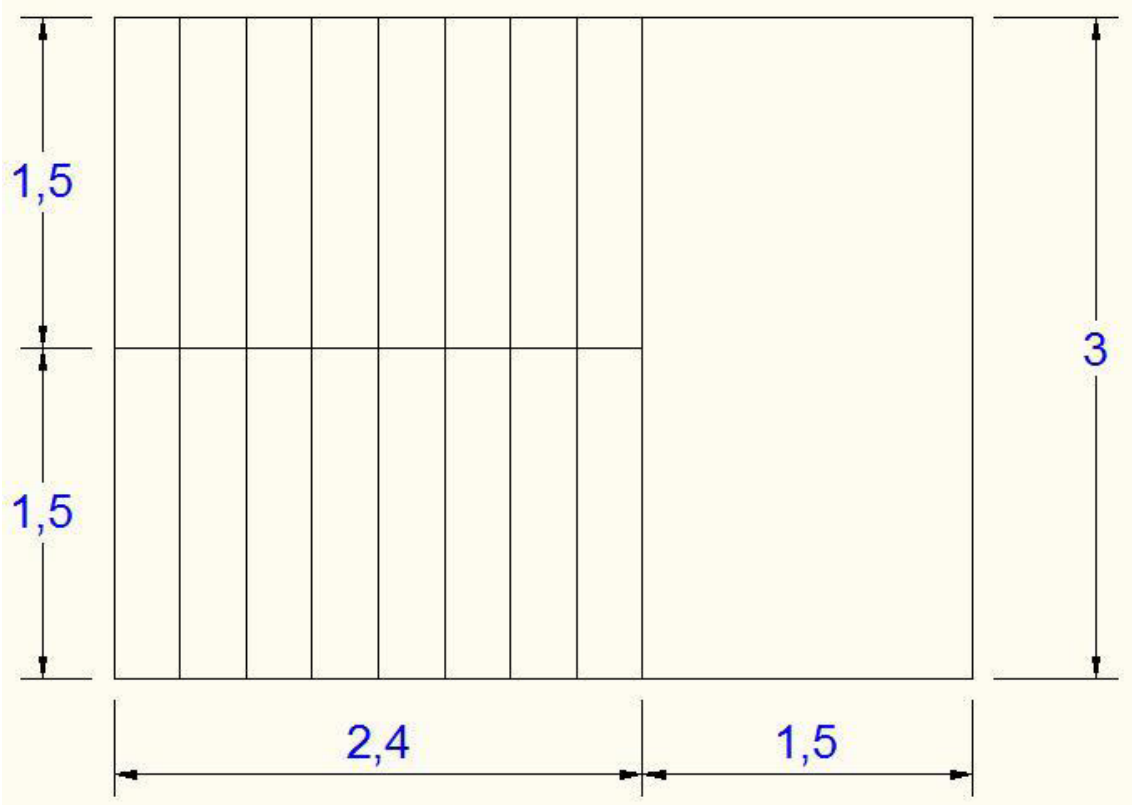
# ESCADA EM BALANÇO

## 1. INTRODUÇÃO

### 1.1. DESCRIÇÃO DO PROBLEMA:

Entre os muitos problemas interessantes de se estudar encontram-se as escadas e, dentre elas, estudaremos dois problemas apresentados pelo Prof. Antonio Stramandinolli, envolvendo escadas em balanço e helicoidais. Apresenta-se assim o esquema de uma escada em balanço:



