

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

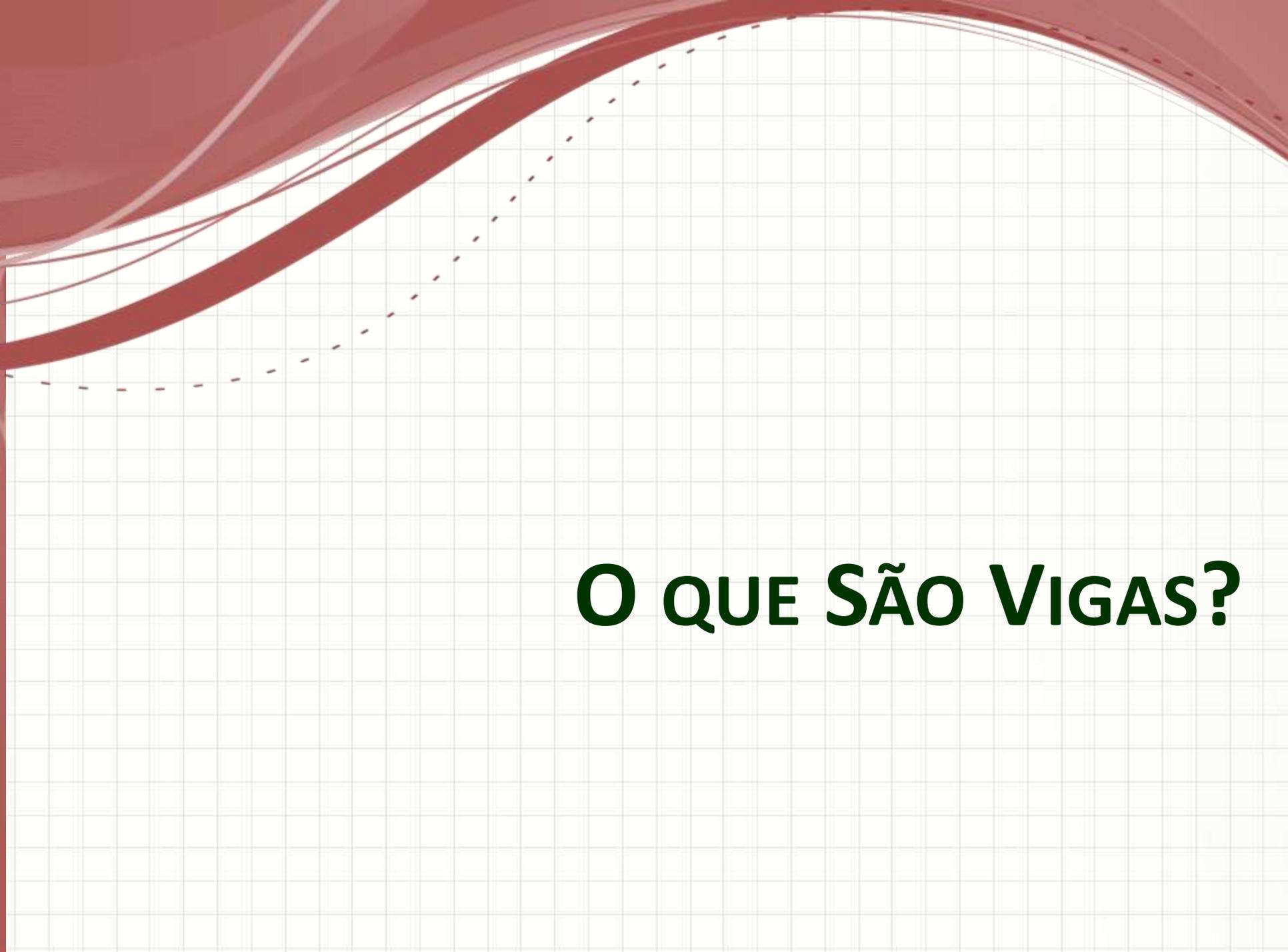
Mecânica Geral (MACIEL), Cap. 5 (SAVA)

Minha Biblioteca

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

Biblioteca Virtual

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



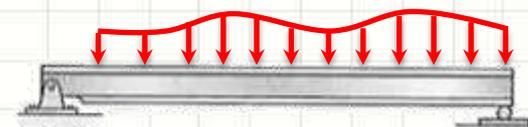
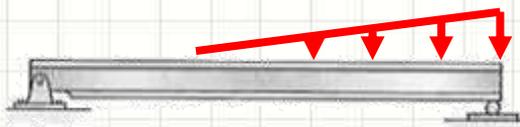
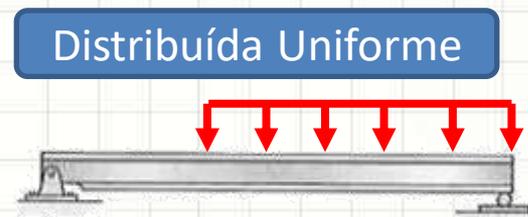
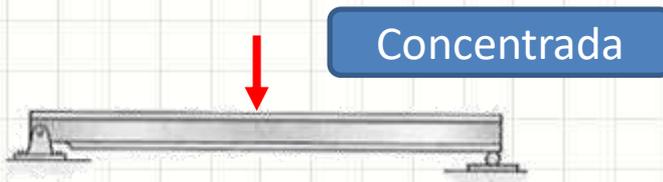
O QUE SÃO VIGAS?

Objeto de Estudo

- Vigas – Cargas perpendiculares ao eixo



- Tipos de Cargas

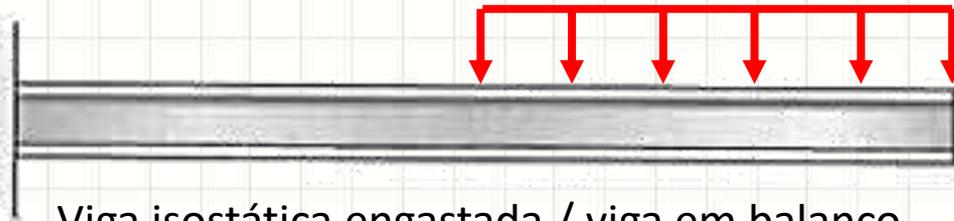


Objeto de Estudo

- Tipos Clássicos de Vigas



Viga isostática bi-apoiada



Viga isostática engastada / viga em balanço



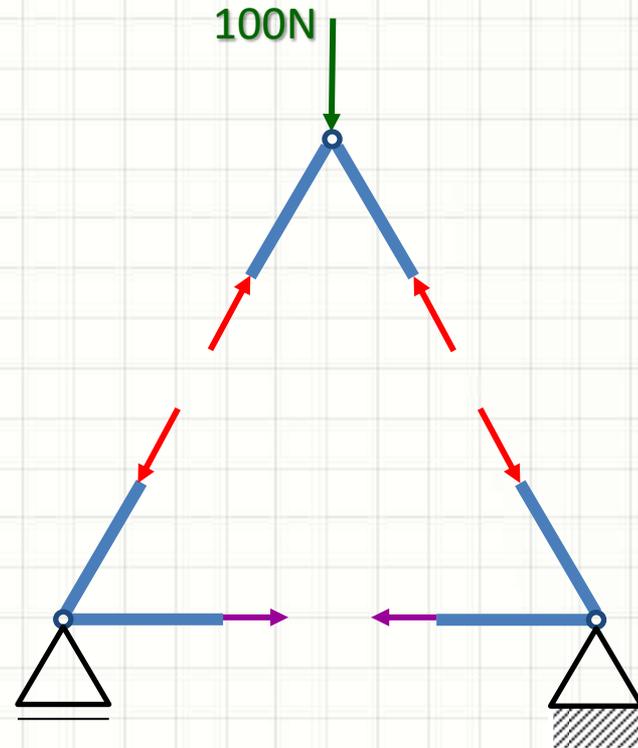
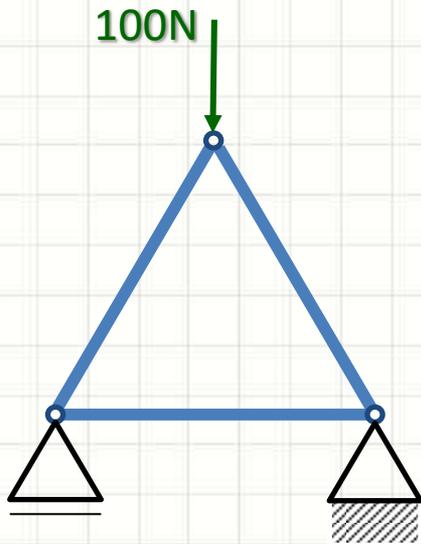
Viga isostática bi-apoiada com extremidade em balanço



ESFORÇOS INTERNOS NAS VIGAS

Forças Internas

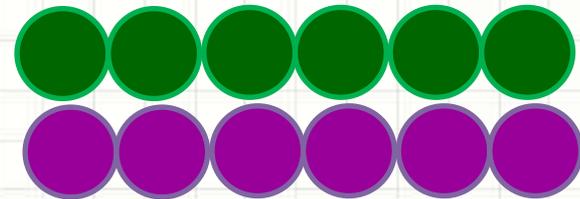
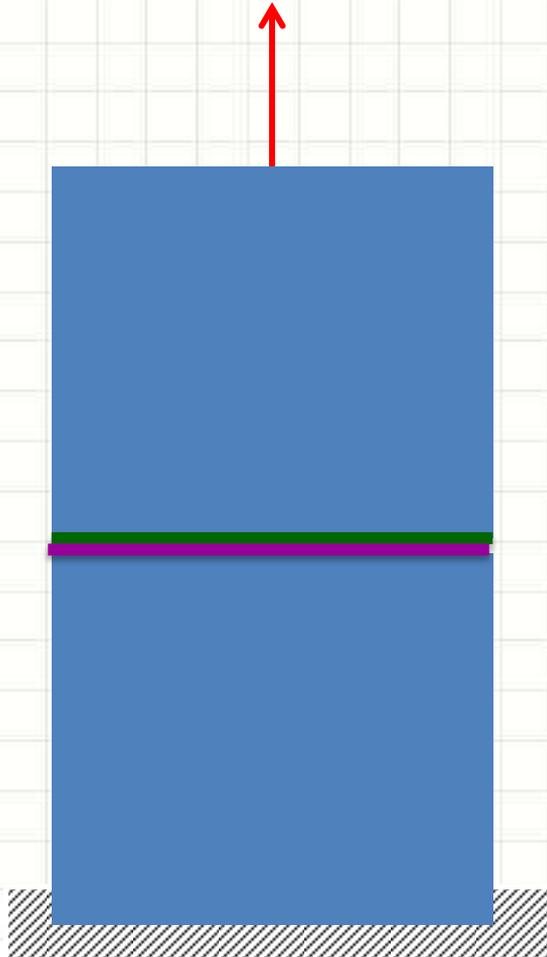
- Forças Internas: mantém estrutura coesa
- Em treliças: só **Tração** e **Compressão**



- E nas vigas?

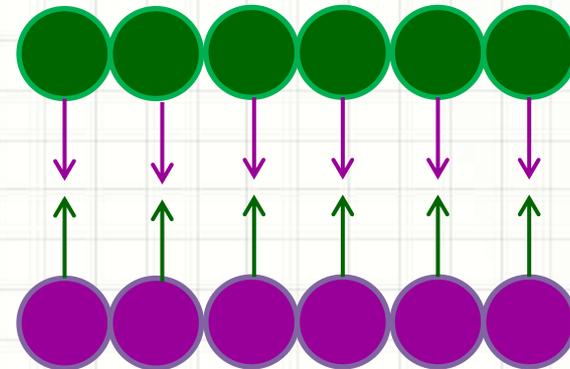
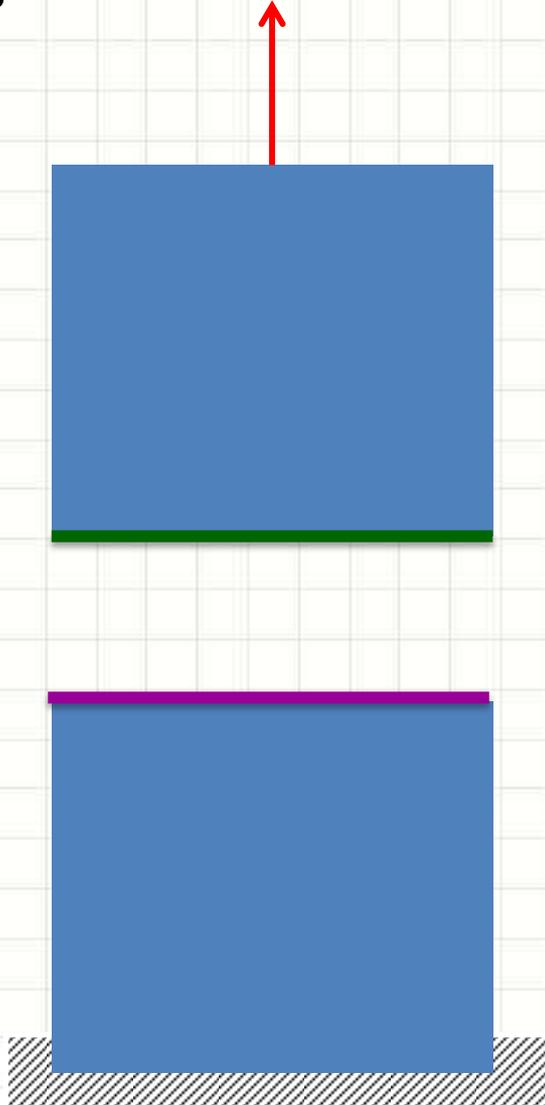
Força Axial x Esforços Normais

- O que são?

