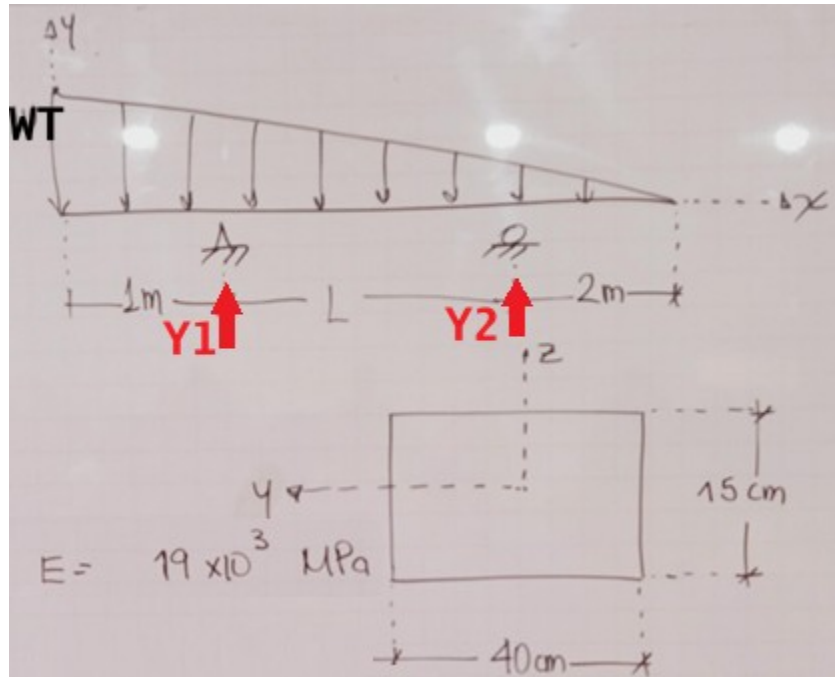


Esfuerzos axiales máximos a flexión pura en las fibras extremas



#1: [CaseMode := Sensitive, InputMode := Word]

#2: [WT :=, L :=, w :=, X1 := 0, Y1 :=, Y2 :=, E := 19.1.e6, w :=, cg :=]

#3:
$$\begin{bmatrix} FV1(x) := & FV2(x) := & FV3(x) := \\ MF1(x) := & MF2(x) := & MF3(x) := \end{bmatrix}$$

Inercia:

#4:
$$I_z := \frac{1}{12} \cdot 0.15 \cdot 0.4^3$$

#5:
$$I_z := \frac{1}{1250}$$

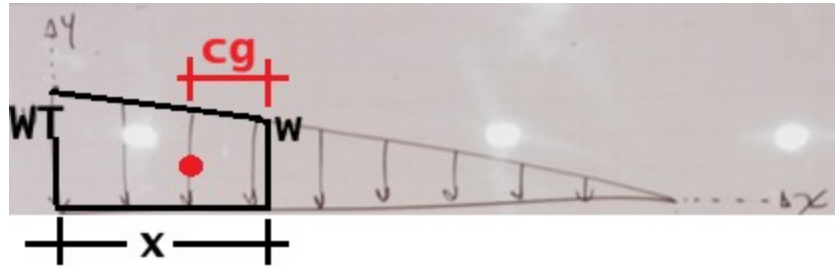
#6:
$$I_z := 0.0008$$

Carga $w(x)$ en cual punto x :

#7:
$$\frac{WT}{1 + L + 2} = \frac{w}{1 + L + 2 - x}$$

#8:
$$w := - \frac{WT \cdot (x - L - 3)}{L + 3}$$

Centroide de la carga trapezoidal medido desde el punto x:



$$\#9: \frac{WT + w}{2} \cdot x \cdot cg = \frac{WT - w}{2} \cdot x \cdot \frac{2}{3} \cdot x + w \cdot x \cdot \frac{x}{2}$$

$$\#10: cg := \frac{x \cdot (x - 3 \cdot (L + 3))}{3 \cdot (x - 2 \cdot (L + 3))}$$

Equilibrio $\Sigma F_y=0$ y $\Sigma M_z(\text{extremo izq})=0$:

$$\#11: \left[\begin{array}{l} Y1 + Y2 - \frac{WT \cdot (1 + L + 2)}{2} = 0 \\ Y1 \cdot 1 + Y2 \cdot (1 + L) - \frac{WT \cdot (1 + L + 2)}{2} \cdot \frac{1}{3} \cdot (1 + L + 2) \end{array} \right]$$

$$\#12: \left[Y1 := \frac{WT \cdot (L + 3)}{3}, Y2 := \frac{WT \cdot (L + 3)}{6} \right]$$

Resumen resultados simbólicos:

$$\#13: \left[WT :=, L :=, w := - \frac{WT \cdot (x - L - 3)}{L + 3}, cg := \frac{x \cdot (x - 3 \cdot (L + 3))}{3 \cdot (x - 2 \cdot (L + 3))}, X1 := 0, Y1 := \frac{WT \cdot (L + 3)}{3}, Y2 := \frac{WT \cdot (L + 3)}{6} \right]$$

