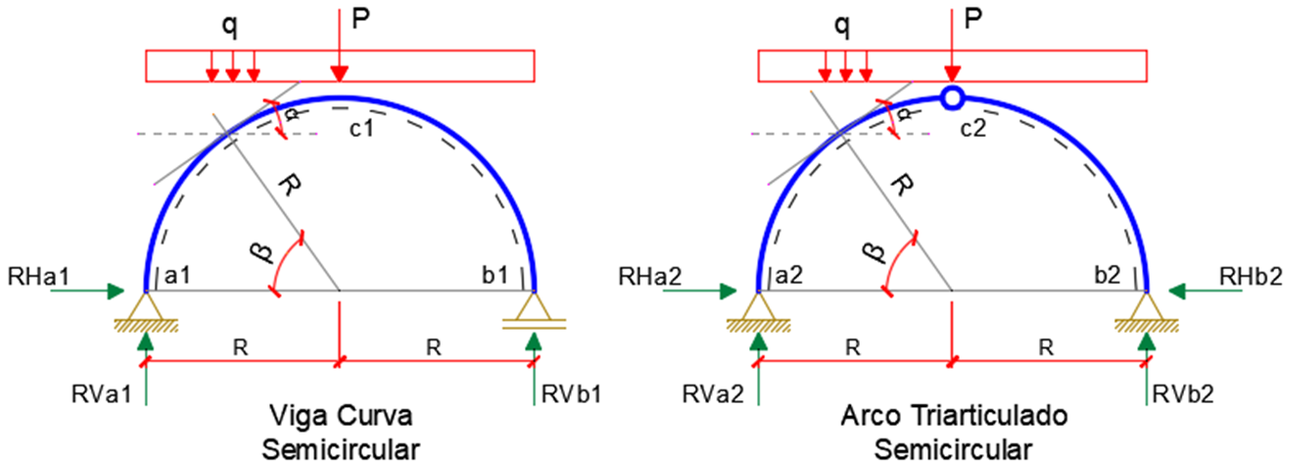
TE1_E07-10

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

Dados comuns aos dois modelos: $q := 25\ \frac{kN}{m}$ $P := 80\ kN$ $R := 4\ m$



Reações de Apoio:

Para a Viga Curva: ΣFh = 0 $RHa1 := 0\ kN$

Pela simetria de carga vertical: $RVa1 := \frac{q \cdot 2 \cdot R + P}{2} = 140\ kN$ $RVb1 := \frac{q \cdot 2 \cdot R + P}{2} = 140\ kN$

Para o Arco:

Pela simetria de carga vertical: $RVa2 := \frac{q \cdot 2 \cdot R + P}{2} = 140\ kN$ $RVb2 := \frac{q \cdot 2 \cdot R + P}{2} = 140\ kN$

ΣMc2 = 0 olhando para esquerda (+) giro antihorário

$RHa2 \cdot R + q \cdot R \cdot \frac{R}{2} - RVa2 \cdot R = 0$ $RHa2 := \frac{1}{R} \cdot \left(- q \cdot R \cdot \frac{R}{2} + RVa2 \cdot R \right) = 90\ kN$

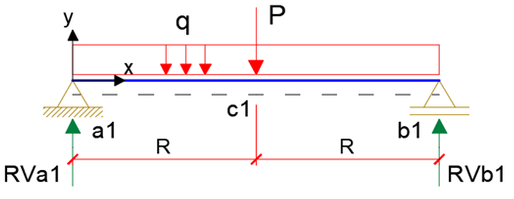
ΣFh = 0 (+) para a direita

$RHa2 - RHb2 = 0$ $RHb2 := RHa2 = 90\ kN$

Equações de Momentos Fletores:

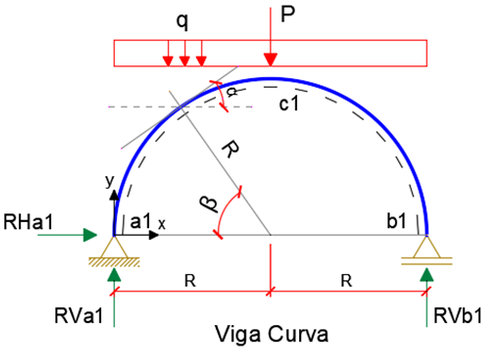
PARA A VIGA:

Devido carga concentrada "P" faz-se necessário o uso de 2 domínio, a saber, com β variando de 0 até 90° (Domínio "ac") e β variando de 90° até 180° (Domínio "cb").



