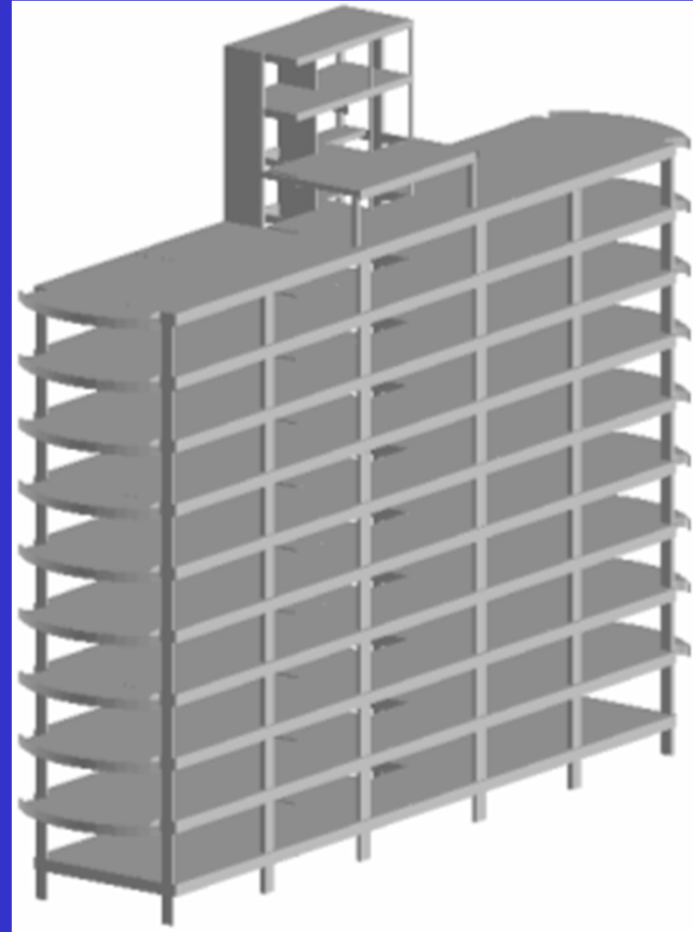


Introdução

Motivação



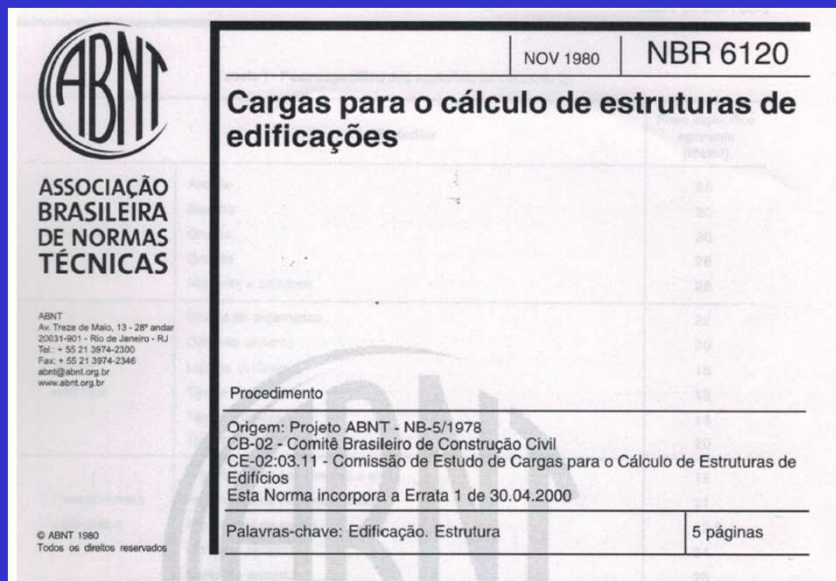
Pórtico 2D

Introdução

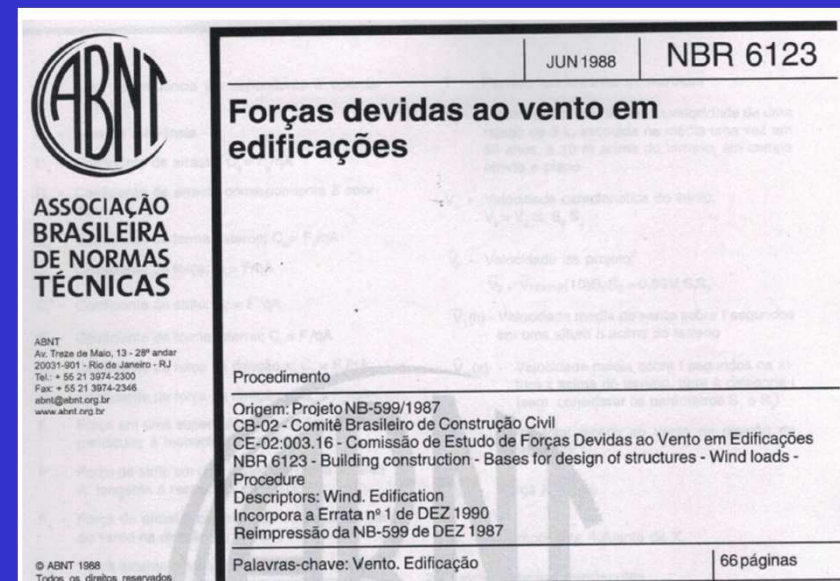
Cargas usuais de projeto

Projeto: EDI-49 Concreto Estrutural II

Ações verticais



Ações horizontais



Introdução

Exercício 1 – Ações horizontais

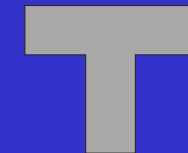
Forças devidas ao vento

$f_{ck} = 30 \text{ MPa}$

Vigas

$b_f = 40 \text{ cm}$?

$d = 40 \text{ cm}$



$t_f = 20 \text{ cm}$

$t_w = 20 \text{ cm}$

Pilares

$d = 40 \text{ cm}$



$t_w = 20 \text{ cm}$

$q = 6 \text{ kN/m}$

$L = 6 \text{ m}$

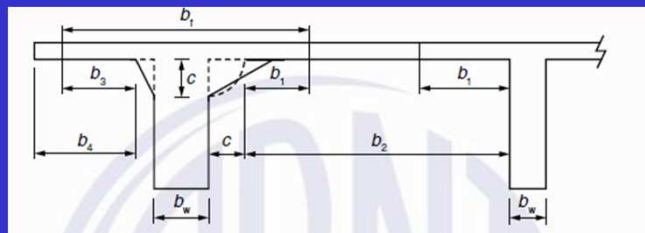
15º andar

$h = 3 \text{ m}$

2º andar

1º andar

Largura efetiva



NORMA
BRASILEIRA

ABNT NBR
6118

Terceira edição
29.04.2014

Válida a partir de
29.05.2014

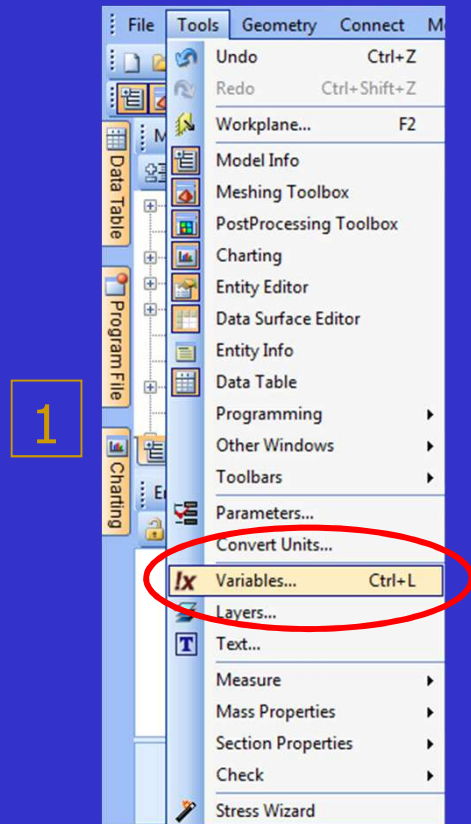
Projeto de estruturas de concreto —
Procedimento