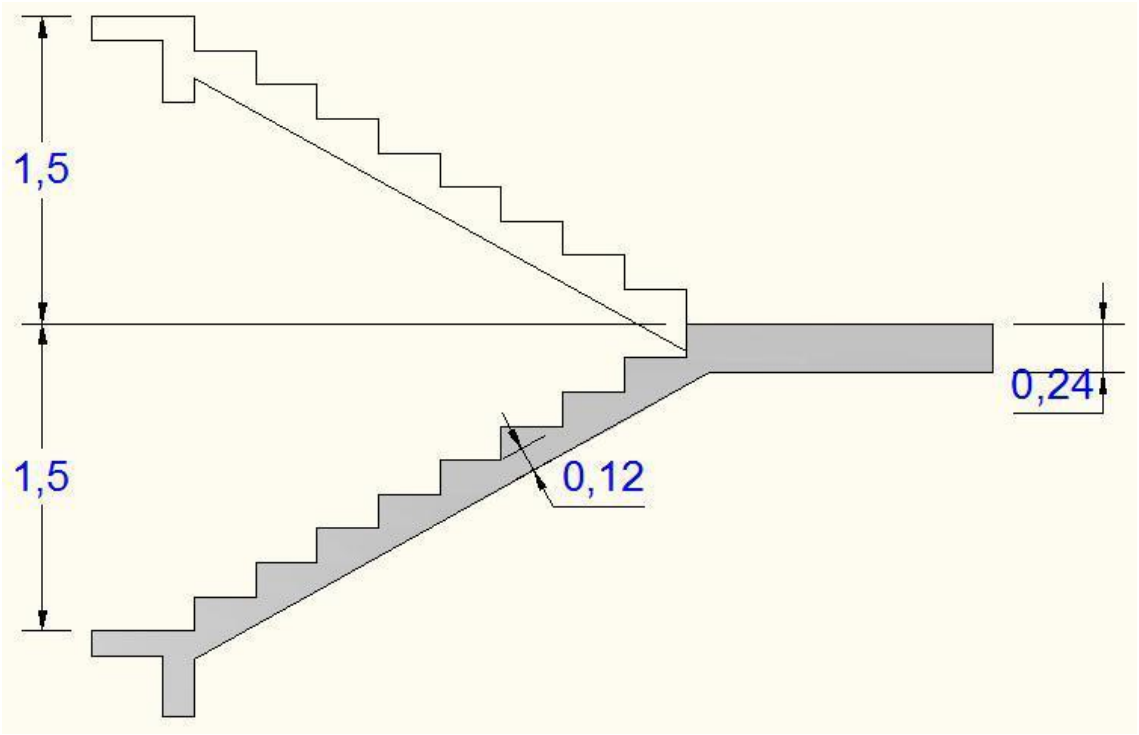



Figura 1 – Esquema da Escada em Balanço.

