



MECÂNICA DOS SÓLIDOS

VIGAS

PARTE I

Prof. Dr. Daniel Caetano

2019 - 2

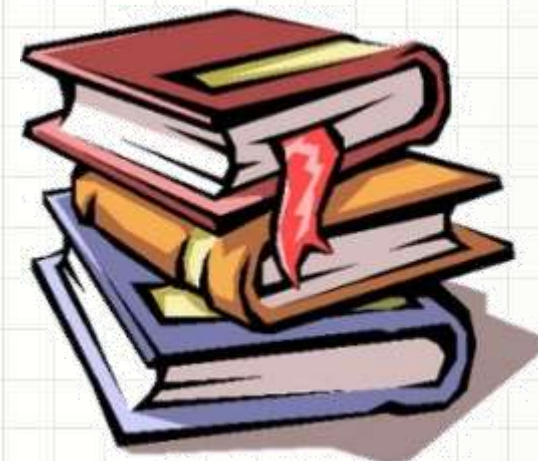
Objetivos

- Conceituar viga e os tipos de cargas que nela atuam
- Conceituar forças cortantes e momentos fletores

- **Atividade Aula 6 – SAVA!**



Material de Estudo



Material

Acesso ao Material

Apresentação

<http://www.caetano.eng.br/>
(Mecânica dos Sólidos – Aula 6)

Material Didático

Mecânica Geral (MACIEL), Cap. 5 (SAVA)

Minha Biblioteca

Estática e Mecânica dos Materiais (BERR;JOHNSTON),
Cap. 11, 12 e 13

Biblioteca Virtual

Resistência dos Materiais (Hibbeler, 7ª, pgs 181-201)



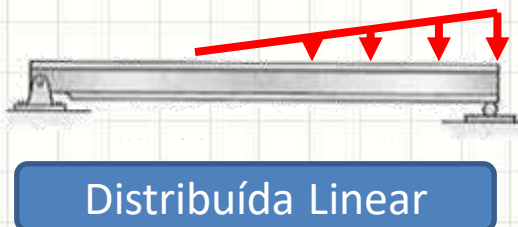
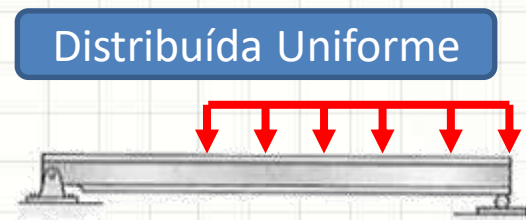
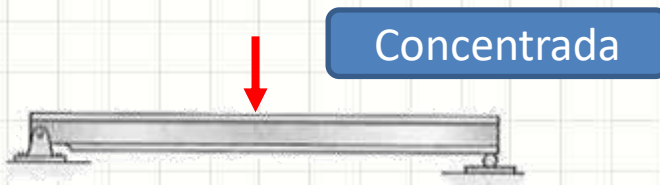
O QUE SÃO VIGAS?

Objeto de Estudo

- Vigas – Cargas perpendiculares ao eixo

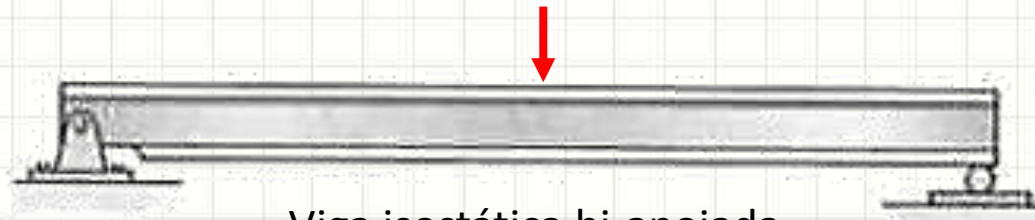


- Tipos de Cargas

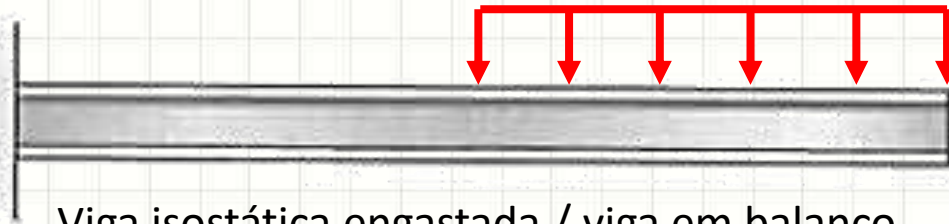


Objeto de Estudo

- Tipos Clássicos de Vigas



Viga isostática bi-apoiada



Viga isostática engastada / viga em balanço



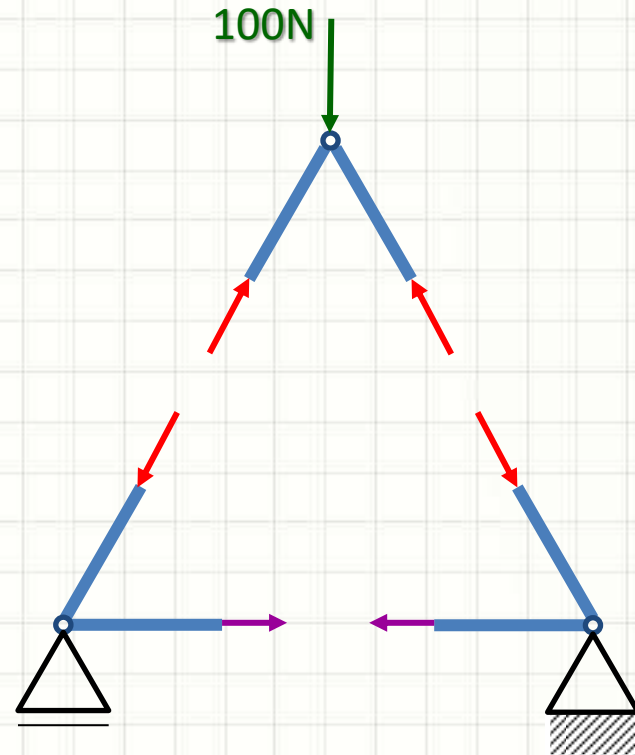
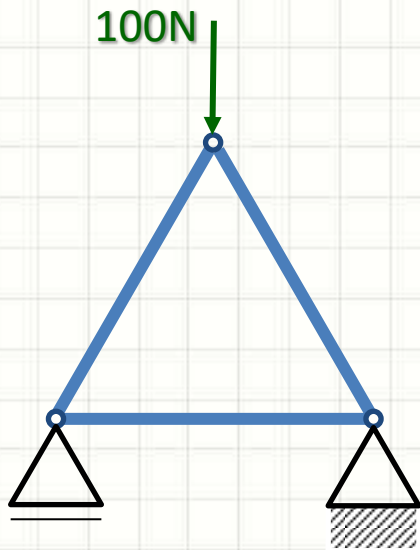
Viga isostática bi-apoiada com extremidade em balanço



ESFORÇOS INTERNOS NAS VIGAS

Forças Internas

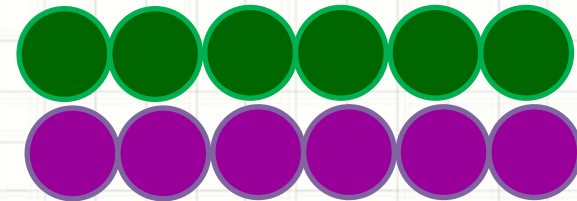
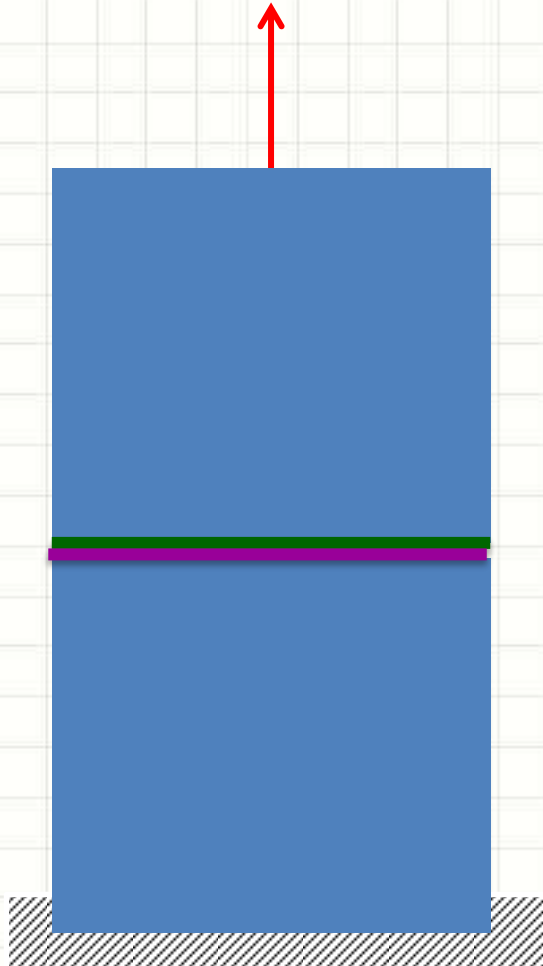
- Forças Internas: mantém estrutura coesa
- Em treliças: só **Tração** e **Compressão**



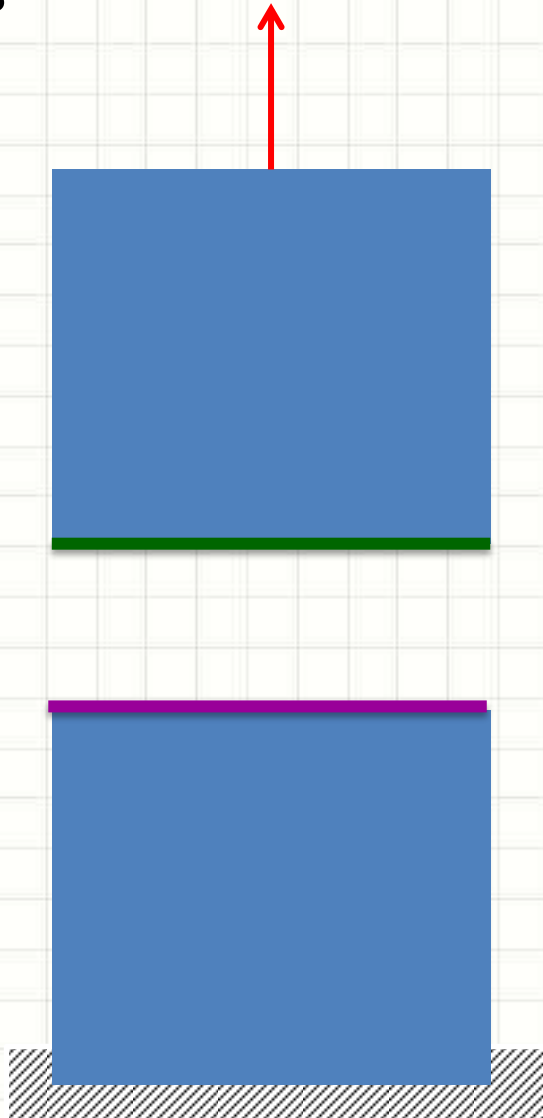
- E nas vigas?

Força Axial x Esforços Normais

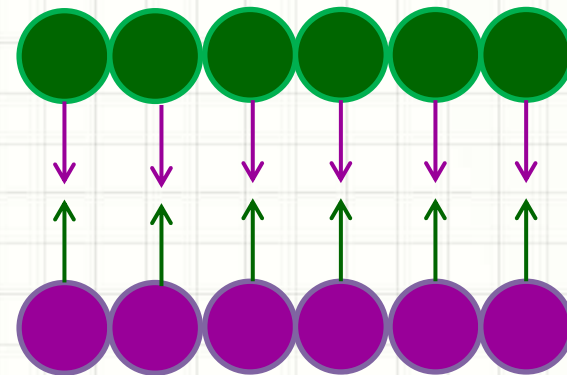
- O que são?