Design of concrete structures — Procedure

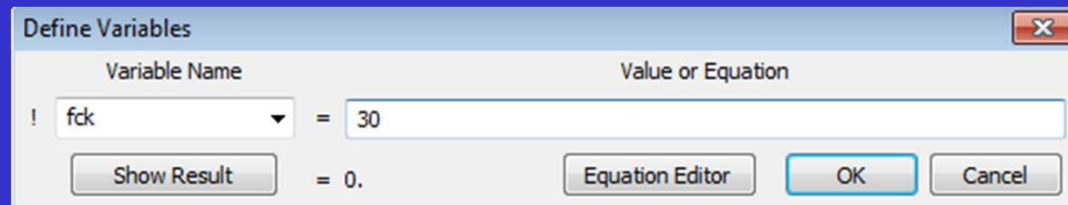
Pórtico 2D

Modelagem

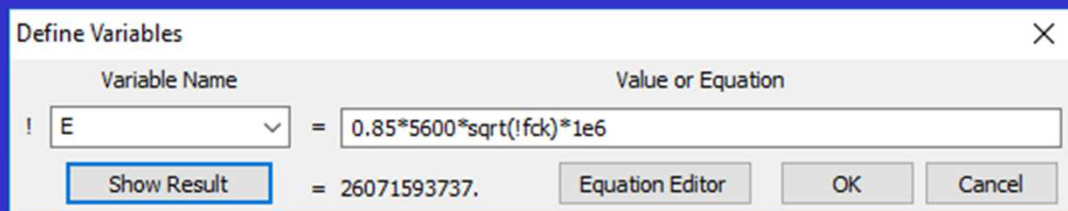
Parâmetros



2

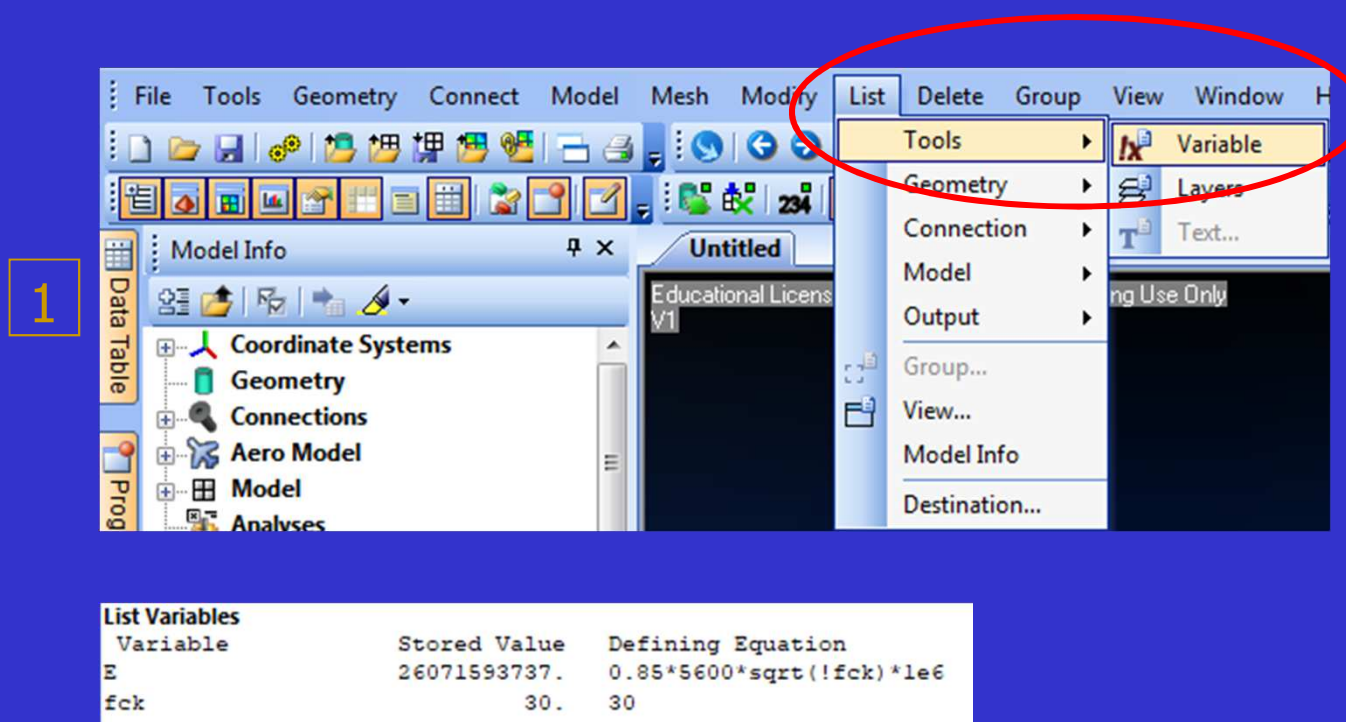


3



Modelagem

Parâmetros



Modelagem

Geometria

- ponto

Geometry : Point : Method(Locate) :

ID1 (0.,0.,0.) ID2 (0.,3.,0.) ID3 (6.,3.,0.) ID4 (6.,0.,0.)

- curva

Geometry : Curve-Line : Points :

ID1 (Pt 1 To Pt 2) ID2 (Pt 2 To Pt 3) ID3 (Pt 3 To Pt 4) ID4

- cópia

Geometry : Copy : Curve : Method(Locate) :

{Repetitions} = 14

{Base} = (0.,0.,0.) & {Topo} = (0.,3.,0.)

Modelagem

Geometria e material

- curva

View : Options : Labels :

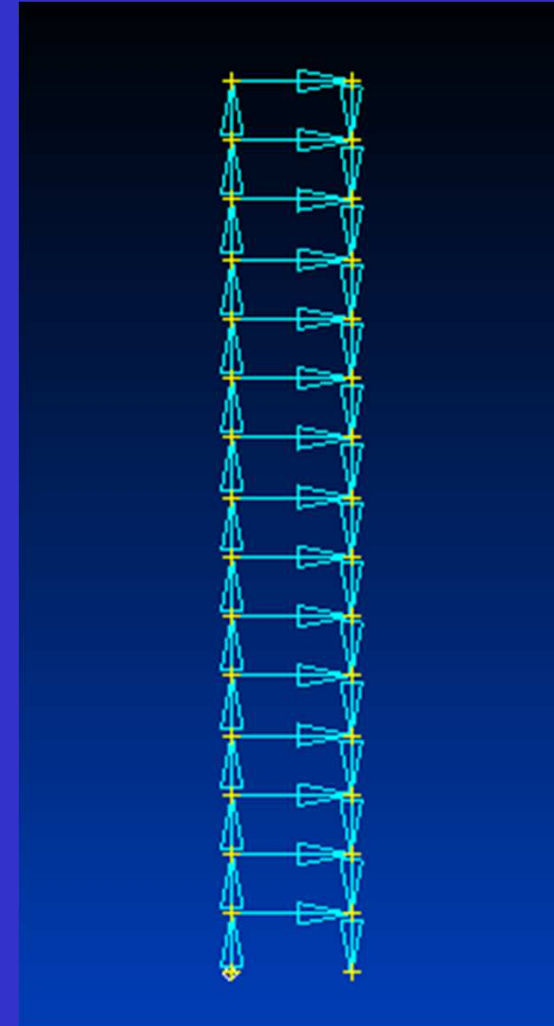
Curve / Surface Directions : Curve Arrows

- material

Model : Material : Isotropic

Title : Concreto $f_{ck} = 30\text{MPa}$

E : E ν : 0.2 & δ : 2500



Modelagem

Propriedades

- propriedade 1

Model : Property : Beam

Title : Pilares

Rectangular Bar & Height : $40e-2$ & Width : $20e-2$

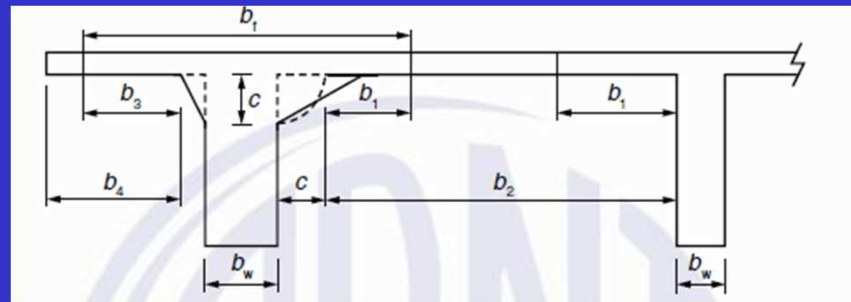
- propriedade 2

Model : Property : Beam

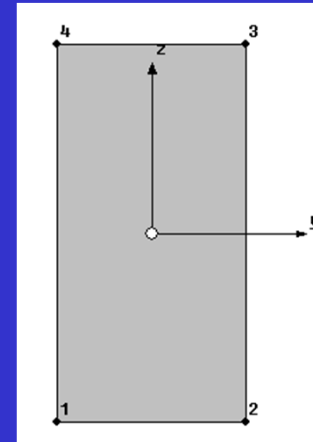
Title : Vigas

T Section & Height : $40e-2$ & Width : $40e-2$ & Thick = Thickness : $20e-2$

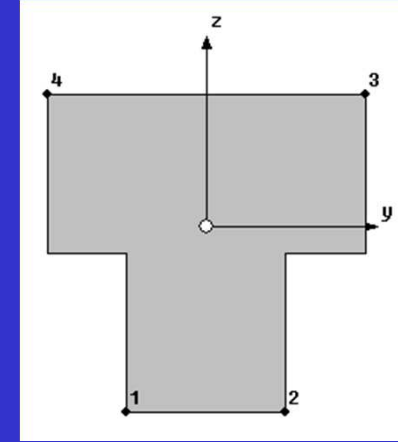
Largura efetiva



Pilares



Vigas



Modelagem

Malha

- refinamento (4 elementos/3m)

Mesh : Mesh Control : Size Along Curve :

Cr n : Pilares (4 el)

Cr n : Vigas (8 el)

- nós & elementos

Mesh : Geometry : Curves(1, 4, 7 ... 43), Curves(3, 6, 9 ... 45) : Property : Pilares