Ecuaciones de fuerza cortante:

$$\#14: \left[\begin{array}{l} FV1(x) := - \frac{WT + w}{2} \cdot x \\ FV2(x) := - \frac{WT + w}{2} \cdot x + Y1 \\ FV3(x) := - \frac{WT + w}{2} \cdot x + Y1 + Y2 \end{array} \right]$$

$$\#15: \left[\begin{array}{l} FV1(x) := \frac{WT \cdot x \cdot (x - 2 \cdot (L + 3))}{2 \cdot (L + 3)} \\ FV2(x) := \frac{WT \cdot (3 \cdot x^2 - 6 \cdot x \cdot (L + 3) + 2 \cdot (L + 3)^2)}{6 \cdot (L + 3)} \\ FV3(x) := \frac{WT \cdot (x^2 - 2 \cdot x \cdot (L + 3) + (L + 3)^2)}{2 \cdot (L + 3)} \end{array} \right]$$

Ecuaciones de momento flector:

$$\#16: \left[\begin{array}{l} MF1(x) := - \frac{WT + w}{2} \cdot x \cdot cg \\ MF2(x) := - \frac{WT + w}{2} \cdot x \cdot cg + Y1 \cdot (x - 1) \\ MF3(x) := - \frac{WT + w}{2} \cdot x \cdot cg + Y1 \cdot (x - 1) + Y2 \cdot (x - 1 - L) \end{array} \right]$$

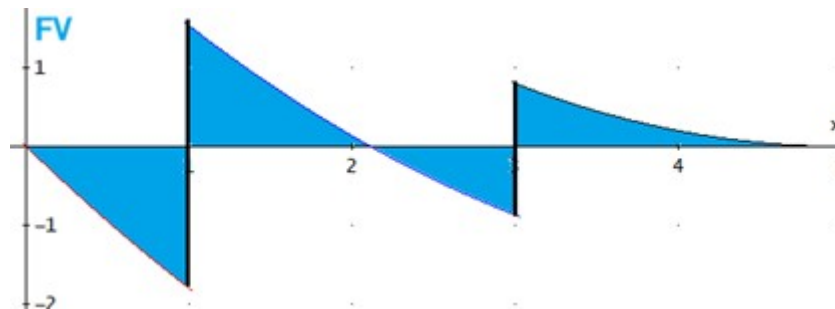
$$\#17: \left[\begin{array}{l} MF1(x) := \frac{WT \cdot x^2 \cdot (x - 3 \cdot (L + 3))}{6 \cdot (L + 3)} \\ MF2(x) := \frac{WT \cdot (x^3 - 3 \cdot x^2 \cdot (L + 3) + 2 \cdot x \cdot (L + 3)^2 - 2 \cdot (L + 3)^2)}{6 \cdot (L + 3)} \\ MF3(x) := \frac{WT \cdot (x^3 - 3 \cdot x^2 \cdot (L + 3) + 3 \cdot x \cdot (L + 3)^2 - (L + 3)^3)}{6 \cdot (L + 3)} \end{array} \right]$$

Usando valores para $WT=2$ y $L=2$:

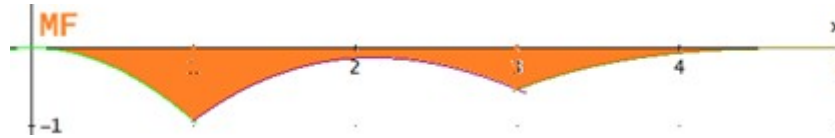
$$\#18: \left[WT := 2, L := 2, w := -\frac{WT \cdot (x - L - 3)}{L + 3}, cg := \frac{x \cdot (x - 3 \cdot (L + 3))}{3 \cdot (x - 2 \cdot (L + 3))}, X1 := 0, Y1 := \frac{WT \cdot (L + 3)}{3}, Y2 := \frac{WT \cdot (L + 3)}{6} \right]$$

$$\#19: \left[WT := 2, L := 2, w := 2 - \frac{2 \cdot x}{5}, cg := \frac{x \cdot (x - 15)}{3 \cdot (x - 10)}, X1 := 0, Y1 := \frac{10}{3}, Y2 := \frac{5}{3} \right]$$

$$\#20: \left[\begin{array}{l} FV1(x) := \frac{x \cdot (x - 10)}{5} \\ FV2(x) := \frac{3 \cdot x^2 - 30 \cdot x + 50}{15} \\ FV3(x) := \frac{x^2 - 10 \cdot x + 25}{5} \end{array} \right]$$



$$\#21: \left[\begin{array}{l} MF1(x) := \frac{x^2 \cdot (x - 15)}{15} \\ MF2(x) := \frac{x^3 - 15 \cdot x^2 + 50 \cdot x - 50}{15} \\ MF3(x) := \frac{x^3 - 15 \cdot x^2 + 75 \cdot x - 125}{15} \end{array} \right]$$



Esfuerzo axial máximo ocurrir en el punto de momento flector máximo, en este caso solo hay momento flector máximo negativo en $x=1$.

$$\#22: \left[\sigma_{\text{Sup}} = - \frac{MF1(1) \cdot 0.2}{I_z}, \sigma_{\text{Inf}} = - \frac{MF1(1) \cdot (-0.2)}{I_z} \right]$$

$$\#23: \left[\sigma_{\text{Sup}} = \frac{700}{3}, \sigma_{\text{Inf}} = - \frac{700}{3} \right]$$

$$\#24: [\sigma_{\text{Sup}} = 233.3333333, \sigma_{\text{Inf}} = -233.3333333]$$