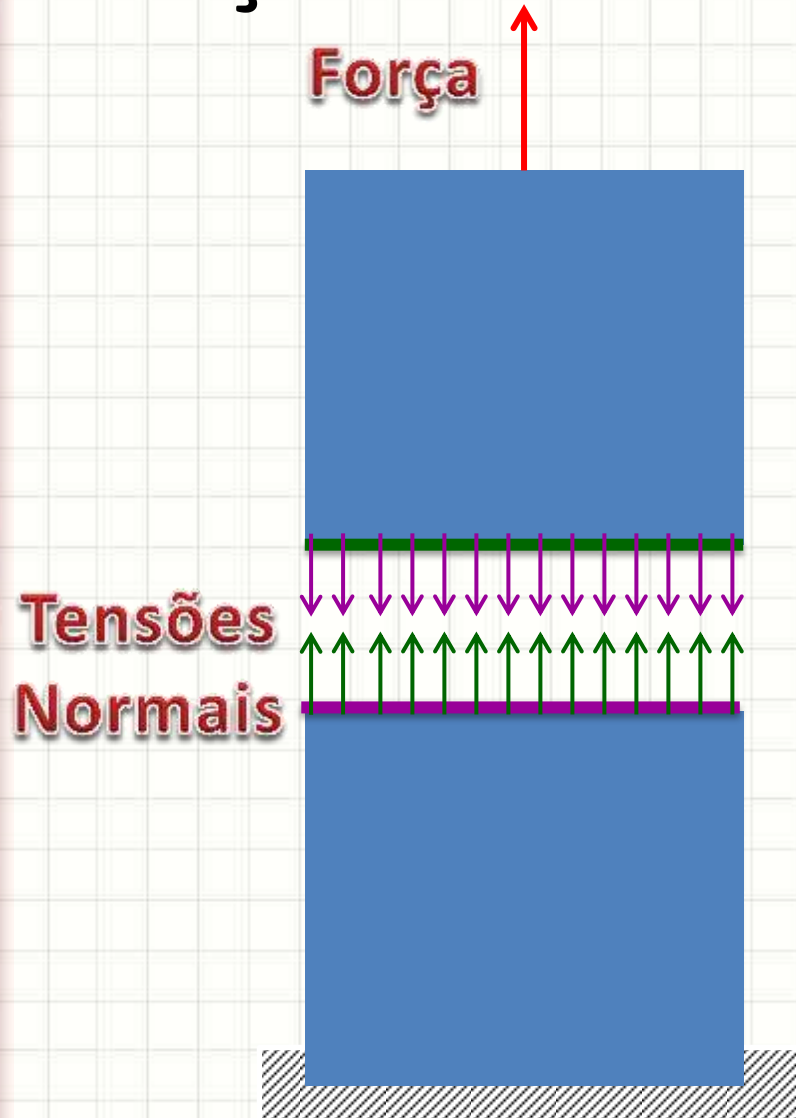
Força Axial x Esforços Normais



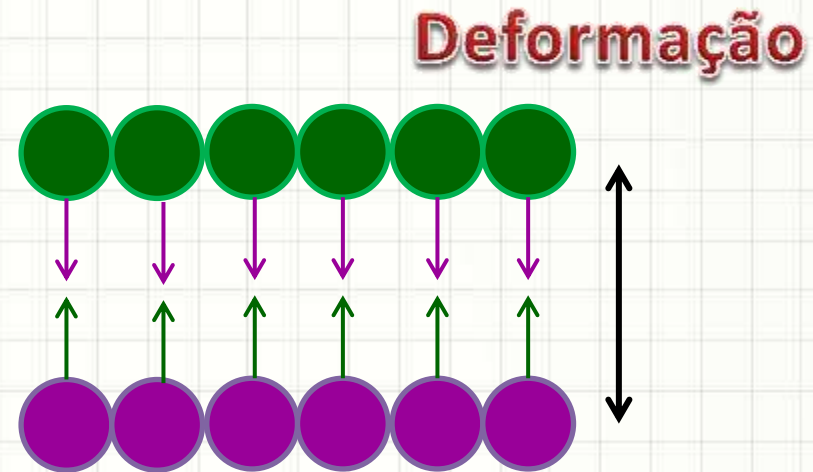
- O que são?



Força Axial x Esforços Normais

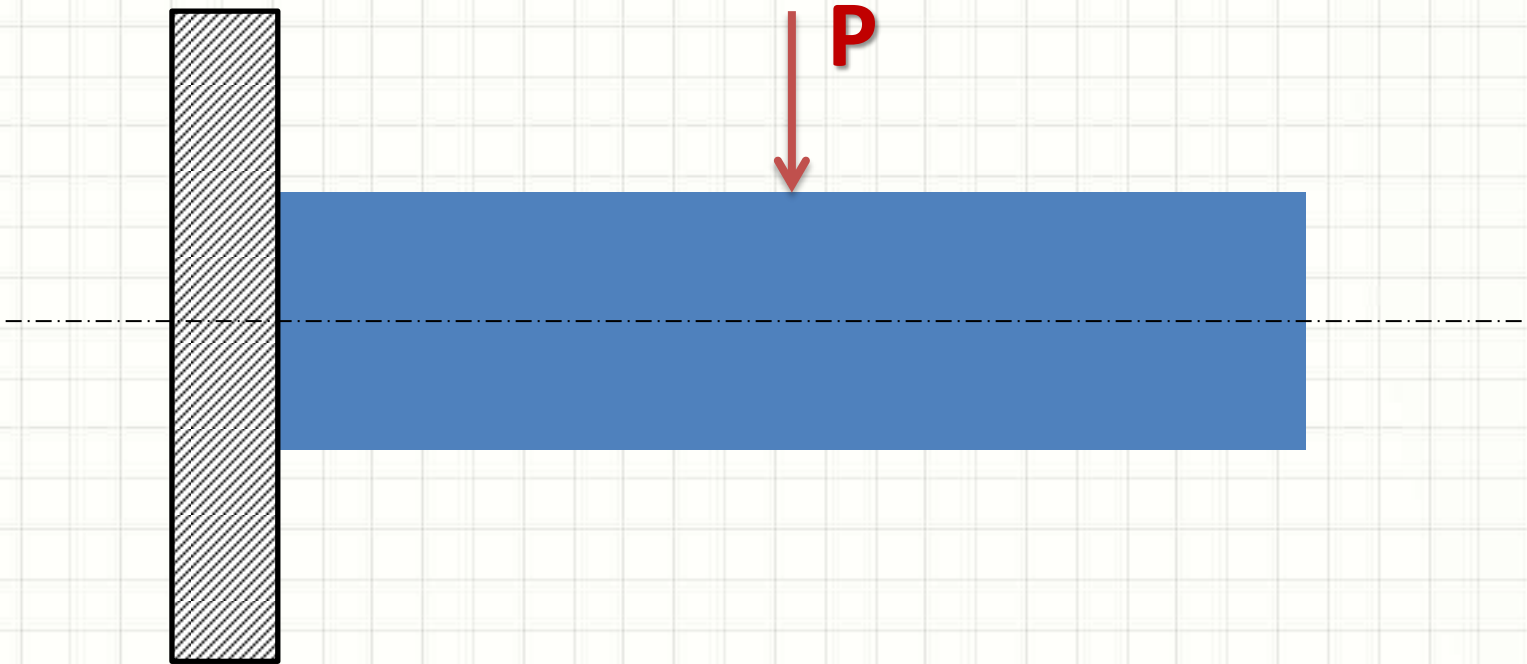


- O que são?



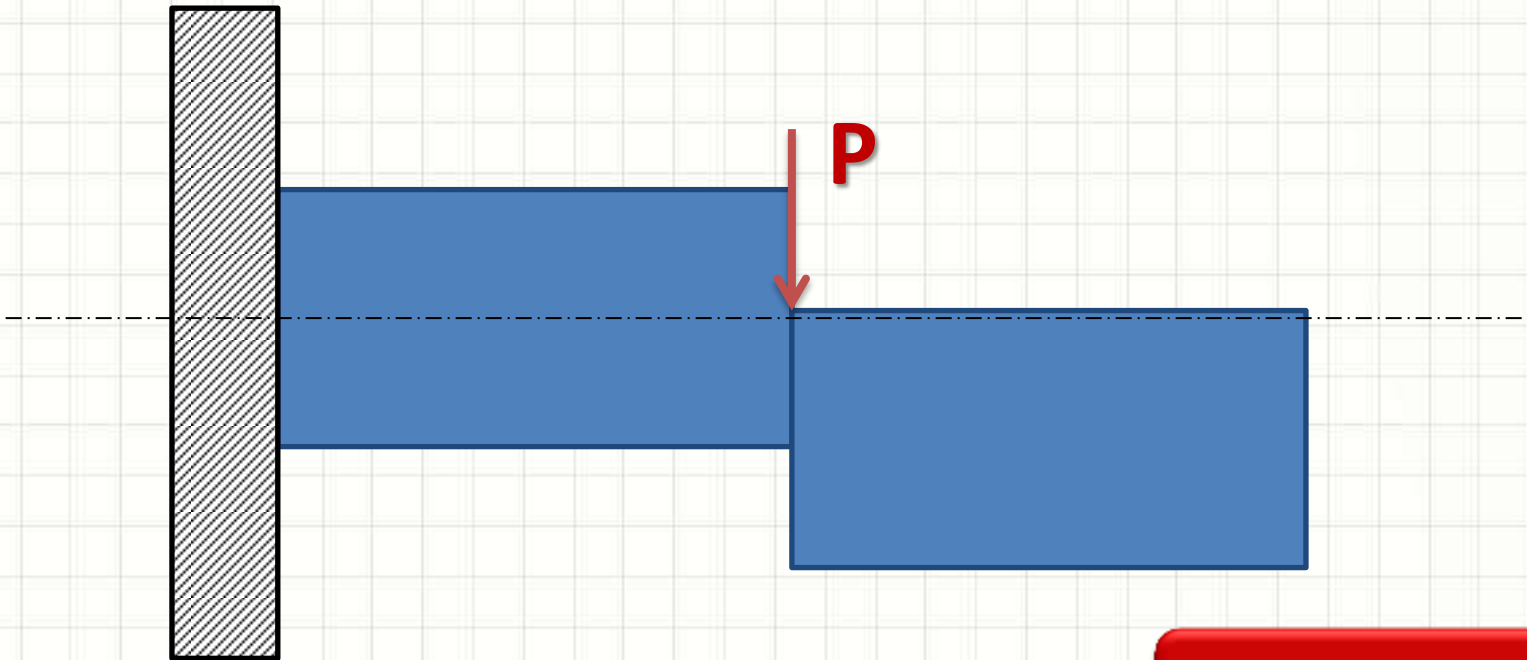
Força Cortante

- Força Cortante: aquela que tende a “fatiar”
 - É perpendicular ao eixo da barra



Força Cortante

- Força Cortante: aquela que tende a “fatiar”
 - É perpendicular ao eixo da barra



Só isso?

