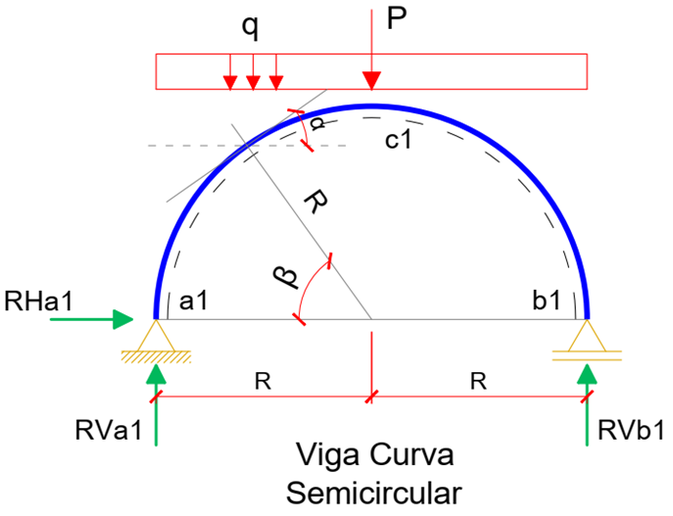
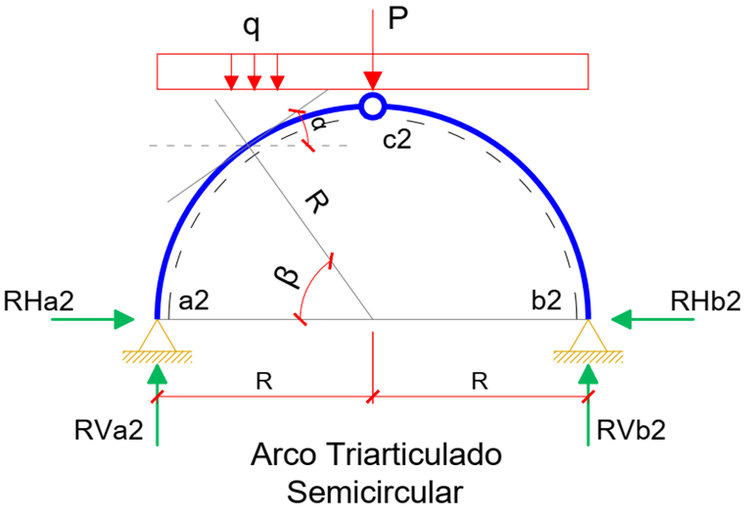
B2T4MA0511E1

Proceder os traçados dos diagramas de Momentos Fletores, Esforços Cortantes e Esforços Axiais para os dois modelos estruturais abaixo .

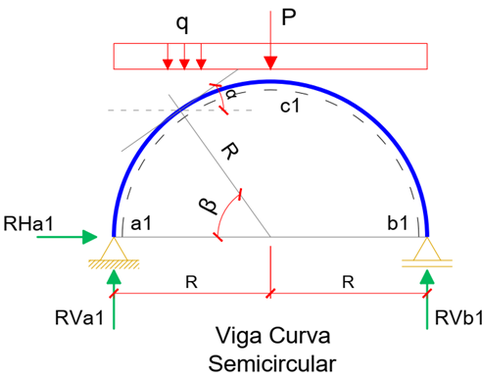
Dados comuns aos dois modelos: $q := 25\ \frac{kN}{m}$ $P := 60\ kN$ $R := 5\ m$





Reações de Apoio:

Para a Viga Curva:



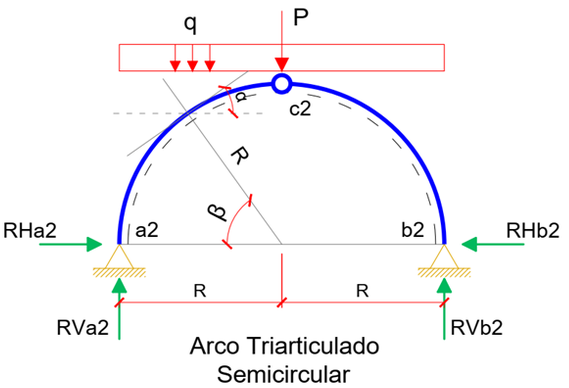
$Rha1 := 0$

$RVa1 := \frac{q \cdot 2 \cdot R}{2} + \frac{P}{2} = 155,0\ kN$

$RVb1 := \frac{q \cdot 2 \cdot R}{2} + \frac{P}{2} = 155,0\ kN$

$RHa1 := 0\ kN$

Para o Arco Triarticulado:



ΣMb2 = 0 (+) horário: RVa2 .2.R - q.(2.R)^2/2 - P.R =0

$RVa2 := \frac{1}{2 \cdot R} \cdot \left(q \cdot \frac{(2 \cdot R)^2}{2} + P \cdot R \right) = 155,0\ kN$

ΣFv = 0 (+) para cima: RVb2 + RVa2 - P - q.2.R =0

$RVb2 := -RVa2 + P + q \cdot 2 \cdot R = 155,0\ kN$

ΣMc2 = 0 (+) antihorário: RHa2.R - RVa2.R + q.R^2/2 = 0

$RHa2 := \frac{1}{R} \cdot \left(RVa2 \cdot R - \frac{q \cdot R^2}{2} \right) = 92,50\ kN$

ΣFh = 0 (+) para direita: RHa2- RHb2 = 0

$RHb2 := RHa2 = 92,50\ kN$

Equações de Momentos Fletores:

Para a Viga Curva no Trecho "ac"

$x := R - R \cdot \cos(\beta)$ $\quad$ $y := R \cdot \sin(\beta)$

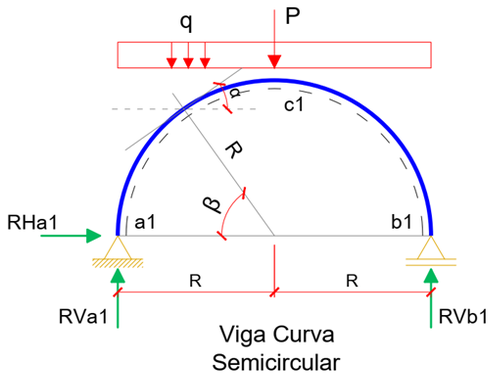
$M1_ach(\beta) := RVa1 \cdot x - \frac{q \cdot x^2}{2}$

$M1_acv(\beta) := -RHa1 \cdot y$

$M1_ac(\beta) := M1_ach(\beta) + M1_acv(\beta)$

$M1_ac(\beta) = \frac{25 \cdot (1 - \cos(\beta)) \cdot (62 - 25 \cdot (1 - \cos(\beta)))}{2}$ kN m

$M1_ac(0) = 0,0000$ $\quad$ $M1_ac(90\ °) = 462,50$ kN m



Para a Viga Curva no Trecho "cb"

$M1_cbh(\beta) := RVa1 \cdot x - \frac{q \cdot x^2}{2} - P \cdot (x - R)$

$M1_cbv(\beta) := -RHa1 \cdot y$

$M1_cb(\beta) := M1_cbh(\beta) + M1_cbv(\beta)$

$M1_cb(\beta) = \frac{25 \cdot \left((1 - \cos(\beta)) \cdot (62 - 25 \cdot (1 - \cos(\beta))) + 24 \cdot \cos(\beta)\right)}{2}$ kN m

$M1_cb(90\ °) = 462,5$ kN m $\quad$ $M1_cb(180\ °) = 0$ kN m

Para o Arco Triarticulado no Trecho "ac" :

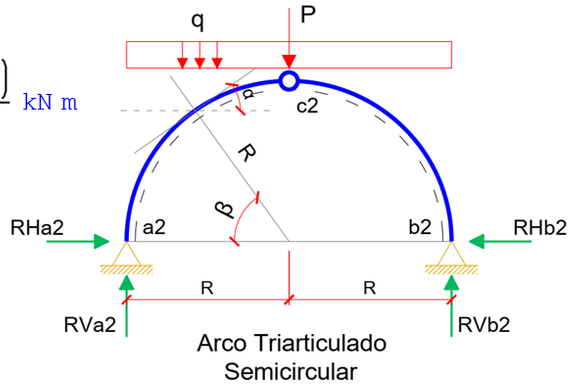
$M2_ach(\beta) := RVa2 \cdot x - \frac{q \cdot x^2}{2}$

$M2_acv(\beta) := -RHa2 \cdot y$

$M2_ac(\beta) := M2_ach(\beta) + M2_acv(\beta)$

$M2_ac(\beta) = \frac{25 \cdot \left((1 - \cos(\beta)) \cdot (62 - 25 \cdot (1 - \cos(\beta))) - 37 \cdot \sin(\beta)\right)}{2}$ kN m