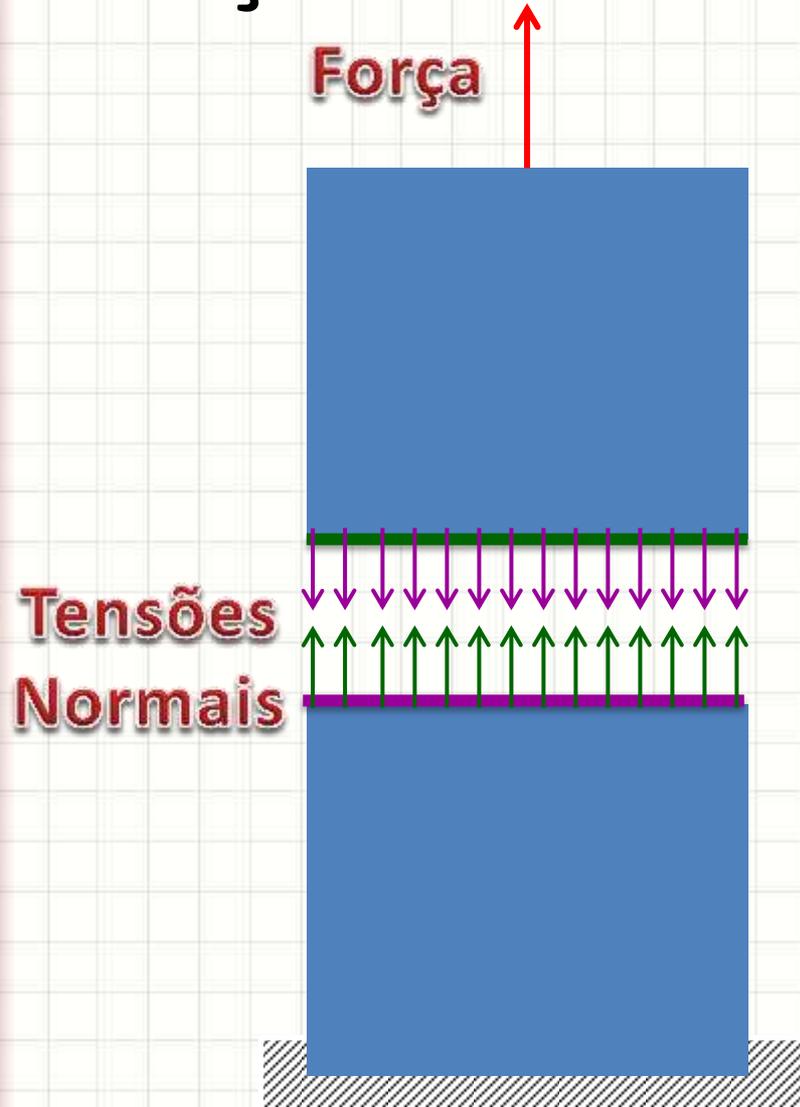


Força Axial x Esforços Normais

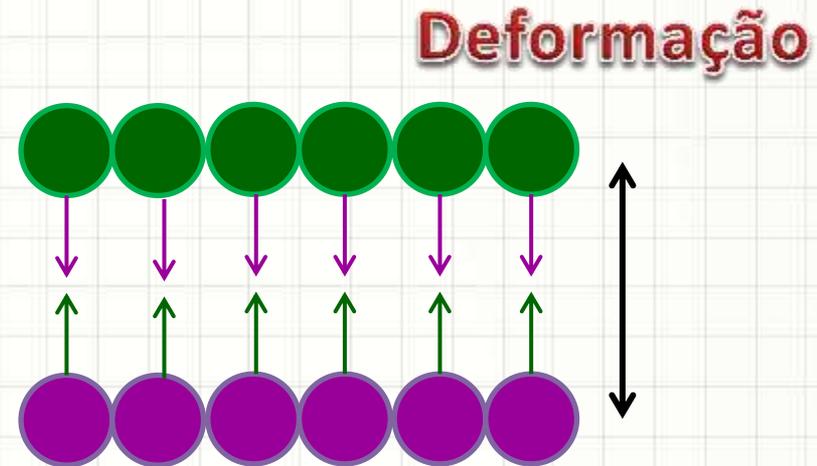
- O que são?



Força Axial x Esforços Normais

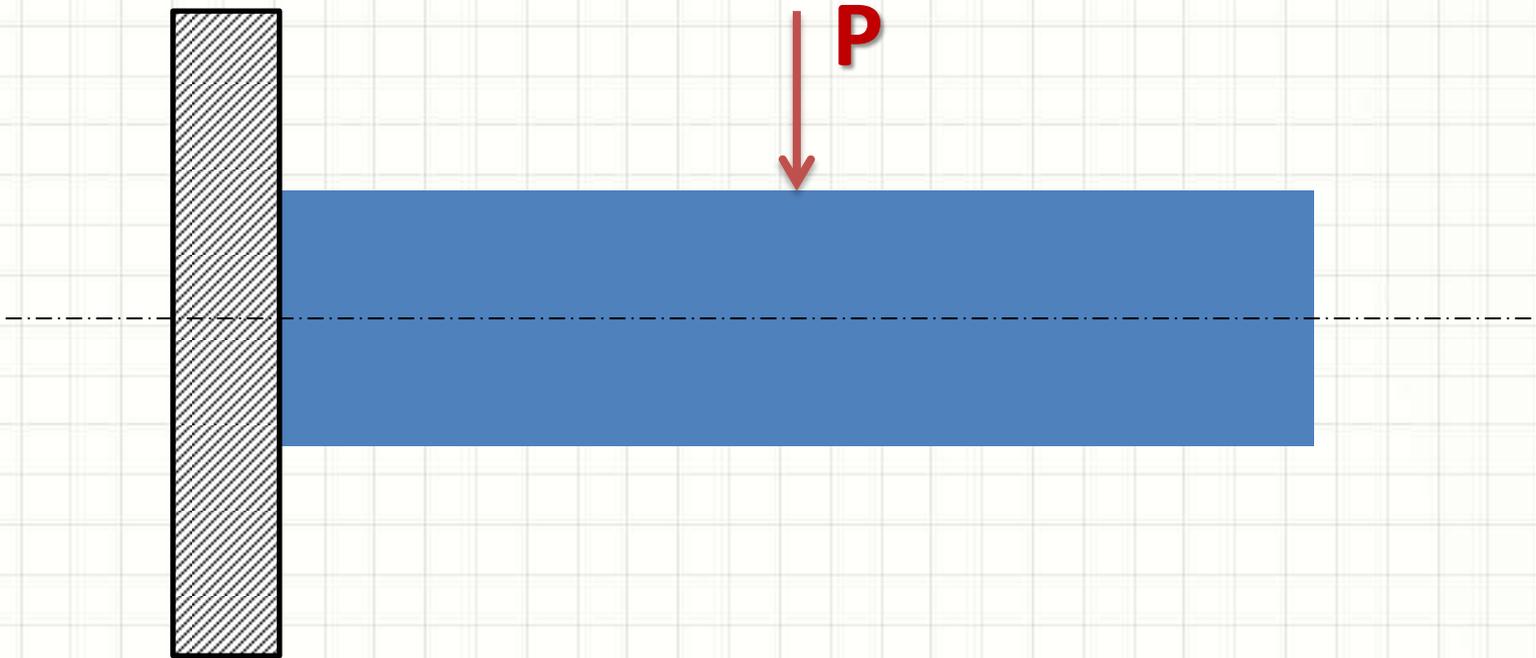


- O que são?



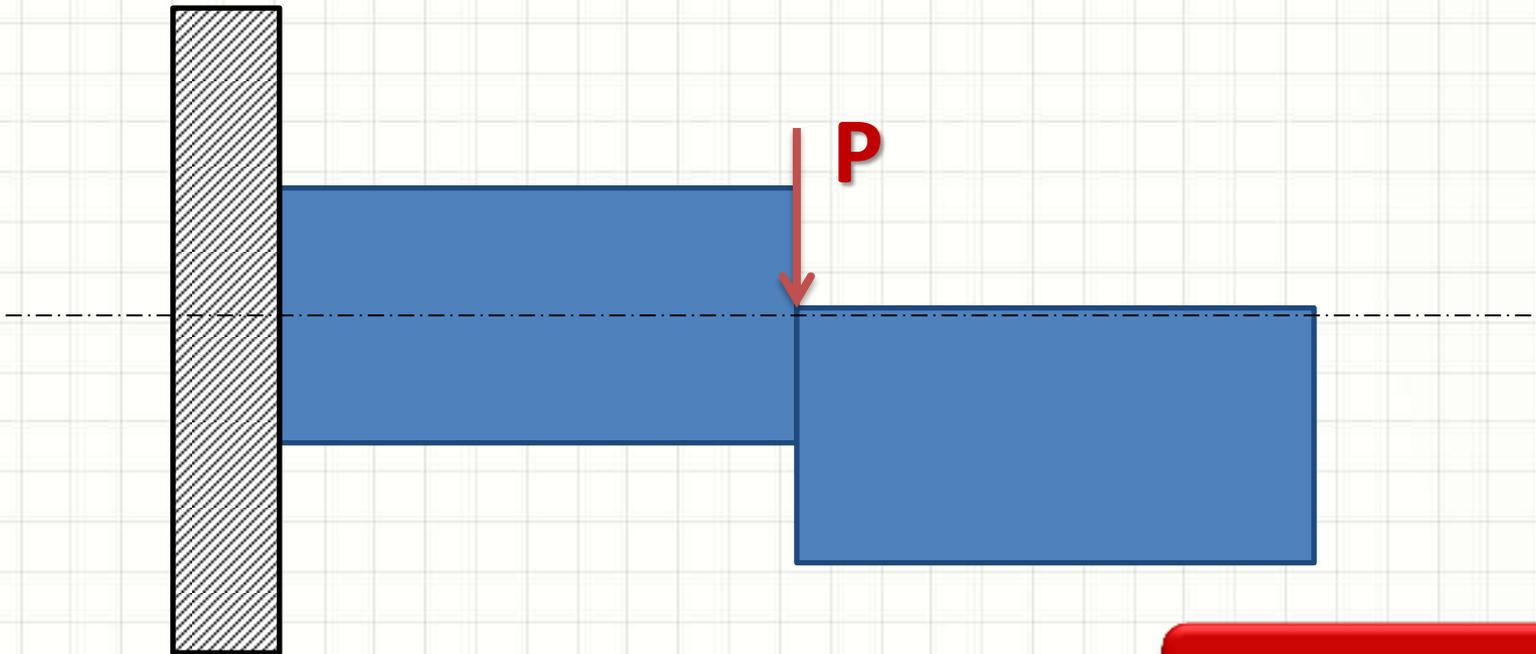
Força Cortante

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



Força Cortante

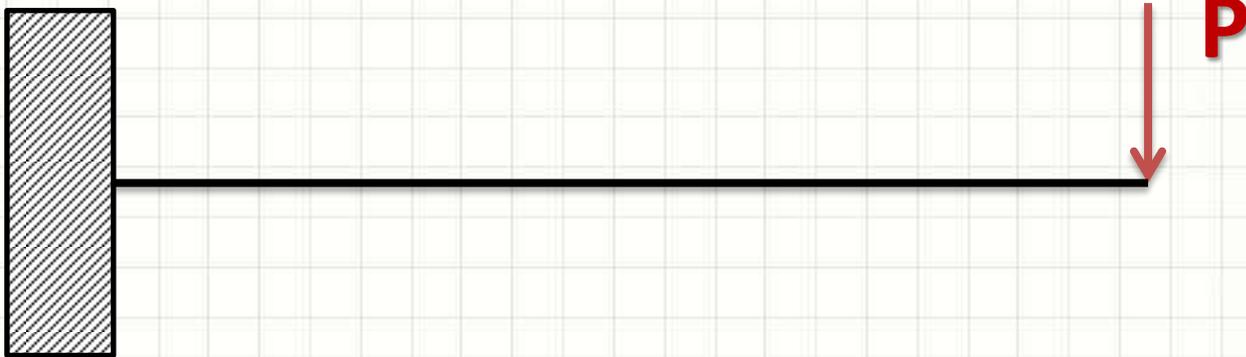
- Força Cortante: aquela que tende a “fatiar”
 - É perpendicular ao eixo da barra



Só isso?