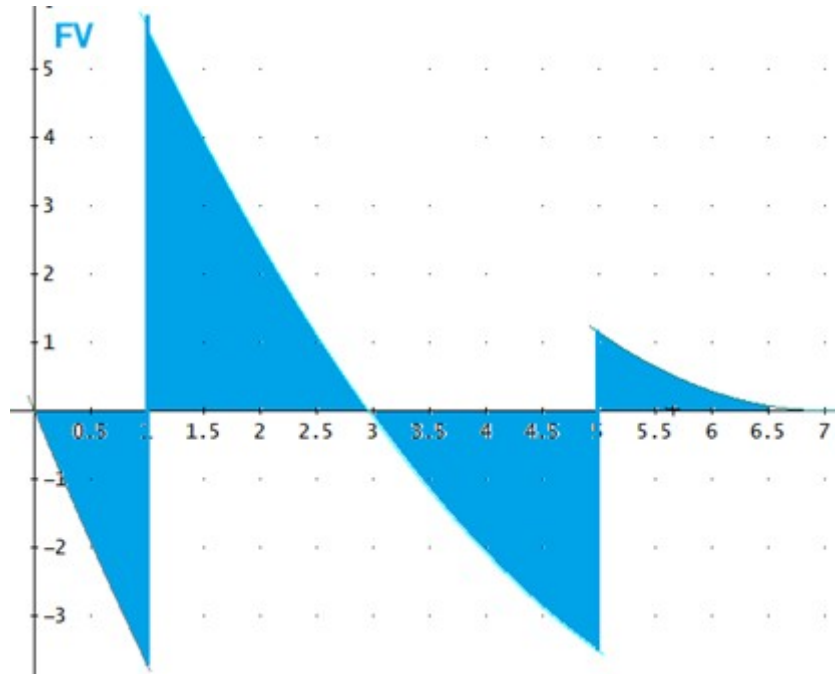
Usando valores para $WT=4$ y $L=4$:

$$\#25: \left[WT := 4, L := 4, w := - \frac{WT \cdot (x - L - 3)}{L + 3}, cg := \frac{x \cdot (x - 3 \cdot (L + 3))}{3 \cdot (x - 2 \cdot (L + 3))}, X1 := 0, Y1 := \frac{WT \cdot (L + 3)}{3}, Y2 := \frac{WT \cdot (L + 3)}{6} \right]$$

$$\#26: \left[WT := 4, L := 4, w := \frac{4 \cdot (7 - x)}{7}, cg := \frac{x \cdot (x - 21)}{3 \cdot (x - 14)}, X1 := 0, Y1 := \frac{28}{3}, Y2 := \frac{14}{3} \right]$$

$$\#27: [Y1 := 9.333333333, Y2 := 4.666666666]$$

$$\#28: \left[\begin{array}{l} FV1(x) := \frac{2 \cdot x \cdot (x - 14)}{7} \\ FV2(x) := \frac{2 \cdot (3 \cdot x^2 - 42 \cdot x + 98)}{21} \\ FV3(x) := \frac{2 \cdot (x^2 - 14 \cdot x + 49)}{7} \end{array} \right]$$



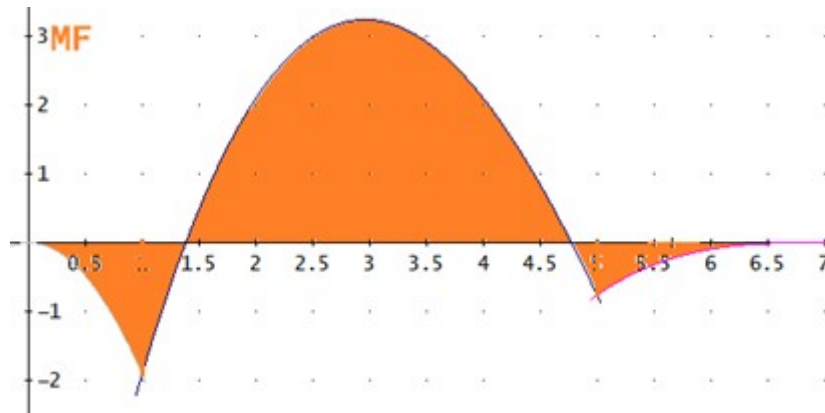
#29: $FV2(x) = 0$

#30:
$$\frac{2 \cdot (3 \cdot x^2 - 42 \cdot x + 98)}{21} = 0$$

#31:
$$x = 7 - \frac{7 \cdot \sqrt{3}}{3} \vee x = \frac{7 \cdot \sqrt{3}}{3} + 7$$

#32:
$$x = 11.04145188 \vee x = 2.958548115$$

#33:
$$\left[\begin{array}{l} MF1(x) := \frac{2 \cdot x^2 \cdot (x - 21)}{21} \\ MF2(x) := \frac{2 \cdot (x^3 - 21 \cdot x^2 + 98 \cdot x - 98)}{21} \\ MF3(x) := \frac{2 \cdot (x^3 - 21 \cdot x^2 + 147 \cdot x - 343)}{21} \end{array} \right]$$