$M2_ac(0\ °) = 0$ kN m $\quad$ $M2_ac(90\ °) = 0$ kN m



Para o Arco Triarticulado no Trecho "cb" :

$M2_cbh(\beta) := RVa2 \cdot x - \frac{q \cdot x^2}{2} - P \cdot (x - R)$

$M2_cbv(\beta) := -RHa2 \cdot y$

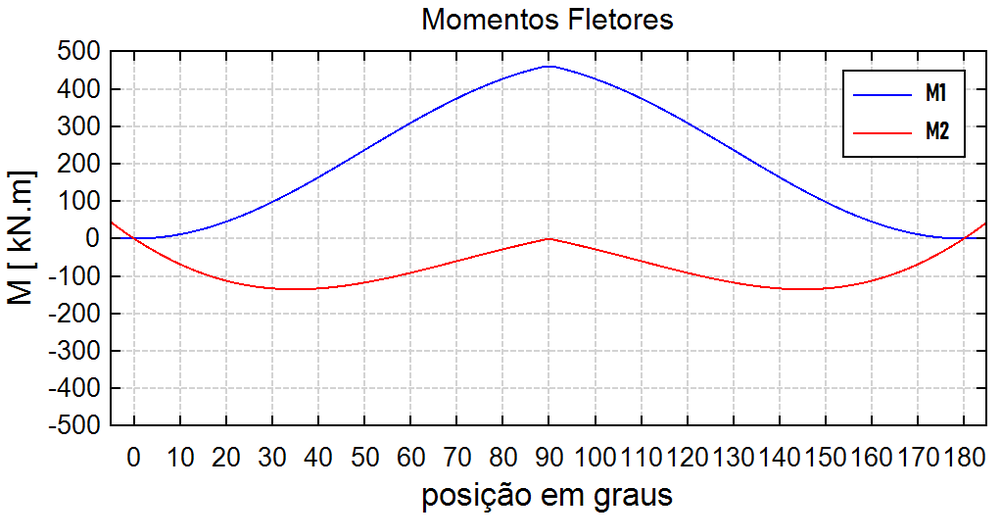
$M2_cb(\beta) := M2_cbh(\beta) + M2_cbv(\beta)$

$M2_cb(\beta) = \frac{25 \cdot \left((1 - \cos(\beta)) \cdot (62 - 25 \cdot (1 - \cos(\beta))) + 24 \cdot \cos(\beta) - 37 \cdot \sin(\beta)\right)}{2}$ kN m

$M2_cb(90\ °) = 0$ kN m $\quad$ $M2_cb(180\ °) = 0$ kN m

$M1(\beta) := \text{if } \beta < 90 \; M1_ac(\beta\,°) \text{ else } M1_cb(\beta\,°)$

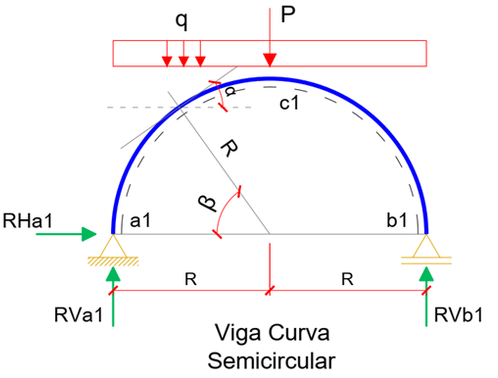
$M2(\beta) := \text{if } \beta < 90 \; M2_ac(\beta\,°) \text{ else } M2_cb(\beta\,°)$



Equações de Cortantes e Axiais:

$$V(\beta) = FV(\beta).\cos\alpha(\beta) + FH(\beta).\operatorname{sen}\alpha(\beta)$$
$$N(\beta) = -FV(\beta).\operatorname{sen}\alpha(\beta) + FH(\beta).\cos\alpha(\beta)$$

Para Viga Curva - Trecho "ac"



$\alpha(\beta) := \frac{\pi}{2} - \beta$

$FV1_ac(\beta) := RVa1 - q \cdot x = 5 \cdot (31 - 25 \cdot (1 - \cos(\beta)))$ kN

$FH1_ac(\beta) := -RHa1 = 0$ kN

$V1_ac(\beta) := FV1_ac(\beta) \cdot \cos(\alpha(\beta)) + FH1_ac(\beta) \cdot \sin(\alpha(\beta))$