Method (Locate) : $\{v\} = \{Tip\} - \{Base\} = (0.,0.,-1.) - (0.,0.,0.)$

View : Options : Labels : Element – Orientation/Shape : Show Cross Section

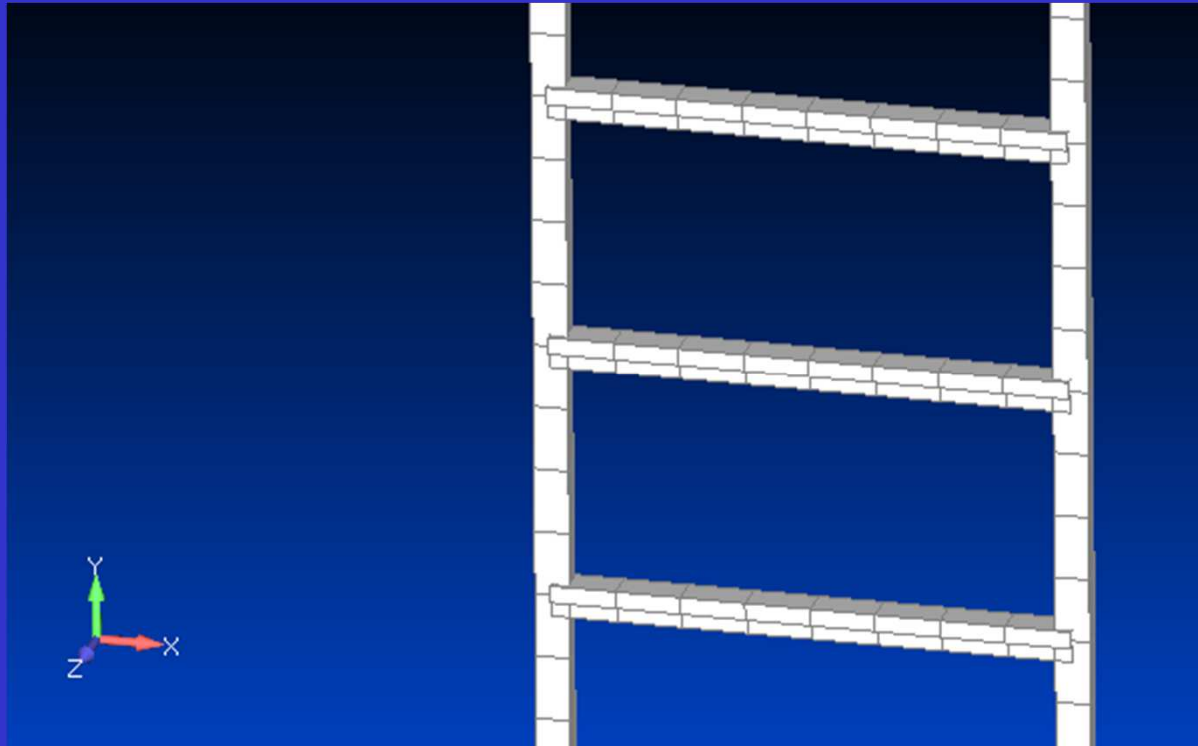
Mesh : Geometry : Curves (2, 5, 8 ... 44) : Property : Travessa

Method (Locate) : $\{v\} = \{Tip\} - \{Base\} = (0.,0.,-1.) - (0.,0.,0.)$

View : Options : Labels : Element – Orientation/Shape : Show Cross Section

Modelagem

Malha



Pórtico 2D

Modelagem

Malha

- nós

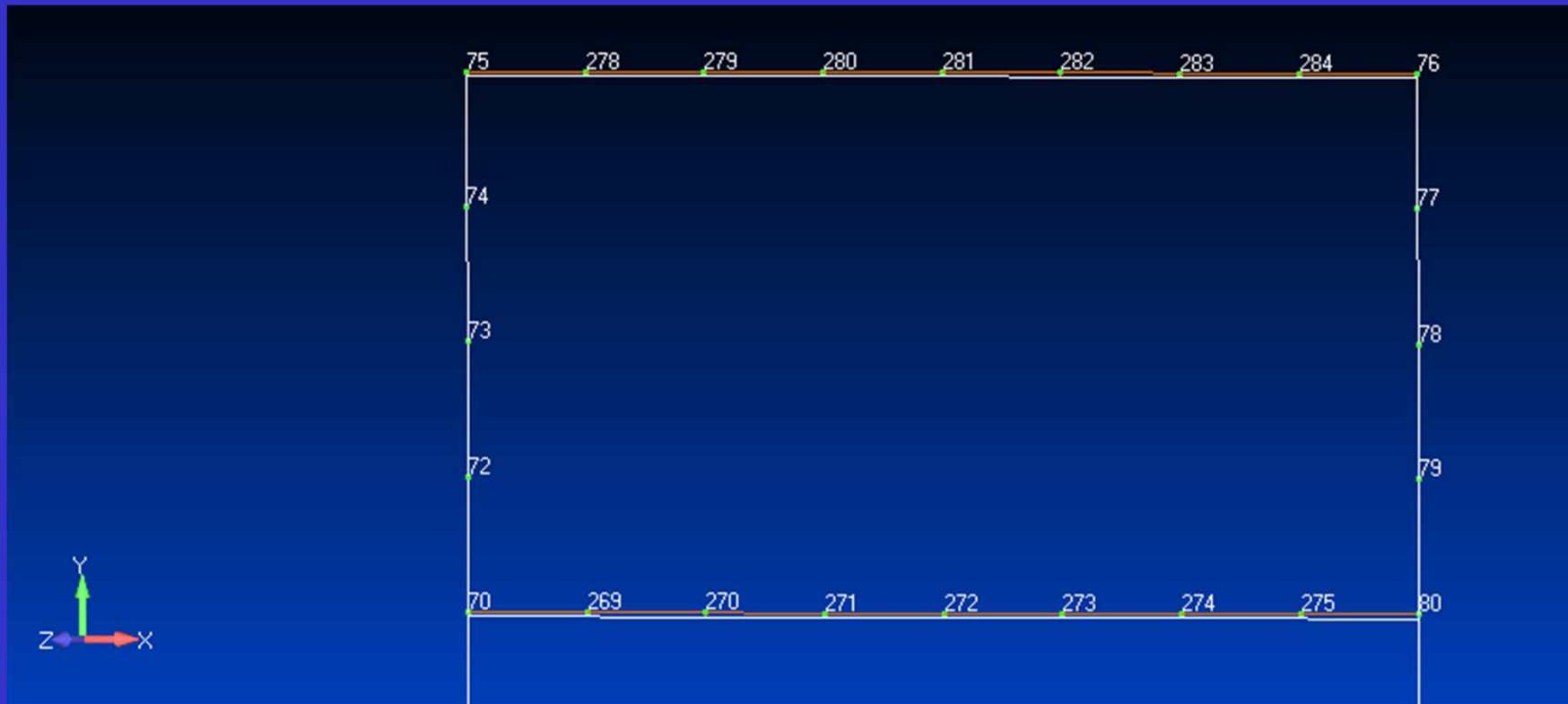
Tools : Check : Coincidents Nodes : Merge



Pórtico 2D

Modelagem

Malha



Pórtico 2D

Modelagem

Condições de Contorno

- carregamento

Model : Load : Create Set : New

Title : Vento

Model : Load : Elemental :

Distributed Load : 6000 N/m.

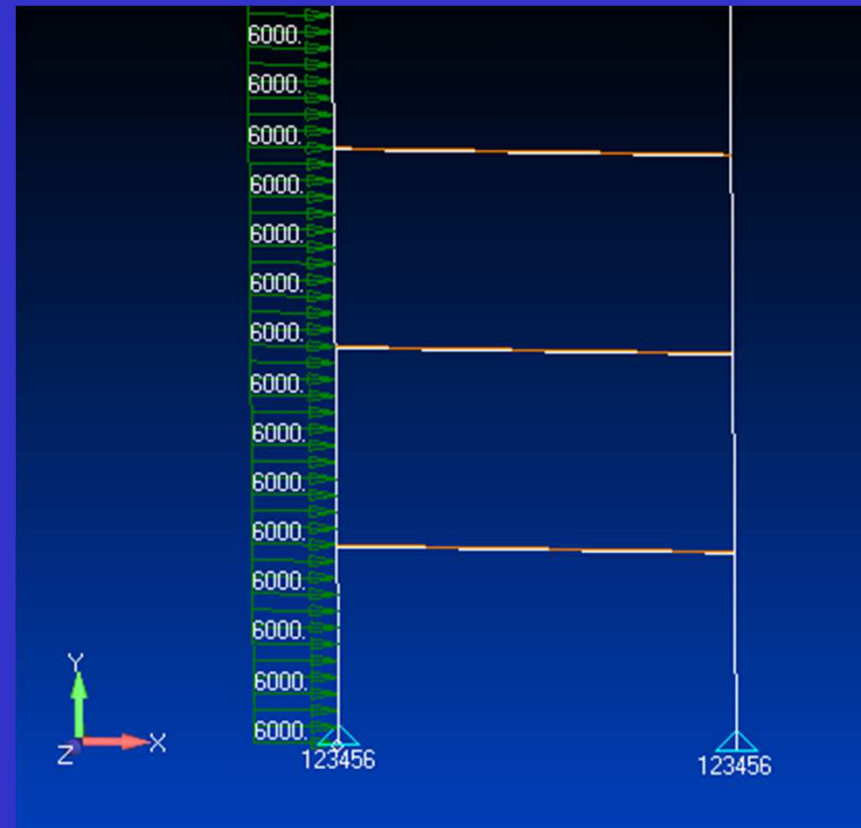
- restrições

Model : Constraint : Create Set : New

Title : Engaste

Model : Constraint : Nodal :

Nd 1,150: Fixed



Análise & Pós-Processamento

Análise Linear

- solução estática linear

Model : Analysis : New :

Title : Linear & Type : Static : Analyze

- configuração deformada

View : Select : Deform (Total Translation)