1.2. PROPRIEDADES DO MATERIAL

E = 1.5E6 tf/m2;
Coeficiente de Poisson = 0.2

1.3. PROPRIEDADES GEOMÉTRICAS

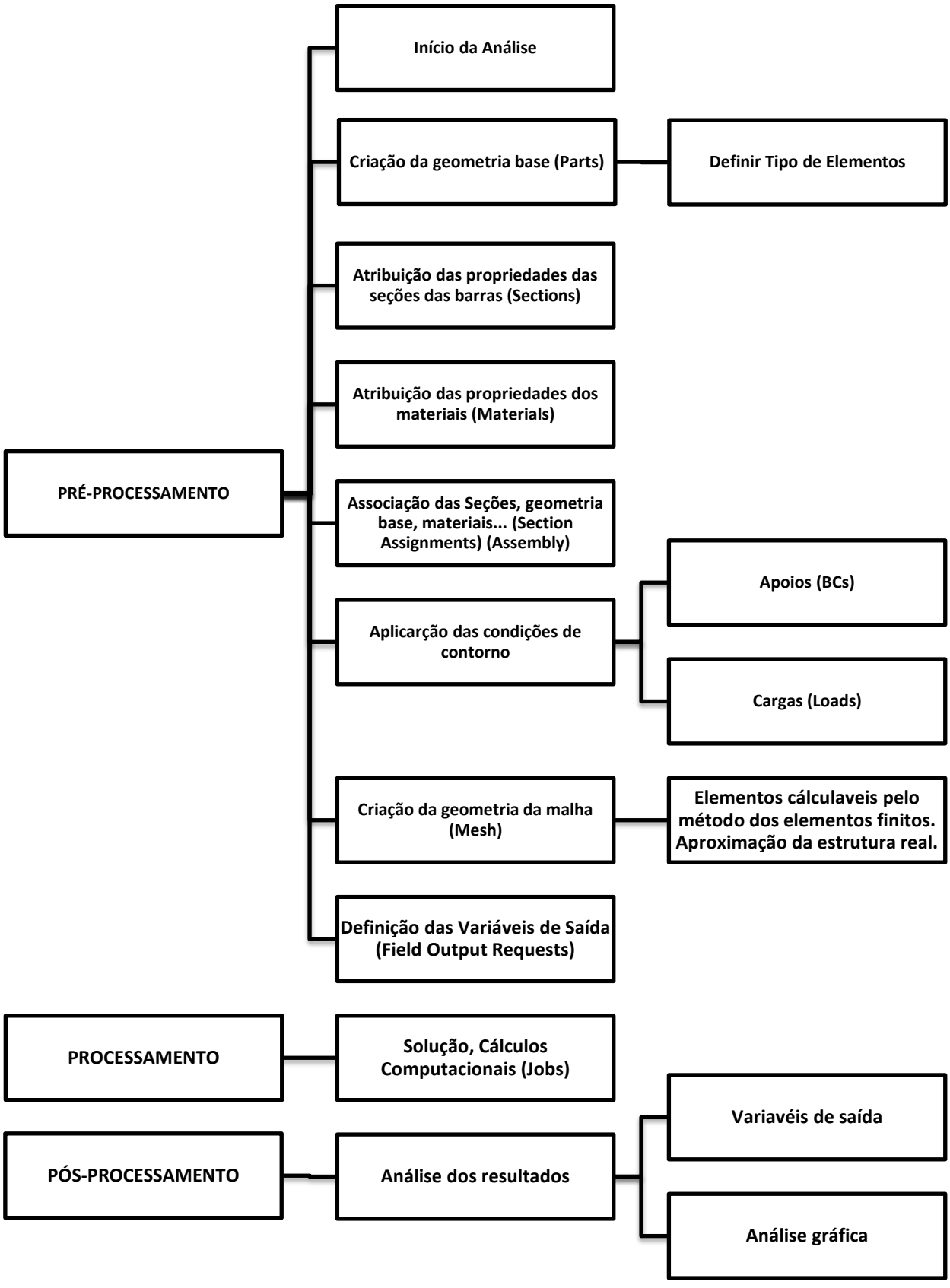
Conforme a Figura 1
Espessura: 12 centímetros.

1.4. CARGA

Carregamento nos lances: P1 = 0.962 tf/m2;
Carregamento no patamar: P2 = 1 tf/m2.

## 2. RESOLUÇÃO

O procedimento de resolução pode ser demonstrado no seguinte fluxograma (a ordem pode eventualmente ser quebrada em pontos específicos por conveniência):