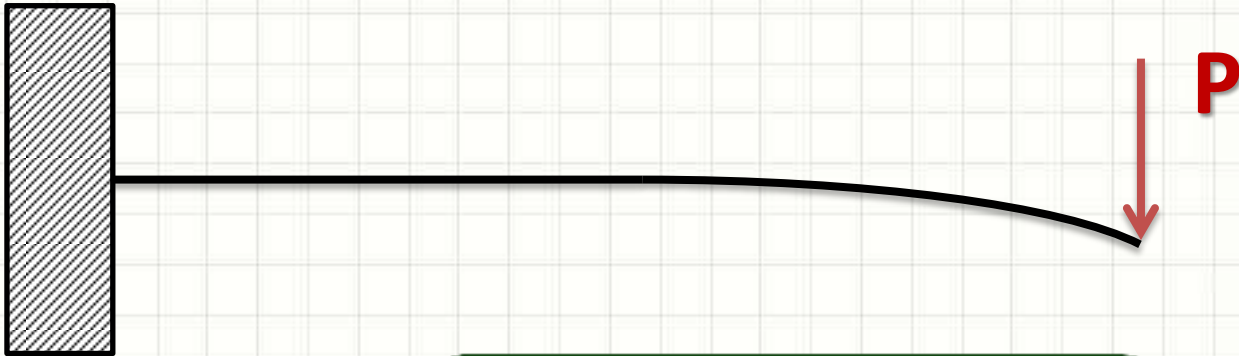
Momento Fletor

- Momento Fletor: esforço que “enverga” barra
 - Resulta das forças cortantes



Momento Fletor

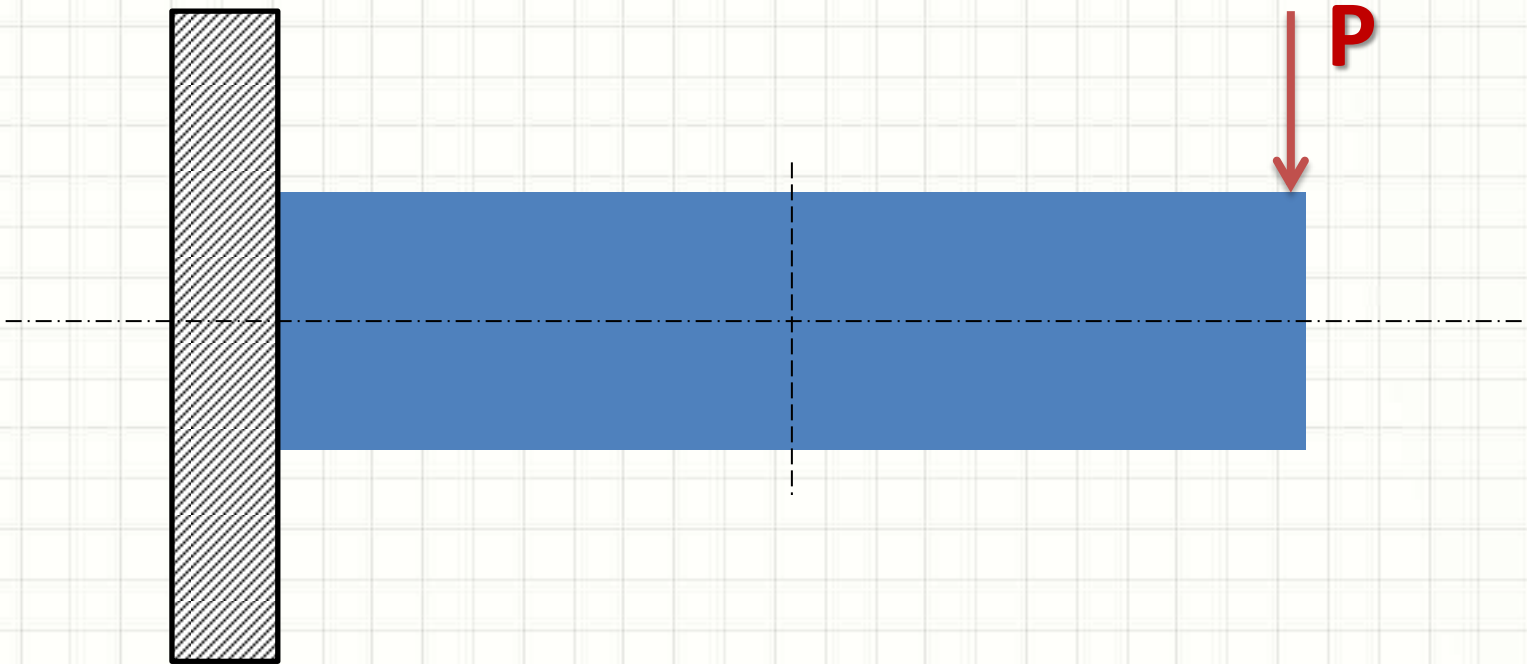
- Momento Fletor: esforço que “enverga” barra
 - Resulta das forças cortantes



Para compreender,
precisamos analisar
um modelo
diferente...

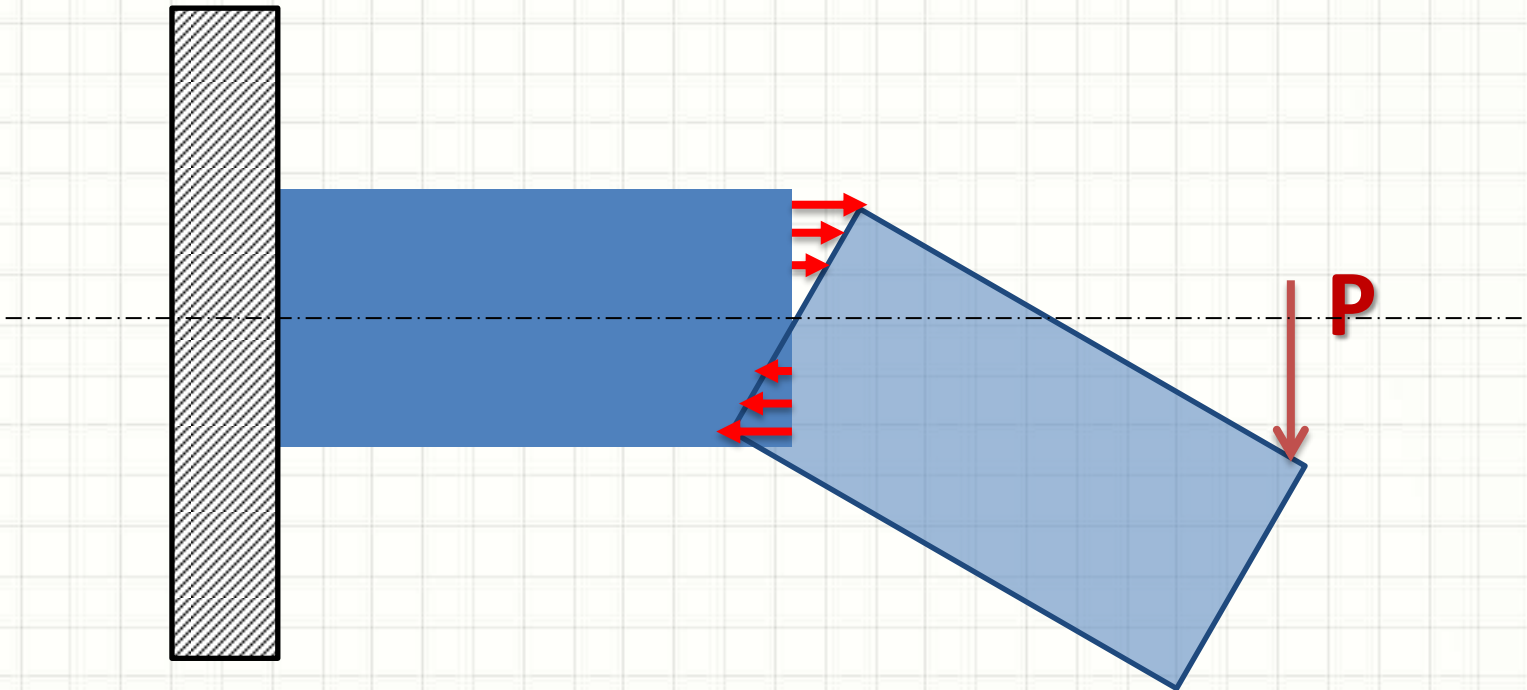
Momento Fletor

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- Momento Fletor: esforço que “enverga” barra
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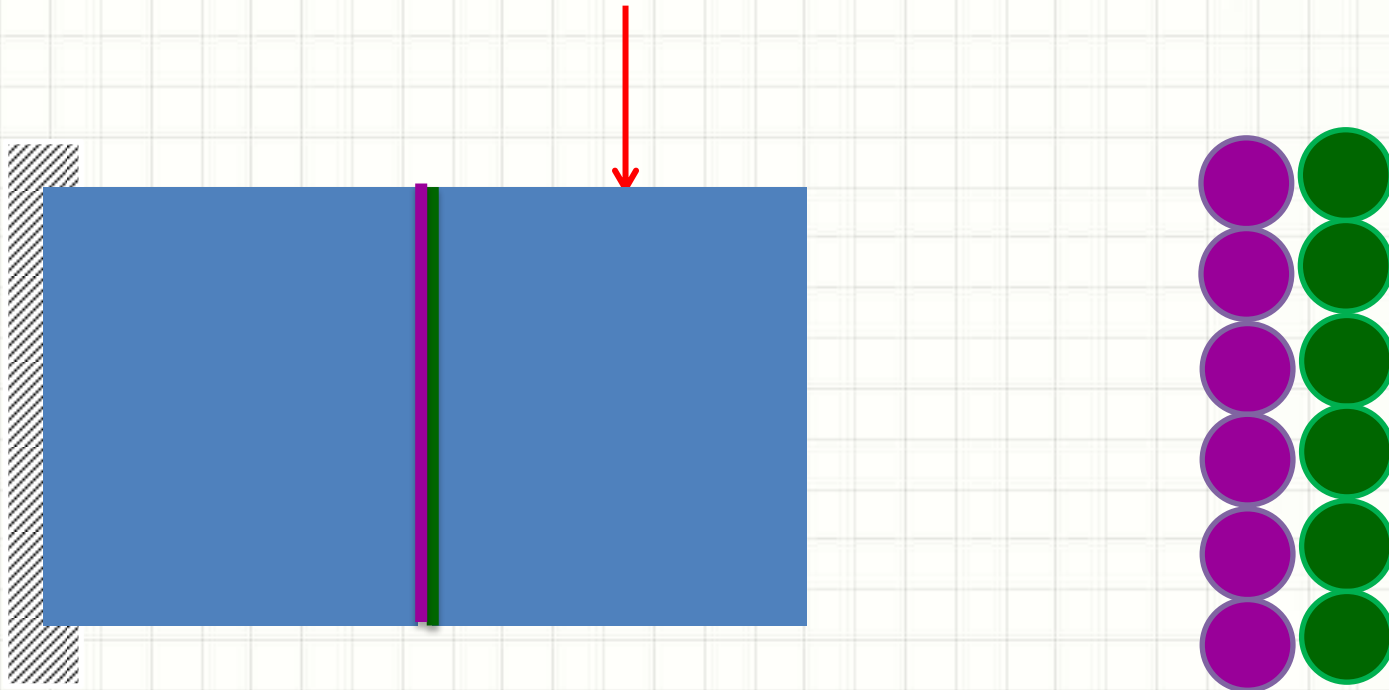




ESFORÇOS CORTANTES E AS TENSÕES DE CISALHAMENTO

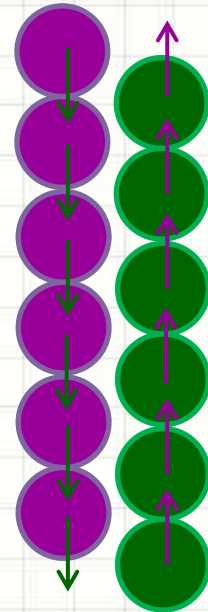
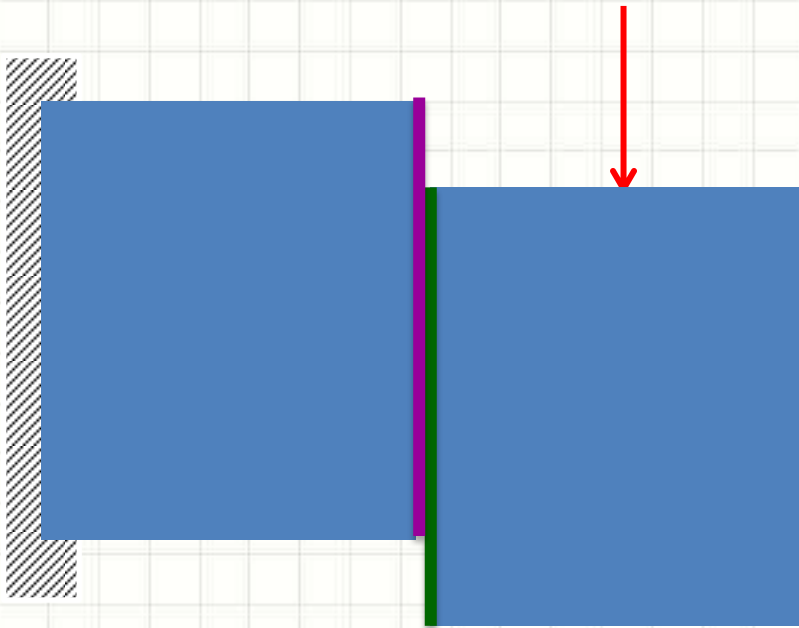
Esforços Cortantes

- O que são?