Momento flector negativo máximo en $x=1$ y momento flector positivo máximo en $x=2.96m$

$$\#34: \left[\begin{array}{cc} \sigma_{Sup1} = - \frac{MF1(1) \cdot 0.2}{I_z} & \sigma_{Inf1} = - \frac{MF1(1) \cdot (-0.2)}{I_z} \\ \sigma_{Sup2} = - \frac{MF2(2.958548115) \cdot 0.2}{I_z} & \sigma_{Inf2} = - \frac{MF2(2.958548115) \cdot (-0.2)}{I_z} \end{array} \right]$$

$$\#35: \left[\begin{array}{cc} \sigma_{Sup1} = 476.1904761 & \sigma_{Inf1} = -476.1904761 \\ \sigma_{Sup2} = -810.0181322 & \sigma_{Inf2} = 810.0181322 \end{array} \right]$$

Usando valores para $WT=5$ y $L=5$:

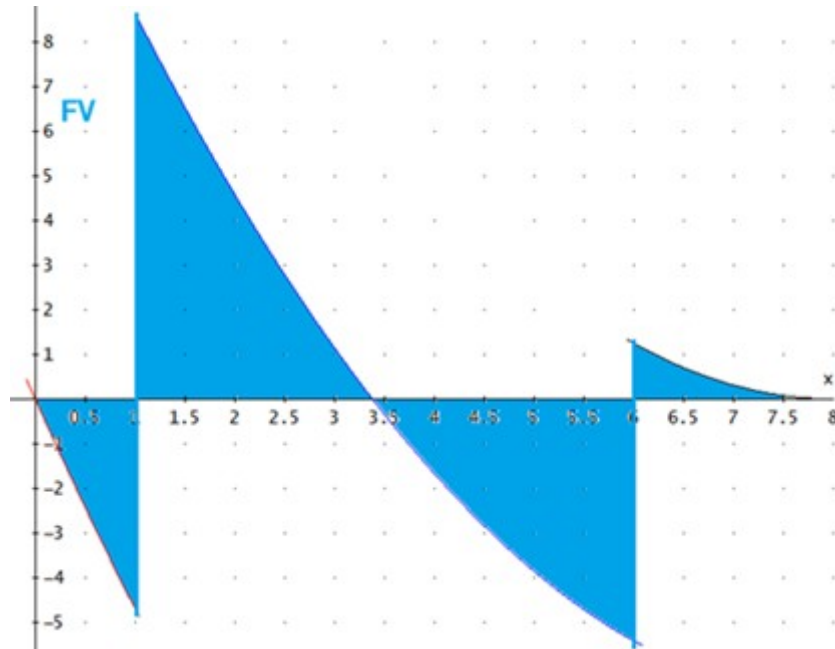
$$\#36: \left[\begin{array}{l} WT := 5, L := 5, w := - \frac{WT \cdot (x - L - 3)}{L + 3}, cg := \frac{x \cdot (x - 3 \cdot (L + 3))}{3 \cdot (x - 2 \cdot (L + 3))}, X1 := 0, Y1 := \\ \frac{WT \cdot (L + 3)}{3}, Y2 := \frac{WT \cdot (L + 3)}{6} \end{array} \right]$$

$$\#37: \left[\begin{array}{l} WT := 5, L := 5, w := \frac{5 \cdot (8 - x)}{8}, cg := \frac{x \cdot (x - 24)}{3 \cdot (x - 16)}, X1 := 0, Y1 := \frac{40}{3}, Y2 := \frac{20}{3} \end{array} \right]$$

$$\#38: [Y1 := 13.33333333, Y2 := 6.666666666]$$

#39:

$$\left[\begin{array}{l} FV1(x) := \frac{5 \cdot x \cdot (x - 16)}{16} \\ FV2(x) := \frac{5 \cdot (3 \cdot x^2 - 48 \cdot x + 128)}{48} \\ FV3(x) := \frac{5 \cdot (x^2 - 16 \cdot x + 64)}{16} \end{array} \right]$$



#40: $FV2(x) = 0$

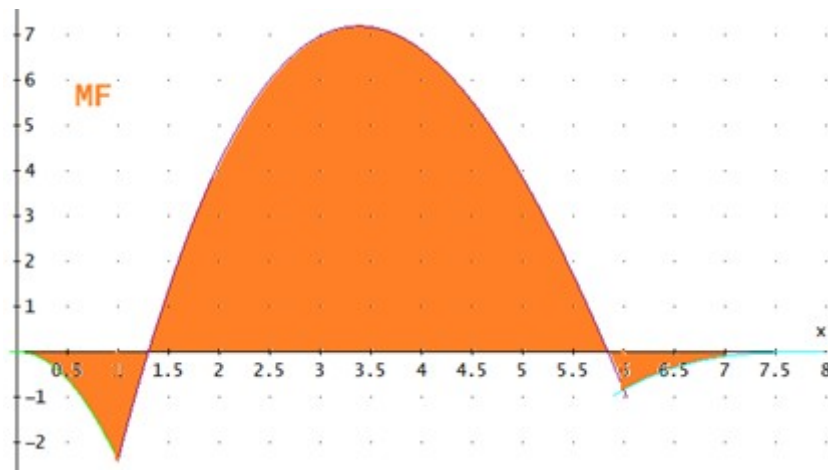
$$\#41: \frac{5 \cdot (3 \cdot x^2 - 48 \cdot x + 128)}{48} = 0$$