Post Options : Scale Deformation : 10

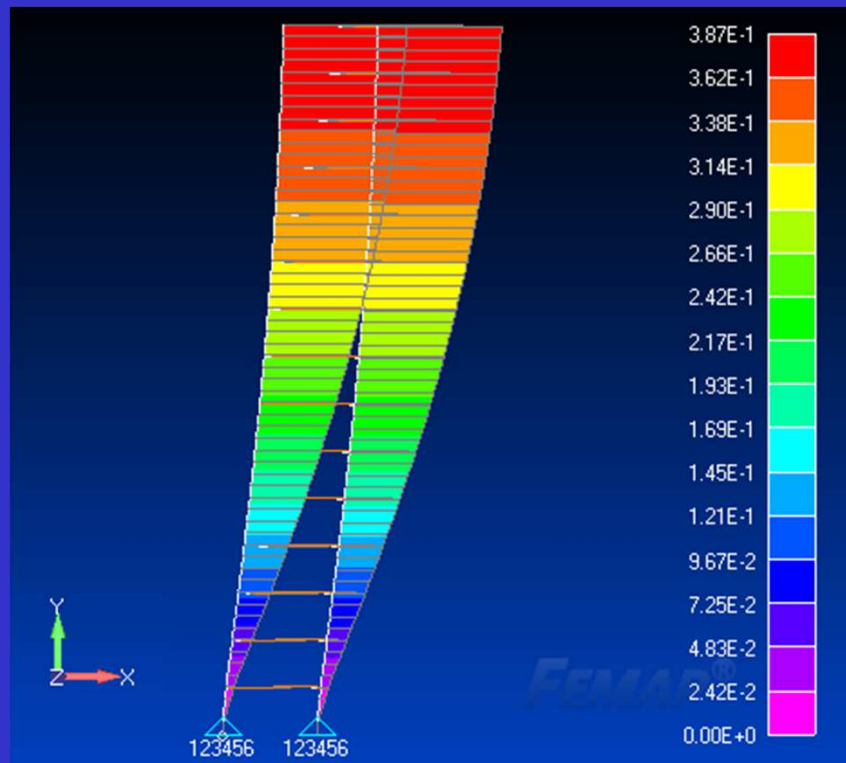


Análise & Pós-Processamento

Análise Linear

- diagrama de deslocamentos

View : Select : Beam Diagram (T1 Translation)



Máximo deslocamento T1 : 38.7 cm

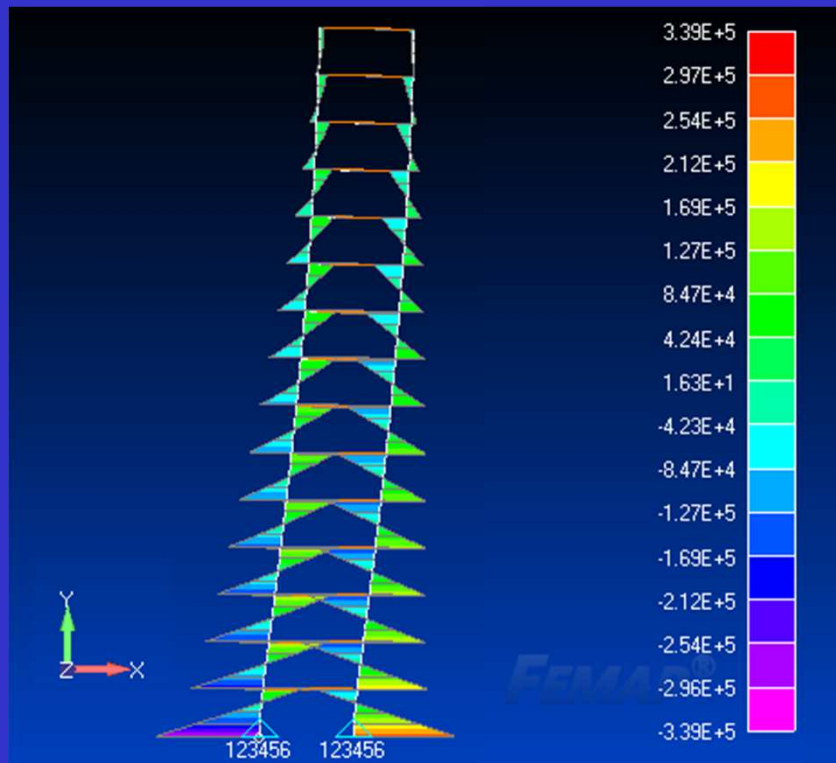
Pórtico 2D

Análise & Pós-Processamento

Análise Linear

- diagrama de momento fletor (DMF)

View : Select : Beam Diagram (Bar EndA Plane2 Moment)



Máximo momento M_z : 339. kN.m

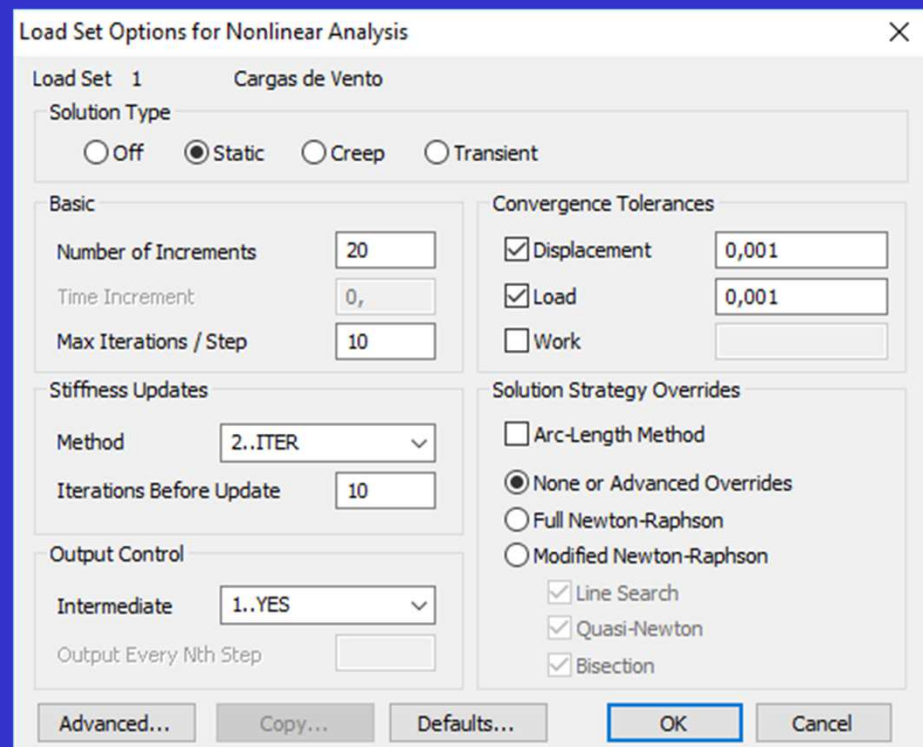
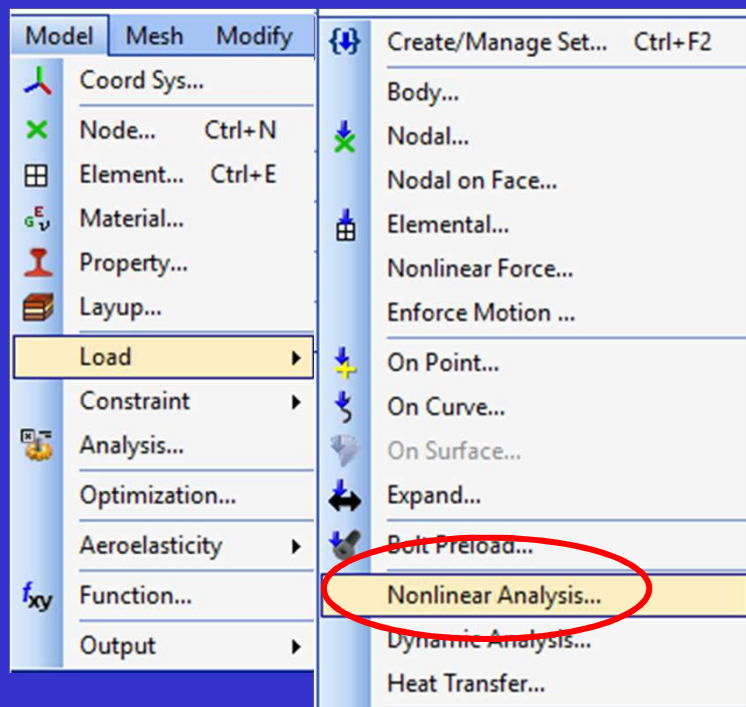
Mínimo momento M_z : -339. kN.m

Pórtico 2D

Análise & Pós-Processamento

Análise Não-Linear Geométrica

- Configurações de análise não-linear



Análise & Pós-Processamento

Análise Não-Linear Geométrica

- Solução não-linear

Model : Analysis : New :