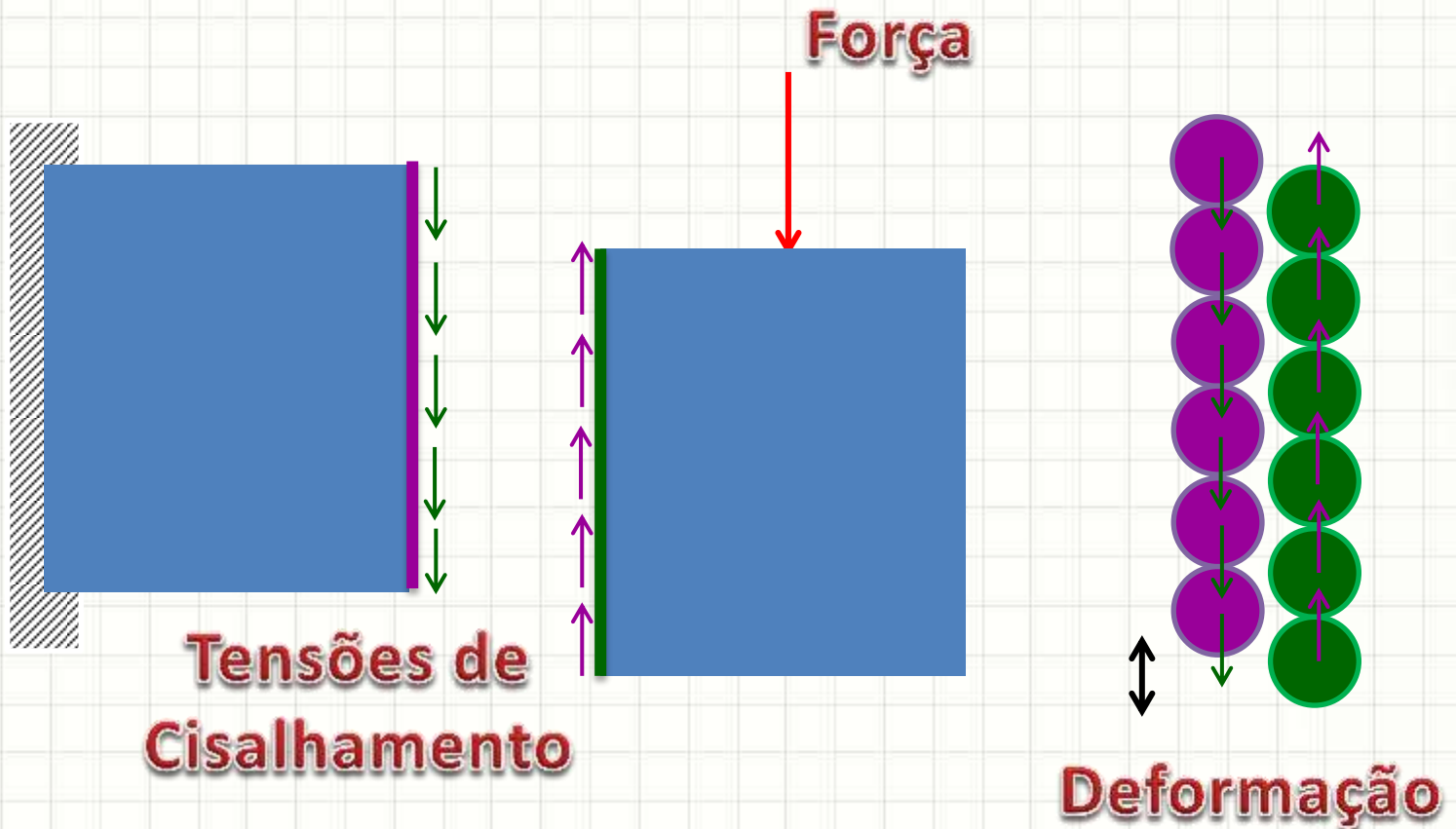
Esforços Cortantes


- O que são?



Esforços Cortantes

- O que são?

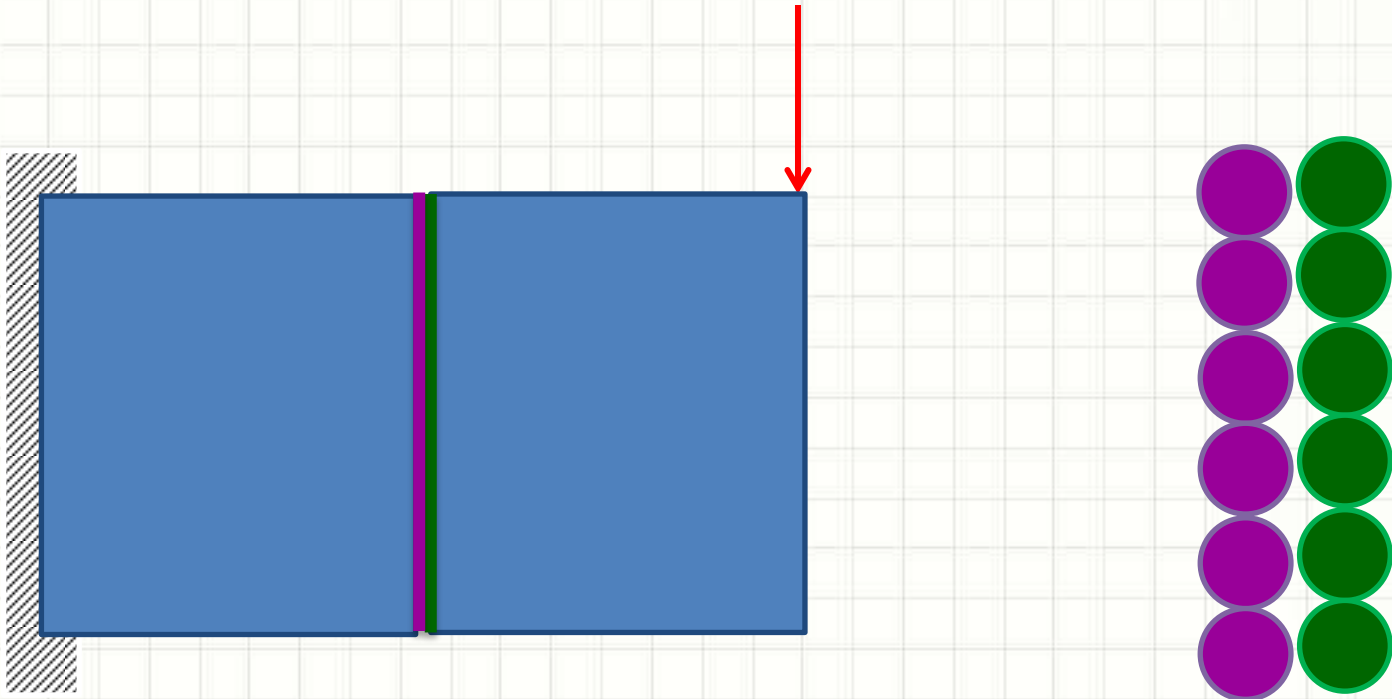




MOMENTO FLETOR E AS TENSÕES NORMAIS

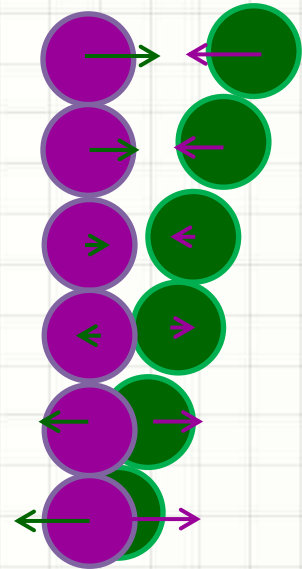
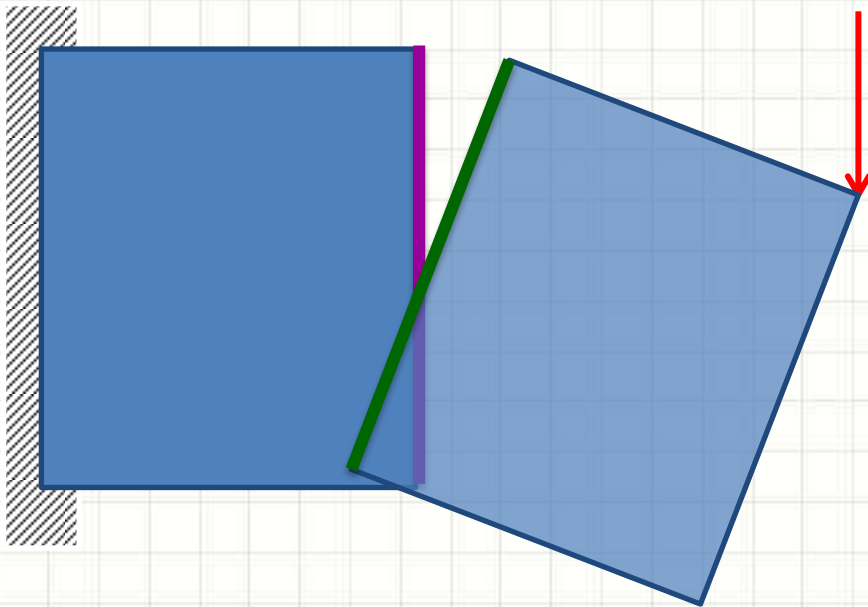
Tensões Normais

- O que são?



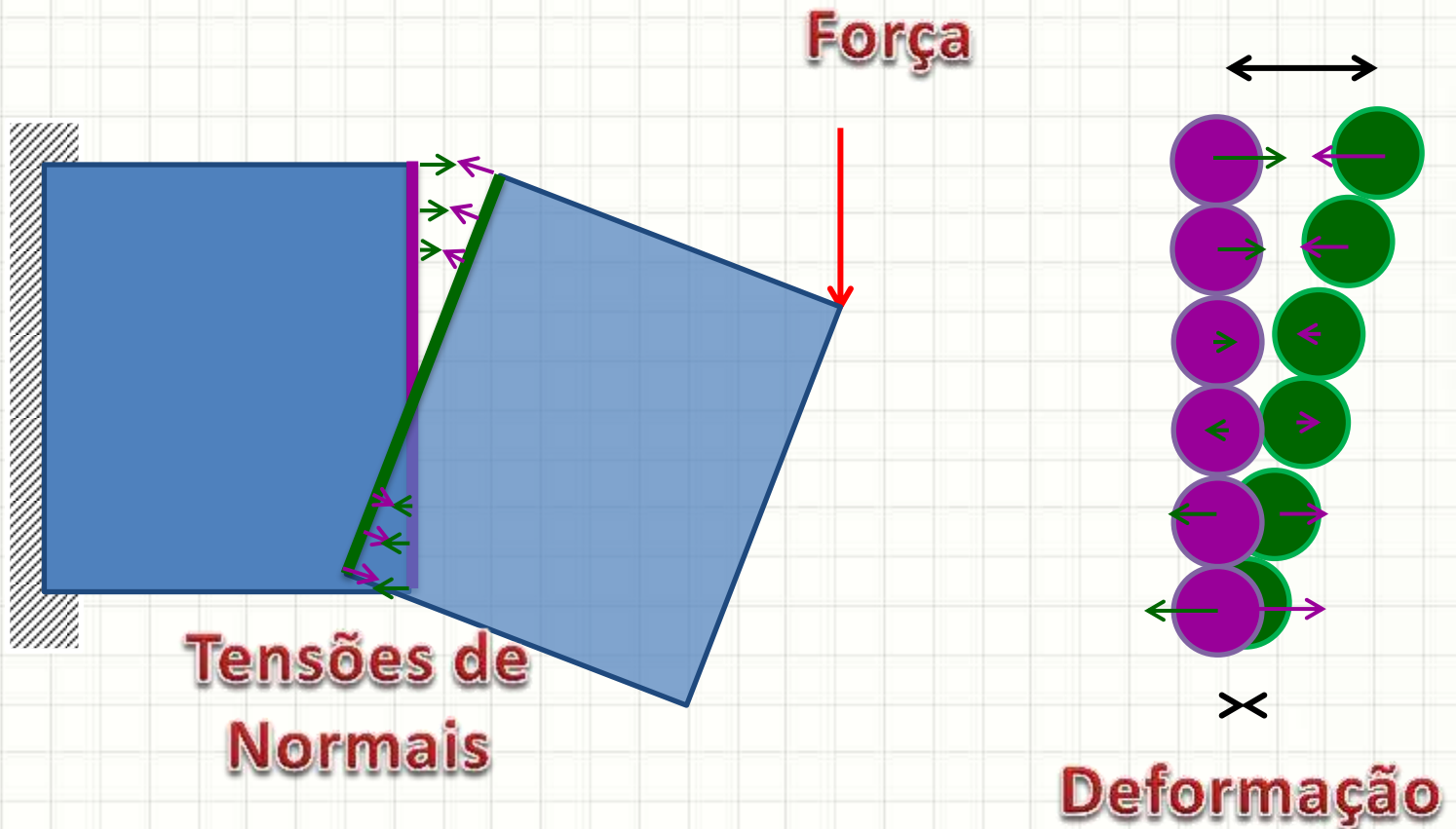
Esforços Cortantes

- O que são?



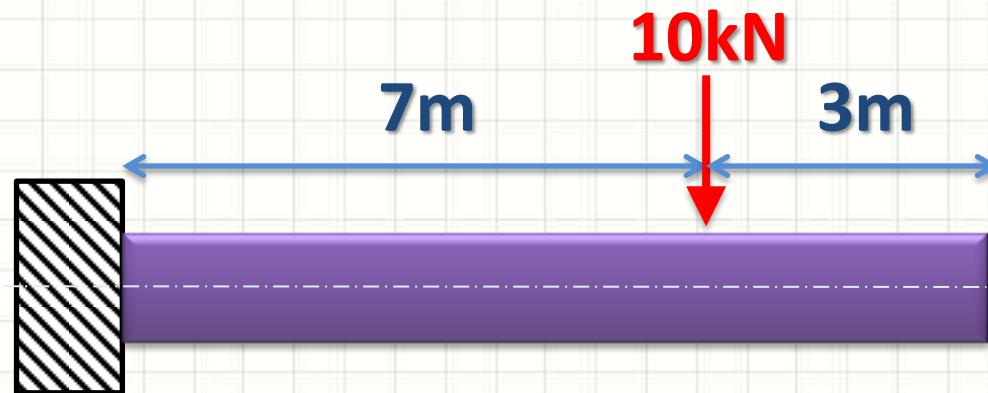
Esforços Cortantes

- O que são?