$$\#42: x = 8 - \frac{8 \cdot \sqrt{3}}{3} \vee x = \frac{8 \cdot \sqrt{3}}{3} + 8$$

$$\#43: x = 3.381197846 \vee x = 12.61880215$$

#44:

$$\left[\begin{array}{l} MF1(x) := \frac{5 \cdot x^2 \cdot (x - 24)}{48} \\ MF2(x) := \frac{5 \cdot (x^3 - 24 \cdot x^2 + 128 \cdot x - 128)}{48} \\ MF3(x) := \frac{5 \cdot (x^3 - 24 \cdot x^2 + 192 \cdot x - 512)}{48} \end{array} \right]$$



Momento flector negativo máximo en $x=1$ y momento flector positivo máximo en $x=3.38m$

#45:

$$\left[\begin{array}{ll} \sigma_{Sup1} = - \frac{MF1(1) \cdot 0.2}{I_z} & \sigma_{Inf1} = - \frac{MF1(1) \cdot (-0.2)}{I_z} \\ \sigma_{Sup2} = - \frac{MF2(3.381197846) \cdot 0.2}{I_z} & \sigma_{Inf2} = - \frac{MF2(3.381197846) \cdot (-0.2)}{I_z} \end{array} \right]$$

#46:

$$\left[\begin{array}{ll} \sigma_{Sup1} = 598.9583333 & \sigma_{Inf1} = -598.9583333 \\ \sigma_{Sup2} = -1798.669059 & \sigma_{Inf2} = 1798.669059 \end{array} \right]$$

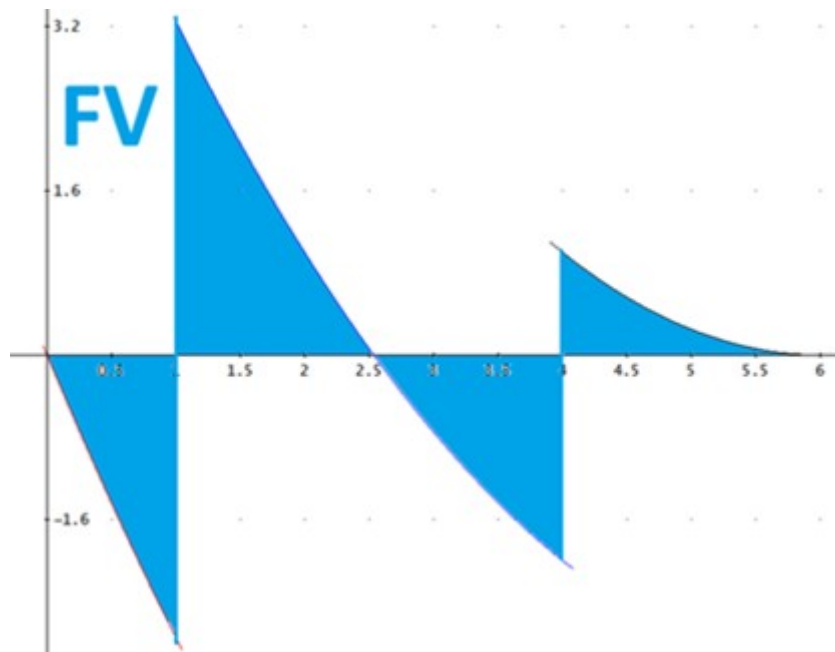
Usando valores para $WT=3$ y $L=3$:

$$\#47: \left[WT := 3, L := 3, w := - \frac{WT \cdot (x - L - 3)}{L + 3}, cg := \frac{x \cdot (x - 3 \cdot (L + 3))}{3 \cdot (x - 2 \cdot (L + 3))}, X1 := 0, Y1 := \right]$$

$$\frac{WT \cdot (L + 3)}{3}, Y2 := \frac{WT \cdot (L + 3)}{6} \Bigg]$$

#48: $\left[WT := 3, L := 3, w := \frac{6 - x}{2}, cg := \frac{x \cdot (x - 18)}{3 \cdot (x - 12)}, X1 := 0, Y1 := 6, Y2 := 3 \right]$

#49: $\left[\begin{array}{l} FV1(x) := \frac{x \cdot (x - 12)}{4} \\ FV2(x) := \frac{x^2 - 12 \cdot x + 24}{4} \\ FV3(x) := \frac{x^2 - 12 \cdot x + 36}{4} \end{array} \right]$



#50:

$$\left[\begin{array}{l} MF1(x) := \frac{x^2 \cdot (x - 18)}{12} \\ MF2(x) := \frac{x^3 - 18 \cdot x^2 + 72 \cdot x - 72}{12} \\ MF3(x) := \frac{x^3 - 18 \cdot x^2 + 108 \cdot x - 216}{12} \end{array} \right]$$

#51: $FV2(x) = 0$

#52:

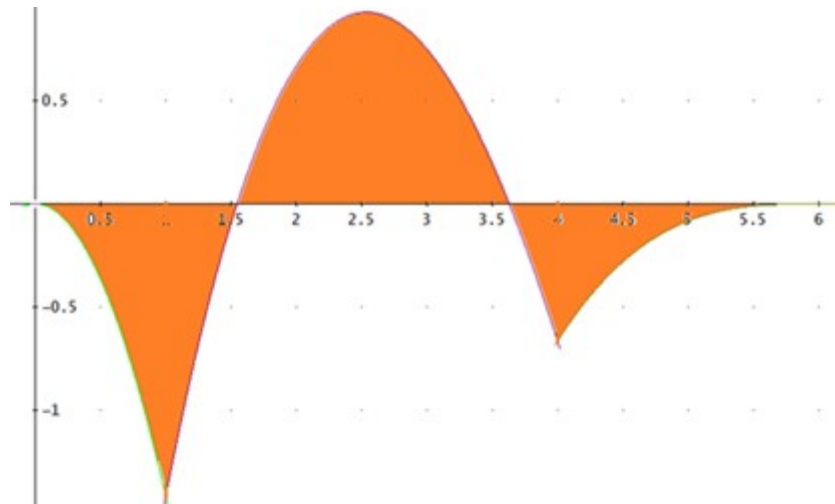
$$\frac{x^2 - 12 \cdot x + 24}{4} = 0$$

#53:

$$x = 6 - 2 \cdot \sqrt{3} \vee x = 2 \cdot \sqrt{3} + 6$$

#54:

$$x = 9.464101615 \vee x = 2.535898384$$



Momento flector negativo máximo en $x=1$ y momento flector positivo máximo en $x=2.54m$

#55:

$$\left[\begin{array}{l} \sigma_{Sup1} = - \frac{MF1(1) \cdot 0.2}{I_z} \quad \sigma_{Inf1} = - \frac{MF1(1) \cdot (-0.2)}{I_z} \\ \sigma_{Sup2} = - \frac{MF2(2.535898384) \cdot 0.2}{I_z} \quad \sigma_{Inf2} = - \frac{MF2(2.535898384) \cdot (-0.2)}{I_z} \end{array} \right]$$

#56:
$$\begin{bmatrix} \sigma_{\text{Sup1}} = 354.1666666 & \sigma_{\text{Inf1}} = -354.1666666 \\ \sigma_{\text{Sup2}} = -232.0508075 & \sigma_{\text{Inf2}} = 232.0508075 \end{bmatrix}$$

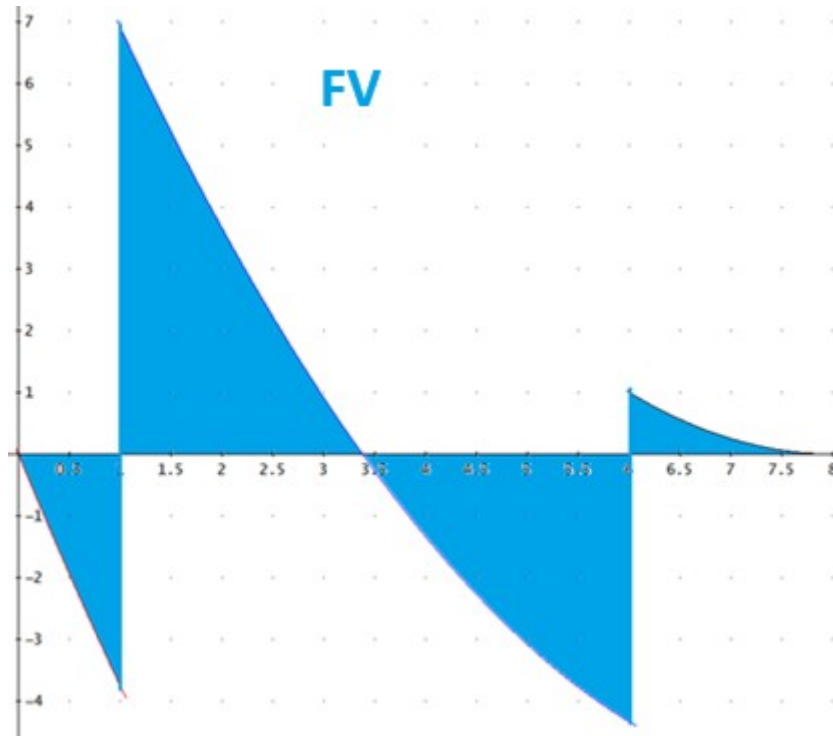
Usando valores para WT=4 y L=5:

#57:
$$\left[\begin{aligned} & WT := 4, L := 5, w := -\frac{WT \cdot (x - L - 3)}{L + 3}, cg := \frac{x \cdot (x - 3 \cdot (L + 3))}{3 \cdot (x - 2 \cdot (L + 3))}, X1 := 0, Y1 := \\ & \frac{WT \cdot (L + 3)}{3}, Y2 := \frac{WT \cdot (L + 3)}{6} \end{aligned} \right]$$

#58:
$$\left[\begin{aligned} & WT := 4, L := 5, w := 4 - \frac{x}{2}, cg := \frac{x \cdot (x - 24)}{3 \cdot (x - 16)}, X1 := 0, Y1 := \frac{32}{3}, Y2 := \frac{16}{3} \end{aligned} \right]$$

