PEF3208

Aula 5

5 mai

PROF. NAKAO

- **Linhas de estado em vigas poligonais espaciais.**
- **Apresentação do programa Ftool.**

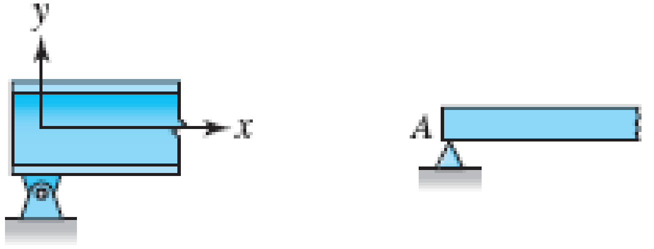
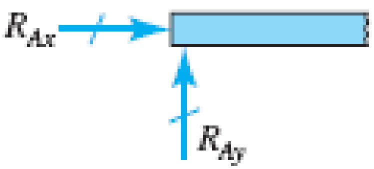
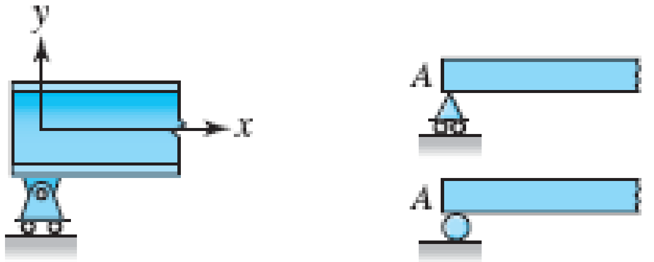
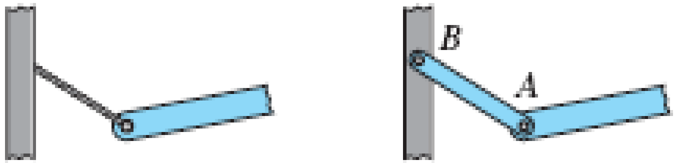
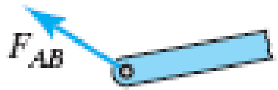
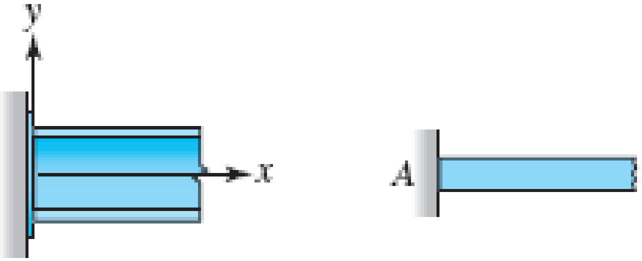
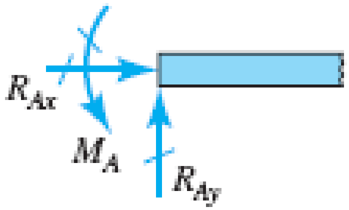
Planar Equations of Equilibrium

For a planar body to be in equilibrium, any one of the following sets of 3 equations may be used to solve for the unknown variables.

1. $\sum F_x = 0$, $\sum F_y = 0$, and $\sum M_A = 0$, where the resultant moment is with respect to any axis z or any point A in the xy-plane, or

2. $\sum F_x = 0$, $\sum M_A = 0$, and $\sum M_B = 0$, provided that the line connecting the points A and B is not perpendicular to the x axis, or

3. $\sum M_A = 0$, $\sum M_B = 0$, and $\sum M_C = 0$, where points A, B, and C are not collinear

Type of Support or Connection		Reaction*
1. Hinge or pin		
2. Roller		
3. Cable or link		
4. Fixed or clamped		

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REVIEW OF STATIC EQUILIBRIUM

Types of loads: External loads and Internal loads

- External loads are due to surface forces and body forces
  - Surfaces forces can be for example, a concentrated load acting at a point or a distributed load both acting on the surface of a body
  - Body forces act on a volumetric portion of the body, forexample, magnetic force or gravitational force
  - Reaction forces caused by the supports
- Internal loads can be considered as forces of interaction between the constituent material particles of the body

CONDITIONS OF EQUILIBRIUM

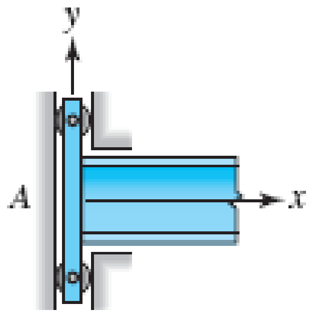
- When a system of forces acting upon a body has zero resultant, the body is said to be in force equilibrium.
- The equations of static equlibrium require:

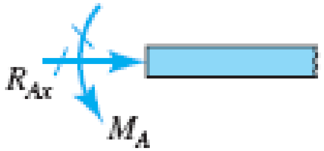
- $\sum F_x = 0$; $\sum F_y = 0$, and $\sum F_z = 0$

- $\sum M_x = 0$; $\sum M_y = 0$, and $\sum M_z = 0$

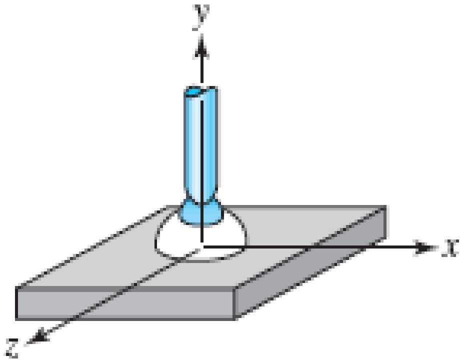
- In other words, for a body to be in static equilibrium, the sum of all forces acting upon a body in any direction is zero and also the sum of all moments taken about any axis is also zero.

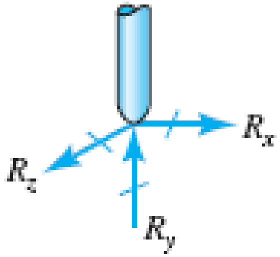
5. Guided



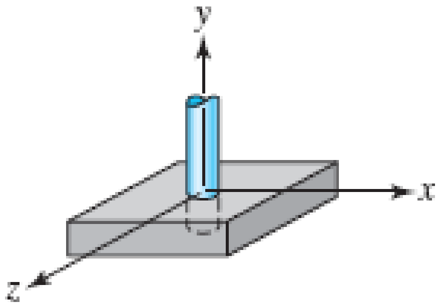


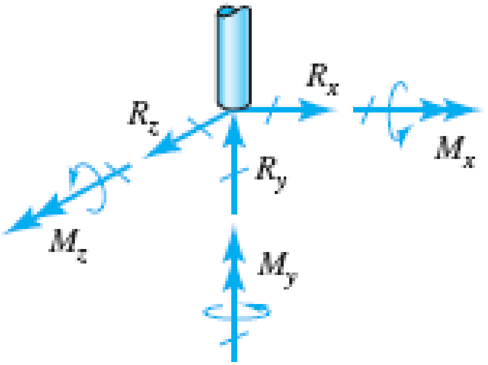
6. Ball and socket
(nonplanar)





7. Fixed
(nonplanar)





*Usually the reaction will be identified in this text with a *slash* drawn through its vector as shown.

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Freebody diagrams

1. Select the free body to be used.
2. Detach this body from its supports and separate it from any other bodies. (If internal force resultants are to be found, use the method of sections).
3. Show on the sketch all of the external forces acting on the body. Location, magnitude, and direction of each force should be marked on the sketch.
4. Label significant points and include dimensions. Any other detail, however, should be omitted.

ESFORÇOS SOLICITANTES EM ESTRUTURAS ESPACIAIS

No esboço dos gráficos dos esforços solicitantes deve-se observar que:

- Se a estrutura é uma **barra poligonal engastada em um único ponto o caminhamento dos esforços deve ser da extremidade livre para o apoio**, não havendo a necessidade da obtenção das reações que poderão ser obtidas a partir dos esforços solicitantes junto ao engastamento.

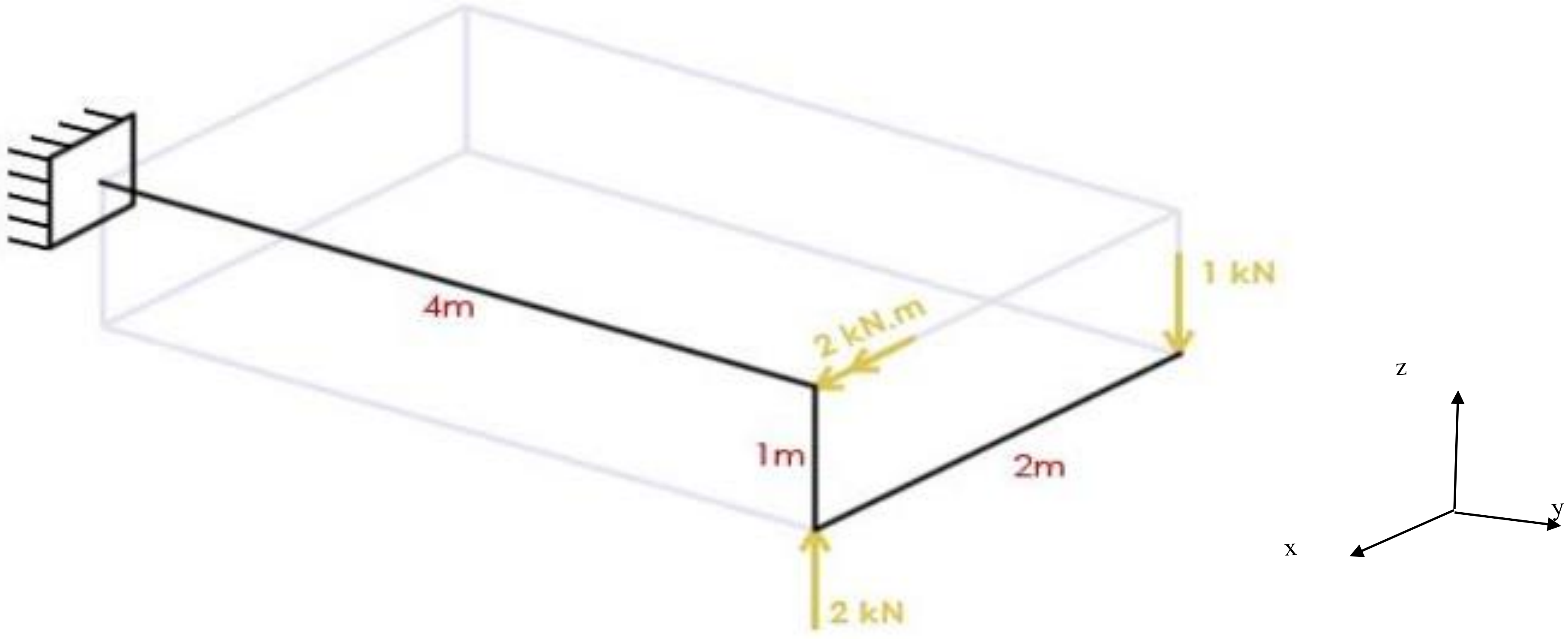
- Se a estrutura tem **vários apoios é necessário obter as reações nos apoios, fazer o diagrama do corpo livre e acompanhar o caminhamento dos esforços entre os apoios**, pois é a estrutura que leva os esforços até os apoios.