$N1_ac(\beta) := (-FV1_ac(\beta)) \cdot \sin(\alpha(\beta)) + FH1_ac(\beta) \cdot \cos(\alpha(\beta))$

$V1_ac(\beta) = 5 \cdot (31 - 25 \cdot (1 - \cos(\beta))) \cdot \cos\left(\frac{-2 \cdot \beta + \pi}{2}\right)$ kN

$N1_ac(\beta) = -5 \cdot (31 - 25 \cdot (1 - \cos(\beta))) \cdot \sin\left(\frac{-2 \cdot \beta + \pi}{2}\right)$ kN

Para Viga Curva - Trecho "cb"

$FV1_cb(\beta) := RVa1 - q \cdot x - P = -5 \cdot (-31 + 25 \cdot (1 - \cos(\beta)) + 12)$ kN

$FH1_cb(\beta) := -RHa1 = 0$ kN

$V1_cb(\beta) := FV1_cb(\beta) \cdot \cos(\alpha(\beta)) + FH1_cb(\beta) \cdot \sin(\alpha(\beta))$

$N1_cb(\beta) := (-FV1_cb(\beta)) \cdot \sin(\alpha(\beta)) + FH1_cb(\beta) \cdot \cos(\alpha(\beta))$

$V1_cb(\beta) = -5 \cdot (-31 + 25 \cdot (1 - \cos(\beta)) + 12) \cdot \cos\left(\frac{-2 \cdot \beta + \pi}{2}\right)$ kN

$N1_cb(\beta) = 5 \cdot (-31 + 25 \cdot (1 - \cos(\beta)) + 12) \cdot \sin\left(\frac{-2 \cdot \beta + \pi}{2}\right)$ kN

$V1_ac(0\,°) = 0{,}0000$ $\qquad N1_ac(0\,°) = -155{,}00\ kN$

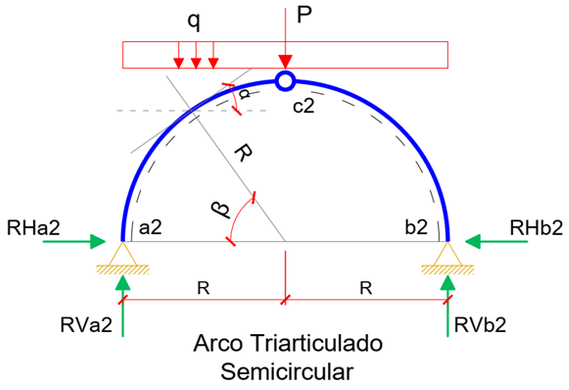
$V1_ac(90\,°) = 30\ kN$ $\qquad N1_ac(90\,°) = 0\ kN$

$V1_cb(90\,°) = -30\ kN$ $\qquad N1_cb(90\,°) = 0\ kN$

$V1_cb(180\,°) = 0\ kN$ $\qquad N1_cb(180\,°) = -155\ kN$

$$V(\beta) = FV(\beta).\cos\alpha(\beta) + FH(\beta).\operatorname{sen}\alpha(\beta)$$
$$N(\beta) = -FV(\beta).\operatorname{sen}\alpha(\beta) + FH(\beta).\cos\alpha(\beta)$$

Para o Arco Triarticulado - Trecho "ac"



$FV2_ac(\beta) := RVa2 - q \cdot x = 5 \cdot (31 - 25 \cdot (1 - \cos(\beta)))\ kN$

$FH2_ac(\beta) := -RHa2 = -92{,}5\ kN$

$V2_ac(\beta) := FV2_ac(\beta) \cdot \cos(\alpha(\beta)) + FH2_ac(\beta) \cdot \sin(\alpha(\beta))$

$N2_ac(\beta) := (-FV2_ac(\beta)) \cdot \sin(\alpha(\beta)) + FH2_ac(\beta) \cdot \cos(\alpha(\beta))$

$$V2_ac(\beta) = \frac{5 \cdot \left(2 \cdot (31 - 25 \cdot (1 - \cos(\beta))) \cdot \cos\left(\frac{\pi - 2 \cdot \beta}{2}\right) - 37 \cdot \sin\left(\frac{\pi - 2 \cdot \beta}{2}\right)\right)}{2}\ kN$$

$$N2_ac(\beta) = -\frac{5 \cdot \left(2 \cdot (31 - 25 \cdot (1 - \cos(\beta))) \cdot \sin\left(\frac{\pi - 2 \cdot \beta}{2}\right) + 37 \cdot \cos\left(\frac{\pi - 2 \cdot \beta}{2}\right)\right)}{2}\ kN$$