#59:
$$\left[\begin{aligned} & WT := 4, L := 5, w := 4 - 0.5 \cdot x, cg := \frac{0.3333333333 \cdot x \cdot (x - 24)}{x - 16}, X1 := 0, Y1 := 10.66666666, \\ & Y2 := 5.333333333 \end{aligned} \right]$$

#60:
$$\left[\begin{aligned} & FV1(x) := \frac{x \cdot (x - 16)}{4} \\ & FV2(x) := \frac{3 \cdot x^2 - 48 \cdot x + 128}{12} \\ & FV3(x) := \frac{x^2 - 16 \cdot x + 64}{4} \end{aligned} \right]$$



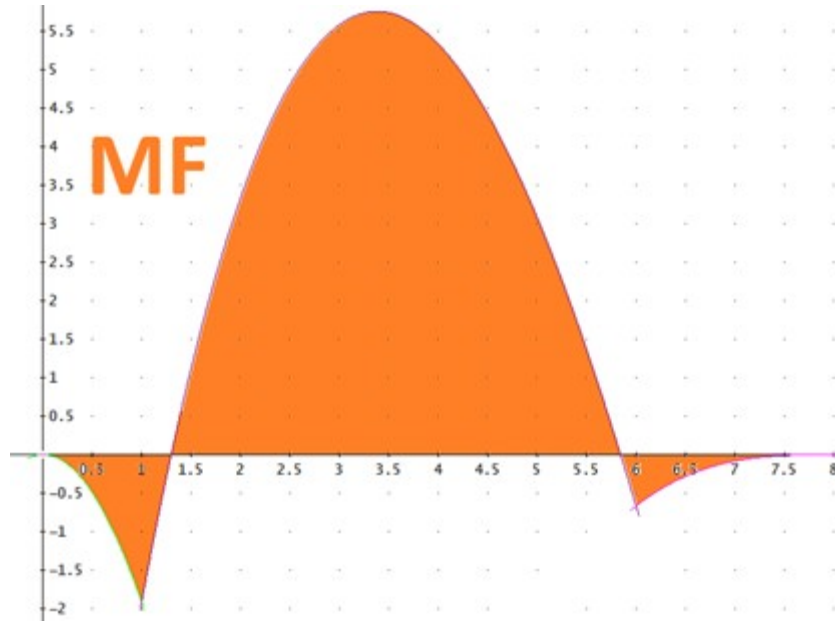
#61: $FV_2(x) = 0$

#62:
$$\frac{3 \cdot x^2 - 48 \cdot x + 128}{12} = 0$$

#63:
$$x = 8 - \frac{8 \cdot \sqrt{3}}{3} \vee x = \frac{8 \cdot \sqrt{3}}{3} + 8$$

#64:
$$x = 3.381197846 \vee x = 12.61880215$$

#65:
$$\left[\begin{array}{l} MF1(x) := \frac{x^2 \cdot (x - 24)}{12} \\ MF2(x) := \frac{x^3 - 24 \cdot x^2 + 128 \cdot x - 128}{12} \\ MF3(x) := \frac{x^3 - 24 \cdot x^2 + 192 \cdot x - 512}{12} \end{array} \right]$$



$$\#66: \left[\begin{array}{cc} \sigma_{\text{Sup1}} = - \frac{\text{MF1}(1) \cdot 0.2}{I_z} & \sigma_{\text{Inf1}} = - \frac{\text{MF1}(1) \cdot (-0.2)}{I_z} \\ \sigma_{\text{Sup2}} = - \frac{\text{MF2}(3.381197846) \cdot 0.2}{I_z} & \sigma_{\text{Inf2}} = - \frac{\text{MF2}(3.381197846) \cdot (-0.2)}{I_z} \end{array} \right]$$

$$\#67: \left[\begin{array}{cc} \sigma_{\text{Sup1}} = 479.1666666 & \sigma_{\text{Inf1}} = -479.1666666 \\ \sigma_{\text{Sup2}} = -1438.935247 & \sigma_{\text{Inf2}} = 1438.935247 \end{array} \right]$$

Momento flector negativo máximo en $x=1$ y momento flector positivo máximo en $x=3.38\text{m}$

Usando valores para $WT=5$ y $L=4$:

$$\#68: \left[\begin{array}{l} WT := 5, L := 4, w := - \frac{WT \cdot (x - L - 3)}{L + 3}, \text{cg} := \frac{x \cdot (x - 3 \cdot (L + 3))}{3 \cdot (x - 2 \cdot (L + 3))}, X1 := 0, Y1 := \\ \frac{WT \cdot (L + 3)}{3}, Y2 := \frac{WT \cdot (L + 3)}{6} \end{array} \right]$$