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

$y := R \cdot \sin(\beta)$



$Mh_ac1(\beta) := RVa1 \cdot x - \frac{q \cdot x^2}{2}$ $Mh_cb1(\beta) := RVa1 \cdot x - \frac{q \cdot x^2}{2} - P \cdot (x - R)$

$Mv_ac1(\beta) := - RHa1 \cdot y$ $Mv_cb1(\beta) := - RHa1 \cdot y$

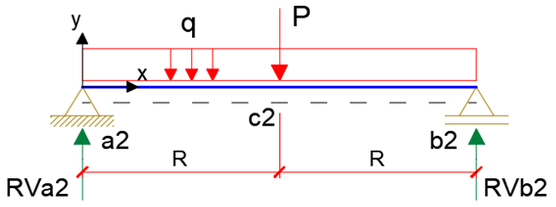
$M1_ac1(\beta) := Mh_ac1(\beta) + Mv_ac1(\beta)$

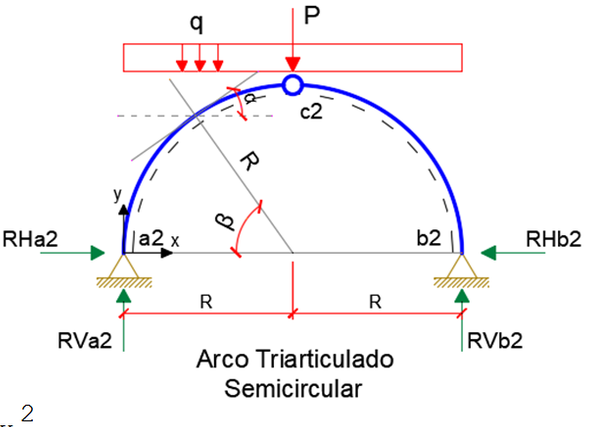
$M1_cb1(\beta) := Mh_cb1(\beta) + Mv_cb1(\beta)$

$M1(\beta) := \text{if } \beta < 90$
$\quad M1_ac1(\beta\ °)$
$\quad \text{else}$
$\quad M1_cb1(\beta\ °)$

PARA O ARCO: $x := R - R \cdot \cos(\beta)$

$y := R \cdot \sin(\beta)$





$Mh_ac2(\beta) := RVa2 \cdot x - \frac{q \cdot x^2}{2}$

$Mh_cb2(\beta) := RVa2 \cdot x - \frac{q \cdot x^2}{2} - P \cdot (x - R)$

$Mv_ac2(\beta) := -RHa2 \cdot y$

$Mv_cb2(\beta) := -RHa2 \cdot y$

$M2_ac2(\beta) := Mh_ac2(\beta) + Mv_ac2(\beta)$

$M2_cb2(\beta) := Mh_cb2(\beta) + Mv_cb2(\beta)$

$M2(\beta) := \text{if } \beta < 90$
$\quad M2_ac2(\beta\ °)$
$\quad \text{else}$
$\quad M2_cb2(\beta\ °)$

$M2(45) = -107,6955\ \text{kN m}$

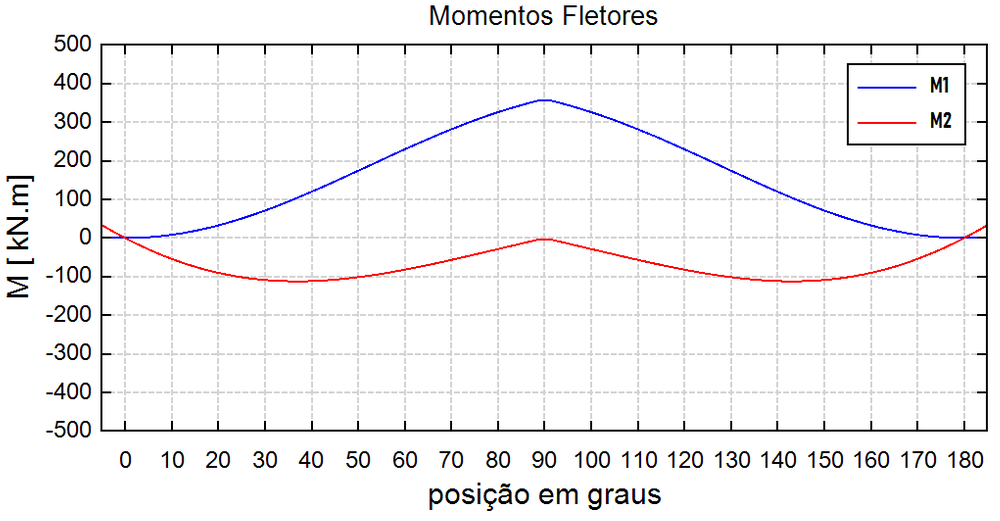
$M2(90) = 0\ \text{kN m}$

$M2(135) = -107,6955\ \text{kN m}$

$M1(45) = 146,8629\ \text{kN m}$

$M1(90) = 360\ \text{kN m}$

$M1(135) = 146,8629\ \text{kN m}$



Equações de Cortantes e Axiais:

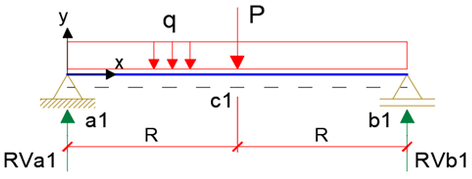
PARA A VIGA:

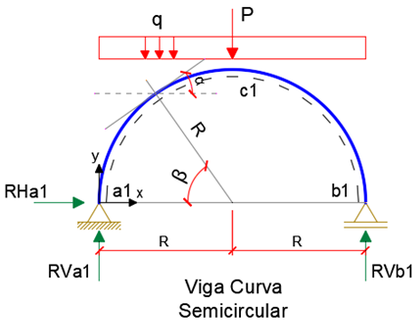
$x := R - R \cdot \cos(\beta)$

$y := R \cdot \sin(\beta)$

$\Sigma VER1_ac(x) := RVa1 - q \cdot x$ $\Sigma VER1_cb(x) := RVa1 - q \cdot x - P$

$\Sigma HOR1_ac(y) := RHa1$ $\Sigma HOR1_cb(y) := RHa1$





$\alpha(\beta) := 90\ ° - \beta$

$$V(\alpha) = \Sigma VER.\cos\alpha - \Sigma HOR.sen\alpha$$
$$N(\alpha) = -\Sigma VER.sen\alpha - \Sigma HOR.\cos\alpha$$

$V1_ac(\beta) := \Sigma VER1_ac(x) \cdot \cos(\alpha(\beta)) - \Sigma HOR1_ac(y) \cdot \sin(\alpha(\beta))$

$N1_ac(\beta) := -\Sigma VER1_ac(x) \cdot \sin(\alpha(\beta)) - \Sigma HOR1_ac(y) \cdot \cos(\alpha(\beta))$

$V1_cb(\beta) := \Sigma VER1_cb(x) \cdot \cos(\alpha(\beta)) - \Sigma HOR1_cb(y) \cdot \sin(\alpha(\beta))$

$N1_cb(\beta) := -\Sigma VER1_cb(x) \cdot \sin(\alpha(\beta)) - \Sigma HOR1_cb(y) \cdot \cos(\alpha(\beta))$

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

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

$V1(0) = 0$ $N1(0) = -140\ kN$

$V1(45) = 78,2843\ kN$ $N1(45) = -78,2843\ kN$

$V1(90) = -40\ kN$ $N1(90) = 0\ kN$

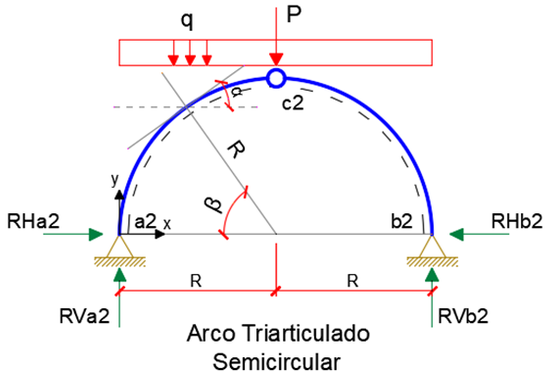
$V1(135) = -78,2843\ kN$ $N1(135) = -78,2843\ kN$

$V1(180) = 0\ kN$ $N1(180) = -140\ kN$

PARA O ARCO:

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

$y := R \cdot \sin(\beta)$

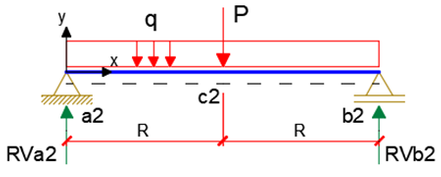


$\Sigma VER2_ac(x) := RVa2 - q \cdot x$

$\Sigma HOR2_ac(y) := RHa2$

$\Sigma VER2_cb(x) := RVa2 - q \cdot x - P$

$\Sigma HOR2_cb(y) := RHa2$



$\alpha(\beta) := 90° - \beta$

$$V(\alpha) = \Sigma VER.\cos\alpha - \Sigma HOR.sen\alpha$$
$$N(\alpha) = -\Sigma VER.sen\alpha - \Sigma HOR.\cos\alpha$$

$V2_ac(\beta) := \Sigma VER2_ac(x)\cdot\cos(\alpha(\beta)) - \Sigma HOR2_ac(y)\cdot\sin(\alpha(\beta))$

$N2_ac(\beta) := -\Sigma VER2_ac(x)\cdot\sin(\alpha(\beta)) - \Sigma HOR2_ac(y)\cdot\cos(\alpha(\beta))$

$V2_cb(\beta) := \Sigma VER2_cb(x)\cdot\cos(\alpha(\beta)) - \Sigma HOR2_cb(y)\cdot\sin(\alpha(\beta))$

$N2_cb(\beta) := -\Sigma VER2_cb(x)\cdot\sin(\alpha(\beta)) - \Sigma HOR2_cb(y)\cdot\cos(\alpha(\beta))$

$V2(\beta) :=$ if $\beta < 90$ $V2_ac(\beta°)$ else $V2_cb(\beta°)$

$N2(\beta) :=$ if $\beta < 90$ $N2_ac(\beta°)$ else $N2_cb(\beta°)$

$V2(0) = -90$ kN

$V2(45) = 14,6447$ kN

$V2(90) = -40$ kN

$V2(135) = -14,6447$ kN

$V2(180) = 90$ kN

$N2(0) = -140$ kN

$N2(45) = -141,9239$ kN

$N2(90) = -90$ kN

$N2(135) = -141,9239$ kN

$N2(180) = -140$ kN