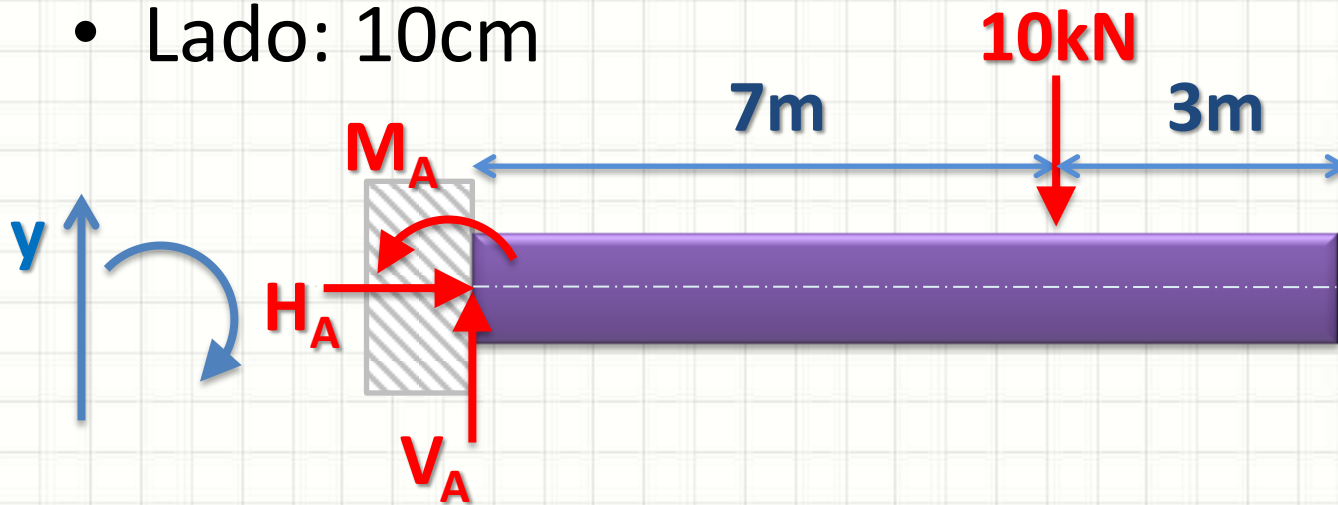
Exemplo

- Considere a viga abaixo, de seção quadrada de lado 10cm. Calcule as reações de apoio.



Exemplo

- Lado: 10cm



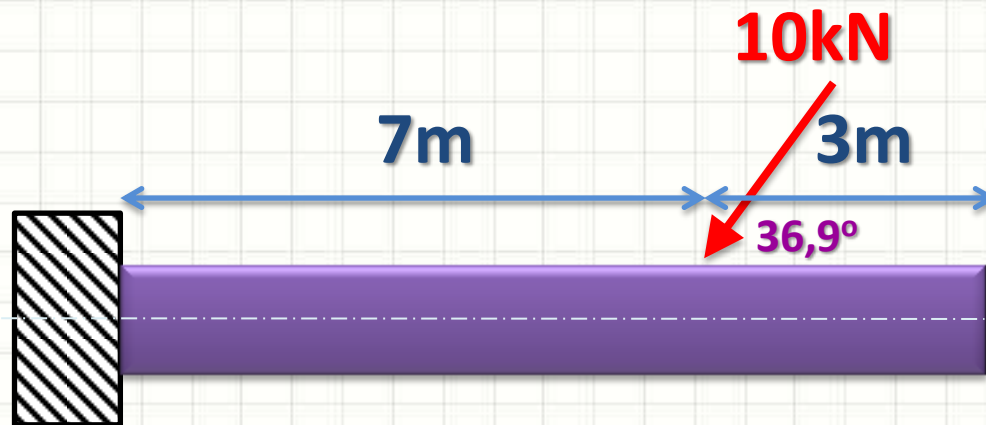
$$\sum F_x = 0 \Rightarrow \boxed{H_A = 0\text{kN}}$$

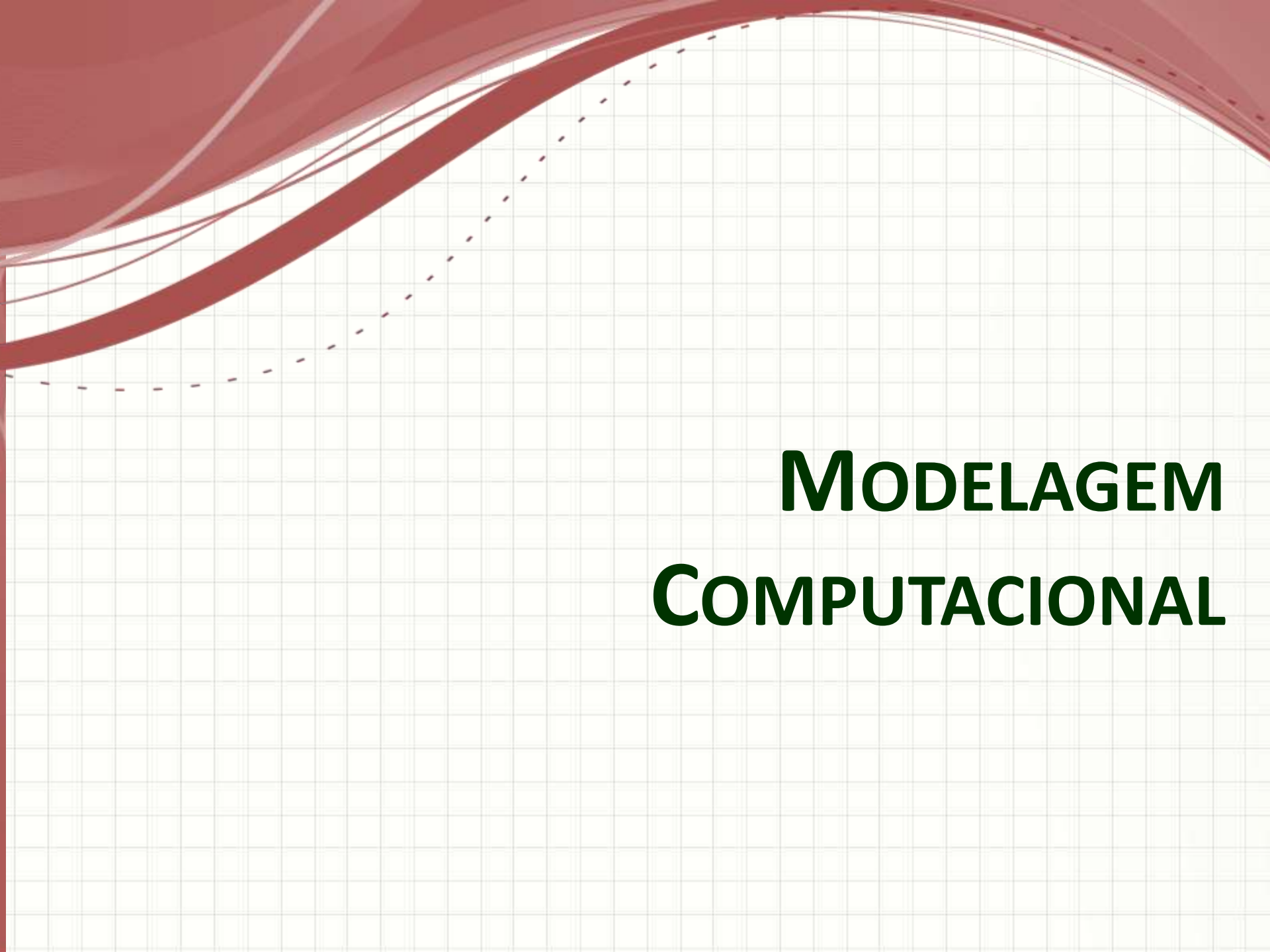
$$\sum F_y = 0 \Rightarrow V_A - 10000 = 0 \Rightarrow \boxed{V_A = 10\text{kN}}$$

$$\sum M_A = 0 \Rightarrow -M_A + 10000 \cdot 7 = 0 \Rightarrow \boxed{M_A = 70\text{kN.m}}$$

Exercício

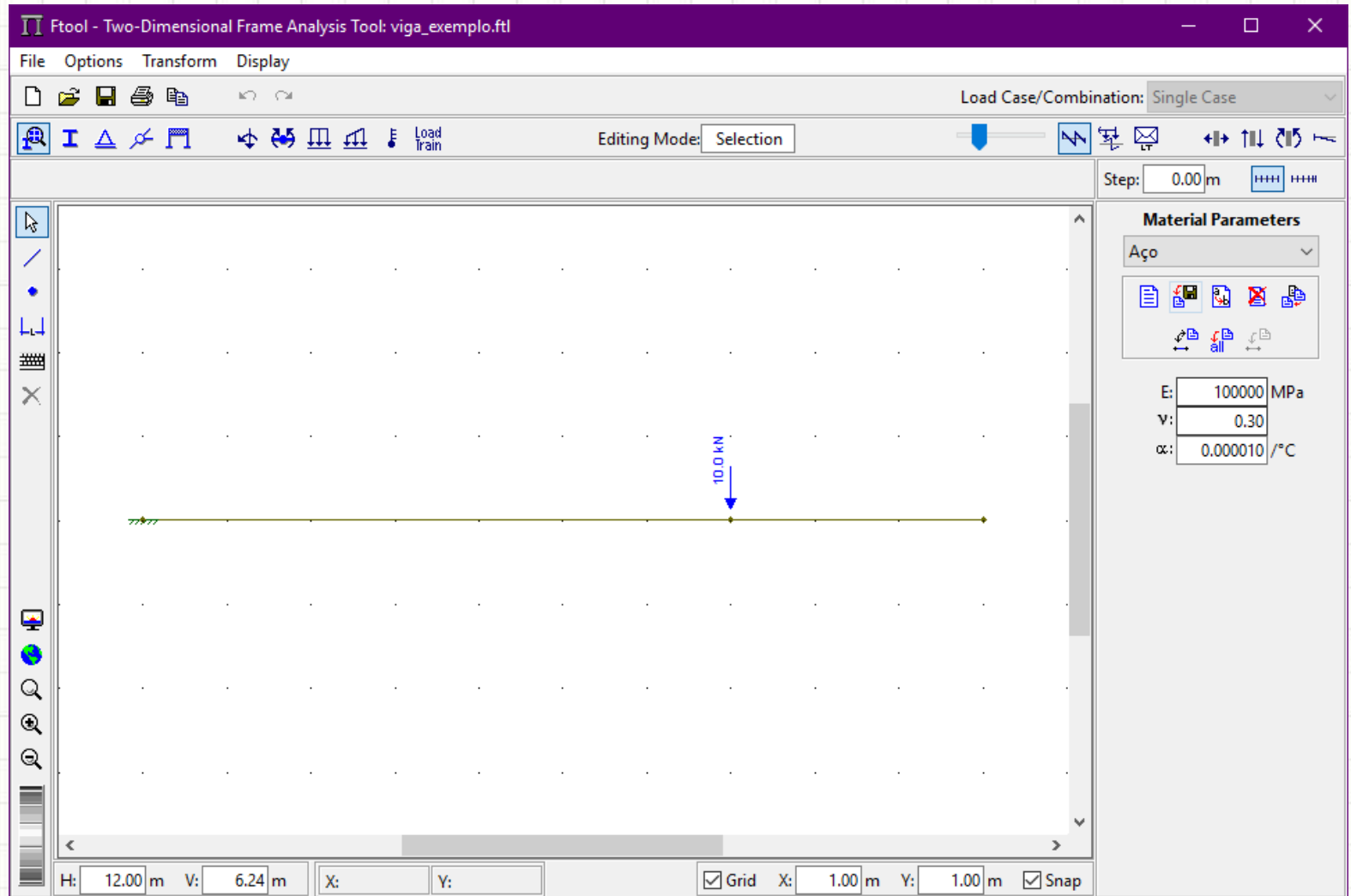
- Considere a viga abaixo, de seção retangular de lado 20x10cm. Calcule as reações de apoio