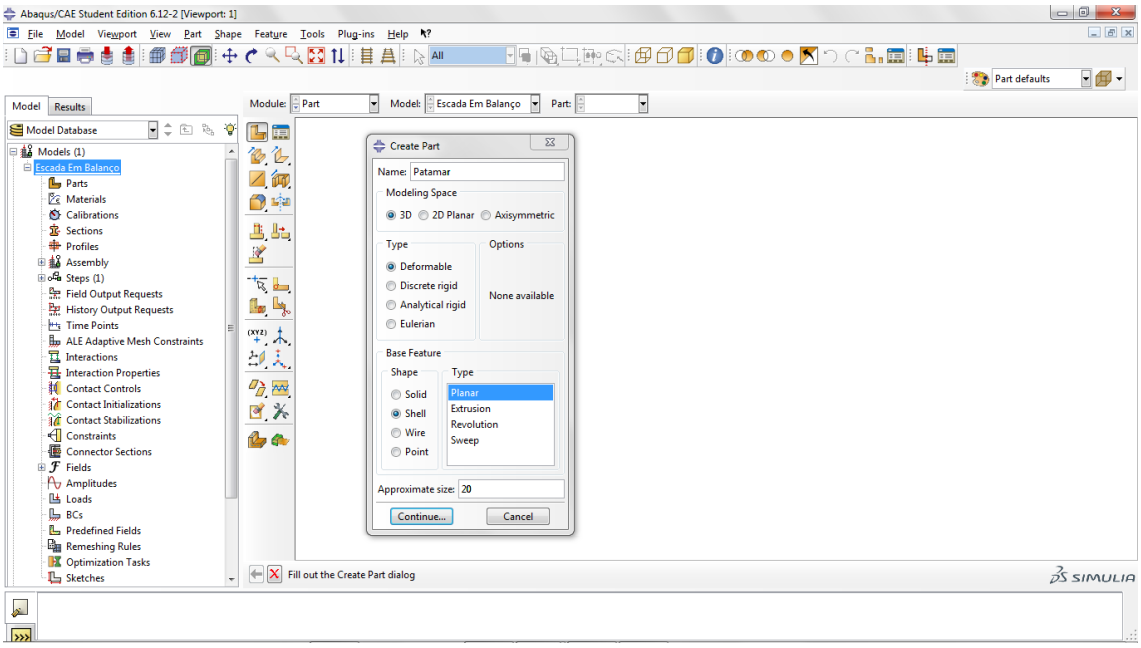

PRÉ-PROCESSAMENTO
Início da Análise
Criação da geometria base (Parts)
Definir Tipo de Elementos
Atribuição das propriedades das seções das barras (Sections)
Atribuição das propriedades dos materiais (Materials)
Associação das Seções, geometria base, materiais... (Section Assignments) (Assembly)
Aplicarção das condições de contorno
Apoios (BCs)
Cargas (Loads)
Criação da geometria da malha (Mesh)
Elementos cálculaveis pelo método dos elementos finitos. Aproximação da estrutura real.
Definição das Variáveis de Saída (Field Output Requests)
PROCESSAMENTO
Solução, Cálculos Computacionais (Jobs)
PÓS-PROCESSAMENTO
Análise dos resultados
Variavéis de saída
Análise gráfica

## 2.1. INÍCIO DA ANÁLISE

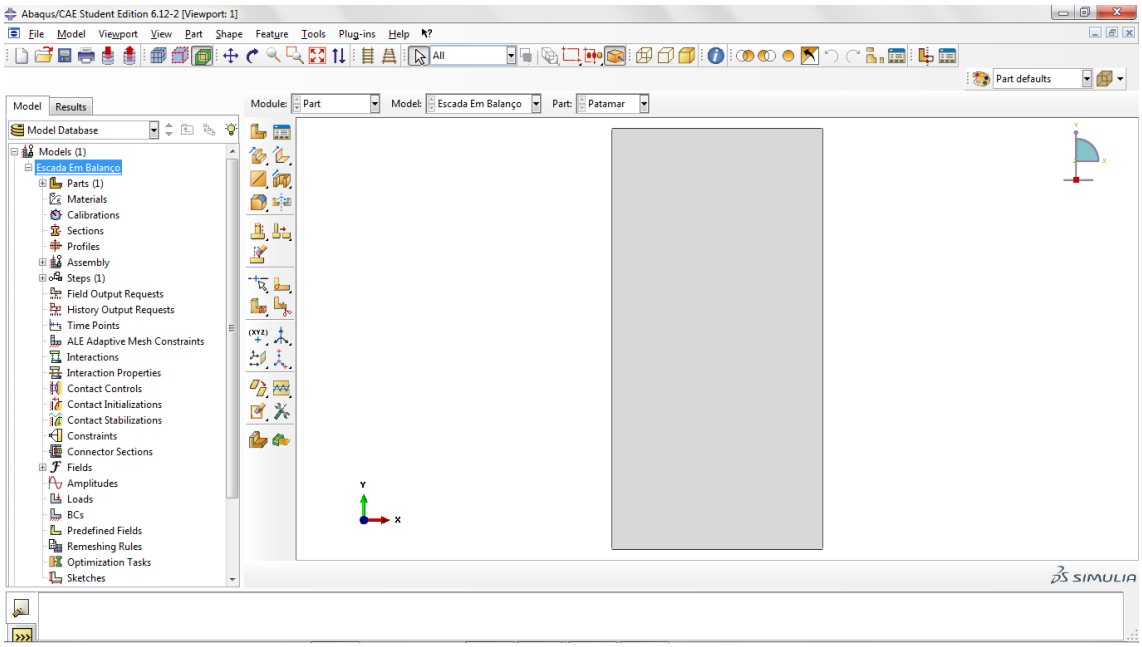
- ✓ Se você ainda não iniciou o programa **Abaqus/CAE**, **digite** *cmd* no **Menu Iniciar** para abrir o **Prompt de Comando** e nele **digite** *abq6122se cae* para executar o Abaqus.
- ✓ Em **Create Model Database** na caixa **Start Session** que aparece, **selecione** **With Standard/Explicit Model**.