ESFORÇOS SOLICITANTES EM ESTRUTURAS ESPACIAIS

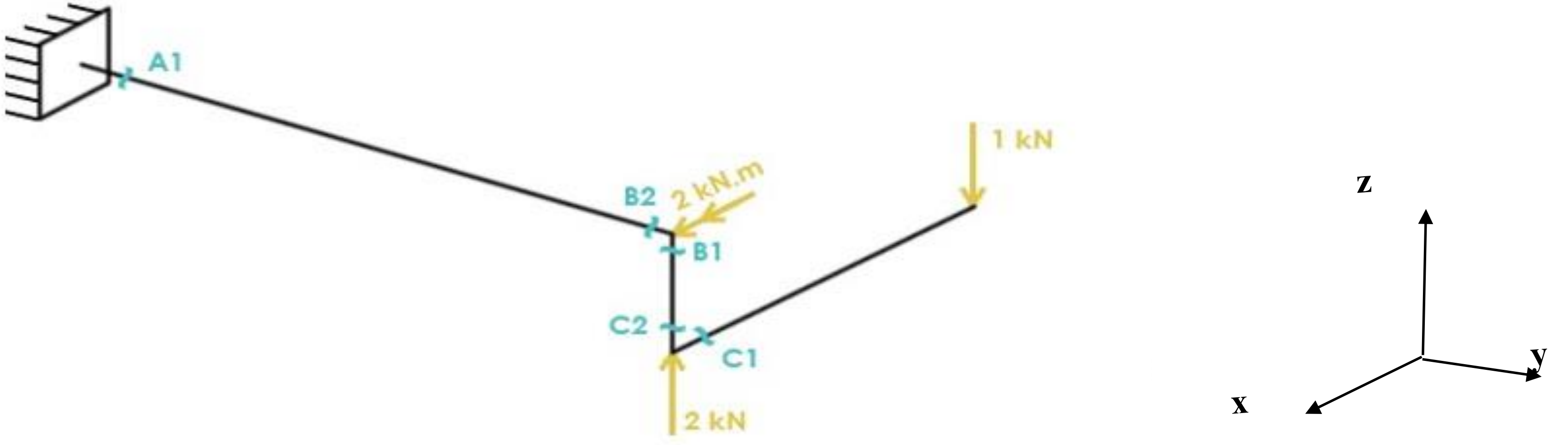
No esboço dos gráficos dos esforços solicitantes deve-se observar que:

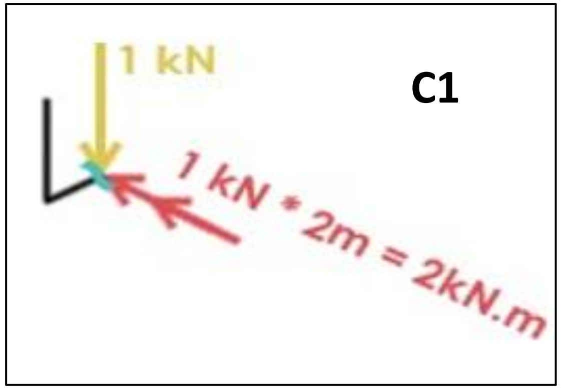
- **O "teorema do corte" deve ser aplicado em seções próximas a esforços ativos ou quando se tem mudança de carregamento ou quando há mudanças de direção das barras da estrutura.**
- As forças normais e os momentos fletores e de torção são reduzidos/transferidos de uma seção a outra sem novos acréscimos.
- As forças cortantes são reduzidas/transferidas de uma seção para a outra acrescentando um momento fletor para que os sistemas sejam mecanicamente equivalentes.

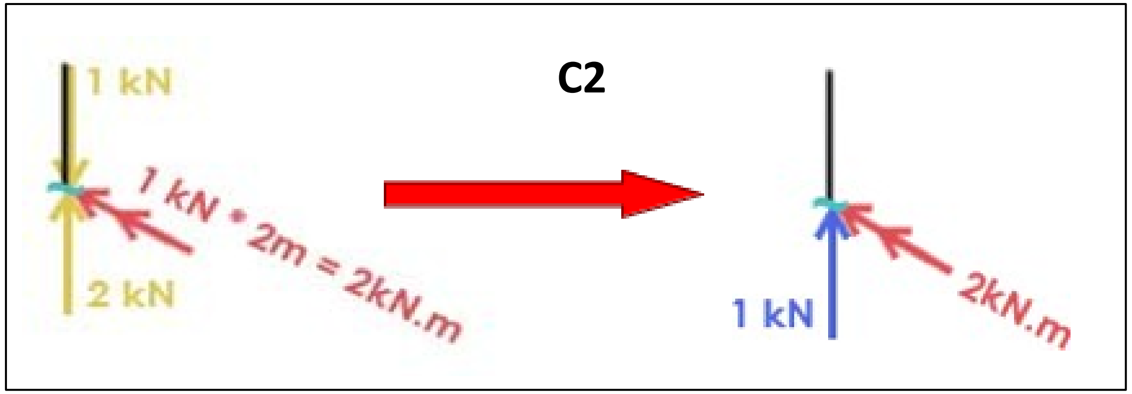
EXERCÍCIO 1.
Esboçar o diagrama dos esforços solicitantes na estrutura espacial

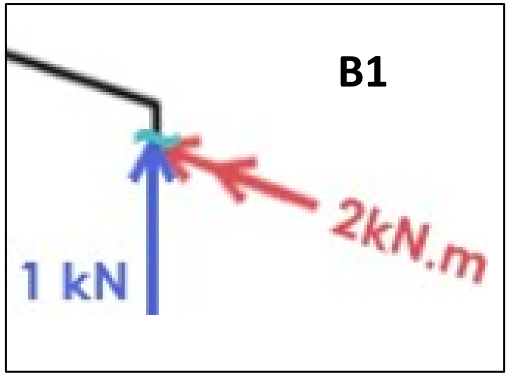


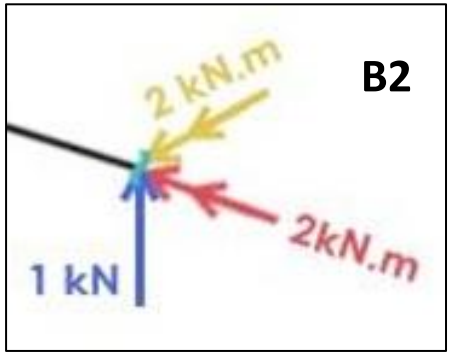
TEOREMA DO CORTE: SEÇÕES C1, C2, B1, B2, A1