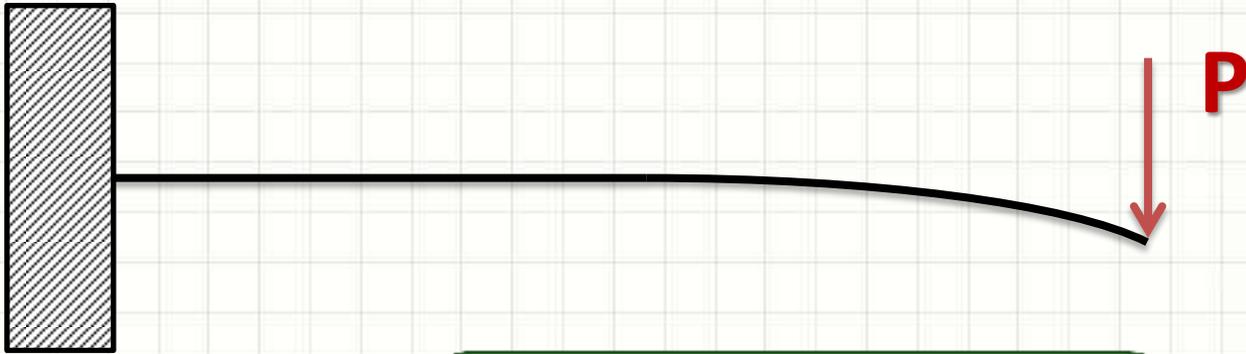
Momento Fletor

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



Momento Fletor

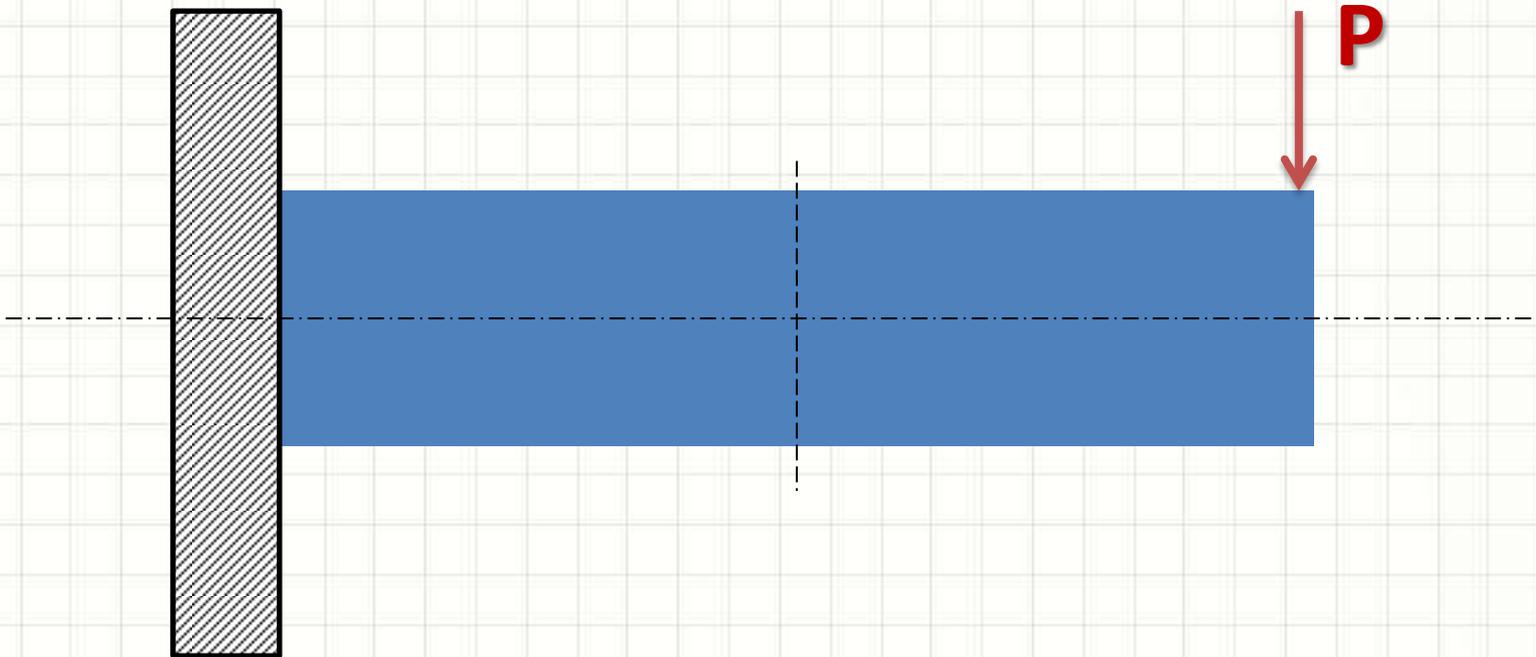
- Momento Fletor: esforço que “enverga” barra
 - Resulta das forças cortantes



Para compreender,
precisamos analisar
um modelo
diferente...

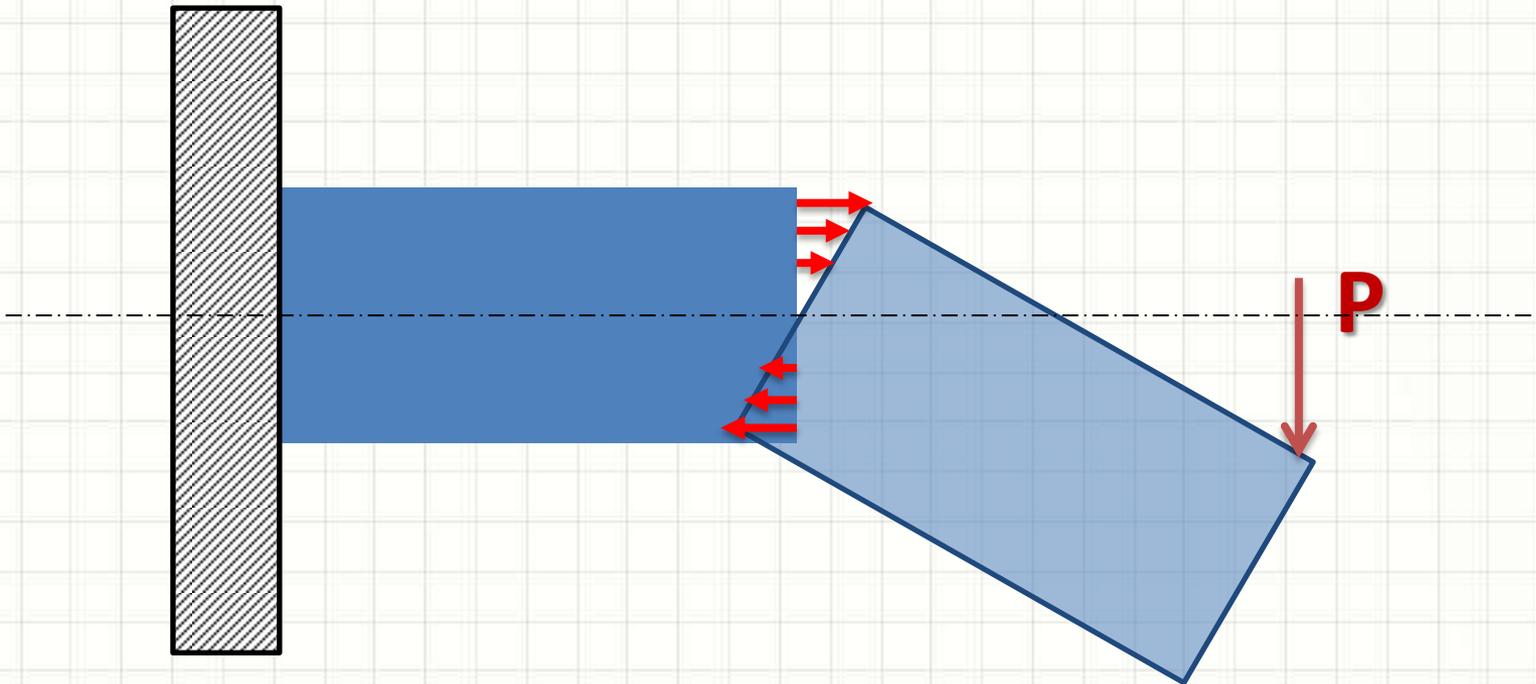
Momento Fletor

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



Momento Fletor

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

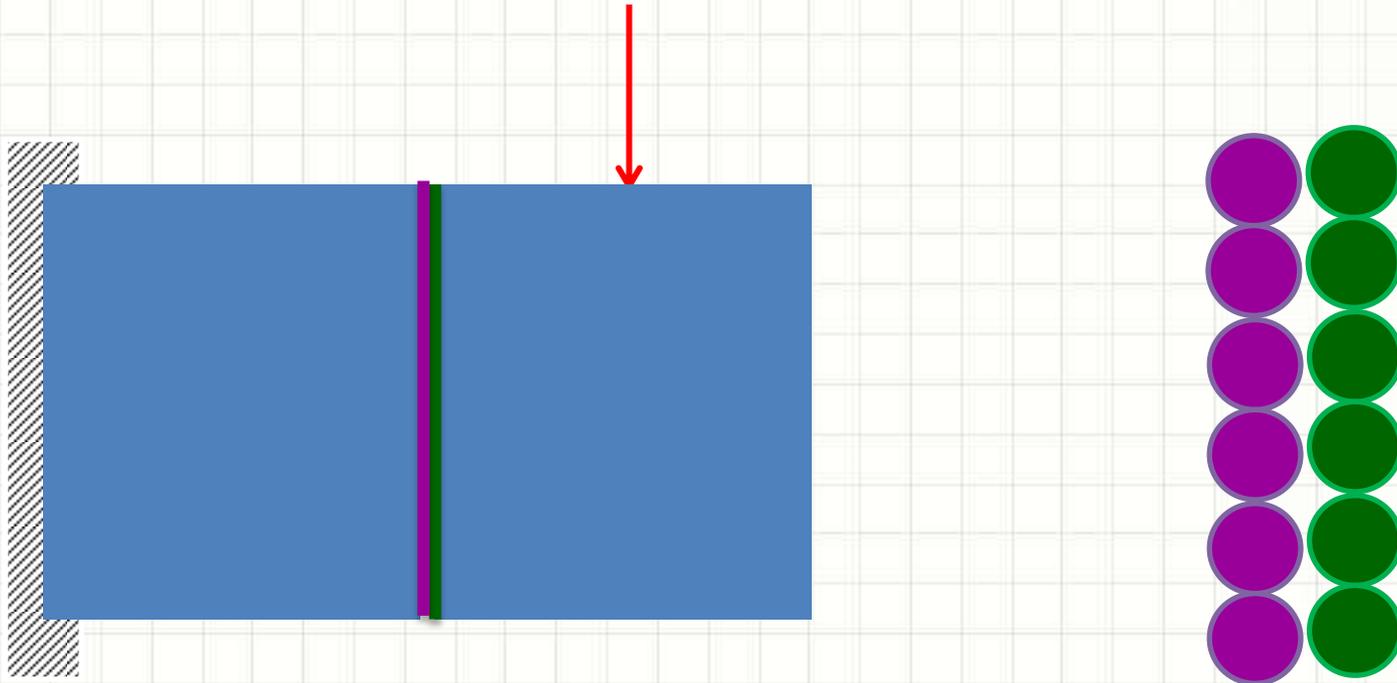




ESFORÇOS CORTANTES E AS TENSÕES DE CISALHAMENTO

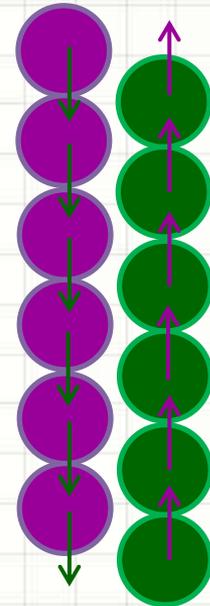
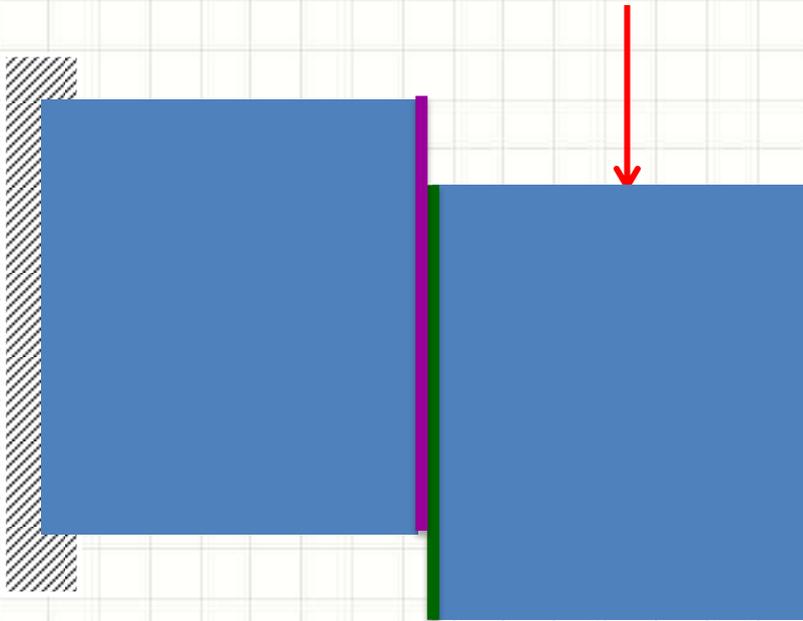
Esforços Cortantes

- O que são?