## 2.2. PRÉ-PROCESSAMENTO

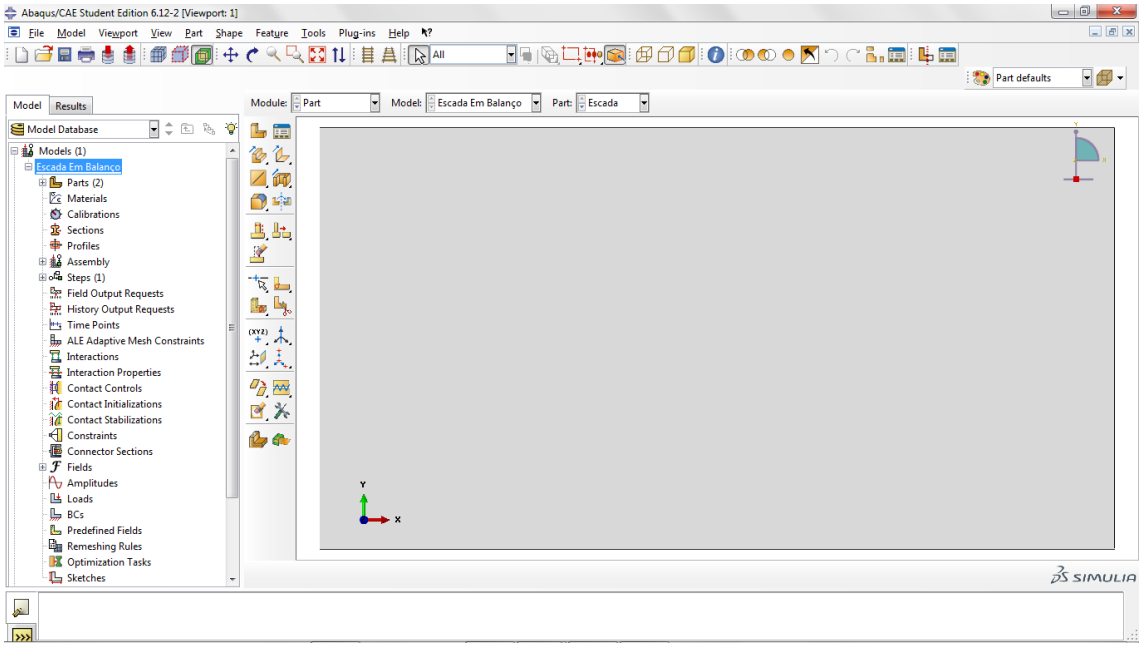
- ✓ No menu **Model** à esquerda, **clique** com o botão direito em **Model-1** e **selecione** **Rename**. **Digite** *EscadaEmBalanço* e **clique** em **OK**.
- ✓ No menu **Model** à esquerda, **dê** duplo clique em **Parts**, no campo **Name** **digite** *Patamar*, e **selecione** as opções: **3D, Deformable, Shell, Planar.** Em **Approximate size** **digite** 20 e **clique** em **Continue**...



