{P_{cr\_Abaqus} = P_{applied} \cdot \lambda = 3.3359\ \text{MN}}$

Thus, we have verified our FEA with hand calculation.