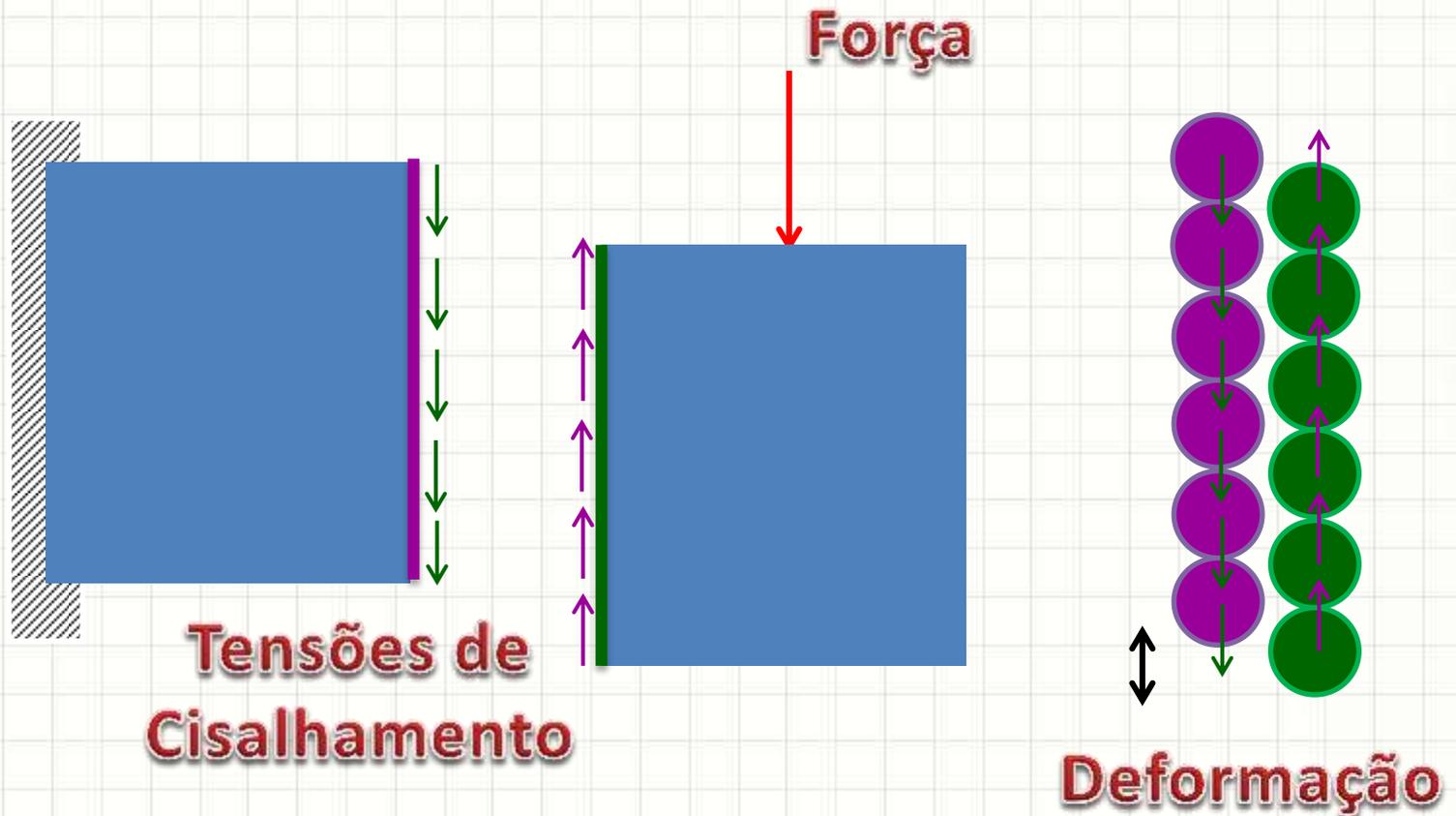
Esforços Cortantes

- O que são?



Esforços Cortantes

- O que são?

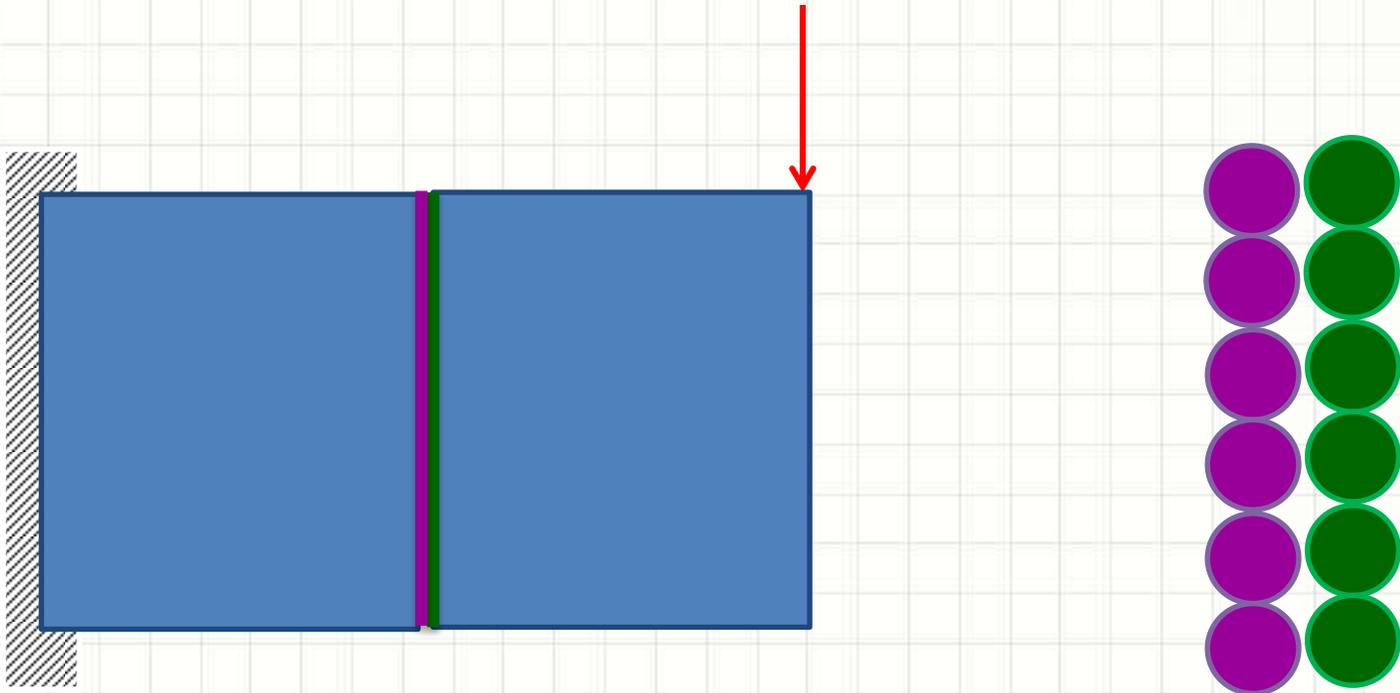




MOMENTO FLETOR E AS TENSÕES NORMAIS

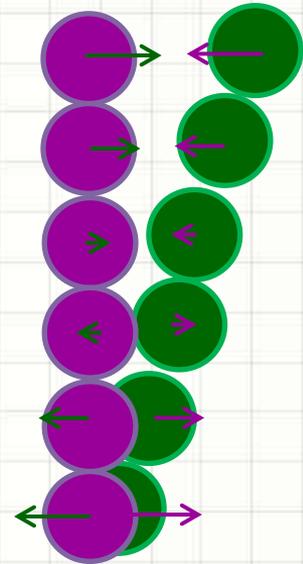
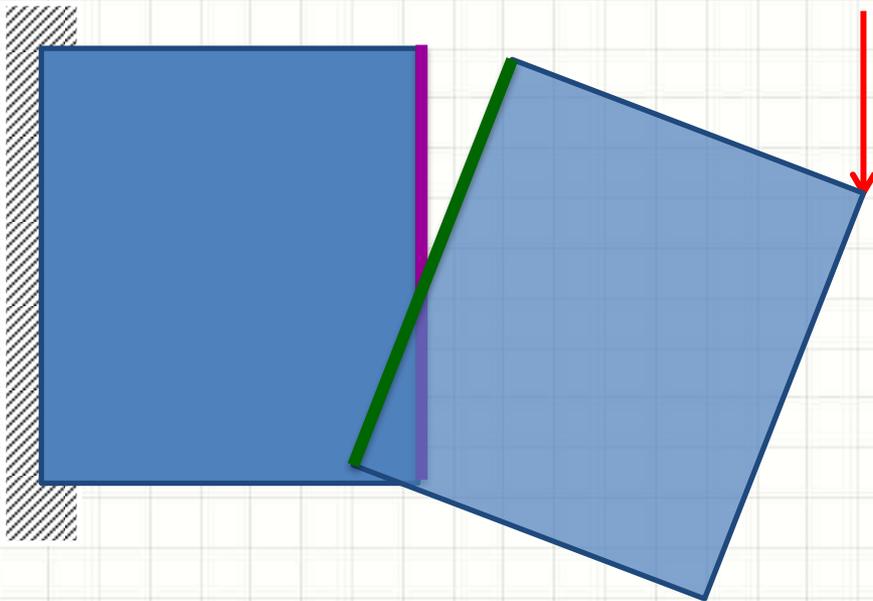
Tensões Normais

- O que são?



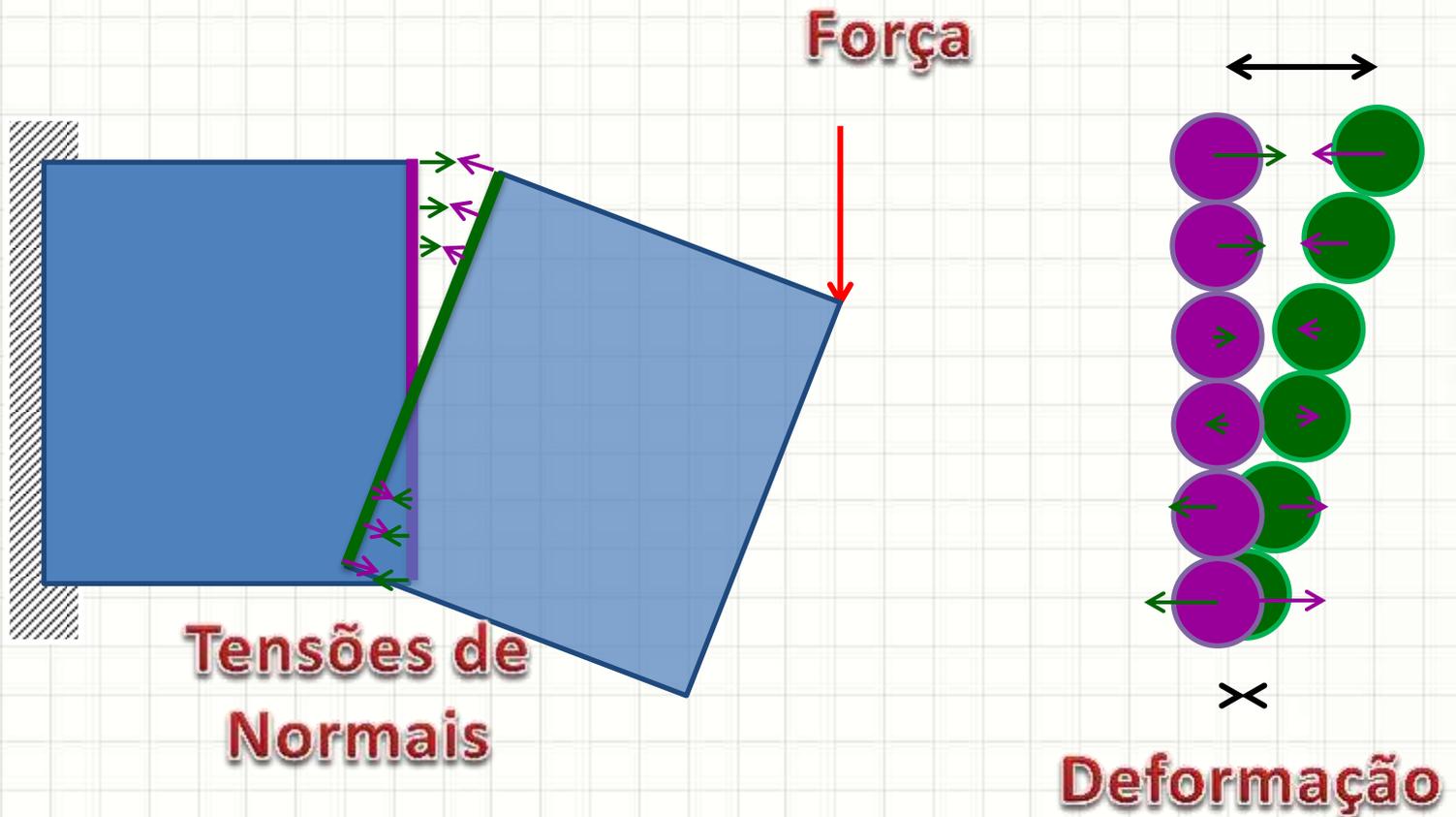
Esforços Cortantes

- O que são?