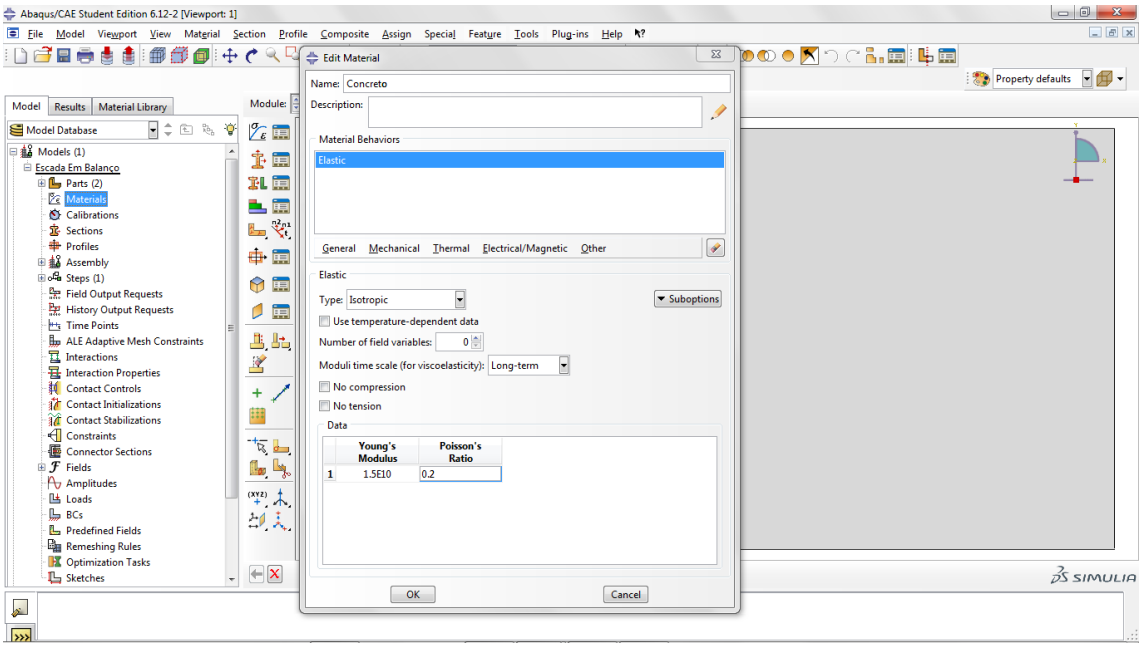

- ✓ **Clique** em **Create Lines: Rectangle (4 lines)** na caixa de ferramentas e **insira** as seguintes coordenadas 0,0 – 1.5,3 , **desative** a função e **clique** em **Done**.



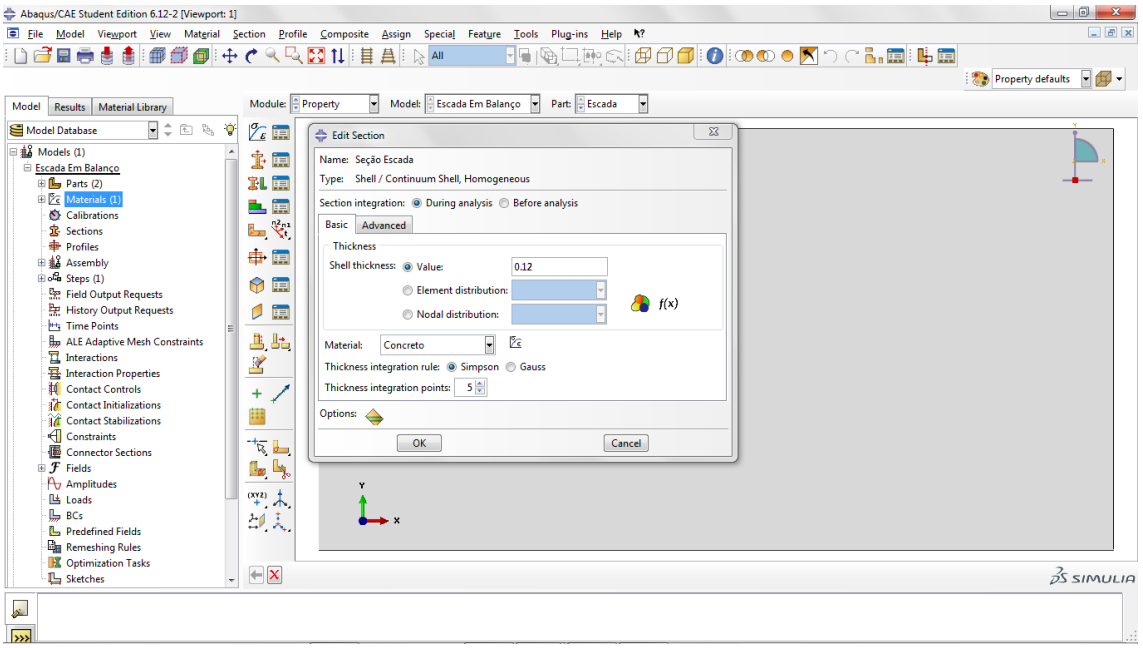

✓ **Repita** o procedimento para criar a *Escada*, inserindo um retângulo com as coordenadas 0,0 e 2.8302,1.5 .