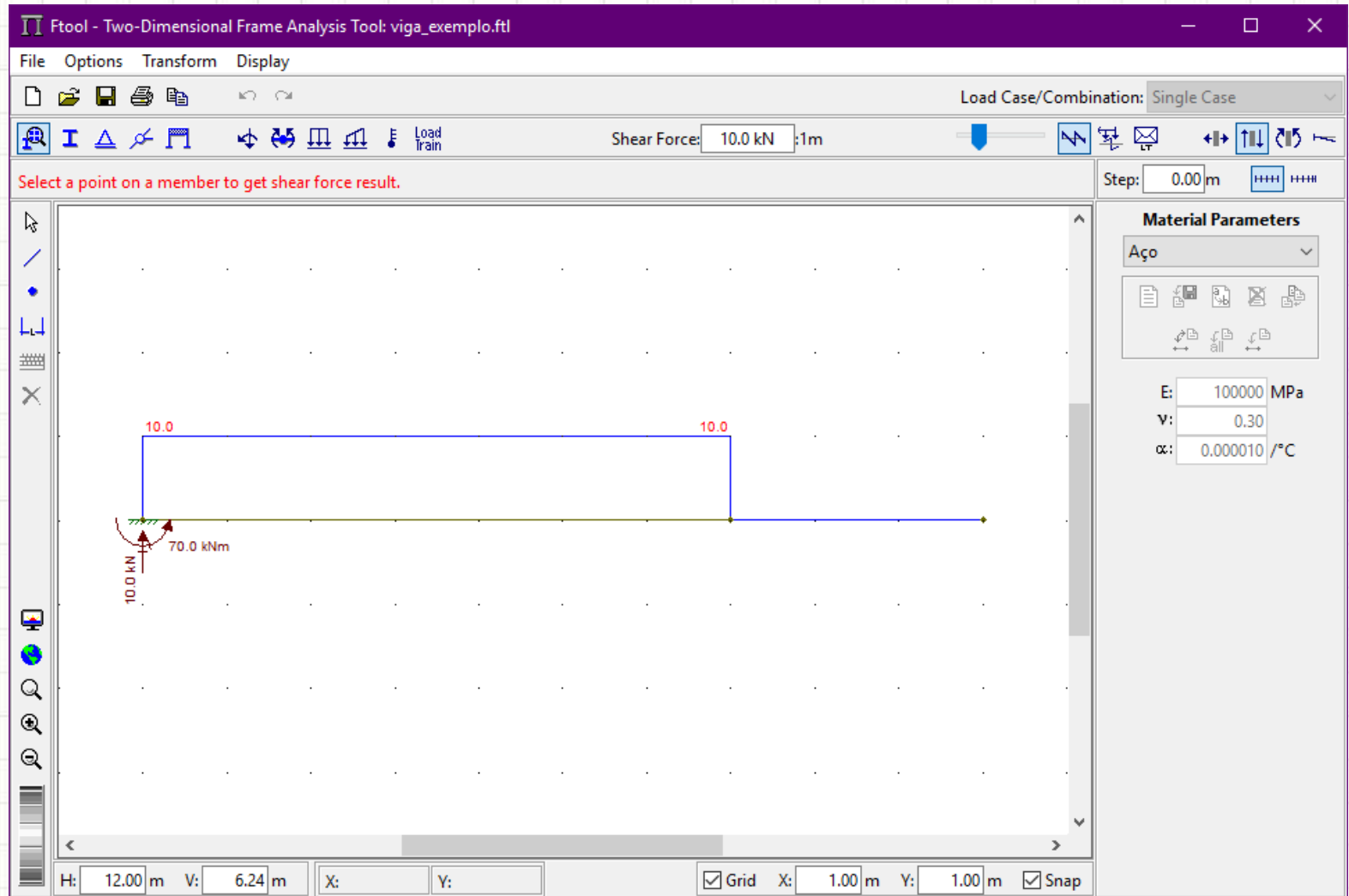
The background features a light gray grid pattern. In the upper left corner, there are several overlapping, wavy red lines of varying thickness and opacity, creating a dynamic, abstract design. A dashed red line also curves across the upper portion of the grid.

MODELAGEM COMPUTACIONAL

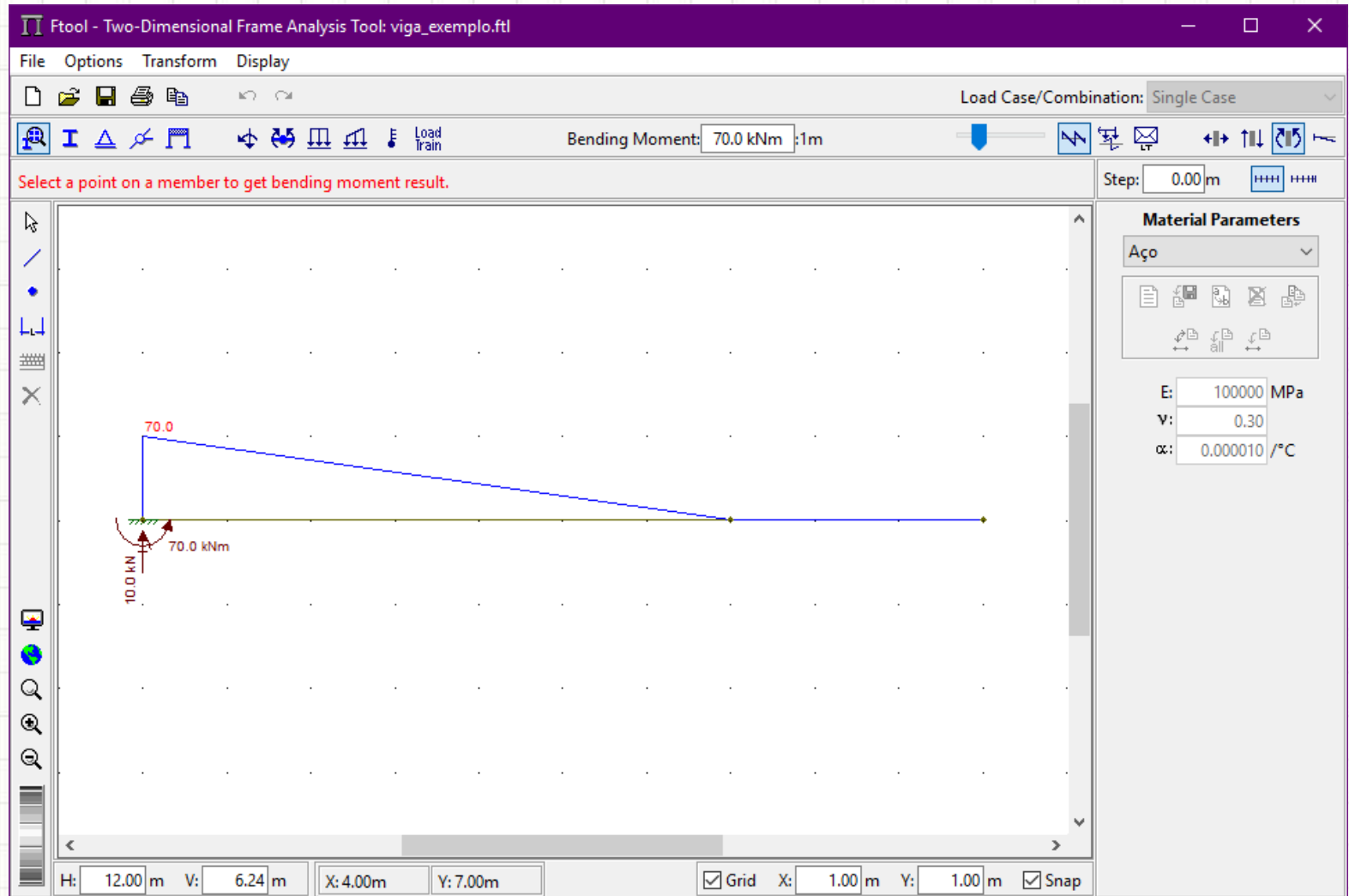
Modelagem Computacional



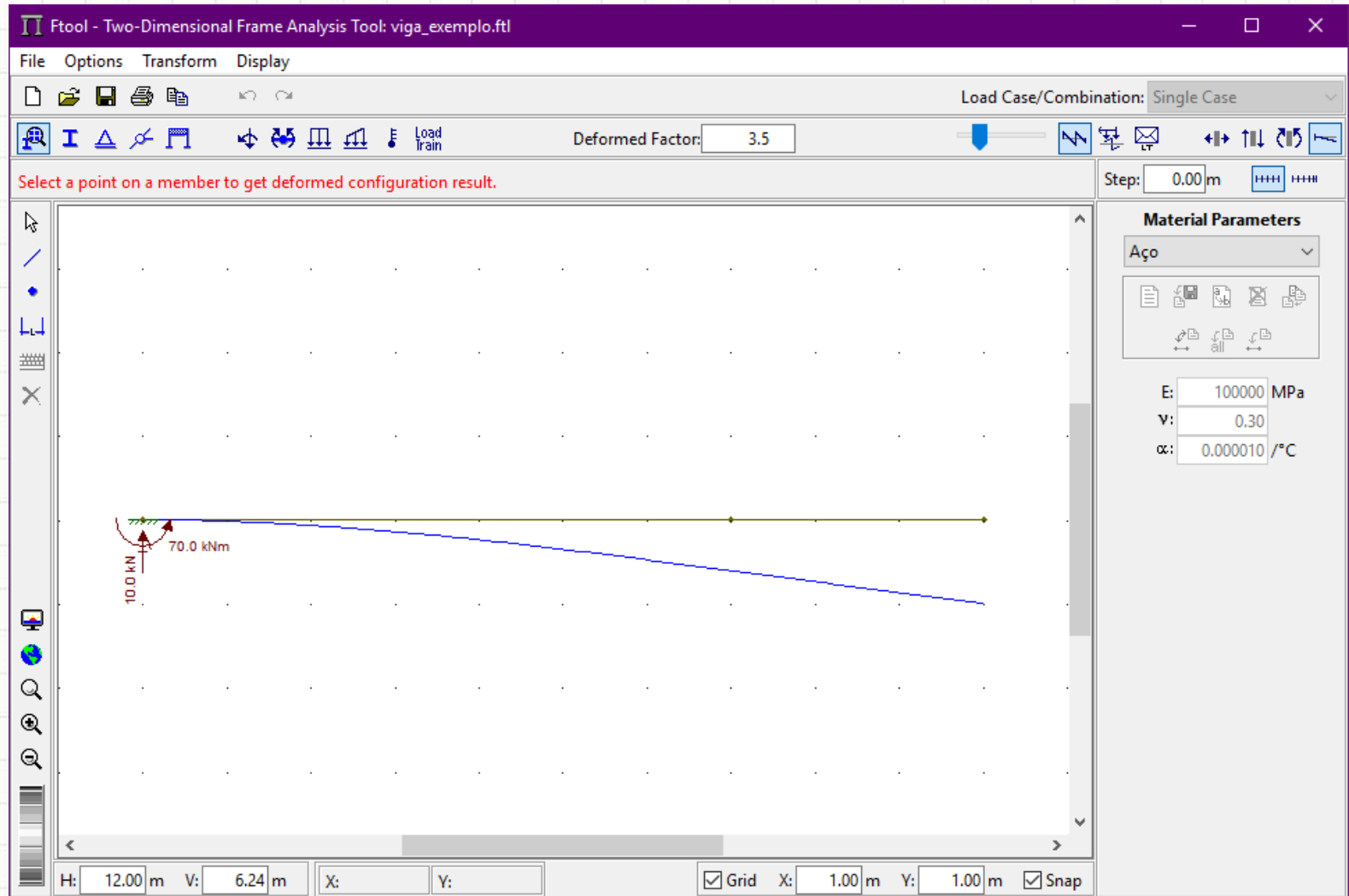
Modelagem Computacional



Modelagem Computacional



Modelagem Computacional



Modelagem Computacional

The screenshot displays the Ftool software interface for a two-dimensional frame analysis. The main window shows a horizontal beam of length 12.00 m, supported by a pin support on the left and a roller support on the right. A vertical downward load of 10.0 kN is applied at the midpoint of the beam. The software interface includes a menu bar (File, Options, Transform, Display), a toolbar with various modeling tools, and a right-hand panel for defining support conditions and spring stiffness values. The status bar at the bottom indicates the grid dimensions and snapping options.

File Options Transform Display

Load Case/Combination: Single Case

Editing Mode: Selection

Step: 0.00 m

Support Conditions

Displac. X: Free Fix Spring Kx

Displac. Y: Free Fix Spring Ky

Rotation Z: Free Fix Spring Kz

Angle: 0.0 deg

Prescribed Displacem./Rot.

Dx: mm
Dy: mm
Rz: rad

Spring Stiffness Values

Kx: kN/m
Ky: kN/m
Kz: kNm/rad

H: 12.00 m V: 7.45 m X: Y: Grid X: 1.00 m Y: 1.00 m Snap

Modelagem Computacional

FTool - Two-Dimensional Frame Analysis Tool: viga_exemplo_2.ftl

File Options Transform Display

Load Case/Combination: Single Case

Shear Force: 7.0 kN :1m

Select a point on a member to get shear force result.

Step: 0.00 m

Support Conditions

Displac. X: Free Fix Spring Kx

Displac. Y: Free Fix Spring Ky

Rotation Z: Free Fix Spring Kz

Angle: 0.0 deg

Prescribed Displacem./Rot.