Title : Não-Linear & Type : Nonlinear Static

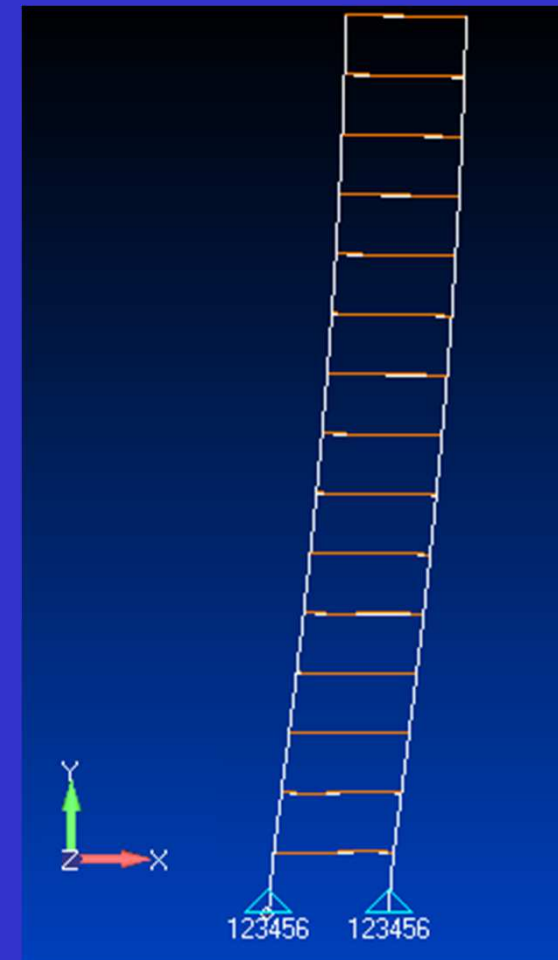
Master Requests and Conditions : Nonlinear options :

Edit : Use Load Set Options : Analyze

- Configuração deformada final

View : Select : Deform (Total Translation)

Post Options : Scale Deformation : 10

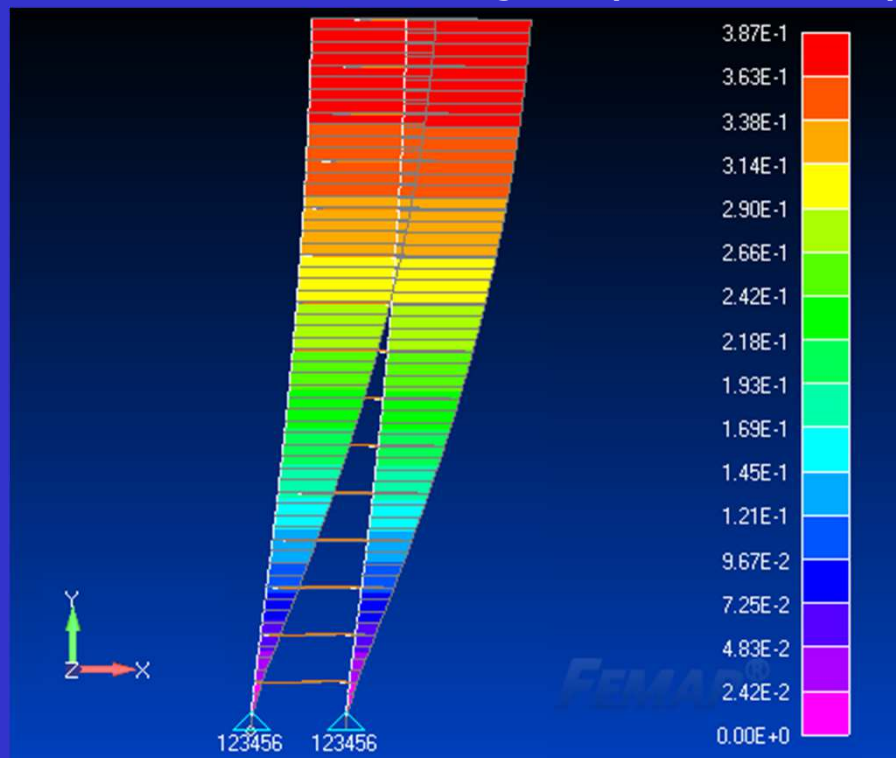


Análise & Pós-Processamento

Análise Não-Linear Geométrica

- diagrama de deslocamentos

View : Select : Beam Diagram (T1 Translation)



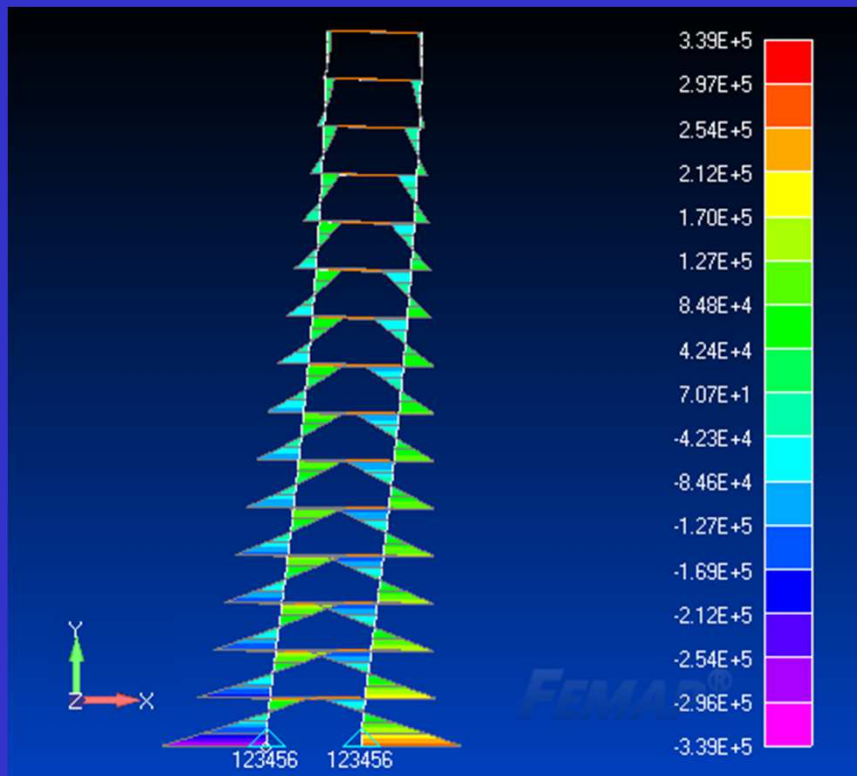
Máximo deslocamento T1 : 38.7 cm

Análise & Pós-Processamento

Análise Não-Linear Geométrica

- diagrama de momento fletor (DMF)

View : Select : Beam Diagram (Bar EndA Plane2 Moment)