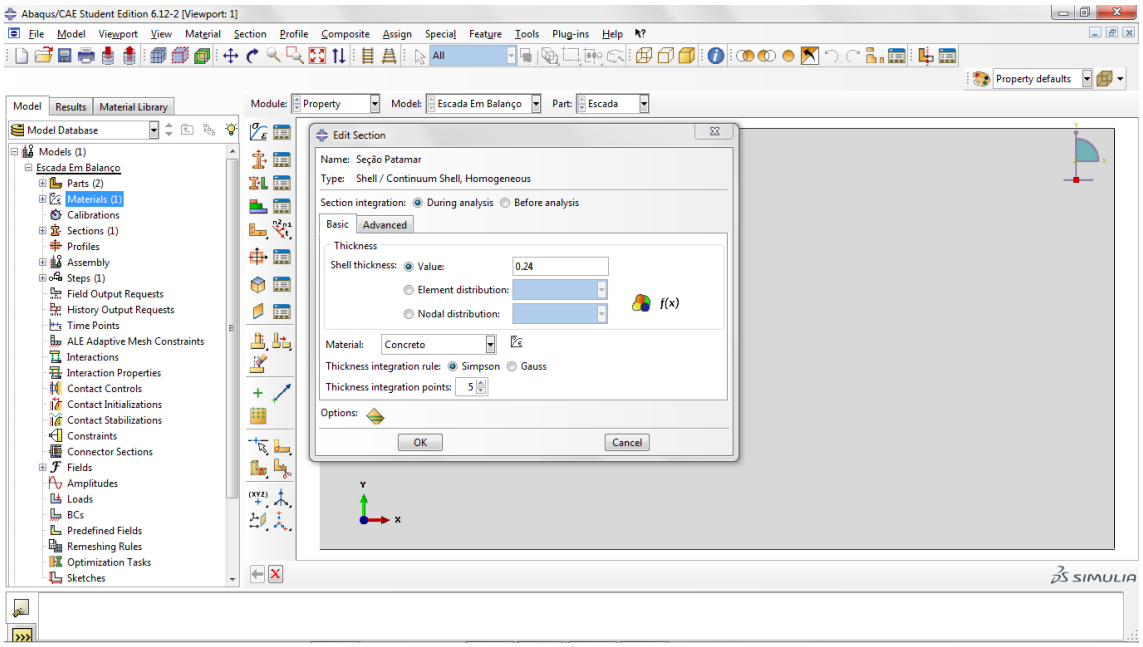

✓ No menu **Model** à esquerda, **dê** duplo clique em **Materials.** Na janela **Edit Material Renomeie** o material para *Concreto*, **selecione Mechanical>Elasticity>Elastic** e **digite** 1.5E10 em **Young's Modulus** e 0.2 em **Poisson's Ratio. Clique** em **OK.**