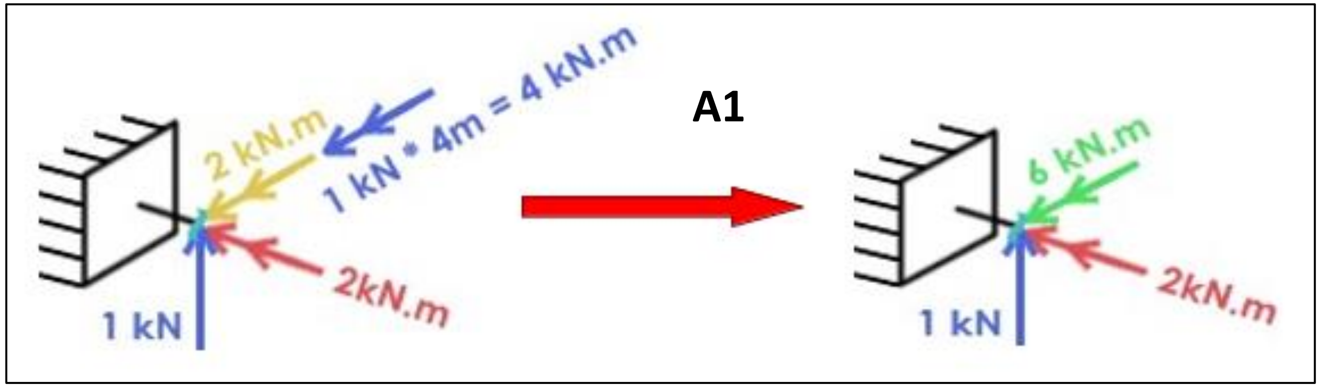




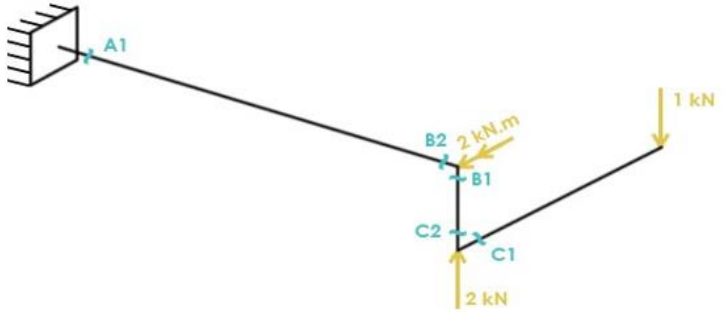




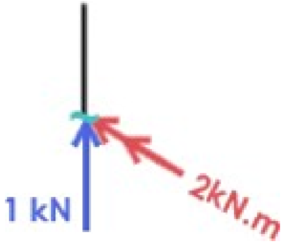




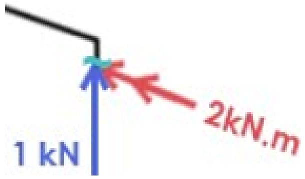
DIAGRAMAS DOS ESFORÇOS SOLICITANTES: FORÇA NORMAL E FORÇA CORTANTE



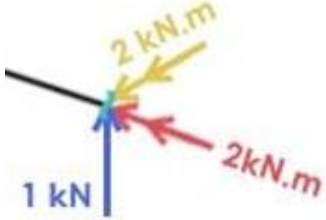
C1



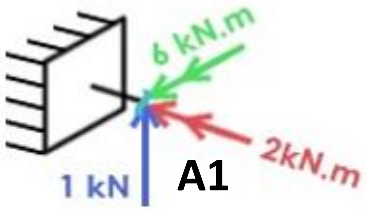
C2



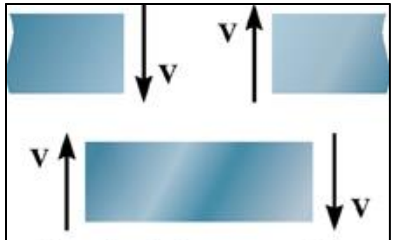
B1



B2

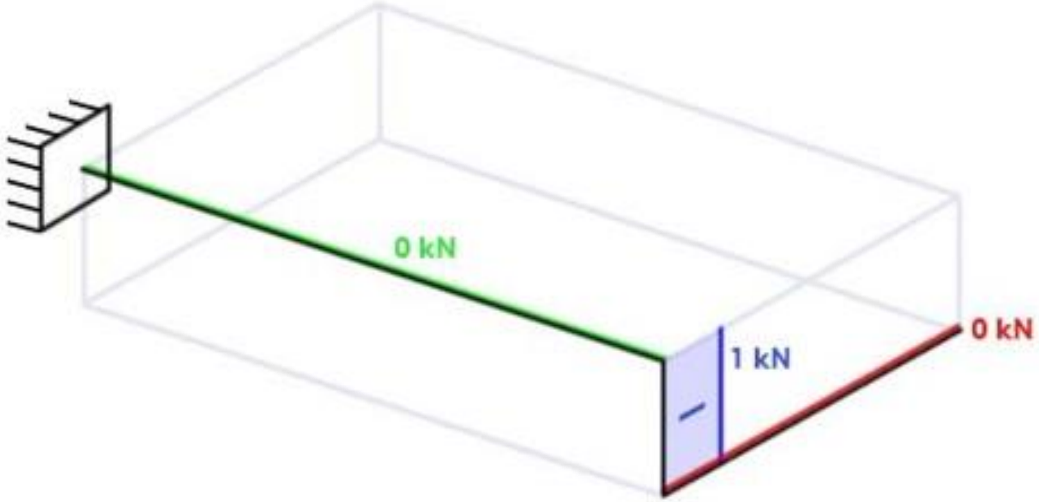


A1

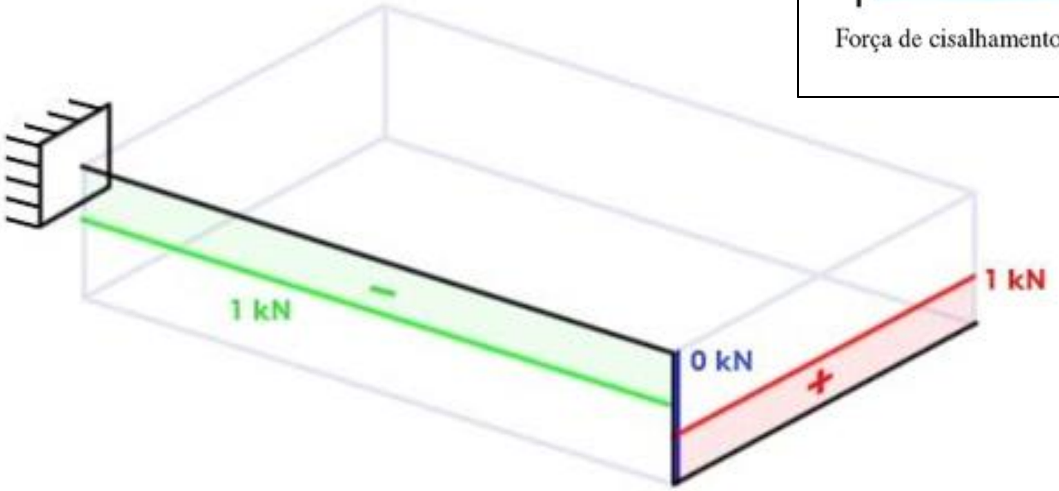


Força de cisalhamento positiva

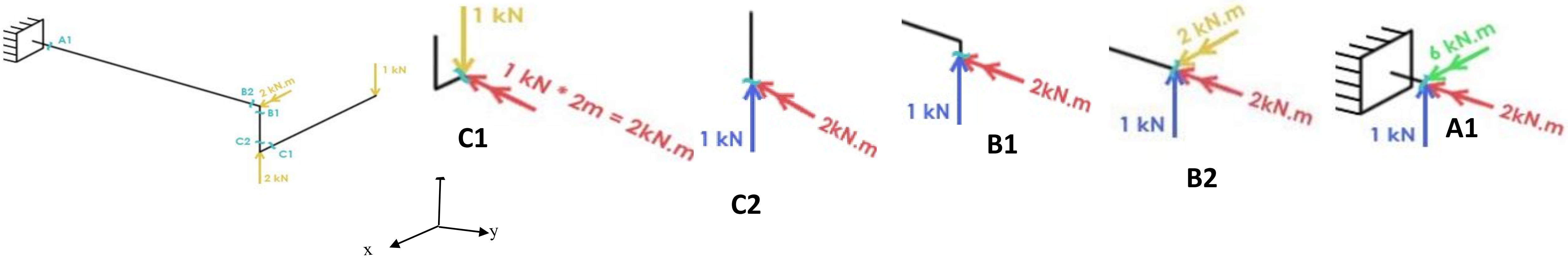