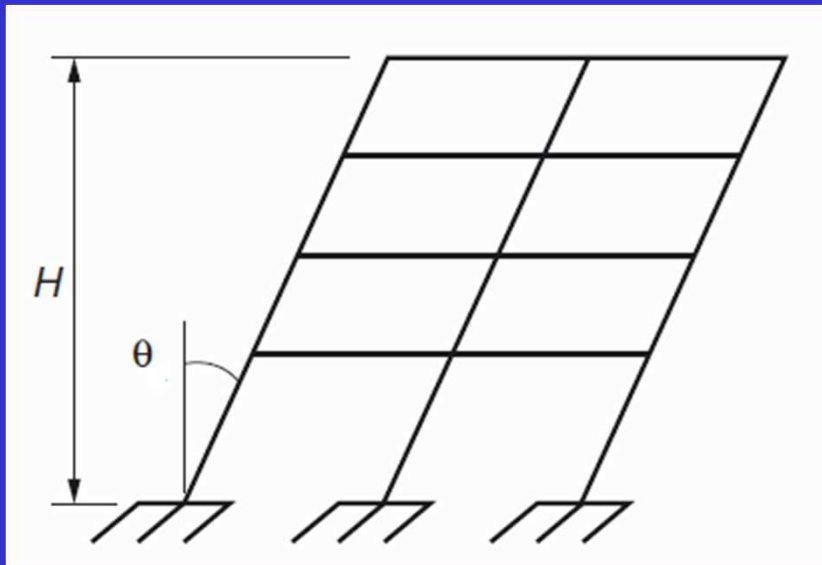
Máximo momento M_z : 339. kN.m

Mínimo momento M_z : -339. kN.m

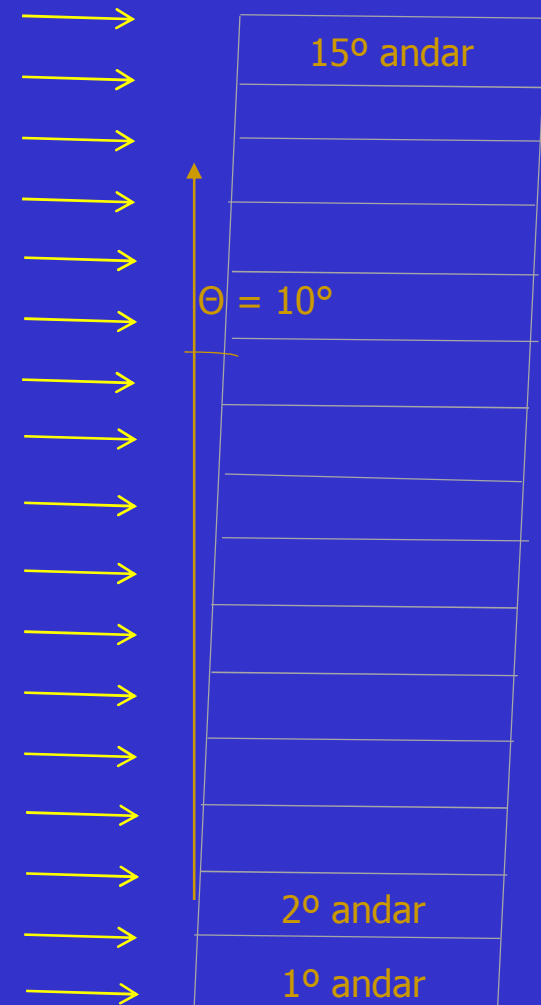
Introdução

Exercício 2 – Imperfeições

Imperfeição geométrica global

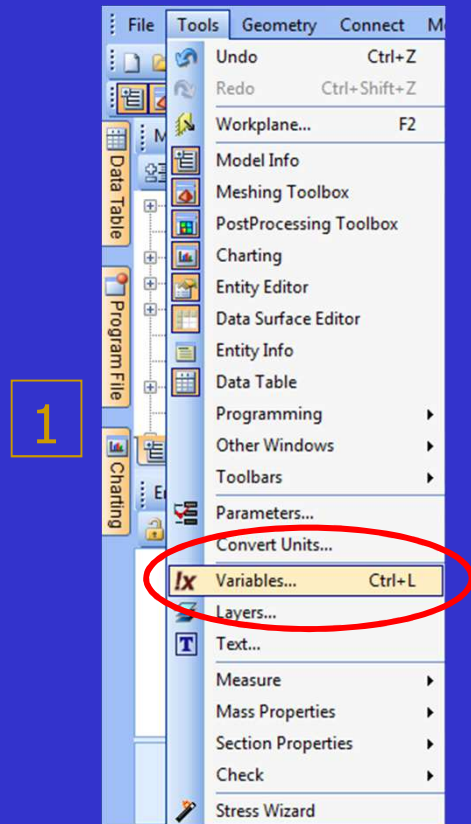


$q = 6 \text{ kN/m}$

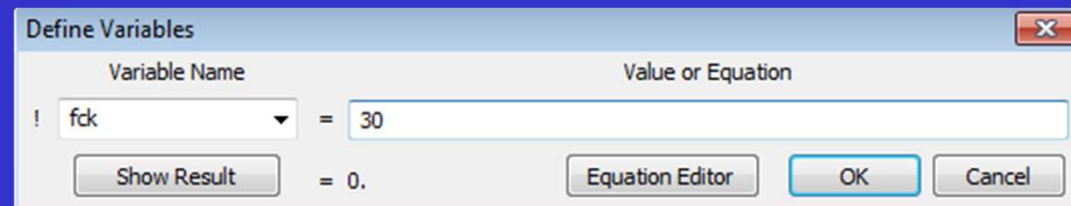


Modelagem

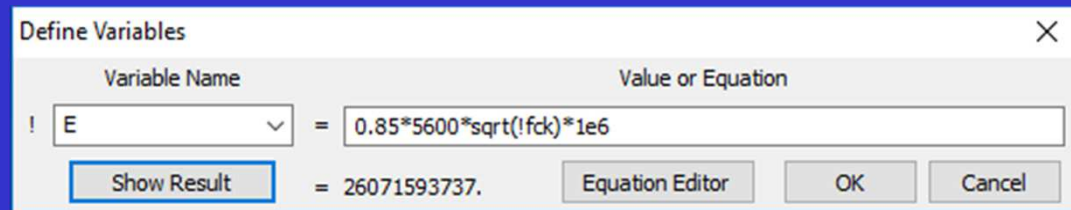
Parâmetros



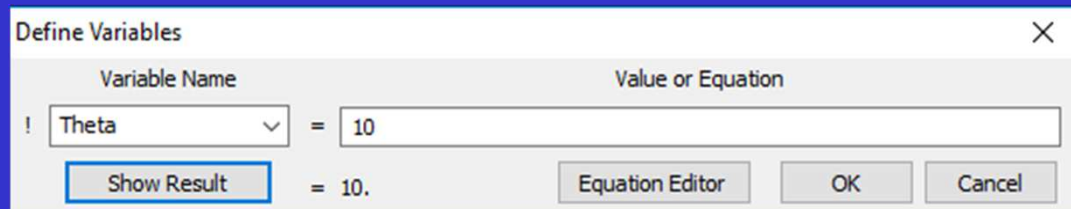
2



3



4



Modelagem

Geometria

- ponto

Geometry : Point : Method(Locate) :

ID1 (0.,0.,0.)

ID2 (3.*tan(!Theta) , 3., 0.)

ID3 (6.+ 3.*tan(!Theta), 3., 0.)

ID4 (6.,0.,0.)

- curva

Geometry : Curve-Line : Points :

ID1 (Pt 1 To Pt 2) ID2 (Pt 2 To Pt 3) ID3 (Pt 3 To Pt 4) ID4

- cópia

Geometry : Copy : Curve : Method(Points) :

{Repetitions} = 14

Base Point ID = 1 Tip Point ID = 2

Modelagem

Geometria e material

- curva

View : Options : Labels :

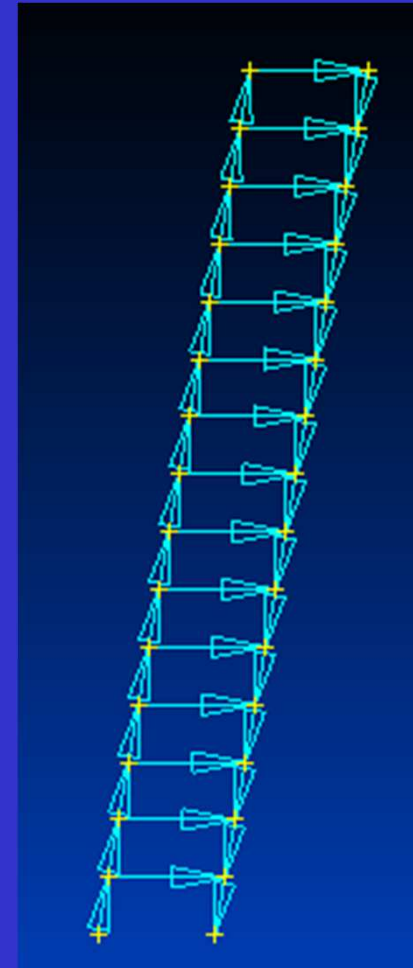
Curve / Surface Directions : Curve Arrows

- material

Model : Material : Isotropic

Title : Concreto $f_{ck} = 30\text{MPa}$

E : E ν : 0.2 & δ : 2500



Modelagem

Propriedades

- propriedade 1

Model : Property : Beam

Title : Pilares

Rectangular Bar & Height : $40e-2$ & Width : $20e-2$

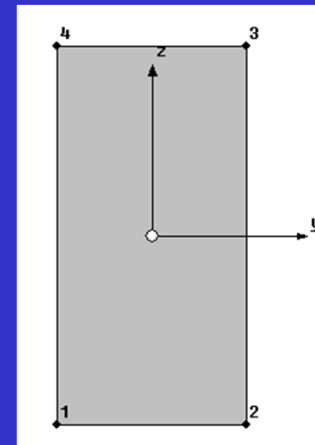
- propriedade 2

Model : Property : Beam

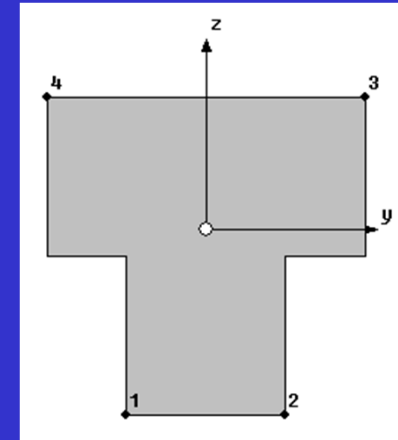
Title : Vigas

T Section & Height : $40e-2$ & Width : $40e-2$ & Thick = Thickness : $20e-2$

Pilares



Vigas



Modelagem

Malha

- refinamento (4 elementos/3m)

Mesh : Mesh Control : Size Along Curve :

Cr n : Pilares (4 el)

Cr n : Vigas (8 el)

- nós & elementos

Mesh : Geometry : Curves(1, 4, 7 ... 43), Curves(3, 6, 9 ... 45) : Property : Pilares

Method (Locate) : $\{v\} = \{Tip\} - \{Base\} = (0.,0., -1.) - (0.,0.,0.)$

View : Options : Labels : Element – Orientation/Shape : Show Cross Section

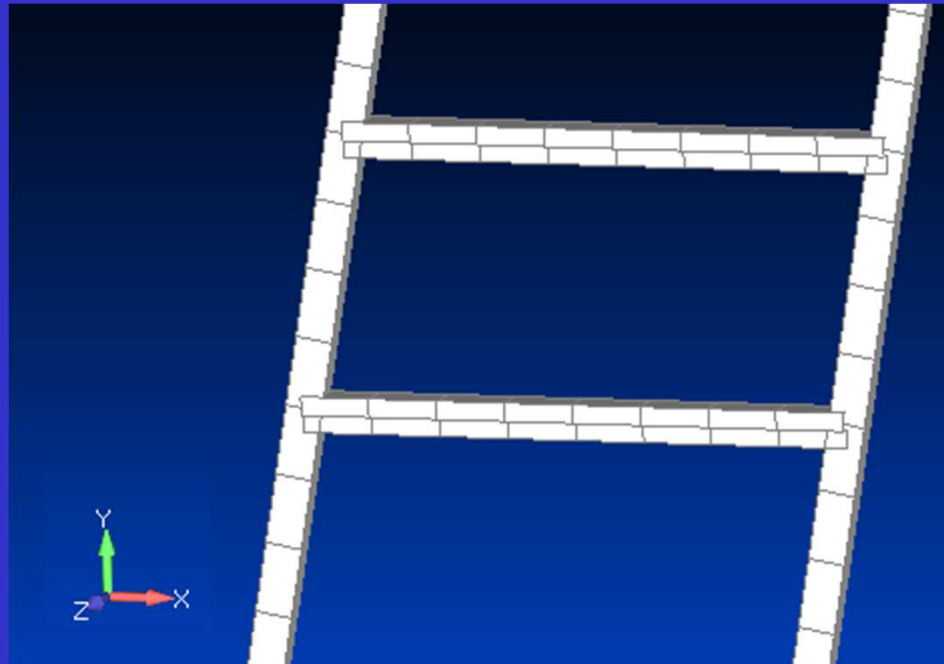
Mesh : Geometry : Curves (2, 5, 8 ... 44) : Property : Vigas

Method (Locate) : $\{v\} = \{Tip\} - \{Base\} = (0.,0.,-1.) - (0.,0.,0.)$

View : Options : Labels : Element – Orientation/Shape : Show Cross Section

Modelagem

Malha



Pórtico 2D

Modelagem

Malah e Condições de Contorno

- Nós

Tools : Check : Coincidents Nodes : Merge

- carregamento

Model : Load : Create Set : New

Title : Cargas de Vento

Model : Load : Elemental :

Distributed Load : 6000 N/m.