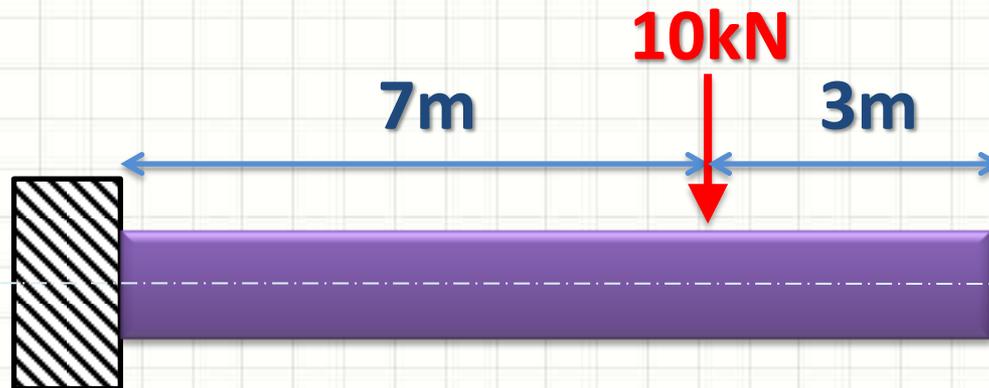
Esforços Cortantes

- O que são?



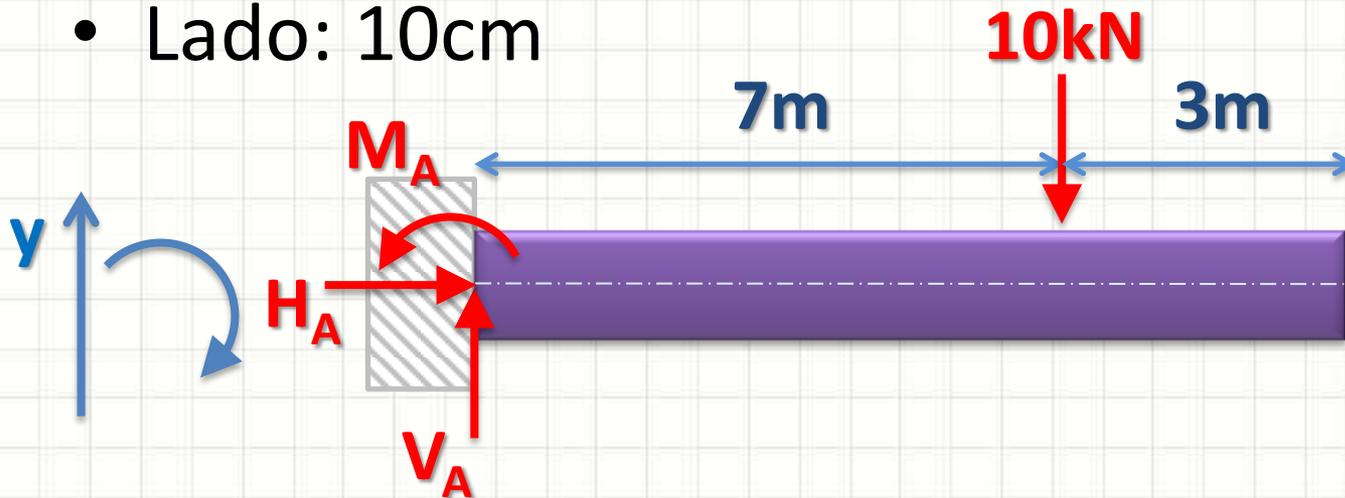
Exemplo

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



Exemplo

- Lado: 10cm



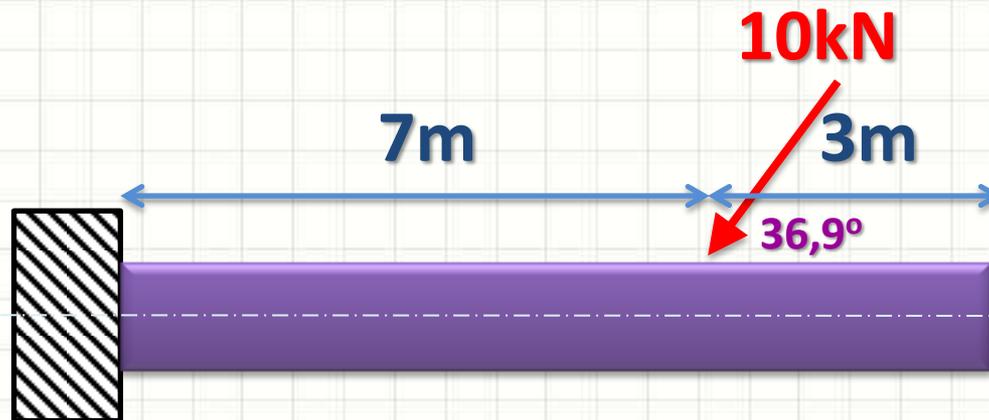
$$\sum F_x = 0 \Rightarrow \boxed{H_A = 0\text{kN}}$$

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

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

Exercício

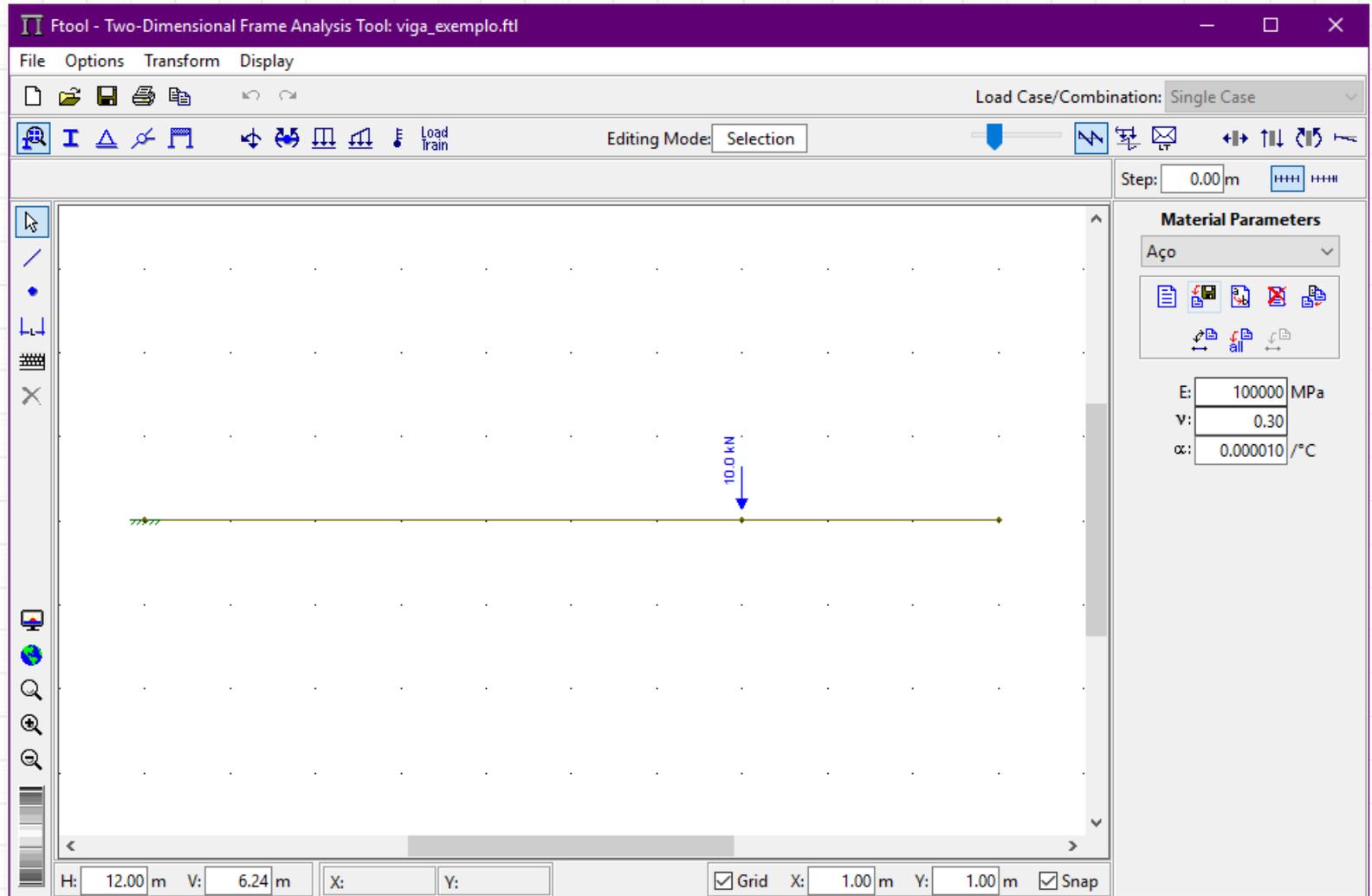
- Considere a viga abaixo, de seção retangular de lado 20x10cm. Calcule as reações de apoio



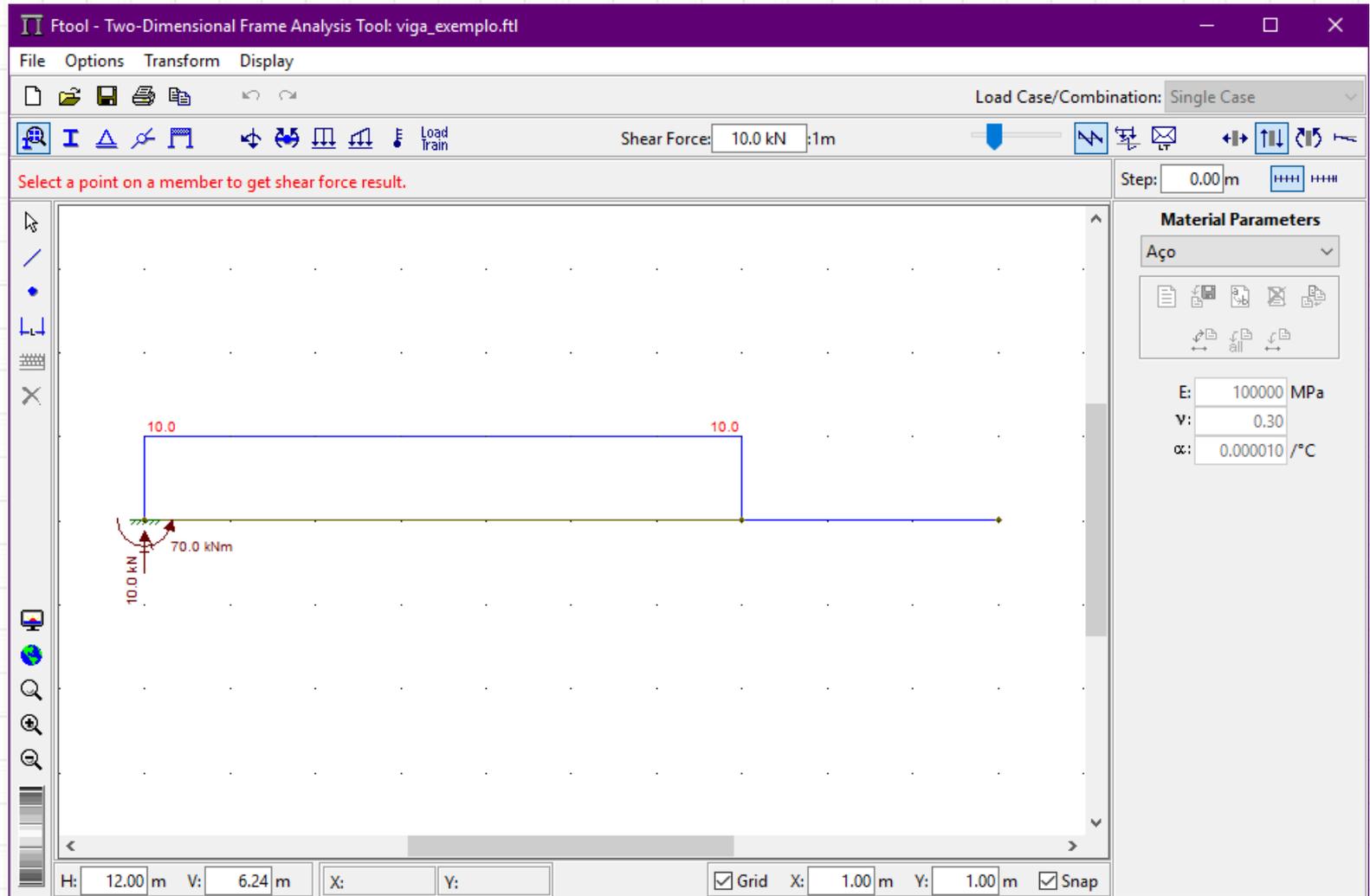
The background features a light gray grid pattern. In the upper left corner, there are several overlapping, wavy red lines of varying thickness and opacity, creating a dynamic, abstract design. A dashed red line also curves across the upper portion of the grid.