FORÇA NORMAL



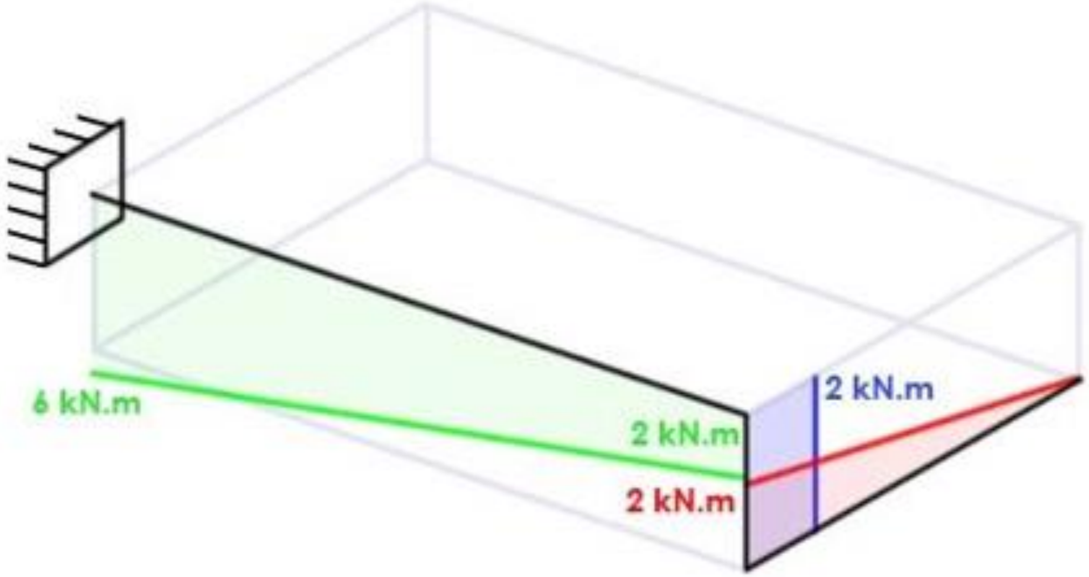
FORÇA CORTANTE



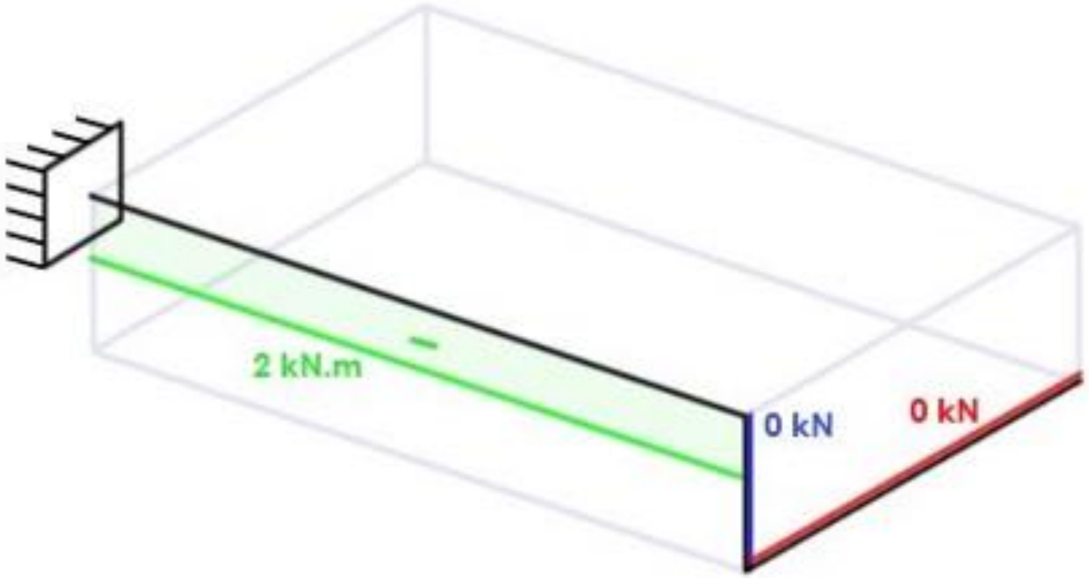
DIAGRAMAS DOS ESFORÇOS SOLICITANTES: MOMENTO FLETOR E MOMENTO DE TORÇÃO



MOMENTO FLETOR

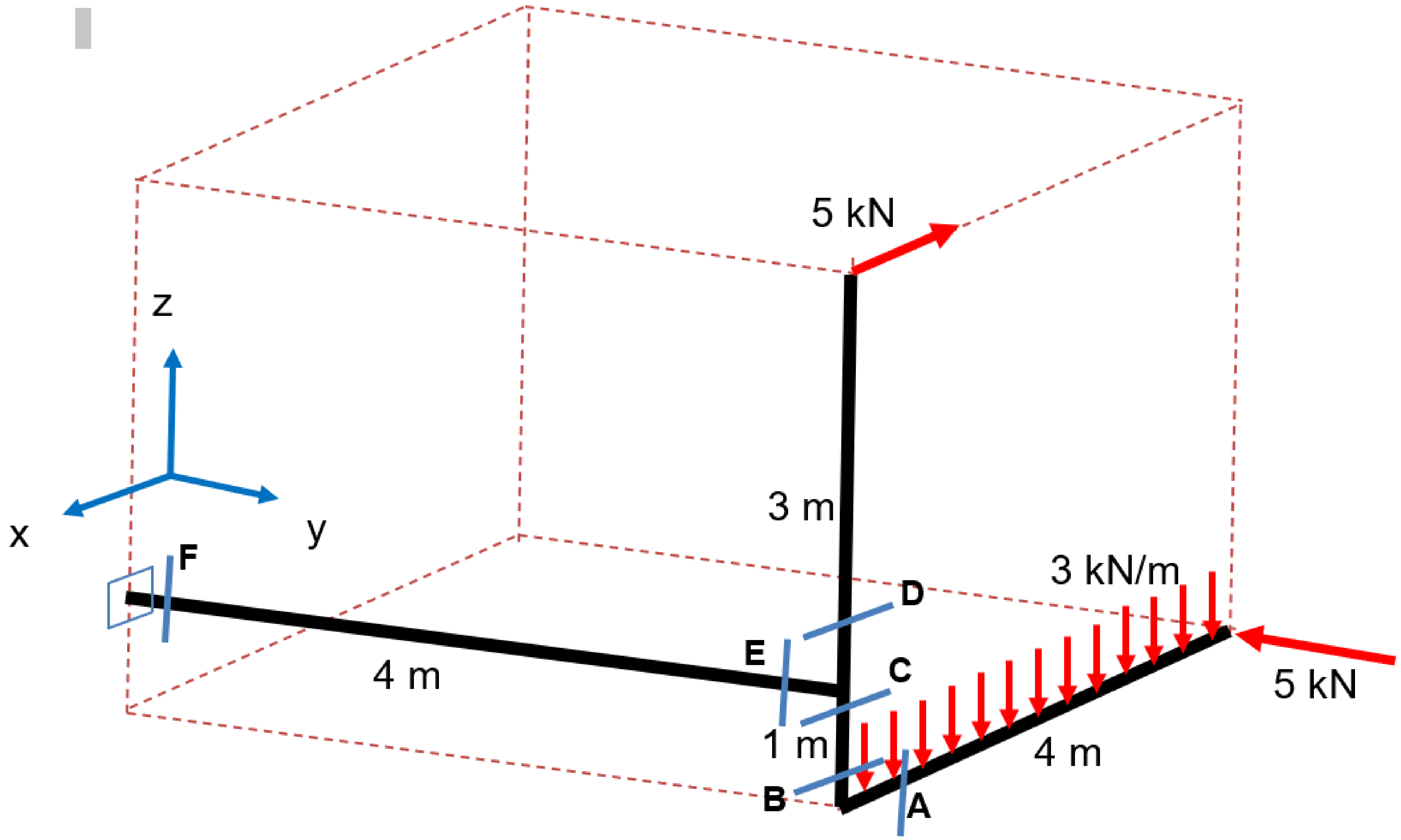


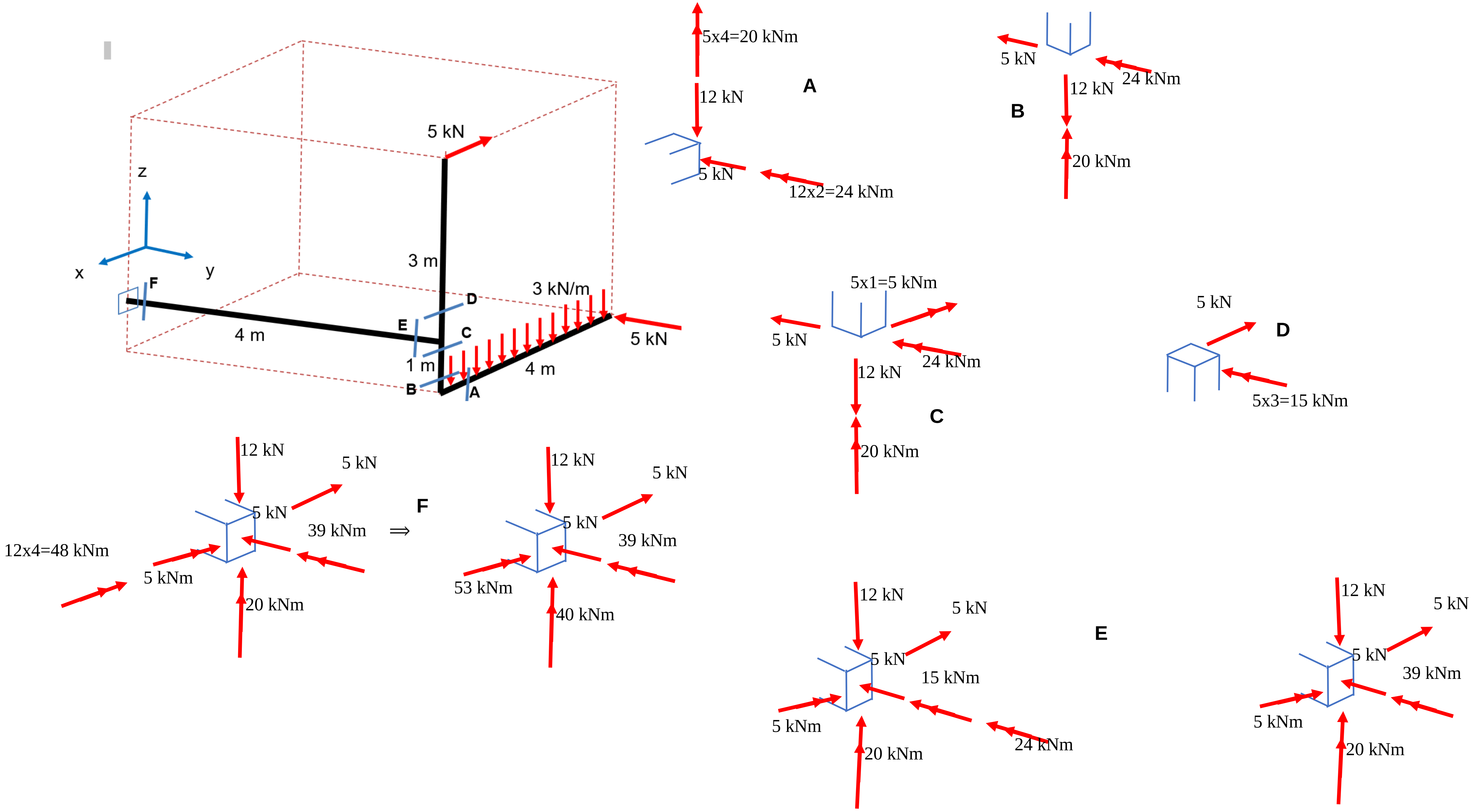
MOMENTO DE TORÇÃO



EXERCÍCIO 2.

Esboçar o diagrama dos esforços solicitantes na estrutura espacial





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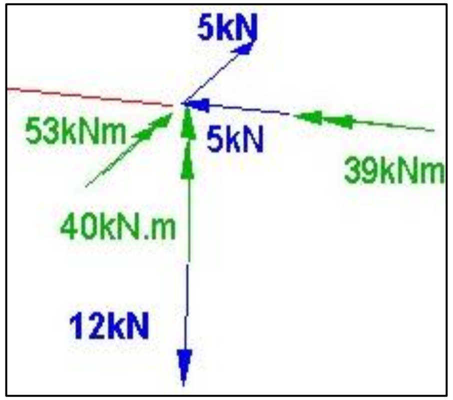
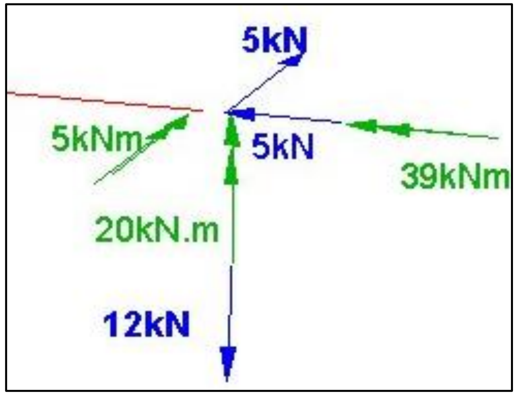
SEÇÃO F





