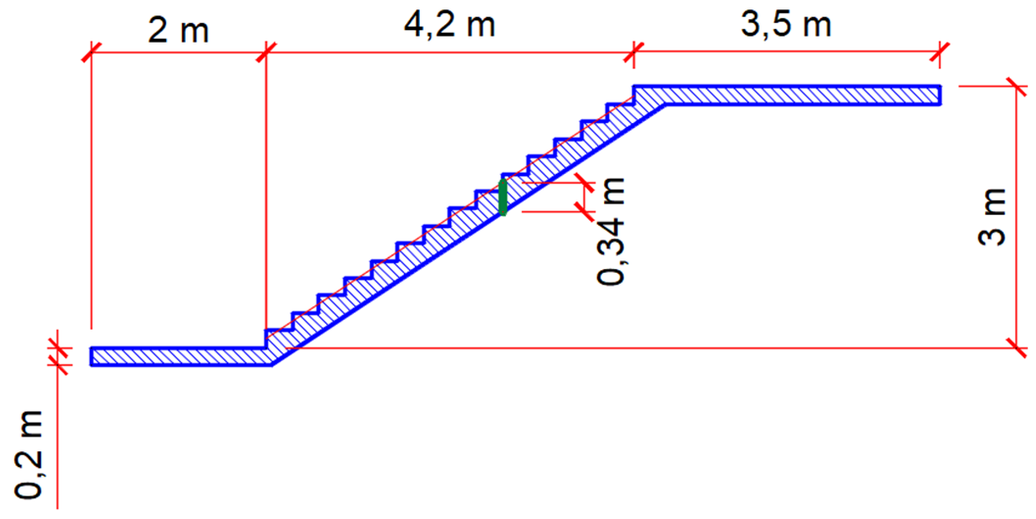
B2T4MA0427-Aula

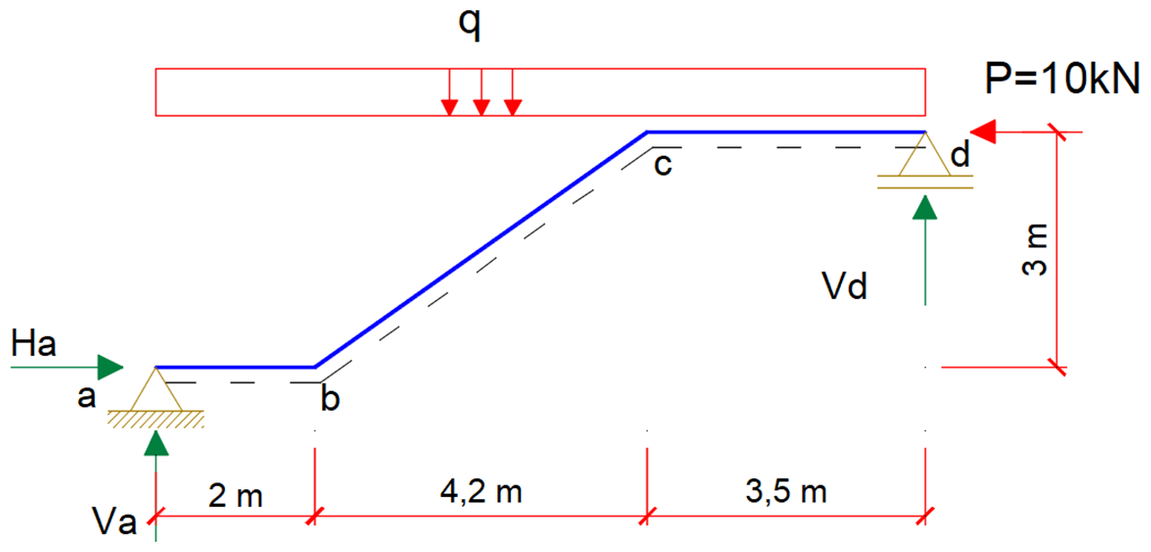
Esboçar os Diagramas M, V e N do carregamento de ocupação do trecho de escada do modelo estrutural apresentado.