- restrições

Model : Constraint : Create Set : New

Title : Engaste

Model : Constraint : Nodal :

Nd 1,150: Fixed

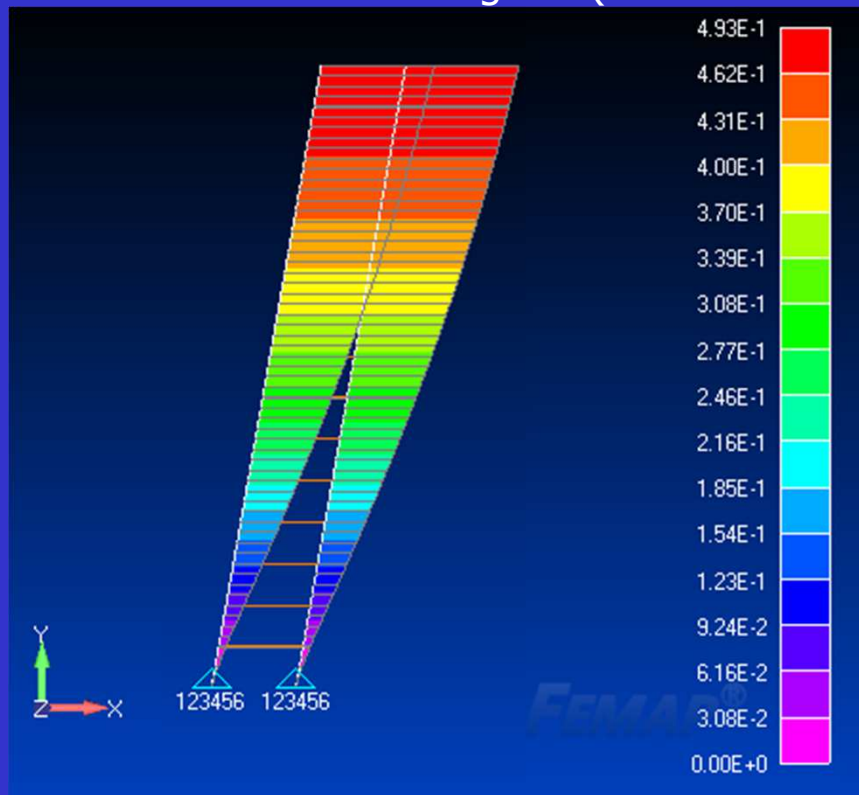


Análise & Pós-Processamento

Análise Linear

- diagrama de deslocamentos

View : Select : Beam Diagram (T1 Translation)



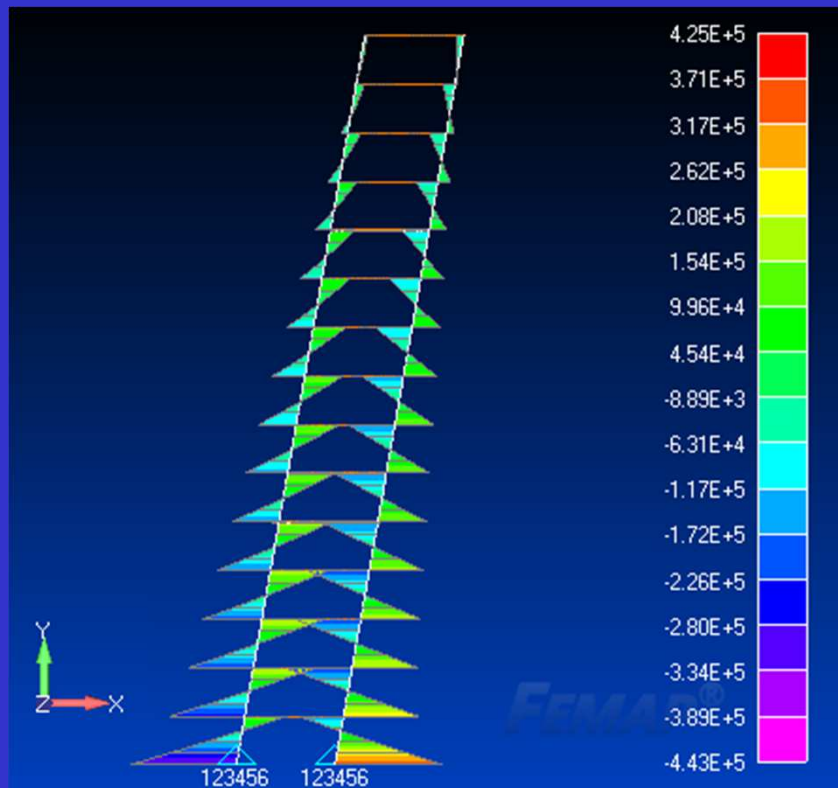
Máximo deslocamento T1 : 49.3 cm

Análise & Pós-Processamento

Análise Linear

- diagrama de momento fletor (DMF)

View : Select : Beam Diagram (Bar EndA Plane2 Moment)



Máximo momento M_z : 425. kN.m

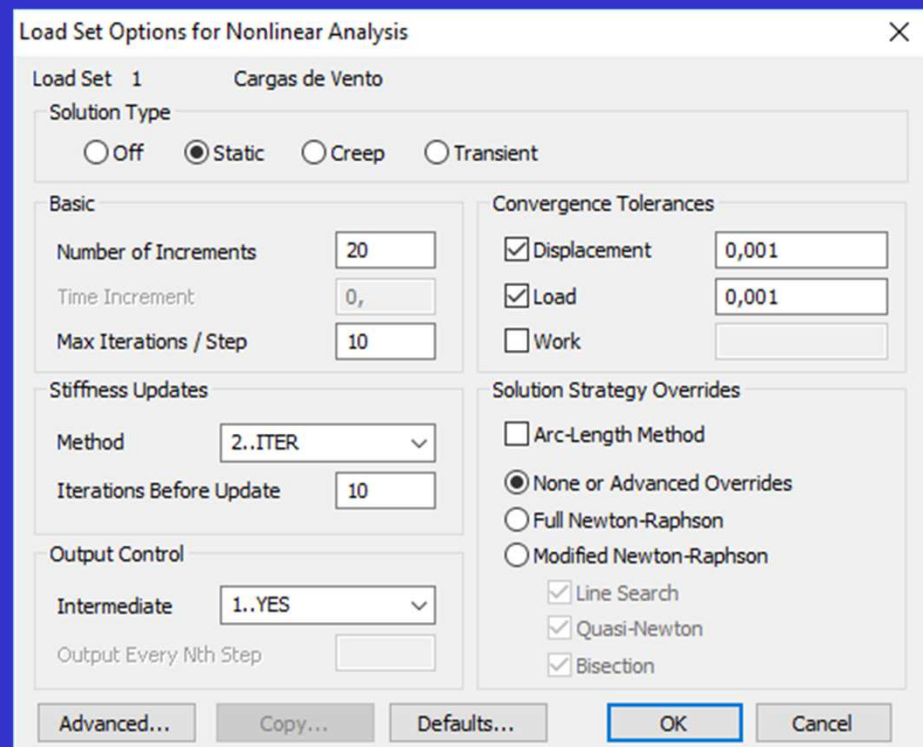
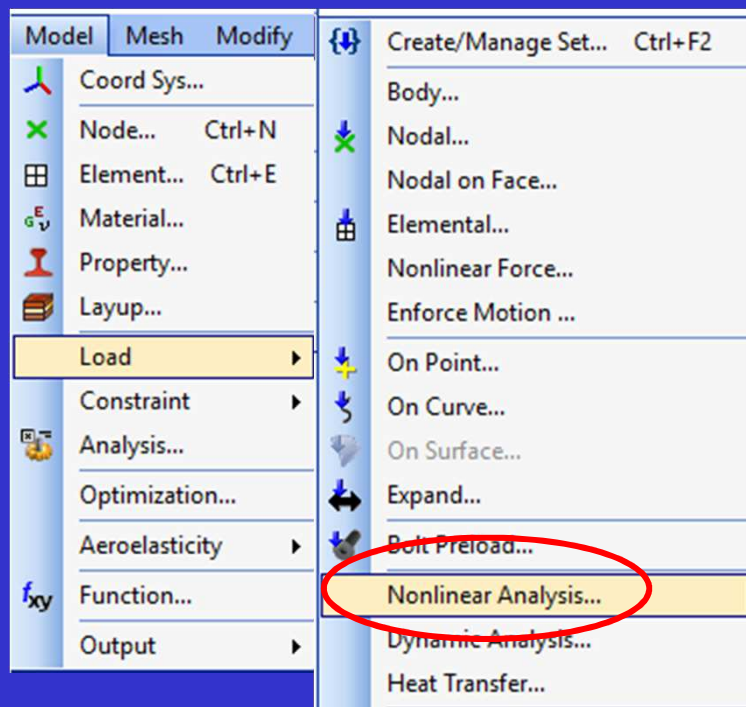
Mínimo momento M_z : -443. kN.m