MODELAGEM COMPUTACIONAL

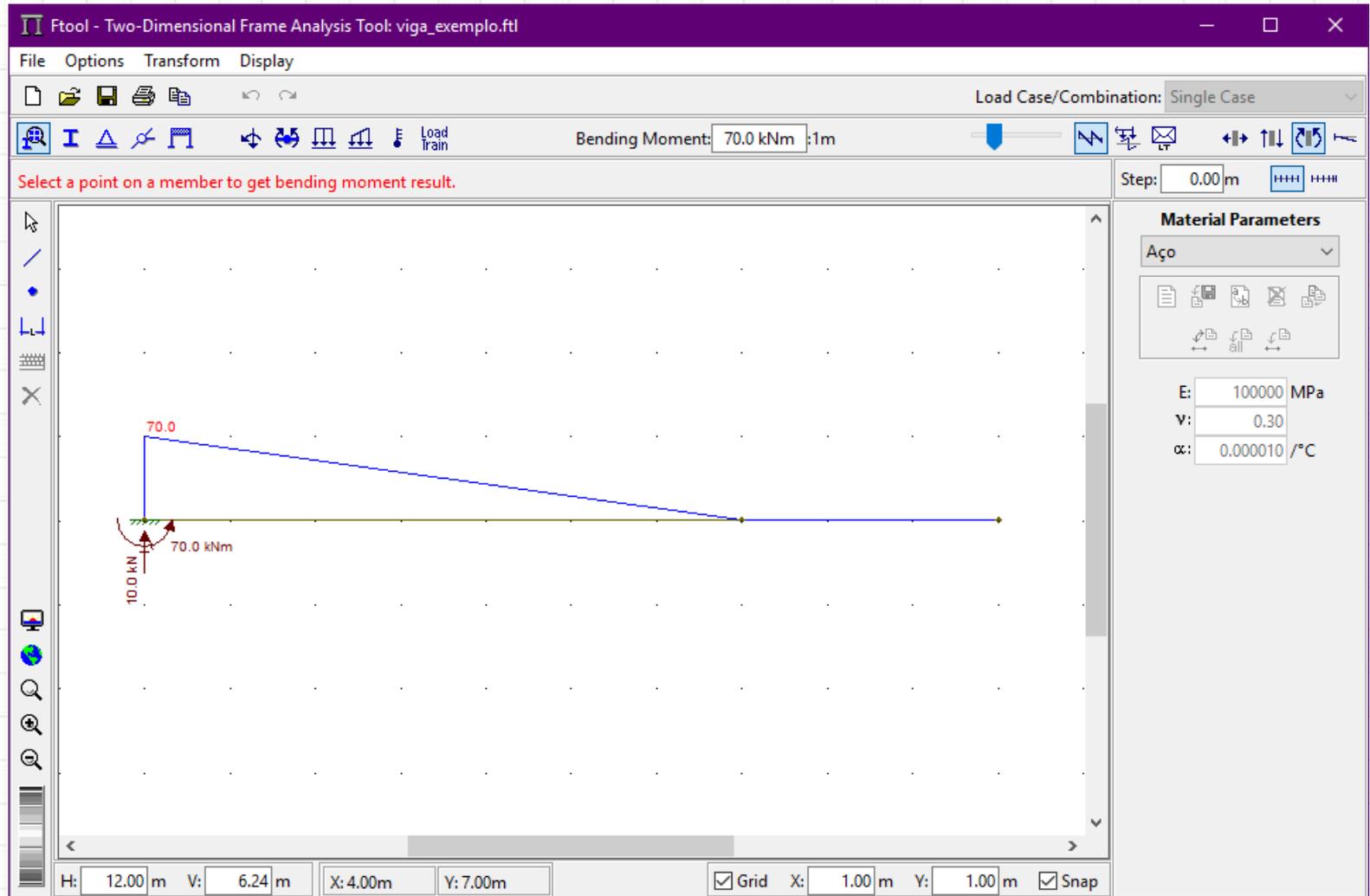
Modelagem Computacional



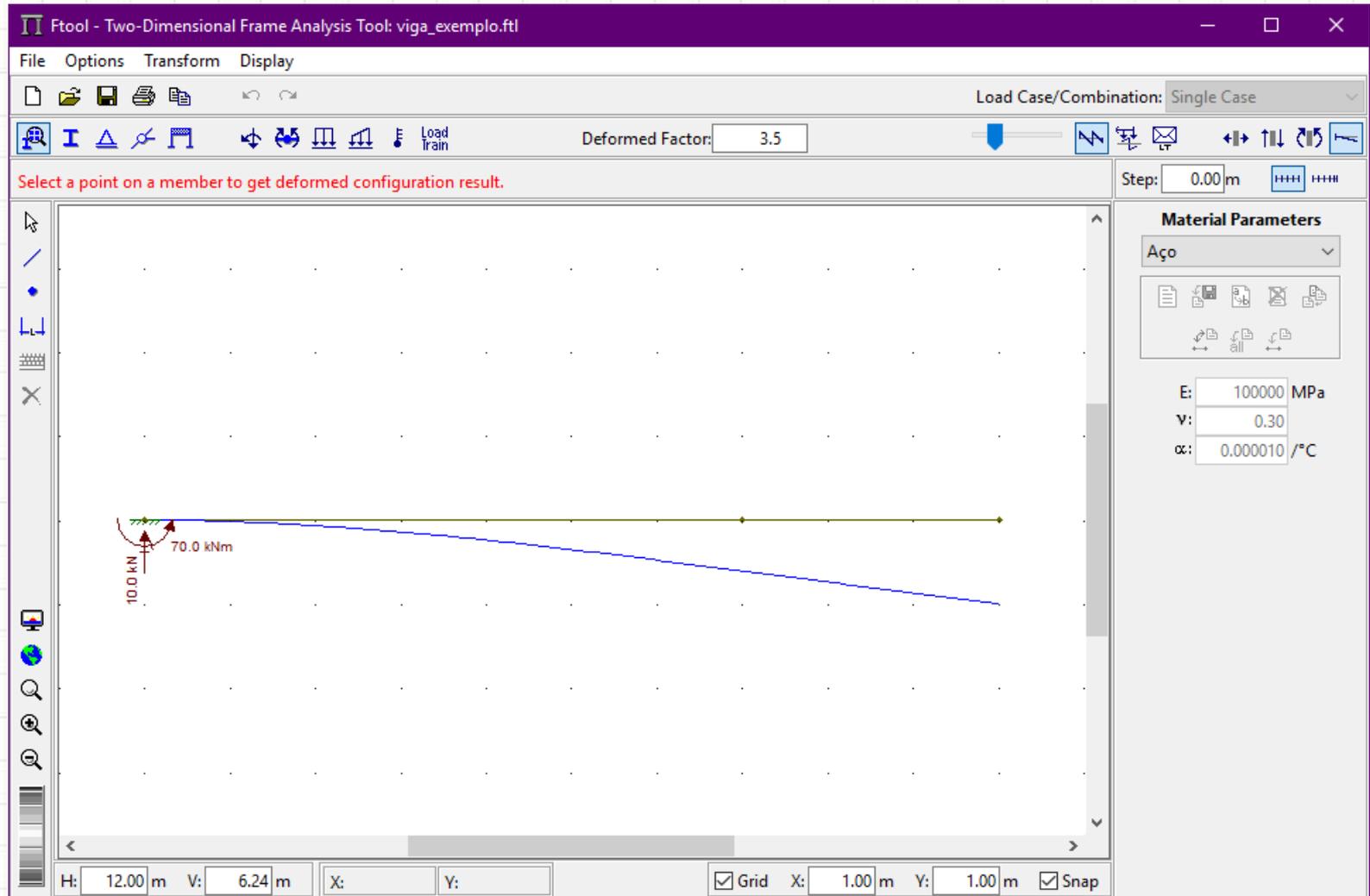
Modelagem Computacional



Modelagem Computacional



Modelagem Computacional



Modelagem Computacional

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

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: 1.00 m Y: 1.00 m Grid 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

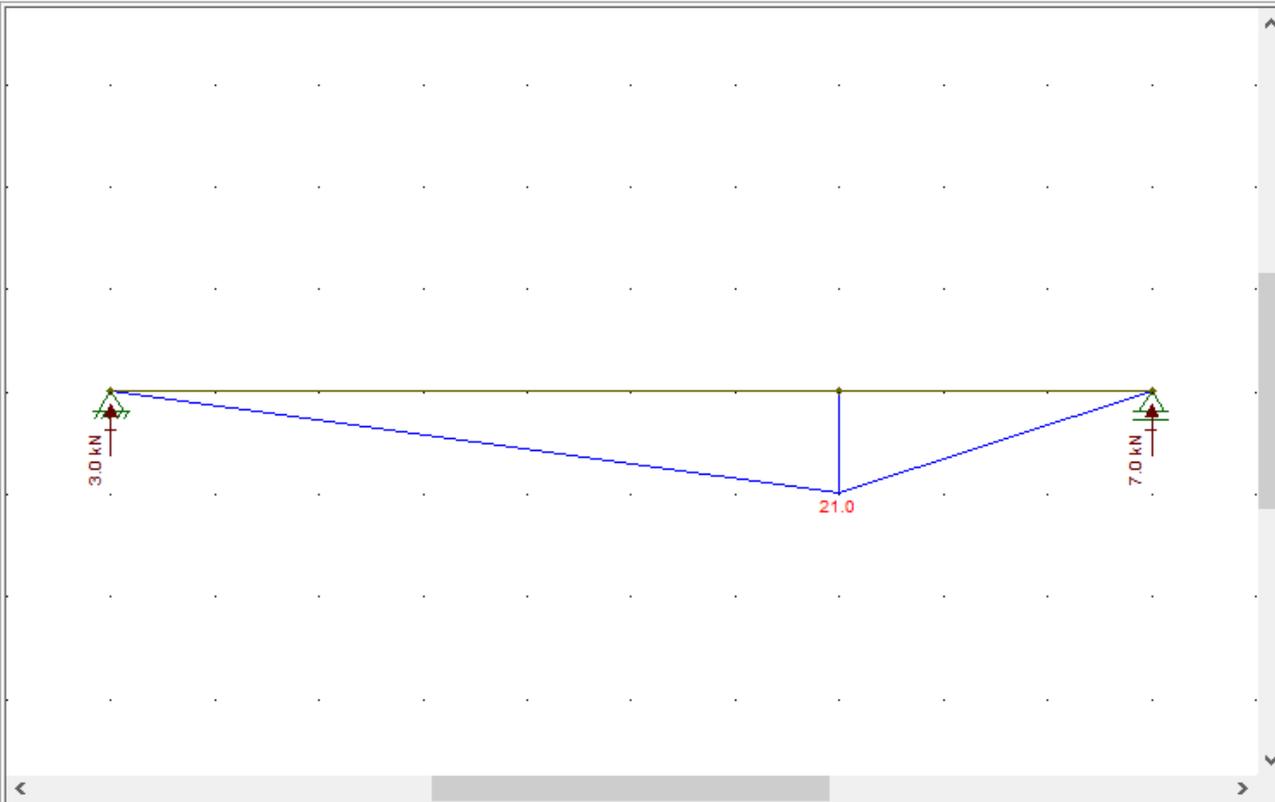
File Options Transform Display

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

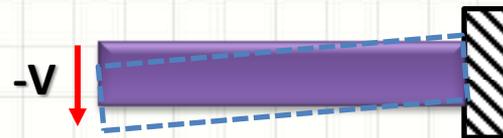
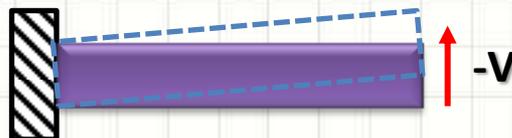
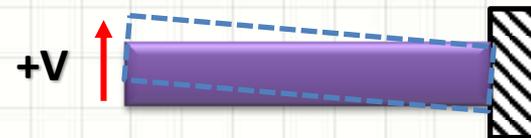
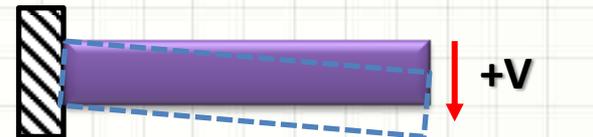
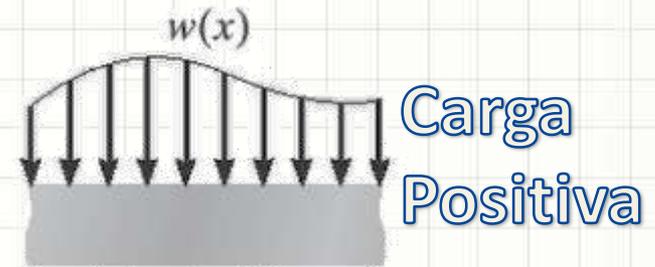
- Convenção de Sinais

- Carregamento

- De cima para baixo: +
 - De baixo para cima: -

- Cortante

- Gira sent. Horário: +
 - Gira sent. Anti-Horário: -

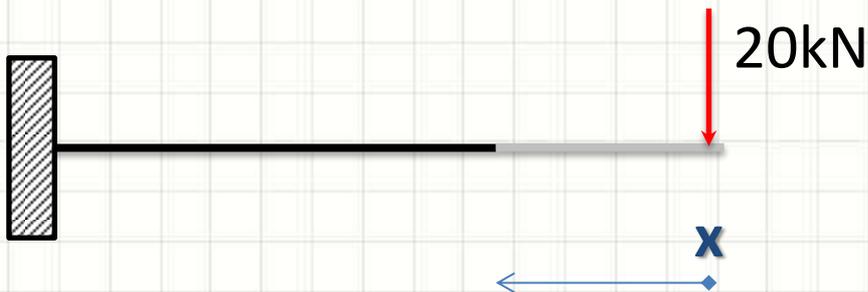


Diagramas de Esforços Cortantes

- Força Cortante Concentrada



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



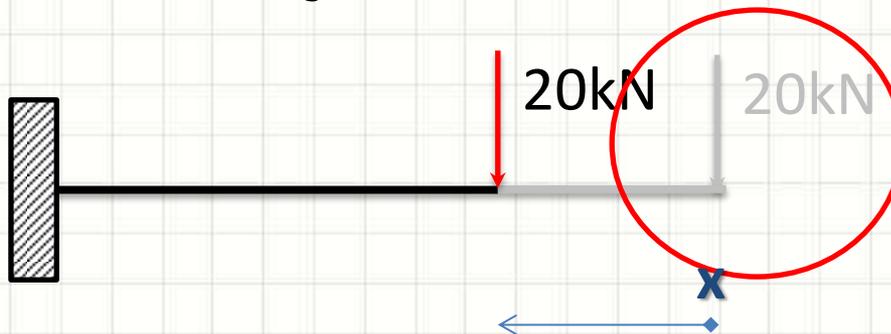
Redução dos
Esforços ao
ponto "x"

Diagramas de Esforços Cortantes

- Força Cortante Concentrada



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

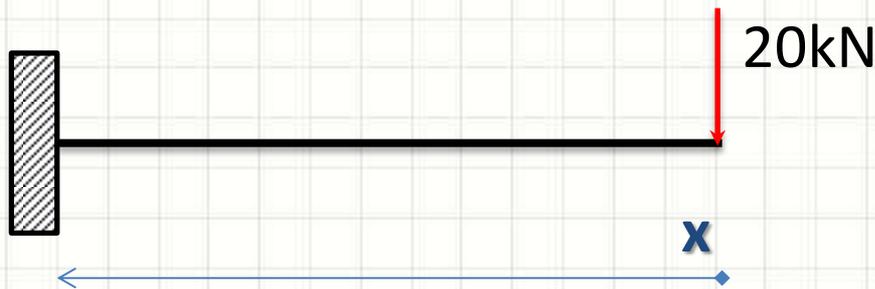


Sentido
Horário!