Para o Arco Triarticulado - Trecho "cb"

$FV2_cb(\beta) := RVa2 - q \cdot x - P = -5 \cdot (-31 + 25 \cdot (1 - \cos(\beta)) + 12)\ kN$

$FH2_cb(\beta) := -RHa2 = -92{,}5\ kN$

$V2_cb(\beta) := FV2_cb(\beta) \cdot \cos(\alpha(\beta)) + FH2_cb(\beta) \cdot \sin(\alpha(\beta))$

$N2_cb(\beta) := (-FV2_cb(\beta)) \cdot \sin(\alpha(\beta)) + FH2_cb(\beta) \cdot \cos(\alpha(\beta))$

$$V2_cb(\beta) = -\frac{5 \cdot \left(2 \cdot (-19 + 25 \cdot (1 - \cos(\beta))) \cdot \cos\left(\frac{\pi - 2 \cdot \beta}{2}\right) + 37 \cdot \sin\left(\frac{\pi - 2 \cdot \beta}{2}\right)\right)}{2}\ kN$$

$$N2_cb(\beta) = \frac{5 \cdot \left(2 \cdot (-19 + 25 \cdot (1 - \cos(\beta))) \cdot \sin\left(\frac{\pi - 2 \cdot \beta}{2}\right) - 37 \cdot \cos\left(\frac{\pi - 2 \cdot \beta}{2}\right)\right)}{2}\ kN$$

$V2_ac(0\,°) = -92{,}5\ kN$ $\qquad N2_ac(0\,°) = -155\ kN$

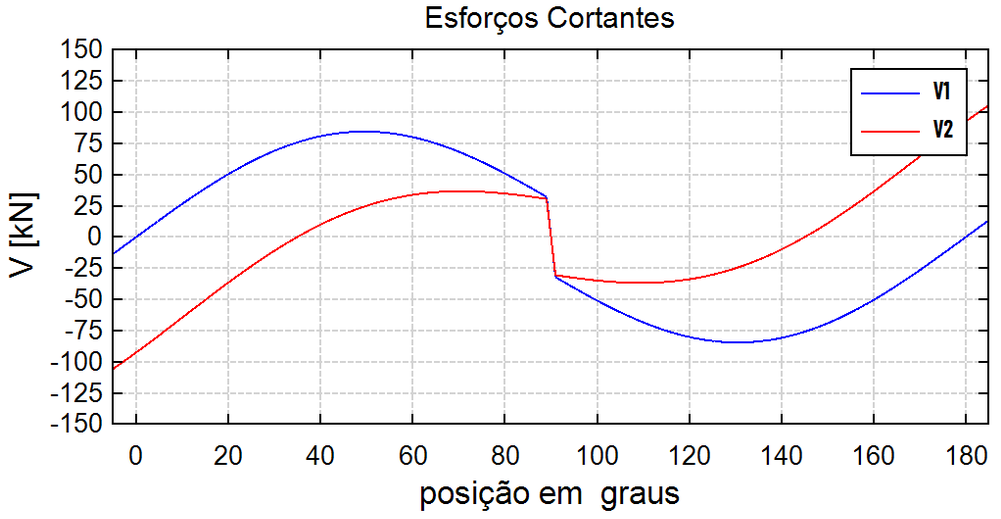
$V2_ac(90\,°) = 30\ kN$ $\qquad N2_ac(90\,°) = -92{,}5\ kN$

$V2_cb(90\,°) = -30\ kN$ $\qquad N2_cb(90\,°) = -92{,}5\ kN$

$V2_cb(180\,°) = 92{,}5\ kN$ $\qquad N2_cb(180\,°) = -155\ kN$

$V1(\beta) := \text{if } \beta < 90 \quad V1_ac(\beta\ °) \quad \text{else} \quad V1_cb(\beta\ °)$

$V2(\beta) := \text{if } \beta < 90 \quad V2_ac(\beta\ °) \quad \text{else} \quad V2_cb(\beta\ °)$



$N1(\beta) := \text{if } \beta < 90 \quad N1_ac(\beta\ °) \quad \text{else} \quad N1_cb(\beta\ °)$

$N2(\beta) := \text{if } \beta < 90 \quad N2_ac(\beta\ °) \quad \text{else} \quad N2_cb(\beta\ °)$