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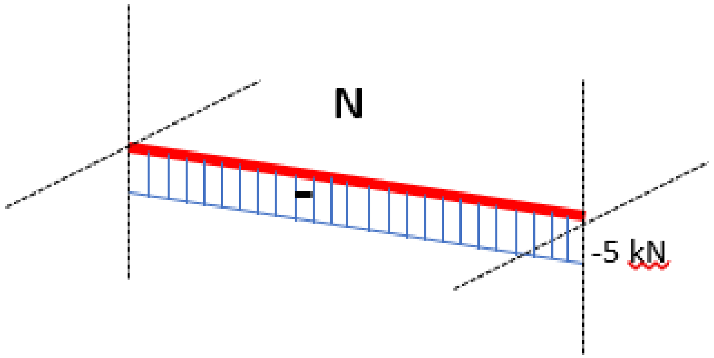

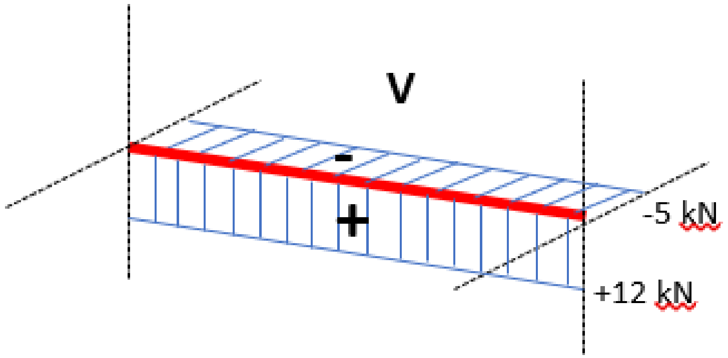

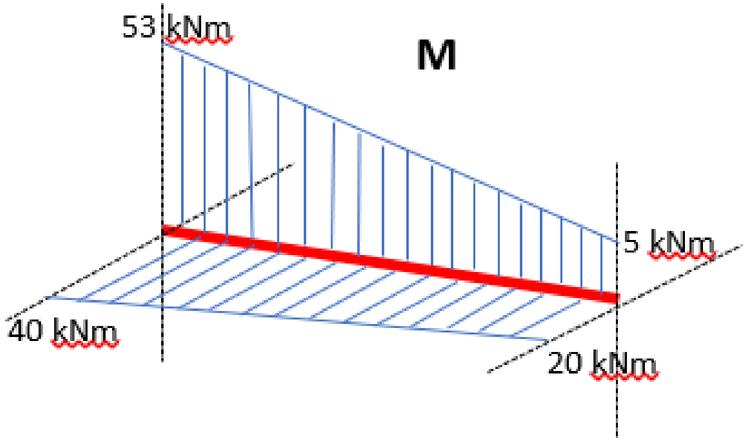

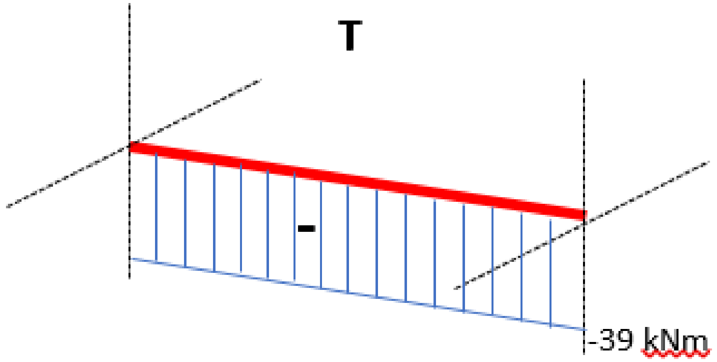

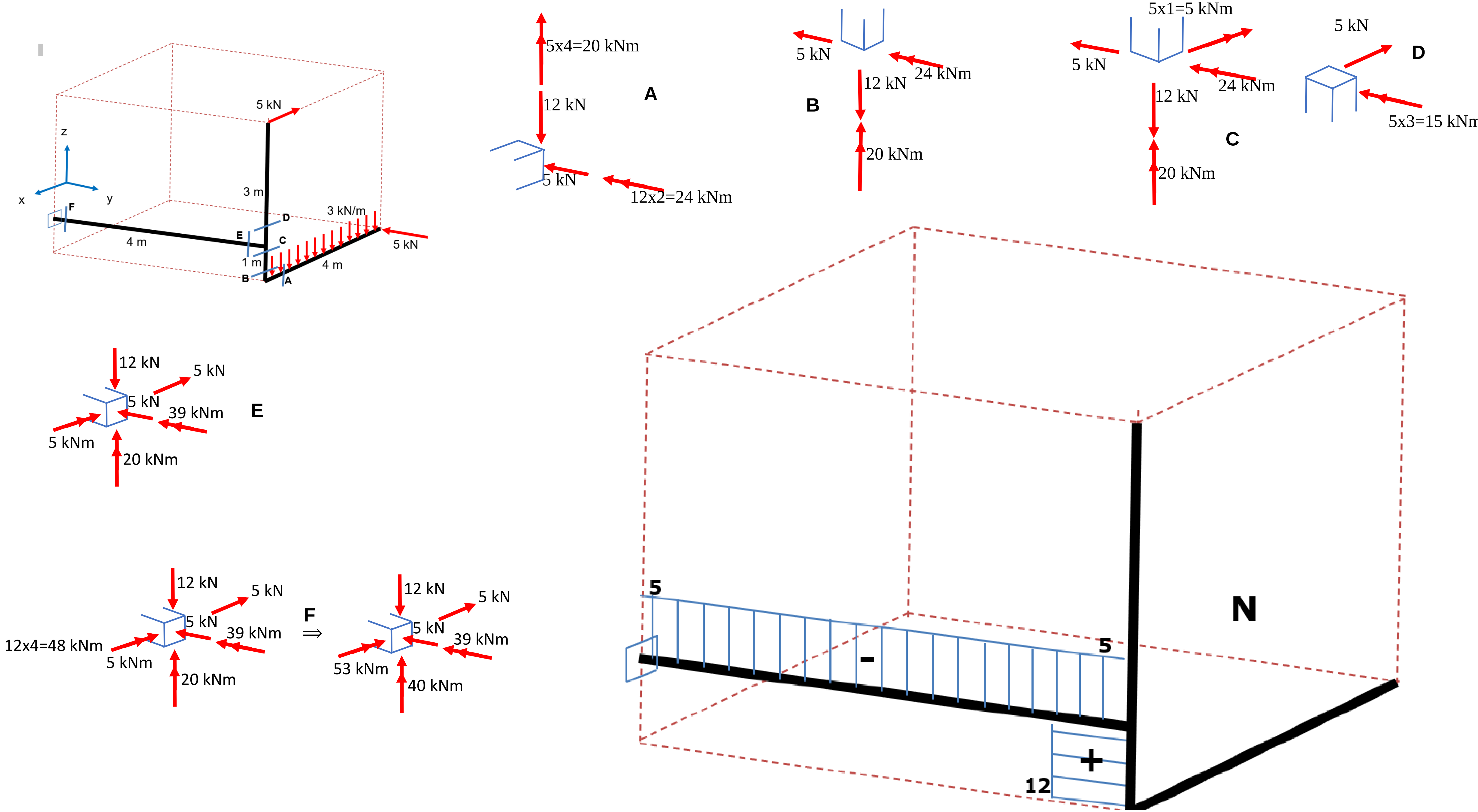

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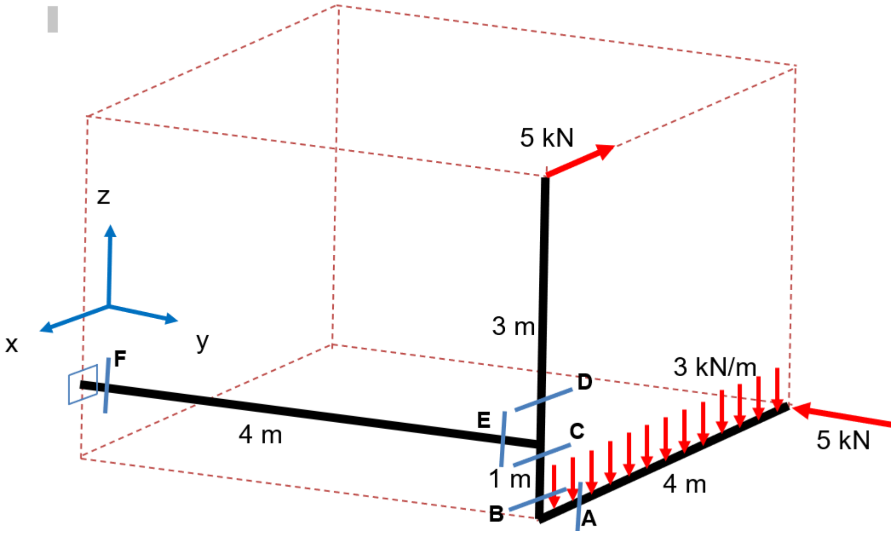
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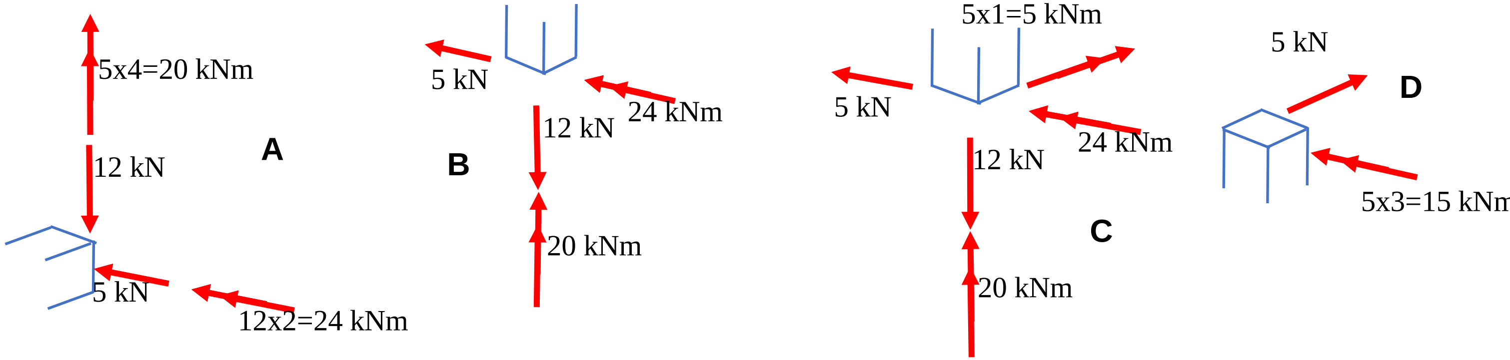