Dx: mm
Dy: mm
Rz: rad

Spring Stiffness Values

Kx: kN/m
Ky: kN/m
Kz: kNm/rad

H: 12.00 m V: 7.45 m X: Y: Grid X: 1.00 m Y: 1.00 m Snap

Modelagem Computacional

FTool - Two-Dimensional Frame Analysis Tool: viga_exemplo_2.ftl

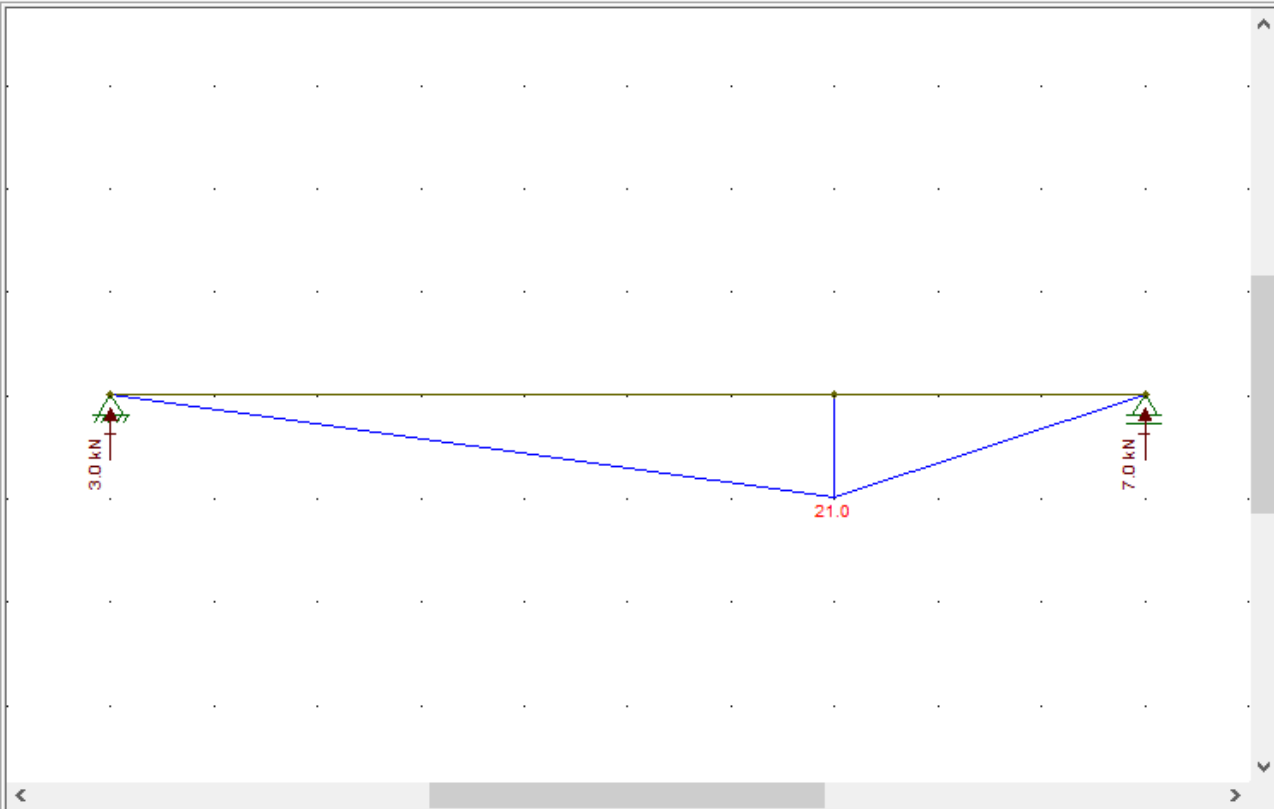
File Options Transform Display

Load Case/Combination: Single Case

Bending Moment: 21.0 kNm :1m

Select a point on a member to get bending moment result.

Step: 0.00 m



Support Conditions

Displac. X: Free Fix Spring Kx

Displac. Y: Free Fix Spring Ky

Rotation Z: Free Fix Spring Kz

Angle: 0.0 deg

Prescribed Displacem./Rot.

Dx: mm
Dy: mm
Rz: rad

Spring Stiffness Values

Kx: kN/m
Ky: kN/m
Kz: kNm/rad

H: 12.00 m V: 7.45 m X: Y: Grid X: 1.00 m Y: 1.00 m Snap

Modelagem Computacional

FTool - Two-Dimensional Frame Analysis Tool: viga_exemplo_2.ftl

File Options Transform Display

Load Case/Combination: Single Case

Deformed Factor: 39.9

Select a point on a member to get deformed configuration result.

Step: 0.00 m

Support Conditions

Displac. X: Free Fix Spring Kx

Displac. Y: Free Fix Spring Ky

Rotation Z: Free Fix Spring Kz

Angle: 0.0 deg

Prescribed Displacem./Rot.

Dx: mm
Dy: mm
Rz: rad

Spring Stiffness Values

Kx: kN/m
Ky: kN/m
Kz: kNm/rad

H: 12.00 m V: 7.45 m X: Y:

Grid X: 1.00 m Y: 1.00 m Snap



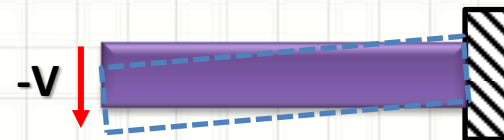
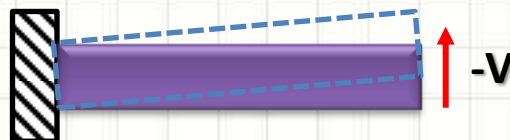
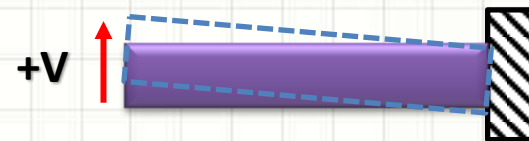
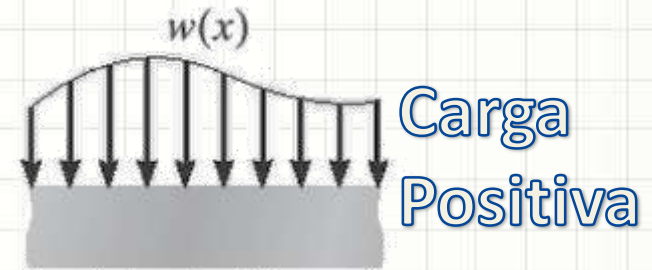
DIAGRAMAS DE ESFORÇOS CORTANTES

Diagramas de Esforços Cortantes

- Por que traçar diagrama de cortante?
 - Cortante pode variar ao longo do comprimento
 - Encontrar o ponto de maior sollicitação

- Convenção de Sinais

- Carregamento
 - De cima para baixo: +
 - De baixo para cima: -
- Cortante
 - Gira sent. Horário: +
 - Gira sent. Anti-Horário: -

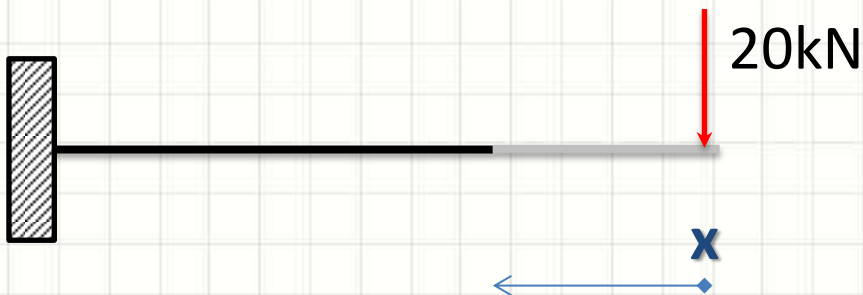


Diagramas de Esforços Cortantes

- Força Cortante Concentrada



- Qual a força cortante em um ponto "x"?



Redução dos
Esforços ao
ponto "x"

Diagramas de Esforços Cortantes

- Força Cortante Concentrada



- Qual a força cortante em um ponto “x”?



Sentido
Horário!

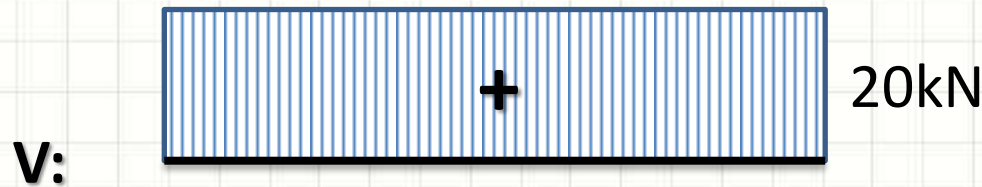
- $V(x) = 20\text{kN}$

Diagramas de Esforços Cortantes

- Força Cortante Concentrada

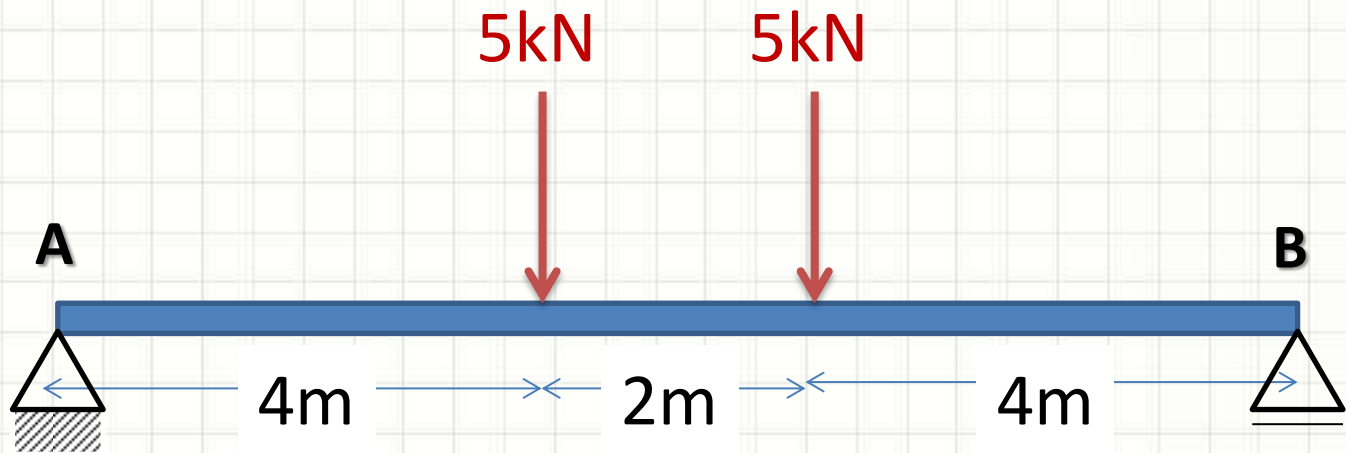


- $V(x) = 20\text{kN}$... Sentido horário
- Logo... O diagrama de cortante é



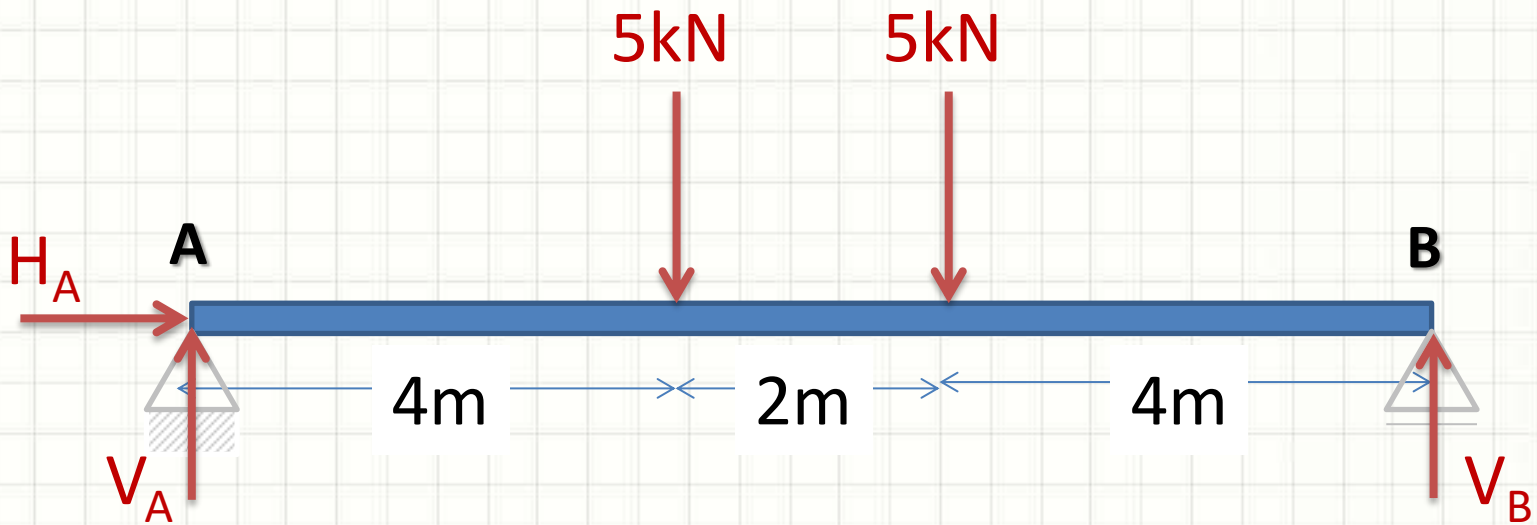
Exemplo: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