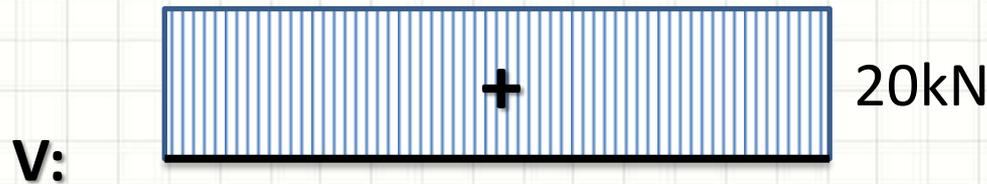
- $V(x) = 20\text{kN}$

Diagramas de Esforços Cortantes

- Força Cortante Concentrada

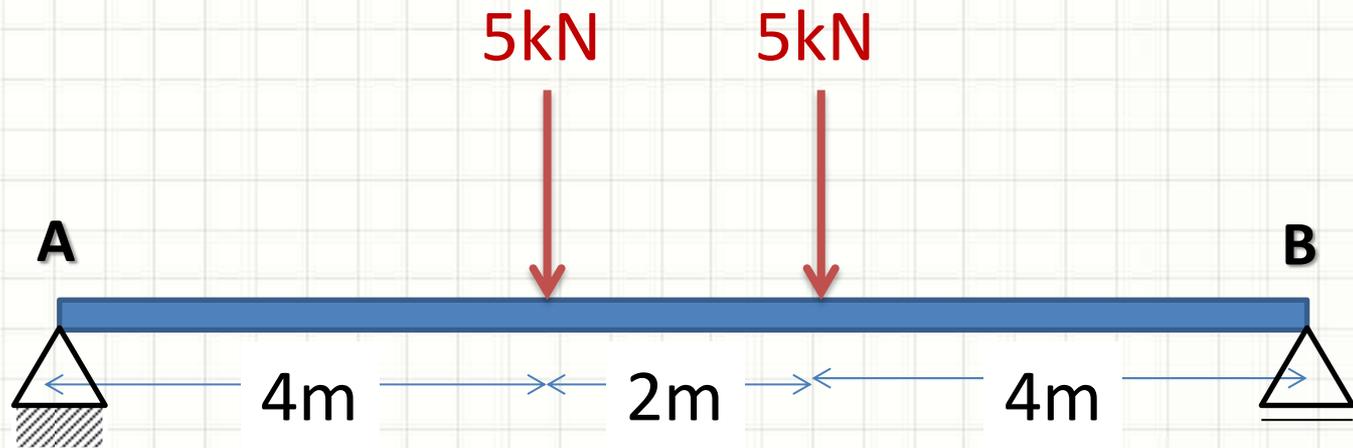


- $V(x) = 20\text{kN}$... Sentido horário
- Logo... O diagrama de cortante é



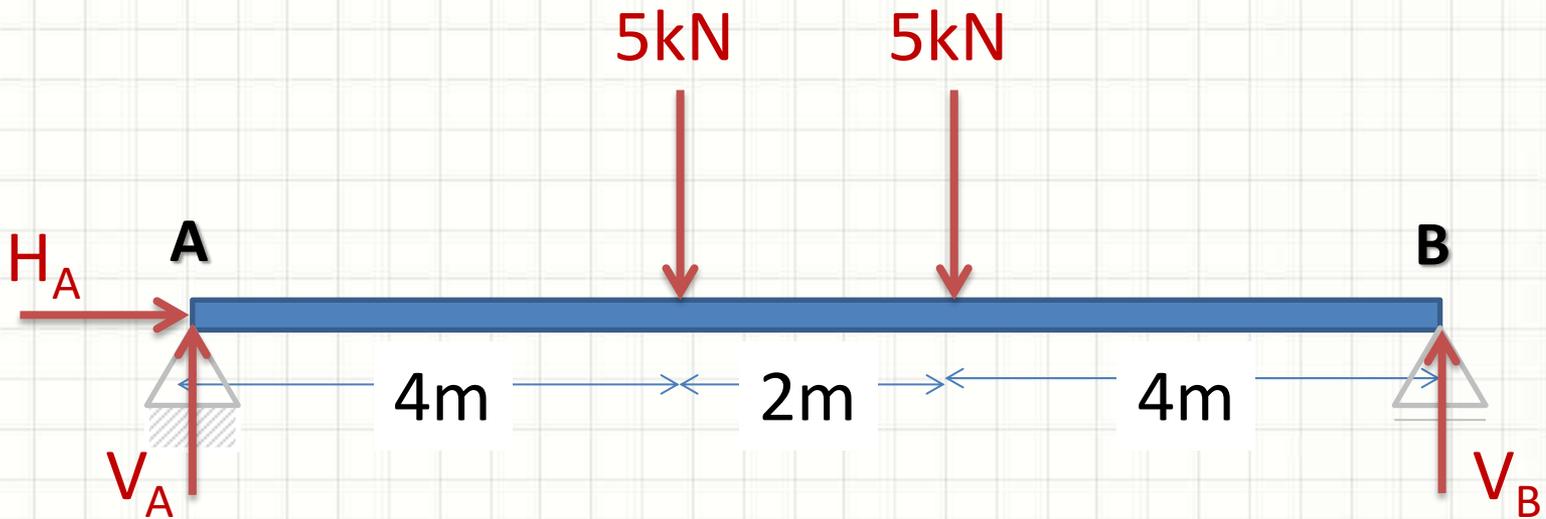
Exemplo: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



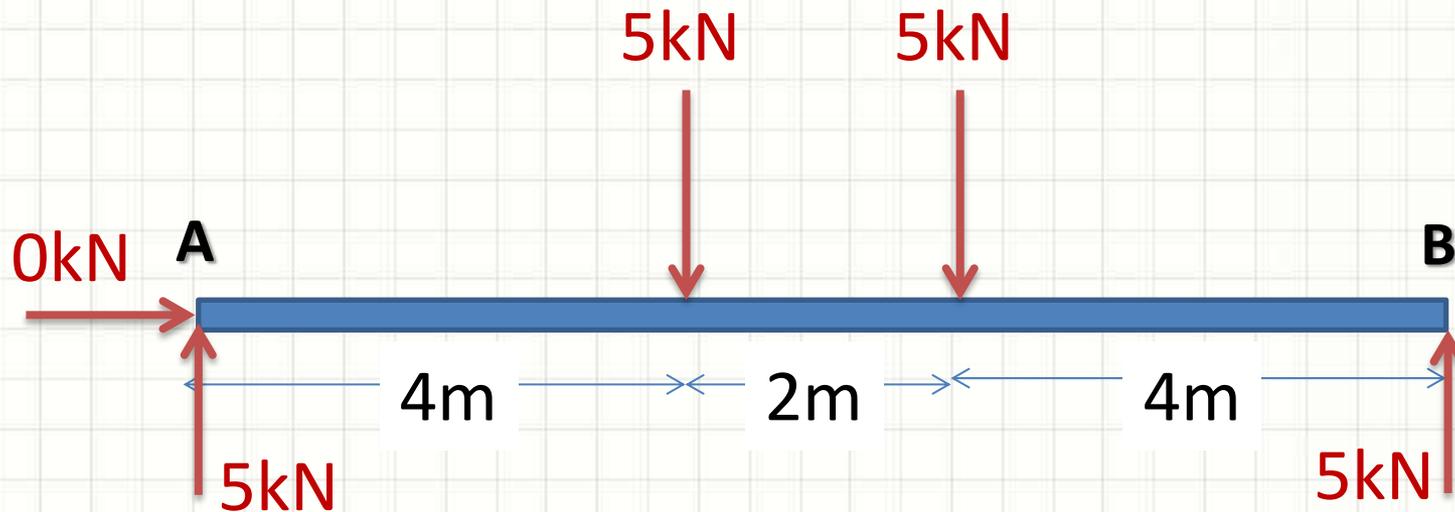
Exemplo: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



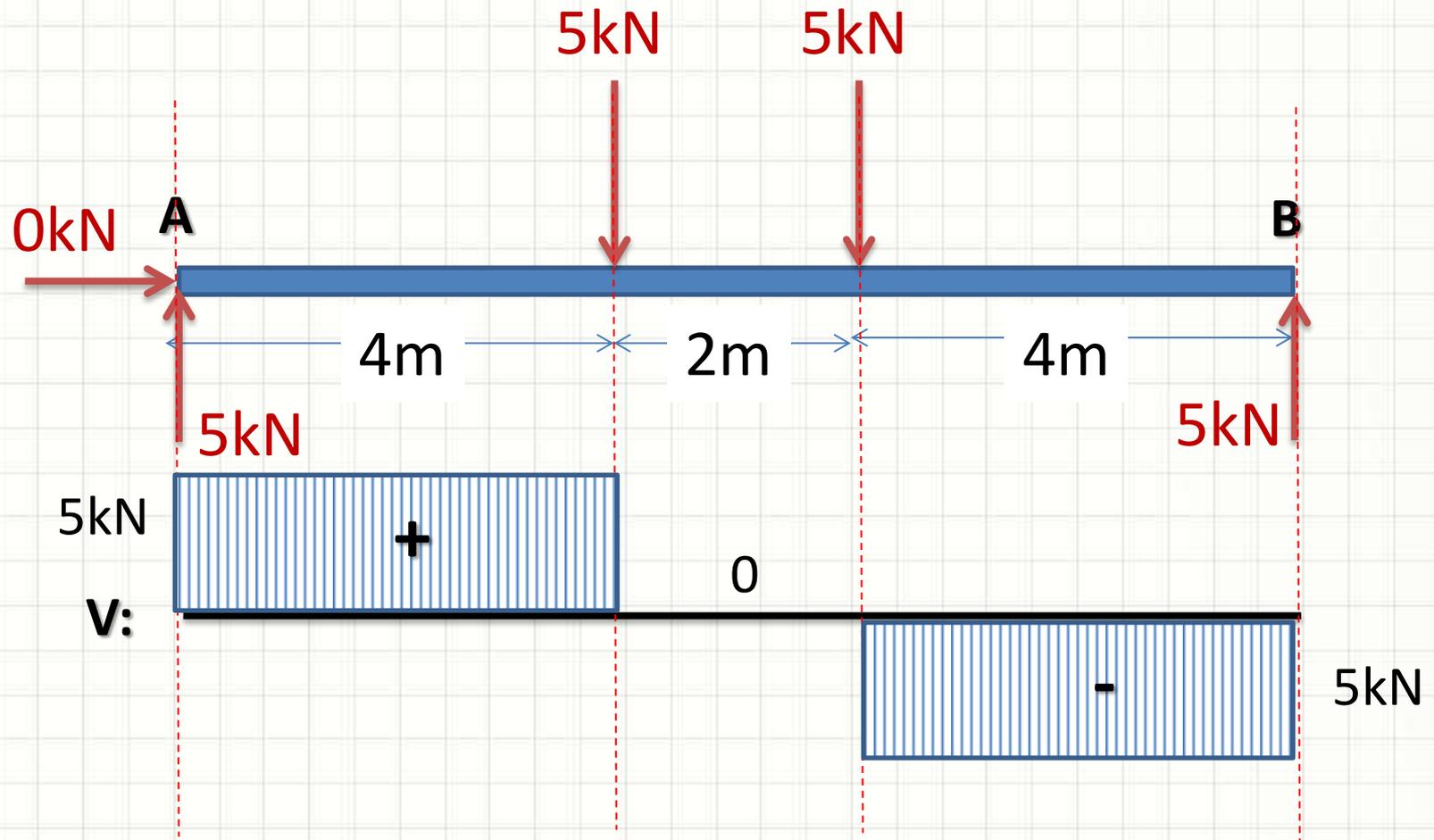
Exemplo: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