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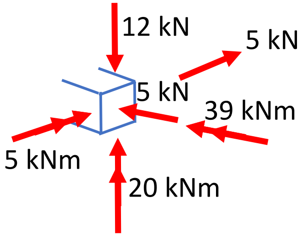
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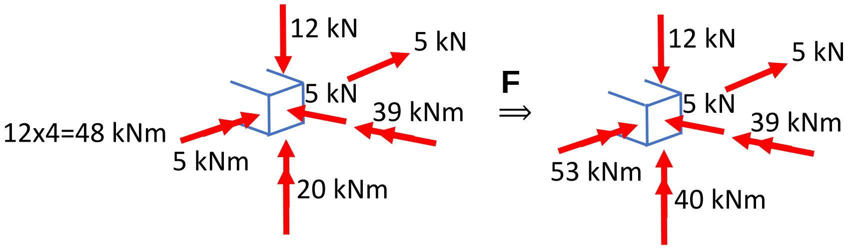
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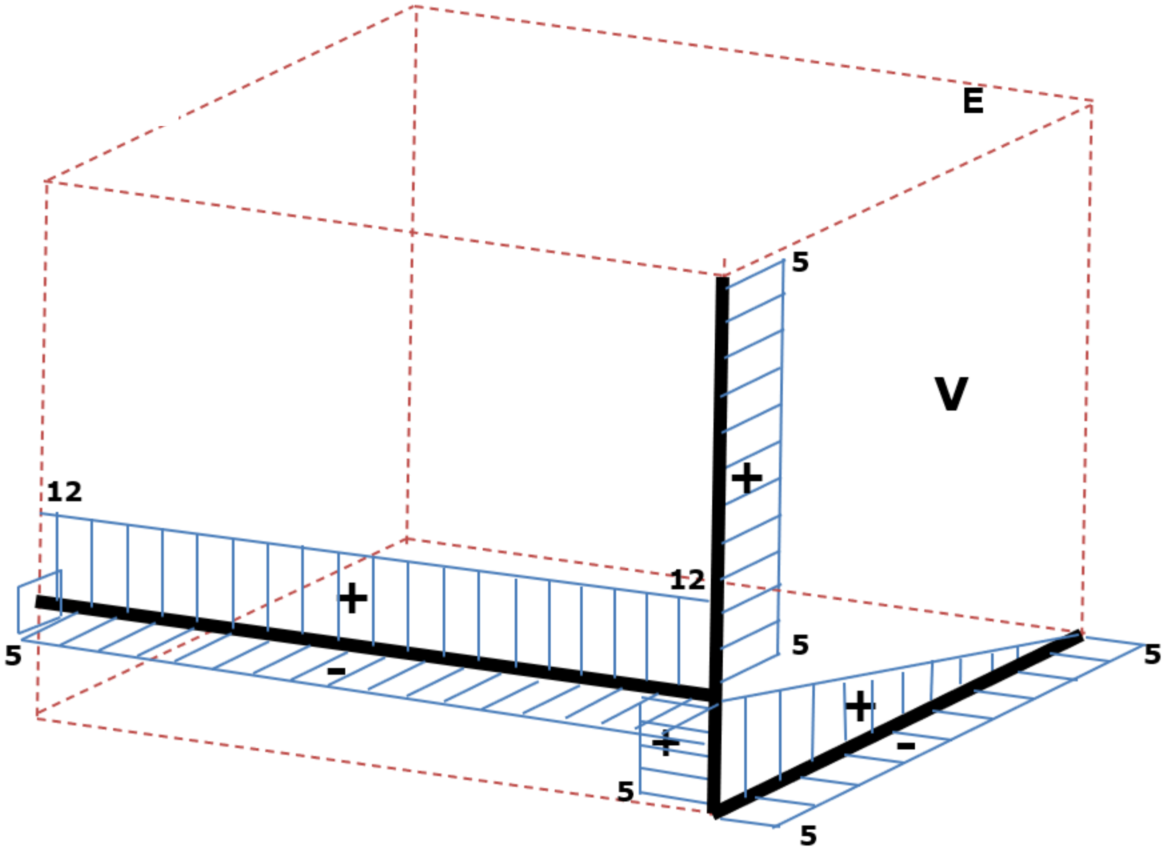
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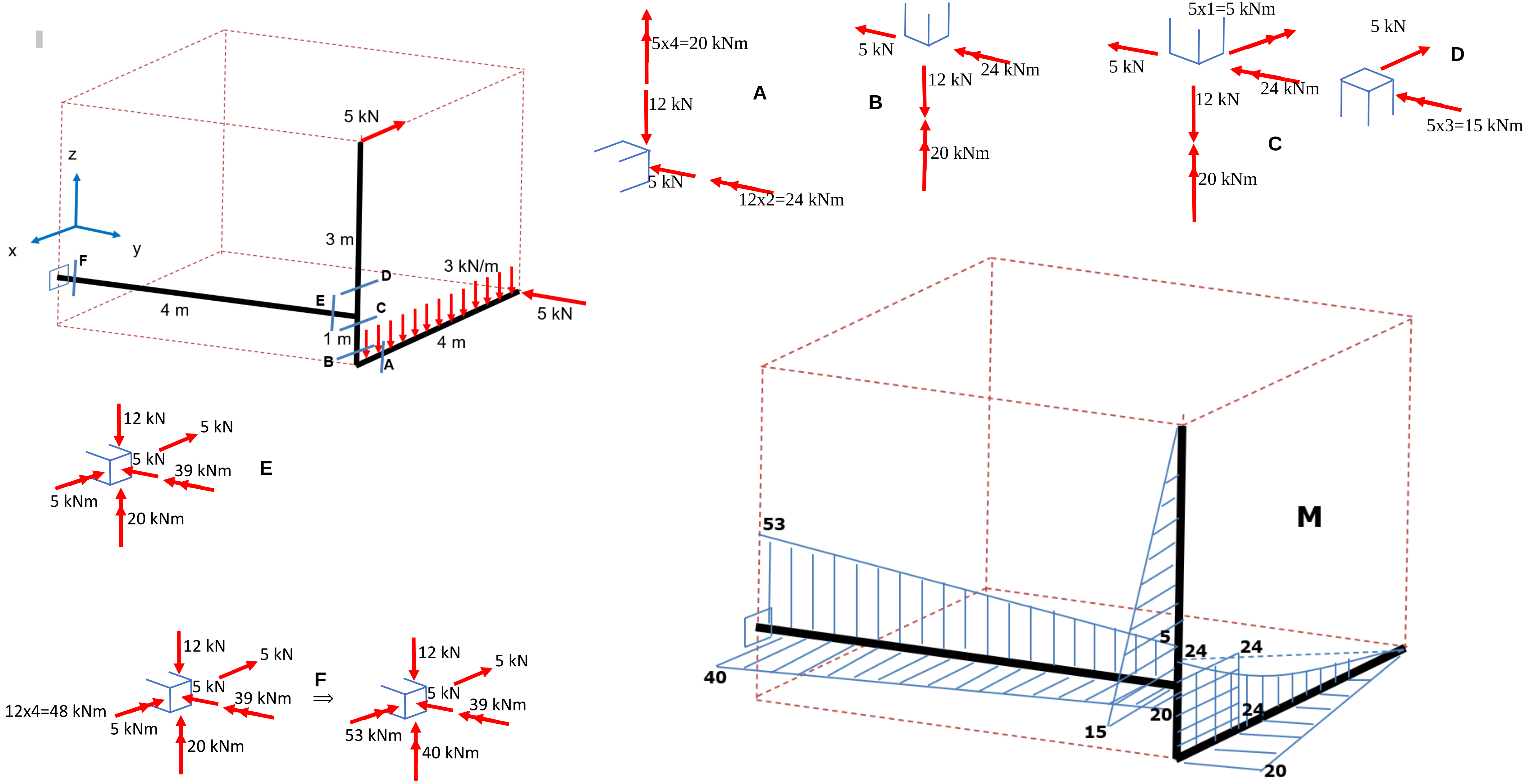