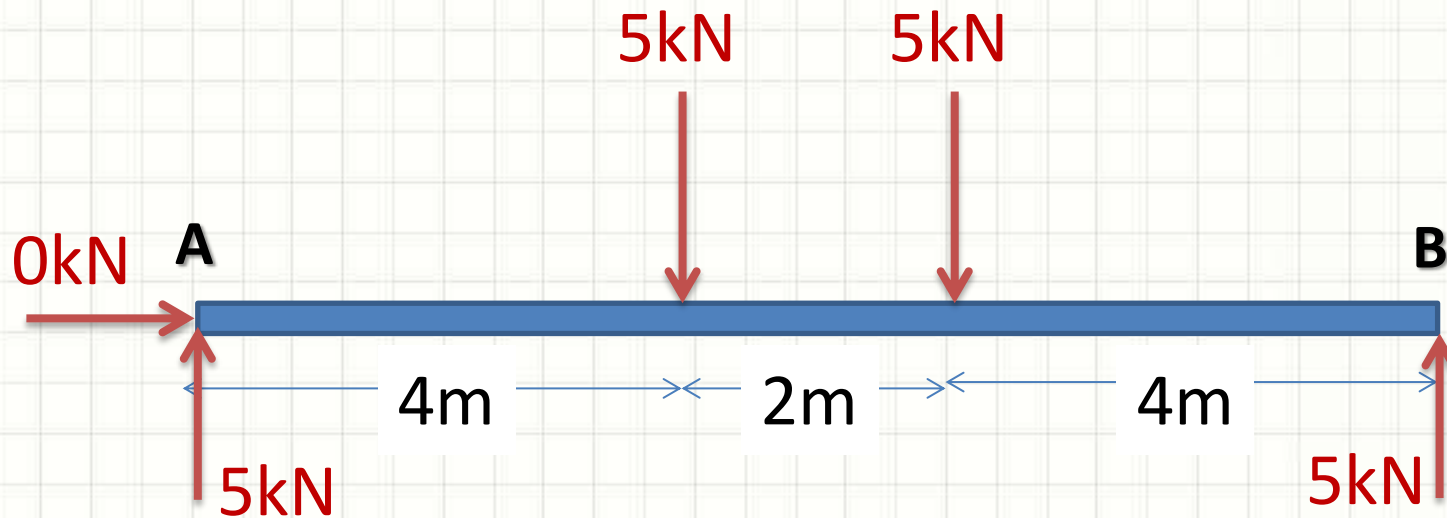
Exemplo: Diagrama de Esf. Cortantes

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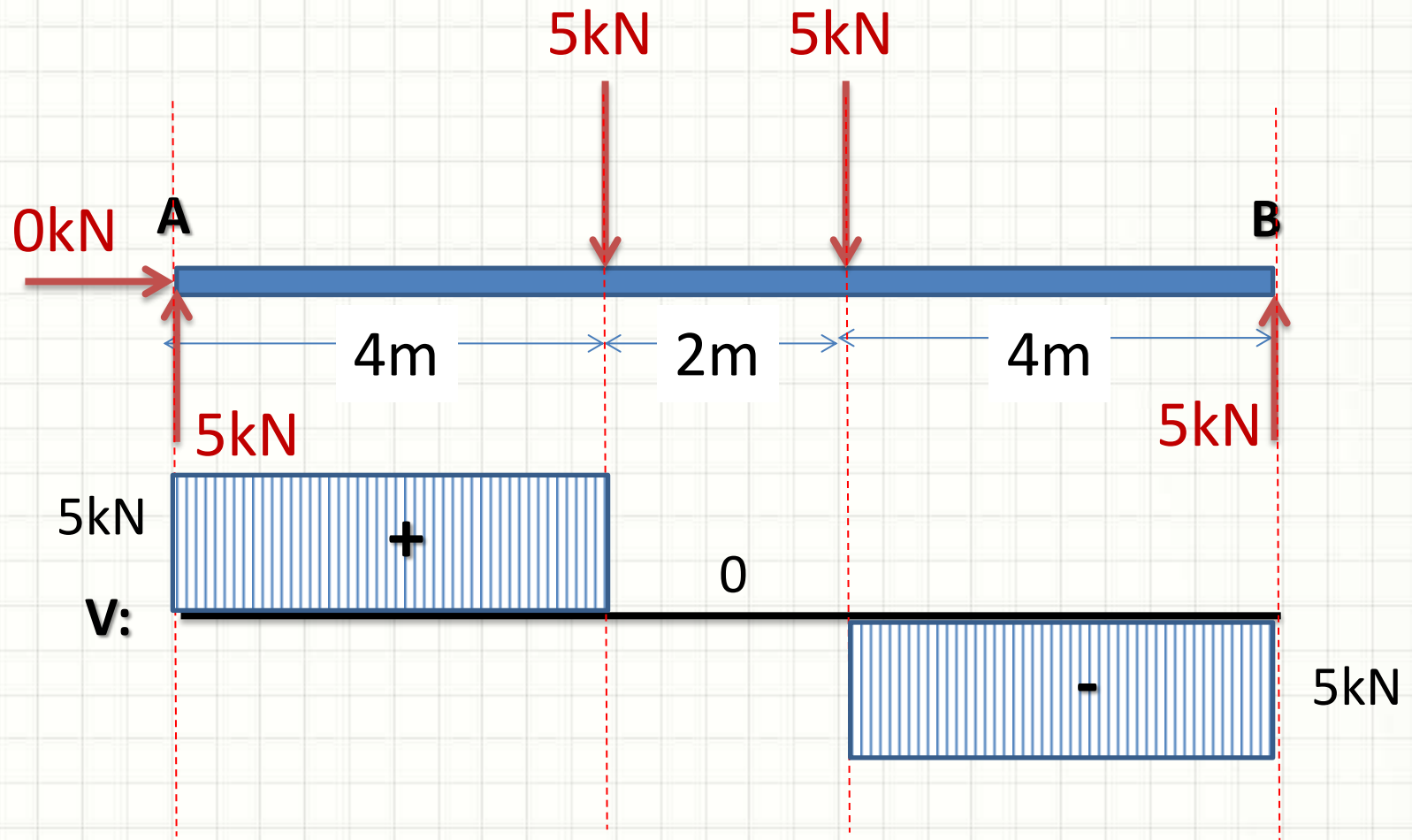
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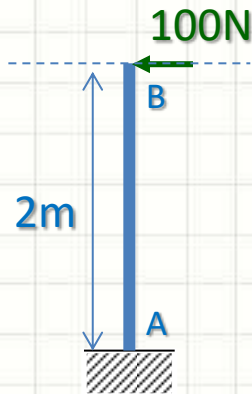
Exemplo: Diagrama de Esf. Cortantes

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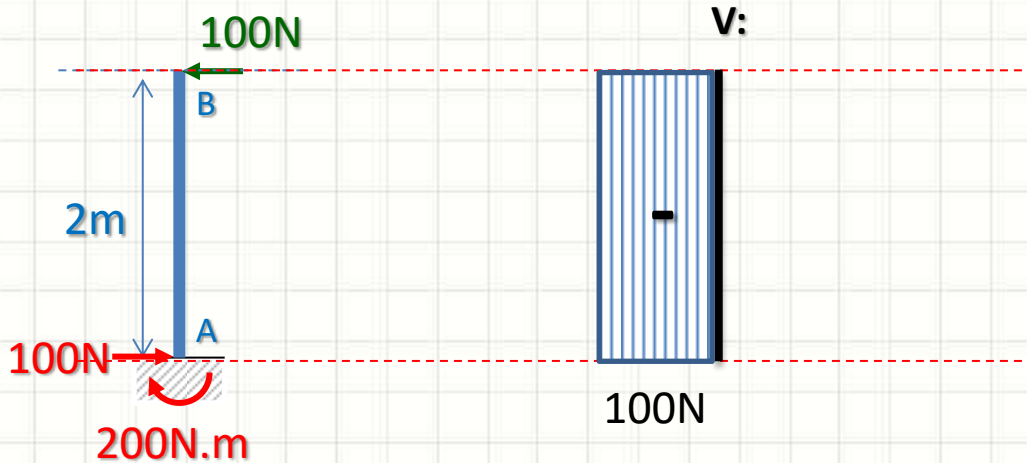
Exercício: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



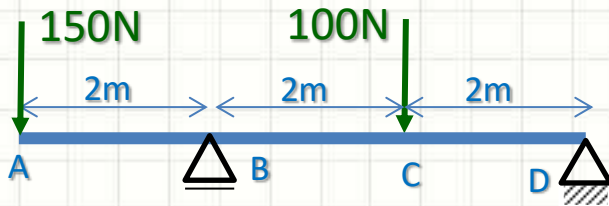
Exercício: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



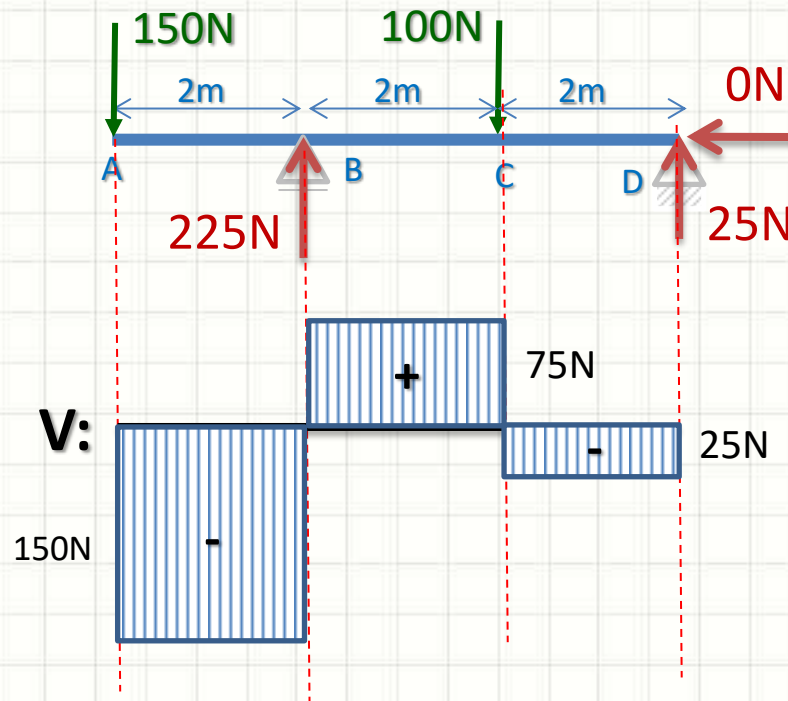
Exercício

- Trace o Diagrama de Cortante para a viga:



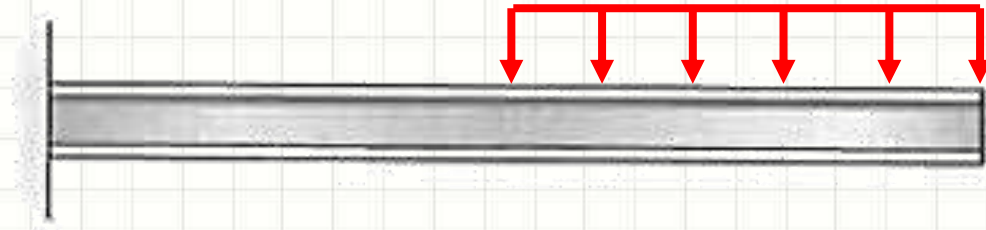
Exercício

- Trace o Diagrama de Cortante para a viga:



Diagramas de Esforços Cortantes

- E se as forças forem uma carga distribuída?
 - Ex.: enchimento de uma laje rebaixada



Próxima aula!



CONCLUSÕES

Resumo

- Vigas: sujeitas a vários esforços internos
 - Forças Cortantes x Momentos Fletores
 - Cisalhamentos e Esforços Normais
 - Esforços variam ao longo da viga!
 - Ponto mais solicitado?
 - **TAREFA:** Exercícios Aula 6
-
- Diagramas de Cortante e Momentos
 - Cargas concentradas e cargas distribuídas



PERGUNTAS?

Exercício para casa

Determine as reações e trace o diagrama de cortante da viga abaixo

