//Bending a flexible cantilever, in a non linear fashion. Such as a hacksaw blade or a fishing rod

$L := 100$ straight length of beam

$n := 200$ number of segment

The load is applied to the tip, positive force is away from the wall and up

$b := 20$ width of beam

$d := .5$ depth of beam

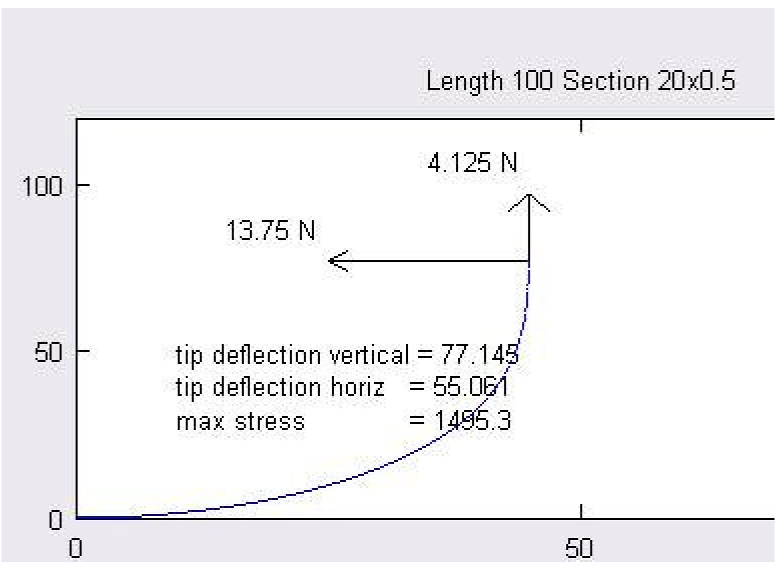
$E := 210000$ Young's modulus

$I := \frac{1}{12} \cdot b \cdot d^{3}$ section modulus

//Most important relationship is M/I=E/R=σ/y, it applies to every location along the beam.

//M=-Fx*(ytip-y)+Fy*(xtip-x)

//Test case



$Fx := -13.75$
$Fy := 4.125$ //these are the input forces

$xtip := L \cdot .9$
$ytip := L \cdot .01$ //xtip and ytip are just guesses to start the whole thing off

$dL := \frac{L}{n}$ //Length of each segment of beam. dθ=dL/R

$y_{1\,1} := 0$ $x_{1\,1} := \frac{L}{n}$ $I = 0.21$ $\theta_{1\,1} := 0$

$dz := L$

$$\text{while } dz > \frac{L}{1000}$$

$$M_{1\,1} := \text{eval}\left((-Fx)\cdot(ytip) + Fy\cdot(xtip)\right)$$

$$d\theta_{1\,1} := \frac{dL\cdot M_{1\,1}}{I\cdot E}$$

$$\text{for } i := 2, i \le n, i := i + 1$$

$$M_{i\,1} := \text{eval}\left((-Fx)\cdot\left(ytip - y_{i-1\,1}\right) + Fy\cdot\left(xtip - x_{i-1\,1}\right)\right)$$

$$d\theta_{i\,1} := \text{eval}\left(\frac{dL\cdot M_{i\,1}}{I\cdot E}\right)$$

$$\theta_{i\,1} := \text{eval}\left(\theta_{i-1\,1} + d\theta_{i\,1}\right)$$

$$y_{i\,1} := \text{eval}\left(y_{i-1\,1} + dL\cdot \sin\left(\theta_{i\,1}\right)\right)$$

$$x_{i\,1} := \text{eval}\left(x_{i-1\,1} + dL\cdot \cos\left(\theta_{i\,1}\right)\right)$$

$$a := 1$$

//use a=1 to fill extra spots in the loop

$$dz := \sqrt{\left(x_{n\,1} - xtip\right)^2 + \left(y_{n\,1} - ytip\right)^2}$$

$$xtip := x_{n\,1}$$

$$ytip := y_{n\,1}$$

$$L - x_{n\,1} = 54.5$$

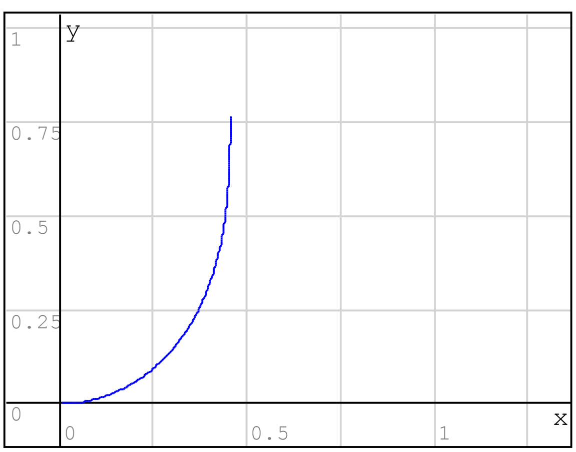
$$y_{n\,1} = 76.82$$

//close, increase n for a better result

$$\text{for } i := 1, i \le n, i := i + 1$$

$$xy_{i\,1} := \frac{x_{i\,1}}{L}$$

$$xy_{i\,2} := \frac{y_{i\,1}}{L}$$



xy

$$\frac{\frac{Fy\cdot L^3}{(3\cdot E\cdot I)}}{y_{n\,1}} = 0.41$$

//linear result if Fx=0