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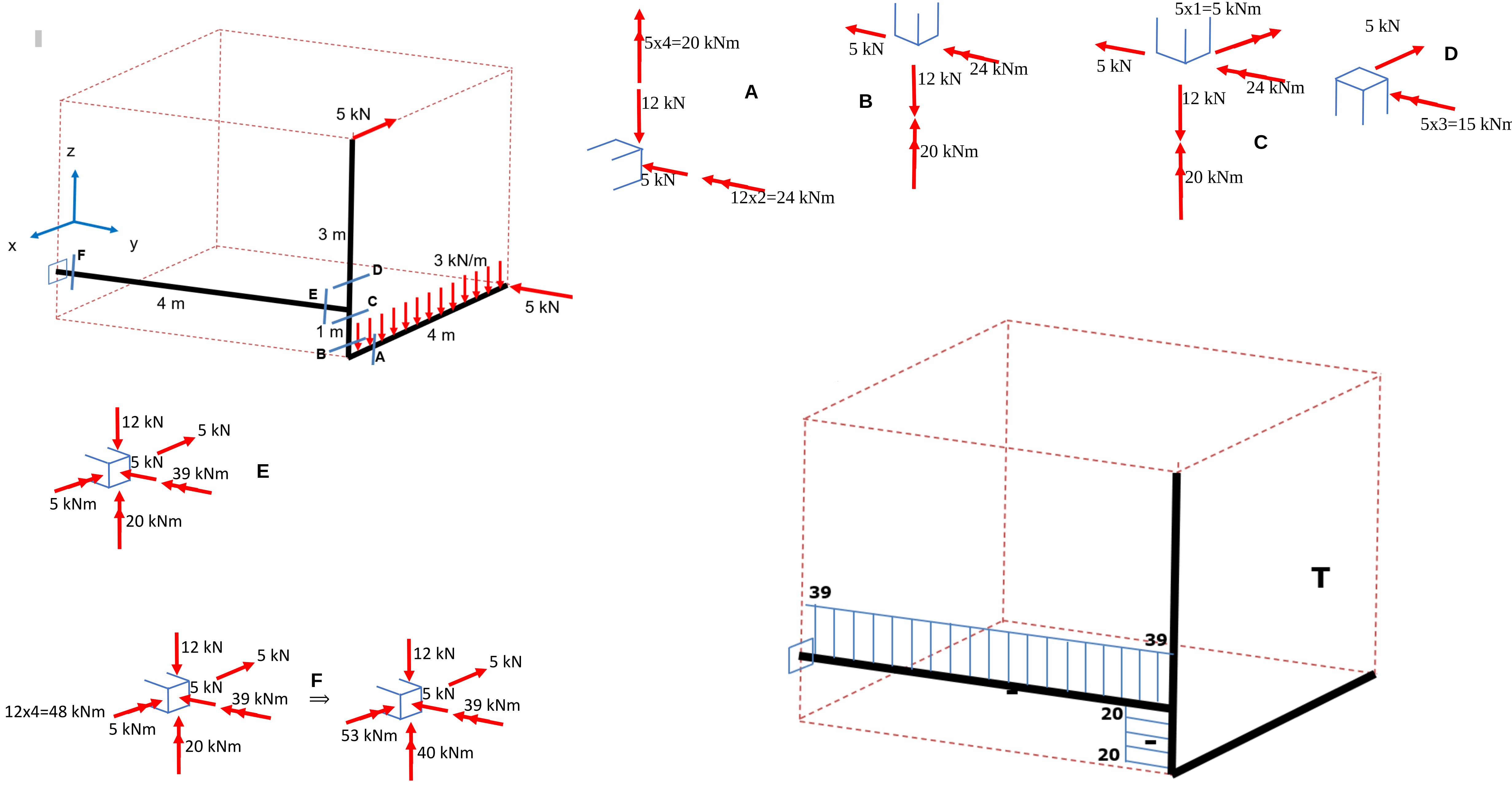

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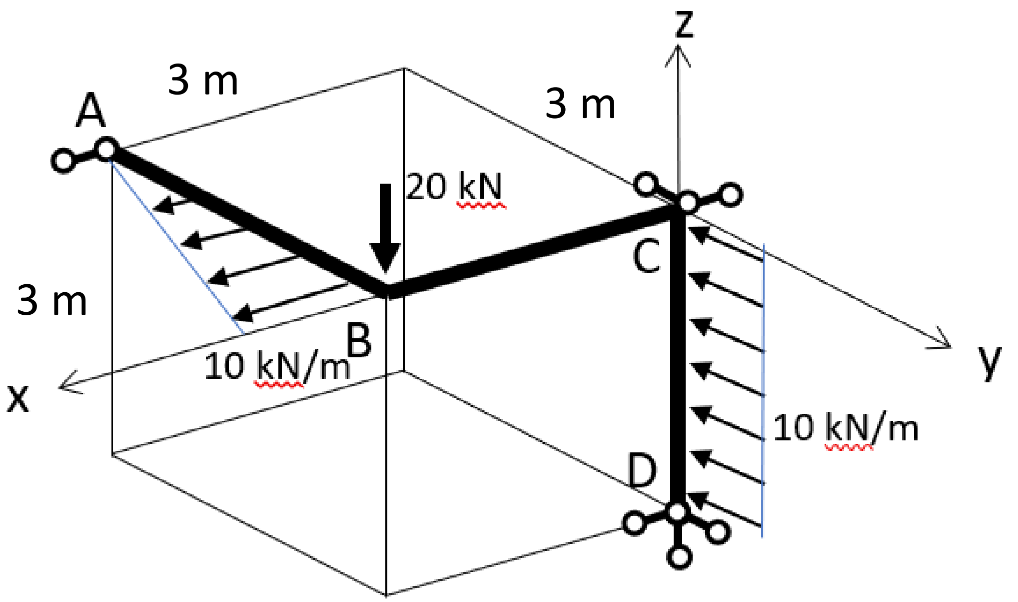
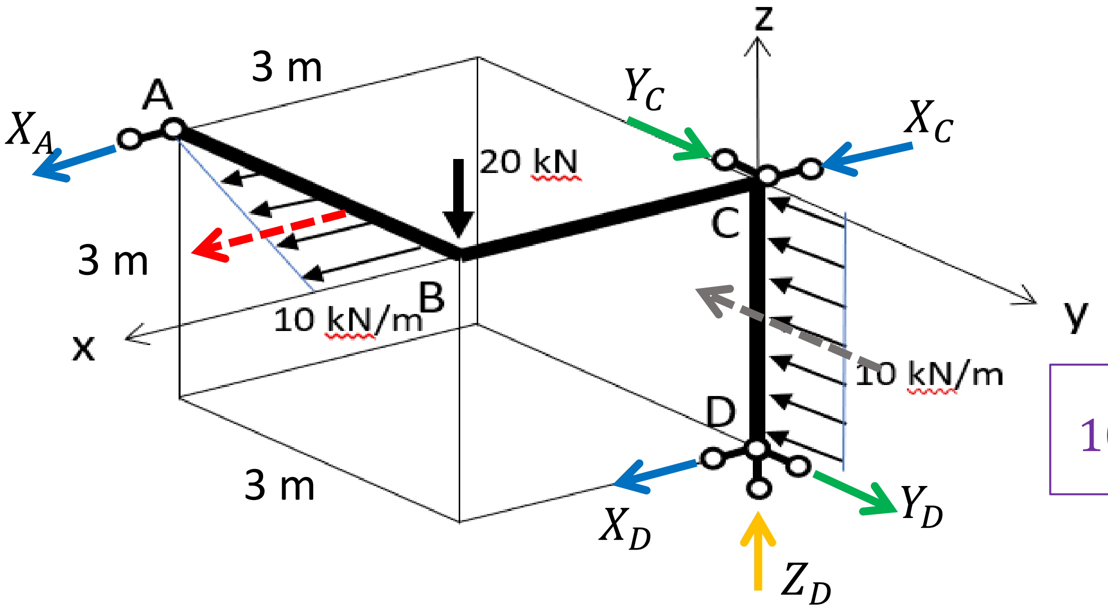
Exercício 3.

$A\ viga\ principal\ ABCD\ da\ figura\ está\ apoiada\ em\ A, C\ e\ D\ por\ barras\ curtas\ nas\ direções\ dos\ eixos\ ortogonais\ x, y\ e\ z. A\ barra\ AB\ na\ direção\ do\ eixo\ y\ está\ submetida\ a\ um\ carregamento\ uniformemente\ variado\ de\ zero\ a\ 10\frac{kN}{m}\ na\ direção\ do\ eixo\ x; a\ barra\ BC\ está\ na\ direção\ do\ eixo\ x; a\ barra\ CD\ na\ direção\ do\ eixo\ z\ está\ submetida\ a\ um\ carregamento\ uniforme\ de\ 10\frac{kN}{m}\ na\ direção\ do\ eixo\ y\ ; em\ B\ há\ uma\ força\ concentrada\ de\ 20\ kN\ na\ direção\ z. Determine:\ a)\ as\ reações\ dos\ apoios\ A, C\ e\ D;\ b) os\ diagramas\ dos\ esforços\ solicitantes\ na\ barra\ CD, considerando\ o\ observador\ de\ frente\ aos\ eixos.$