Pórtico 2D

Análise & Pós-Processamento

Análise Não-Linear Geométrica

- Configurações de análise não-linear

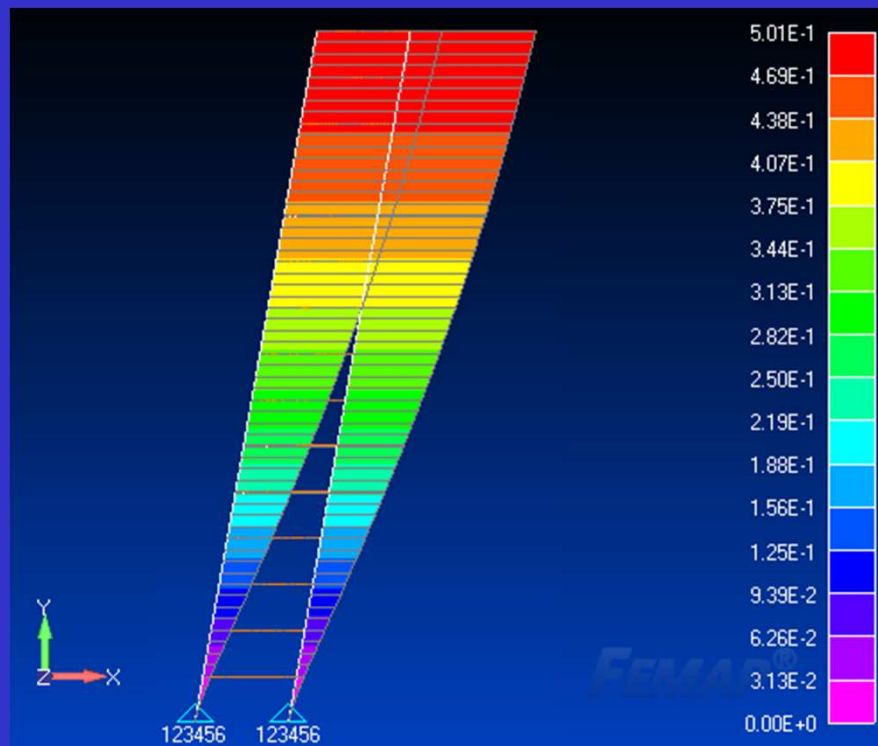


Análise & Pós-Processamento

Análise Não-Linear Geométrica

- diagrama de deslocamentos

View : Select : Beam Diagram (T1 Translation)



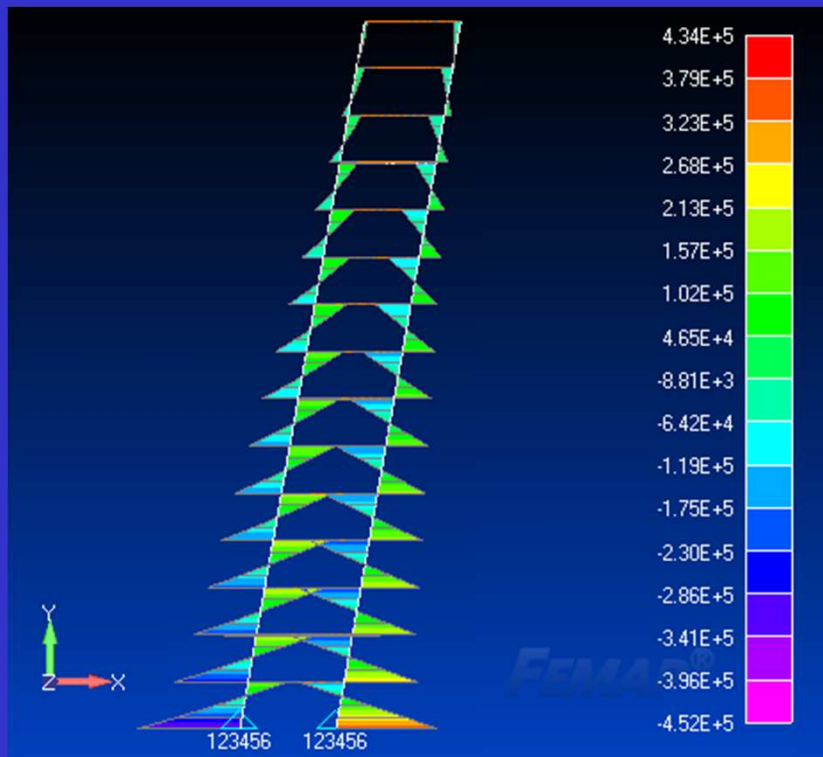
Máximo deslocamento T1 : 50.1 cm

Análise & Pós-Processamento

Análise Não-Linear Geométrica

- diagrama de momento fletor (DMF)

View : Select : Beam Diagram (Bar EndA Plane2 Moment)



Máximo momento M_z : 434. kN.m

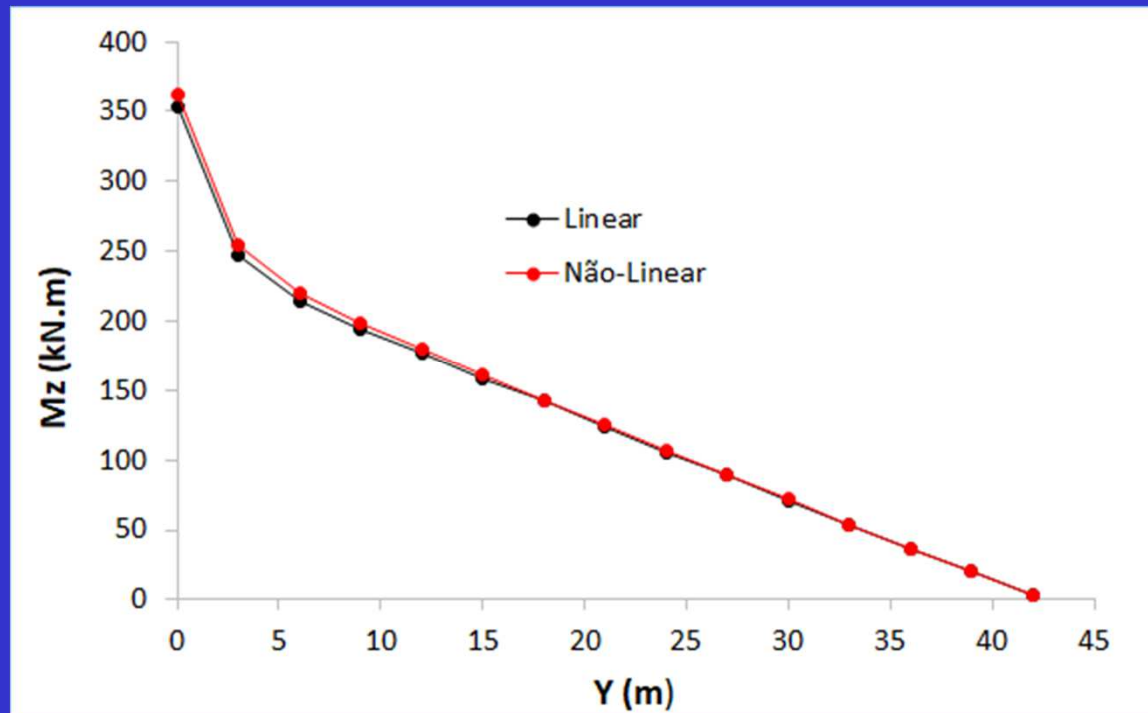
Mínimo momento M_z : -452. kN.m

Análise dos Resultados

Comparação das análises

- Linear x Não-Linear

Plane2 Moment : M_z



Exercício – Casa

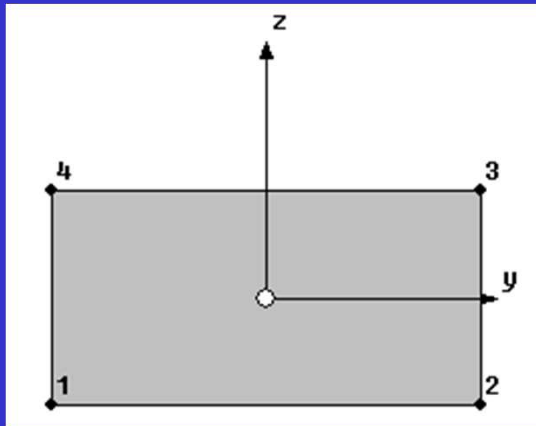
Au boulot!

Refaça o modelo estrutural do pórtico 2D, sem e com a imperfeição Geométrica, sujeito às forças horizontais, considerando:

(1) O peso próprio da estrutura;



(2) Os pilares sendo fletidos na direção de menor inércia;



Pórtico 2D

Exercício – Casa

Au boulot!

Determine para as análises linear e não-linear do modelo estrutural do pórtico:

- (1) O diagrama de deslocamento horizontal e o valor do maior deslocamento horizontal;
- (2) Os diagramas DEC (esforço cortante) e DMF (momento fletor) para a estrutura analisada;
- (3) Os valores extremos (máximo e mínimo) do esforço cortante e do momento fletor nos pilares do pórtico;
- (4) As curvas $M_z \times Y$.