-Largura da escada : B = 1,5 m (transversal)
-Carga de Ocupação : 3 kN/m²

Corte Longitudinal da Escada



Modelo Estrutural:



Cálculo da Carga de Ocupação:

$q_area := 3\ \frac{kN}{m^2}$ $B := 1,5\ m$

$q := q_area \cdot B = 4,5\ \frac{kN}{m}$

Reações de Apoio:

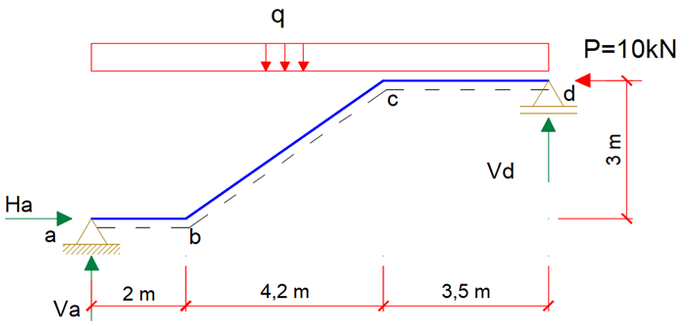
$Lab := 2,0\ m$ $Lbch := 4,2\ m$ $Lcd := 3,5\ m$ $Lv := 3,0\ m$ $P := 10\ kN$

ΣMa = 0 (+) antihorário

Vd.(Lab+Lbch+Lcd)-q.((Lab+Lbch+Lcd)^2)/2 + P.Lv= 0

$$Vd := \frac{1}{Lab + Lbch + Lcd} \cdot \left(\frac{q \cdot (Lab + Lbch + Lcd)^2}{2} - P \cdot Lv \right)$$

$Vd = 18,7322\ kN$



ΣFh = 0 (+) para direita

$Ha := P = 10\ kN$

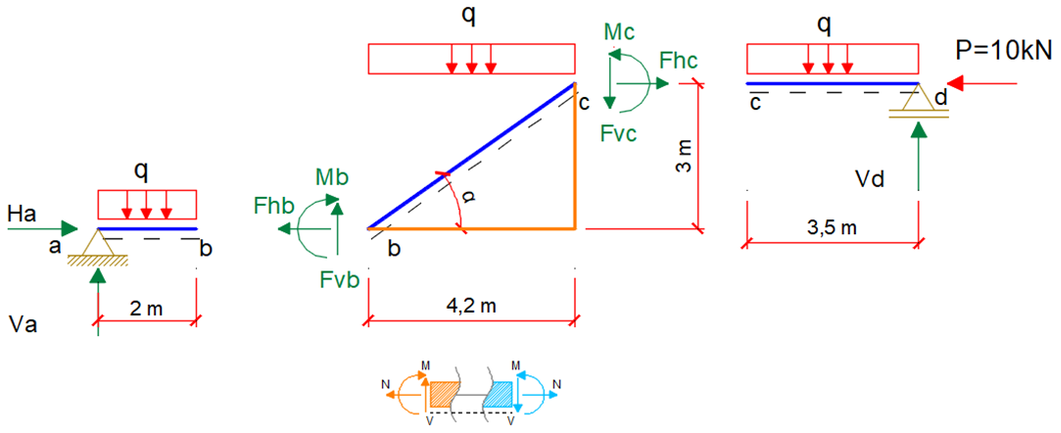
ΣFv = 0 (+) para cima

Va-q.(Lab+Lbch+Lcd)+Vd=0

$Va := q \cdot (Lab + Lbch + Lcd) - Vd$

$Va = 24,9178\ kN$

Equilíbrio Individual da barra "bc" no sistema horizontal vertical:



Esforços em sistema horizontal e vertical no ponto "b":