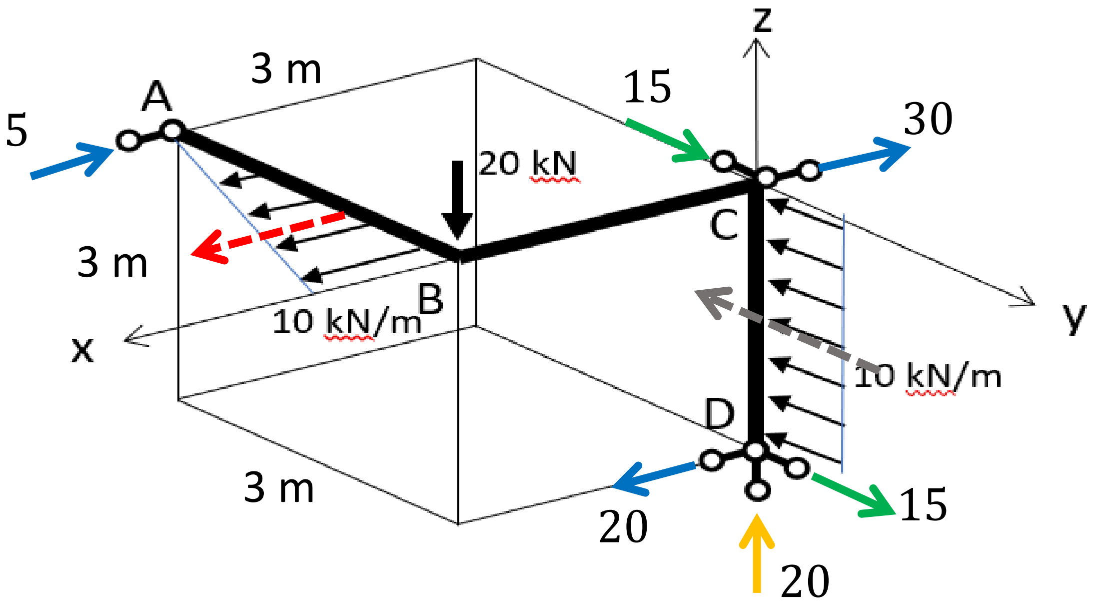


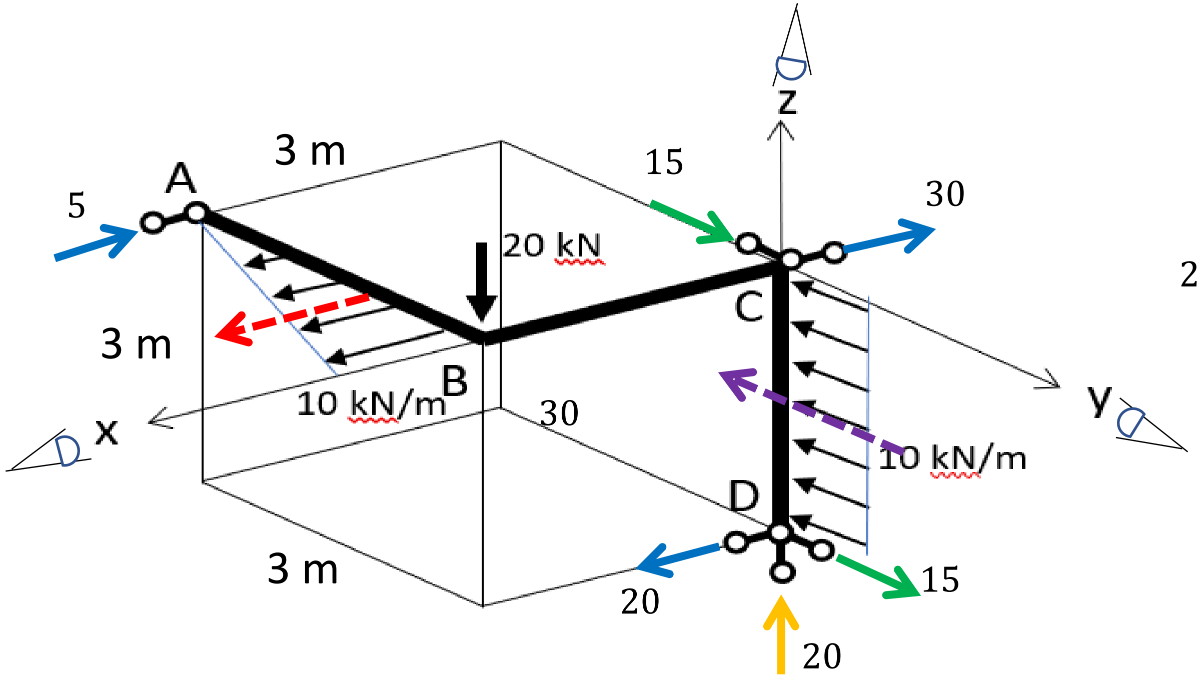
$$10\frac{kN}{m} * 3m \div 2 = 15\ kN$$

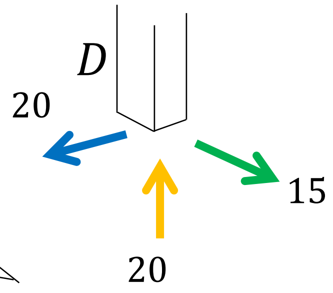


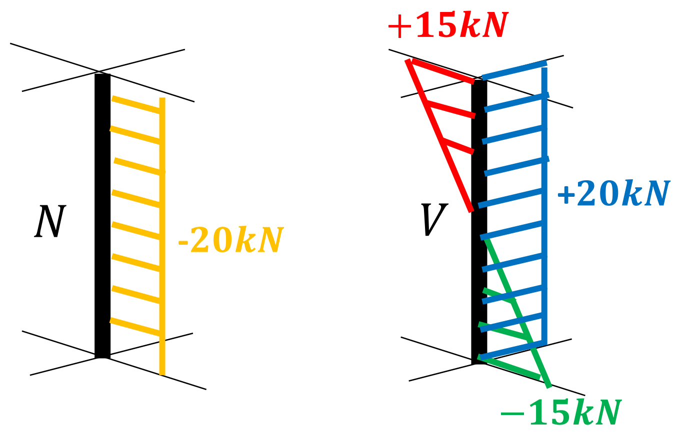
$$10\frac{kN}{m} * 3m = 30\ kN$$

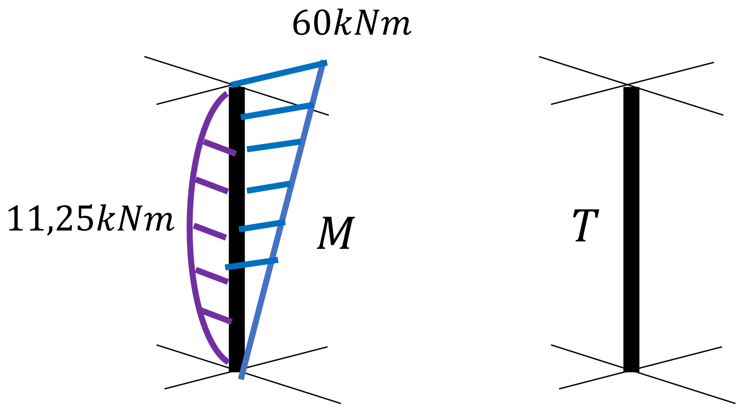
$$\begin{cases} \sum X = 0 = X_A + 15 + X_C + X_D \Longrightarrow X_C = -30kN \\ \sum Y = 0 = Y_C - 30 + Y_D \Longrightarrow Y_C = 15kN \\ \sum Z = 0 = -20 + Z_D \Longrightarrow Z_D = 20kN \\ \sum M_x = 0 = -30 * 1{,}5 + Y_D * 3 \Longrightarrow Y_D = 15kN \\ \sum M_y = 0 = 20 * 3 - X_D * 3 \Longrightarrow X_D = 20kN \\ \sum M_z = 0 = X_A * 3 + 15 * 1 \Longrightarrow X_A = -5kN \end{cases}$$

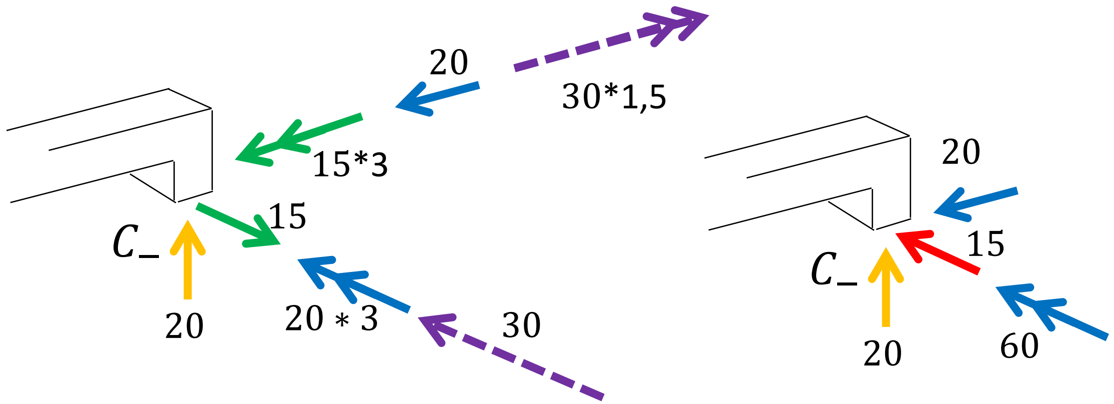












$$\frac{pl^2}{8} = \frac{10 * 3^2}{8} = 11{,}25kNm$$

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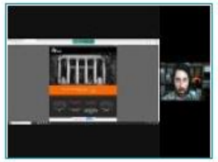
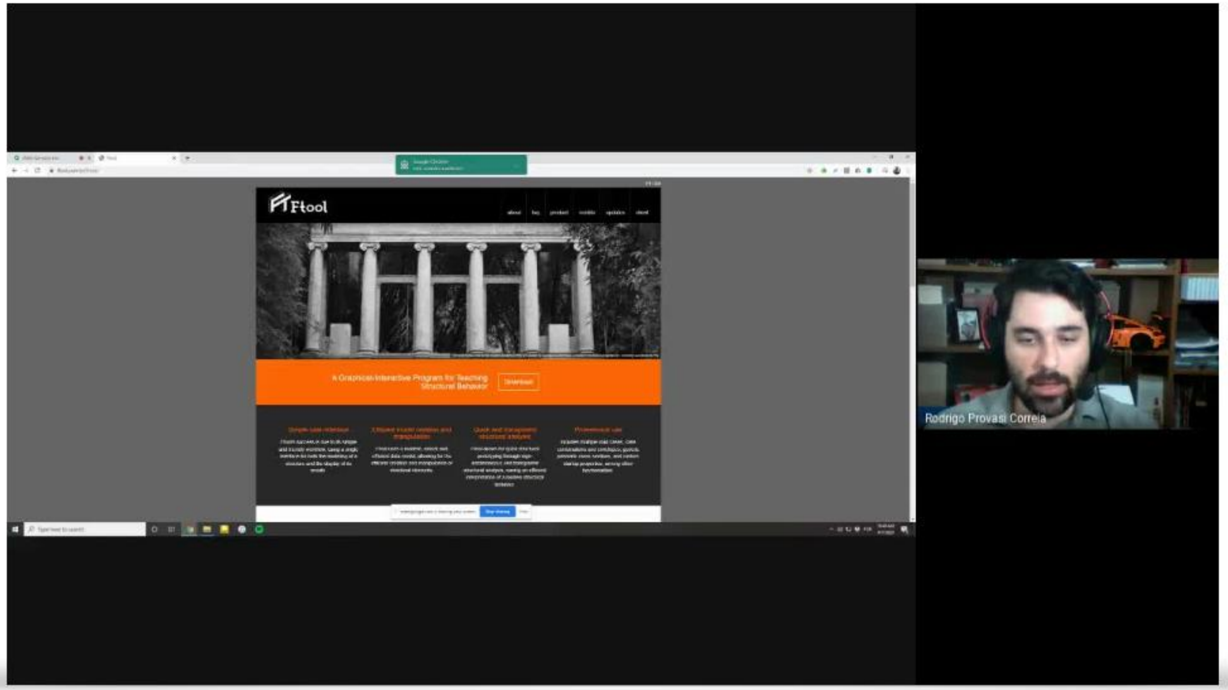
PEF 3208 - FTool

por Rodrigo Provasi Correia

Vídeo 6 de 18
Fundamentos de Mecânica das Estruturas





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