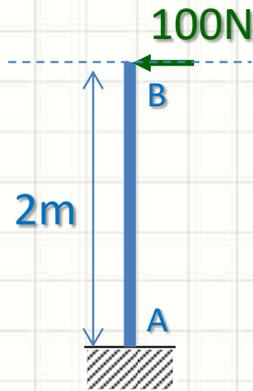
Exemplo: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



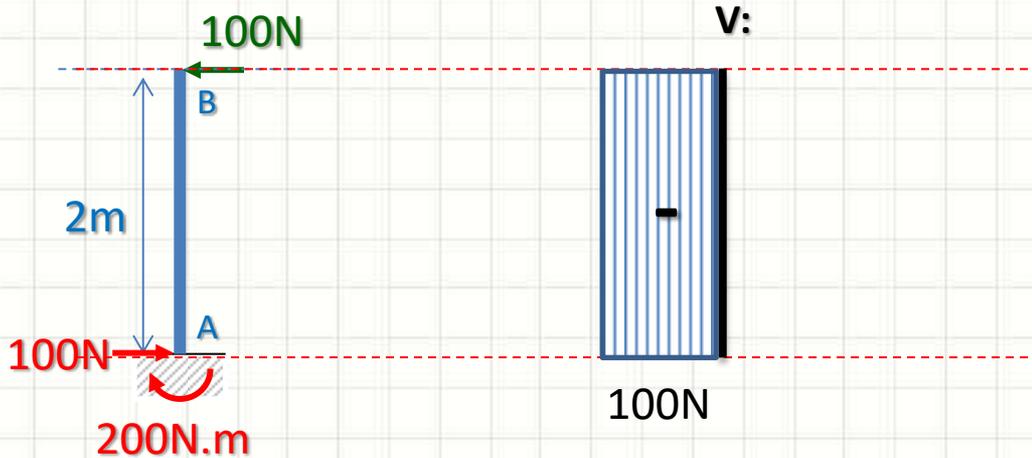
Exercício: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



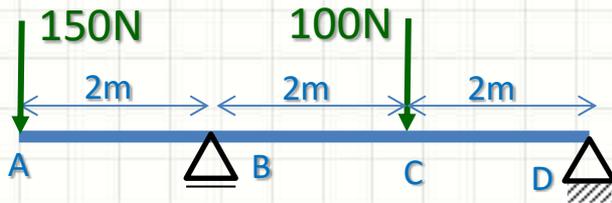
Exercício: Diagrama de Esf. Cortantes

- Trace o Diagrama de Cortante para a viga:



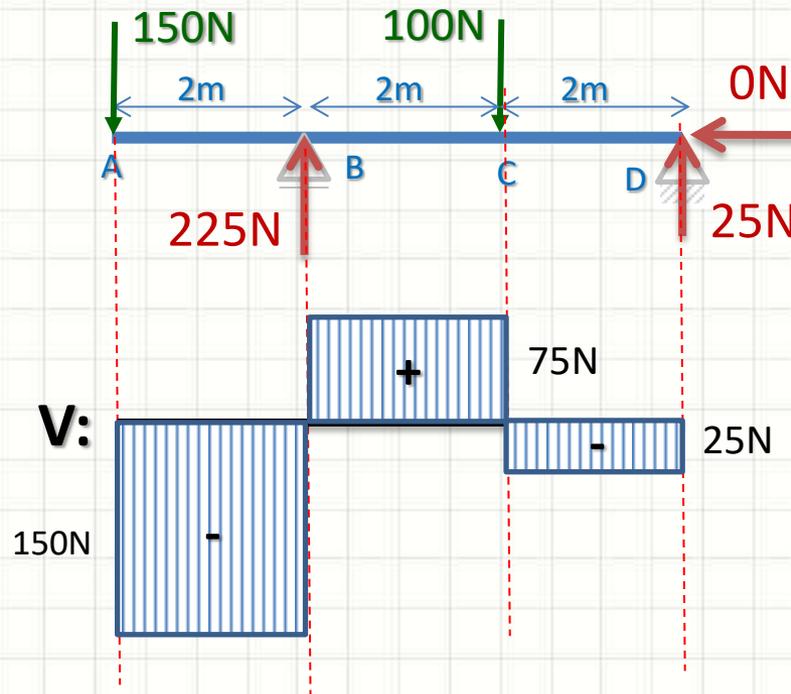
Exercício

- Trace o Diagrama de Cortante para a viga:



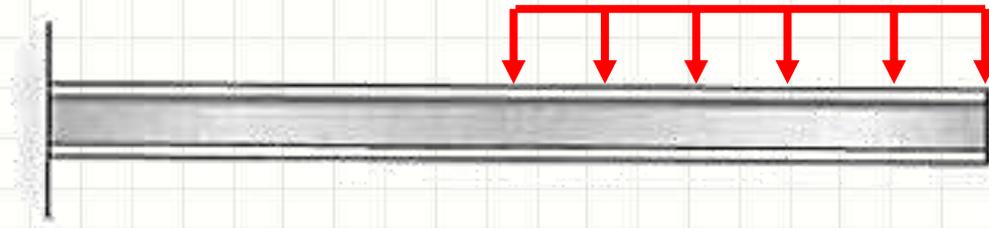
Exercício

- Trace o Diagrama de Cortante para a viga:

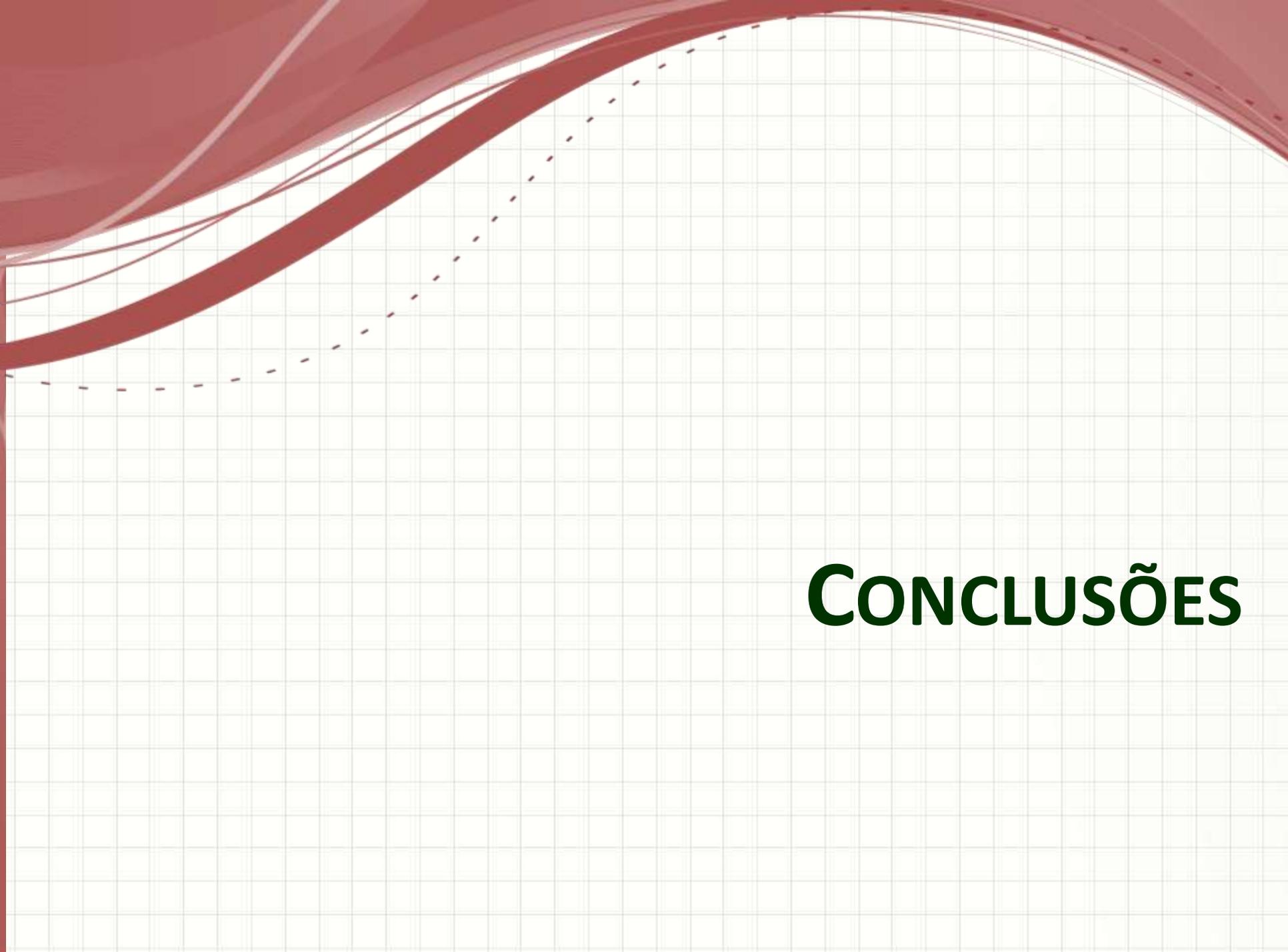


Diagramas de Esforços Cortantes

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



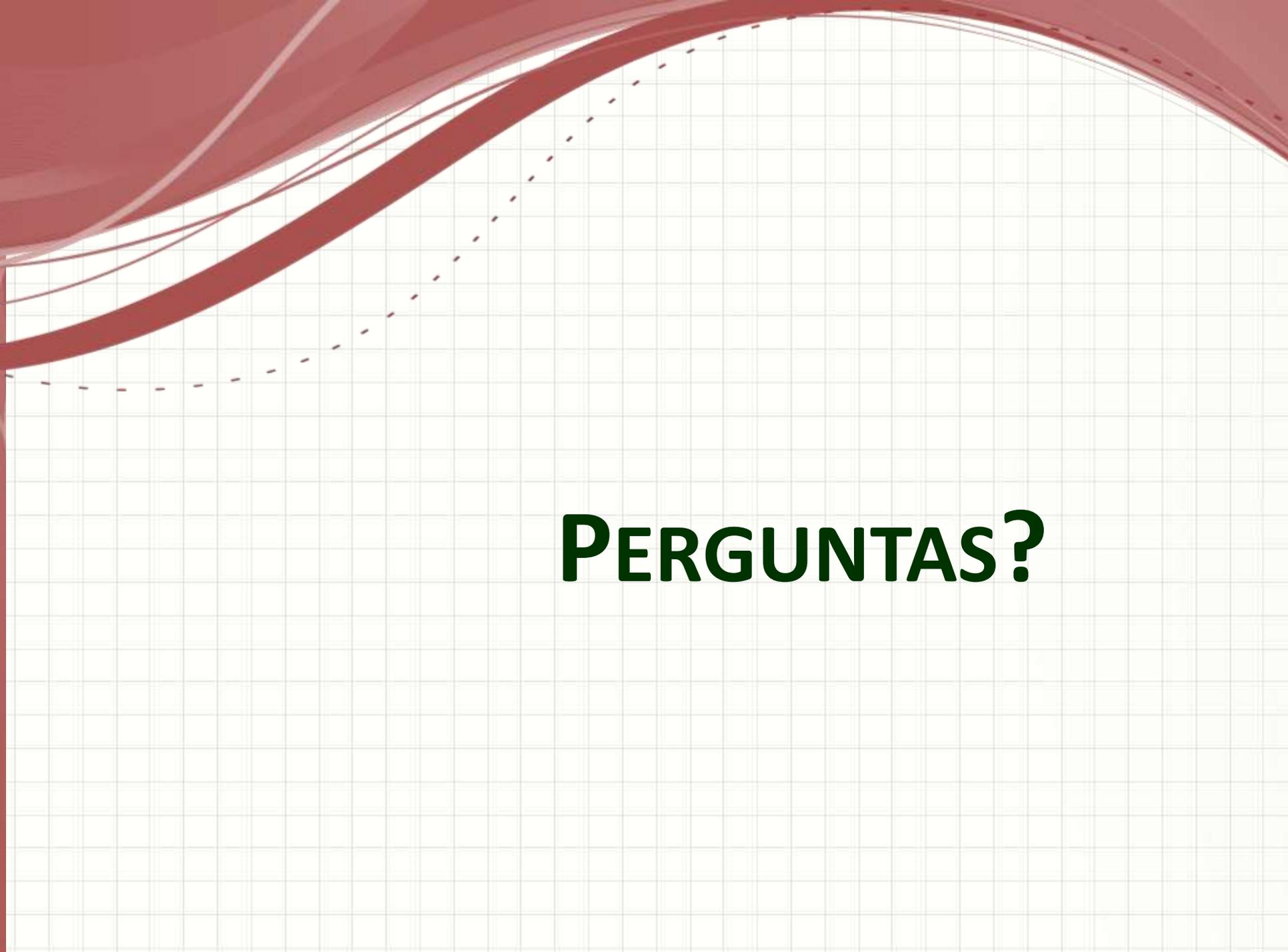
Próxima aula!



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