$Fvb := Va - q \cdot Lab = 15,9178\ kN$

$Fhb := -Ha = -10\ kN$

$$Mb := Va \cdot Lab - \frac{q \cdot Lab^2}{2} = 40,8356\ kN\,m$$

Esforços em sistema horizontal e vertical no ponto "c":

$Fvc := -Vd + q \cdot Lcd = -2,9822\ kN$

$Fhc := -P = -10\ kN$

$$Mc := Vd \cdot Lcd - \frac{q \cdot Lcd^2}{2} = 38,0003\ kN\,m$$

Projeção das Forças nos eixos Paralelo e Perpendicular:

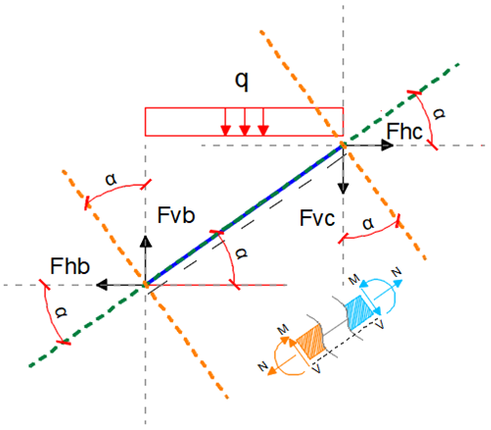
Relações Trigonométricas:

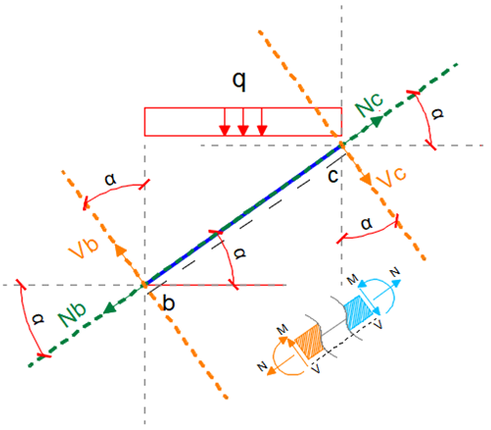
V = VER.cosα + HOR.senα
N = -VER.senα + HOR.cosα

$Lbc := \sqrt{Lbch^2 + Lv^2} = 5,1614\ m$

$cos\alpha := \frac{Lbch}{Lbc} = 0,8137$

$sen\alpha := \frac{Lv}{Lbc} = 0,5812$





Transformação de sistema no ponto "b" (ponto à esqueda da barra):

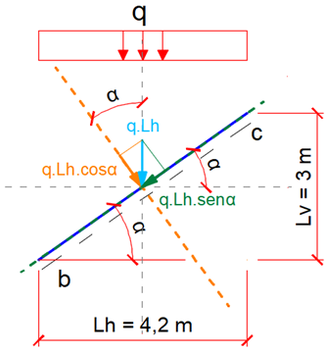
$Vb := +Fvb \cdot cos\alpha + Fhb \cdot sen\alpha = 7,1405\ kN$

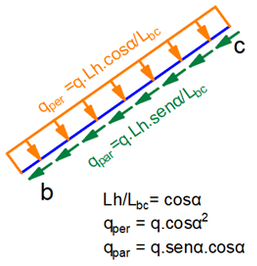
$Nb := -Fvb \cdot sen\alpha + Fhb \cdot cos\alpha = -17,3894\ kN$

Transformação de sistema no ponto "c" (ponto à direita da barra):