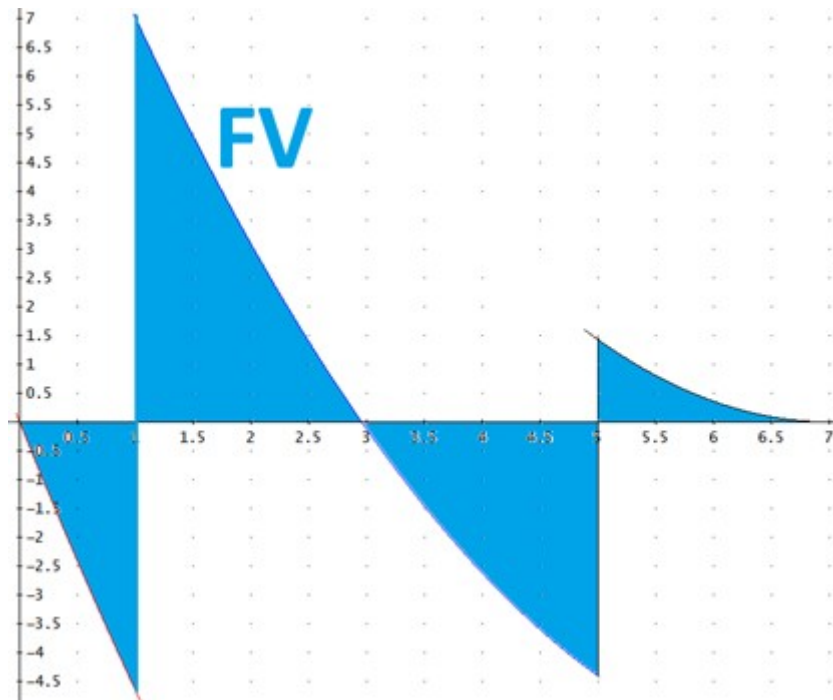
$$\#69: \left[\begin{array}{l} WT := 5, L := 4, w := 5 - \frac{5 \cdot x}{7}, \text{cg} := \frac{x \cdot (x - 21)}{3 \cdot (x - 14)}, X1 := 0, Y1 := \frac{35}{3}, Y2 := \frac{35}{6} \end{array} \right]$$

$$\#70: \left[\begin{array}{l} WT := 5, L := 4, w := 5 - \frac{5 \cdot x}{7}, \text{cg} := \frac{x \cdot (x - 21)}{3 \cdot (x - 14)}, X1 := 0, Y1 := 11.66666666, Y2 := \end{array} \right]$$

$$5.833333333 \left. \vphantom{\frac{5.833333333}{1}} \right]$$

#71:

$$\left[\begin{array}{l} FV1(x) := \frac{5 \cdot x \cdot (x - 14)}{14} \\ FV2(x) := \frac{5 \cdot (3 \cdot x^2 - 42 \cdot x + 98)}{42} \\ FV3(x) := \frac{5 \cdot (x^2 - 14 \cdot x + 49)}{14} \end{array} \right]$$



#72: $FV2(x) = 0$

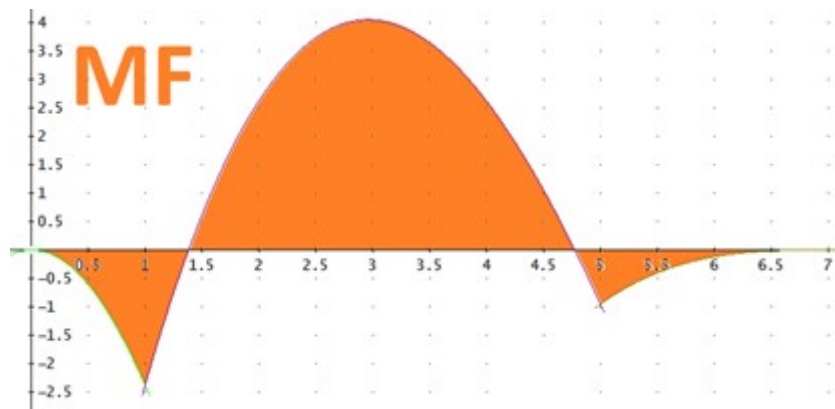
#73:
$$\frac{5 \cdot (3 \cdot x^2 - 42 \cdot x + 98)}{42} = 0$$

#74:
$$x = 7 - \frac{7 \cdot \sqrt{3}}{3} \vee x = \frac{7 \cdot \sqrt{3}}{3} + 7$$

#75:
$$x = 11.04145188 \vee x = 2.958548115$$

#76:

$$\left[\begin{array}{l} \text{MF1}(x) := \frac{5 \cdot x^2 \cdot (x - 21)}{42} \\ \text{MF2}(x) := \frac{5 \cdot (x^3 - 21 \cdot x^2 + 98 \cdot x - 98)}{42} \\ \text{MF3}(x) := \frac{5 \cdot (x^3 - 21 \cdot x^2 + 147 \cdot x - 343)}{42} \end{array} \right]$$



Momento flector negativo máximo en $x=1$ y momento flector positivo máximo en $x=2.96\text{m}$

#77:

$$\left[\begin{array}{l} \sigma_{\text{Sup1}} = - \frac{\text{MF1}(1) \cdot 0.2}{I_z} \quad \sigma_{\text{Inf1}} = - \frac{\text{MF1}(1) \cdot (-0.2)}{I_z} \\ \sigma_{\text{Sup2}} = - \frac{\text{MF2}(2.958548115) \cdot 0.2}{I_z} \quad \sigma_{\text{Inf2}} = - \frac{\text{MF2}(2.958548115) \cdot (-0.2)}{I_z} \end{array} \right]$$

#78:

$$\left[\begin{array}{ll} \sigma_{\text{Sup1}} = 595.2380952 & \sigma_{\text{Inf1}} = -595.2380952 \\ \sigma_{\text{Sup2}} = -1012.522665 & \sigma_{\text{Inf2}} = 1012.522665 \end{array} \right]$$