$Vc := +Fvc \cdot cos\alpha + Fhc \cdot sen\alpha = -8,2391\ kN$

$Nc := -Fvc \cdot sen\alpha + Fhc \cdot cos\alpha = -6,404\ kN$





$resq := q \cdot Lbch = 18,9\ kN$

$resq_per := resq \cdot cos\alpha = 15,3796\ kN$

$resq_par := resq \cdot sen\alpha = 10,9854\ kN$

$q_per := \frac{resq_per}{Lbc} = 2,9797\ \frac{kN}{m}$

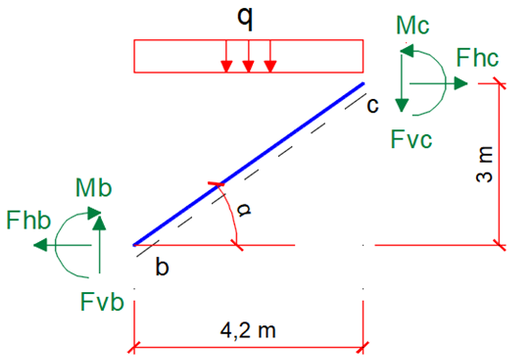
$q_par := \frac{resq_par}{Lbc} = 2,1284\ \frac{kN}{m}$

$q_per := q \cdot cos\alpha^2 = 2,9797\ \frac{kN}{m}$

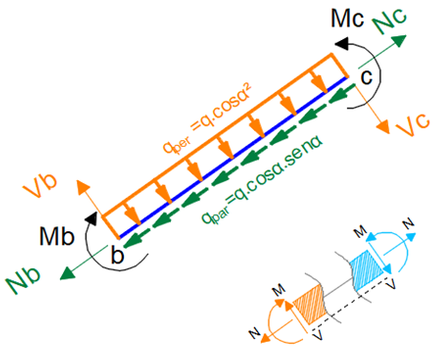
$q_par := q \cdot sen\alpha \cdot cos\alpha = 2,1284\ \frac{kN}{m}$

Traçado dos Diagramas:

Sistema de Forças
HORIZONTAL e VERTICAL



Sistema de Forças
PARALELO (AXIAIS) e PERPENDICULAR
(CORTANTE)



Equação de Cortantes:

$Vbc(x) := Vb - q_per \cdot x$

$Vbc(0\ m) = 7,1405\ kN$
$Vbc(2\ m) = 1,181\ kN$
$Vbc(4\ m) = -4,7785\ kN$
$Vbc(Lbc) = -8,2391\ kN$

Equação de Axiais:

$Nbc(x) := Nb + q_par \cdot x$

$Nbc(0\ m) = -17,3894\ kN$
$Nbc(2\ m) = -13,1326\ kN$
$Nbc(4\ m) = -8,8758\ kN$
$Nbc(Lbc) = -6,404\ kN$

Eq. Mom. (x_inc):

$$Mbc_inc(x) := Mb + Vb \cdot x - q_per \cdot \frac{x^2}{2}$$

Eq. Mom. (x_hor):

$$Mbc_hor(x) := Mb + Fvb \cdot x + Fhb \cdot x \cdot \frac{Lv}{Lbch} - q \cdot \frac{x^2}{2}$$

$$Mbc_inc\left(\frac{Lbc}{2}\right) = 49,3404\ kN\ m$$

$$Mbc_hor\left(\frac{Lbch}{2}\right) = 49,3404\ kN\ m$$

Diagrama de Cortantes (kN):

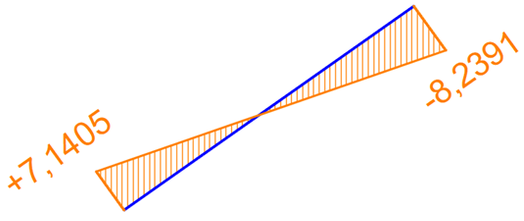


Diagrama de Momentos (kNm):

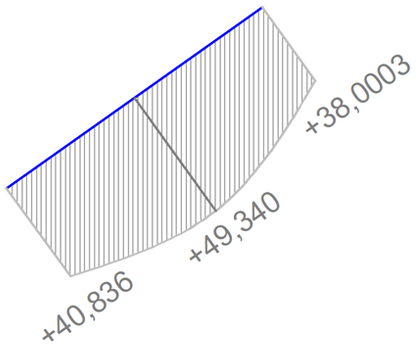


Diagrama de Axiais (kN):