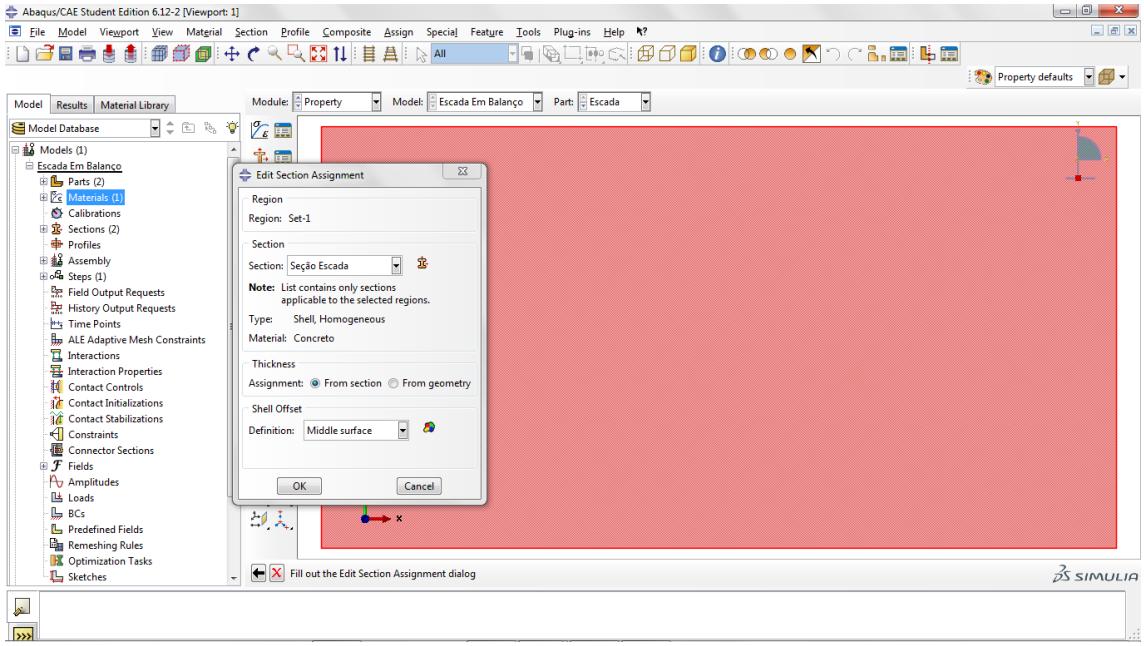

✓ No menu **Model** à esquerda, **dê** duplo clique em **Sections.** No campo **Name: digite** *Seção Escada,* em **Category selecione Shell**, e em **Type selecione Homogeneous**. **Clique** em **Continue...** Na janela **Edit Section**, **certifique-se** de que *Concreto Armado* está selecionado em **Material**, **selecione Value** no campo **Thickness**, **insira** o valor de 0.12 e **clique** em **OK.**



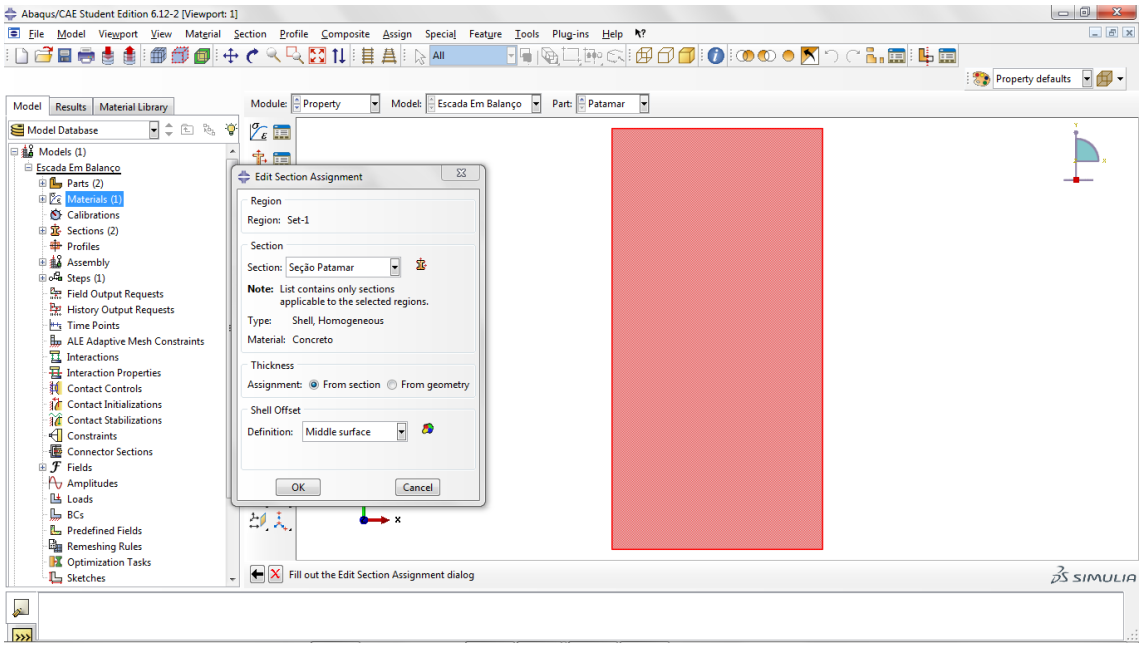

✓ **Repita** esse procedimento para criar a seção patamar, com **thickness** de 0.24.



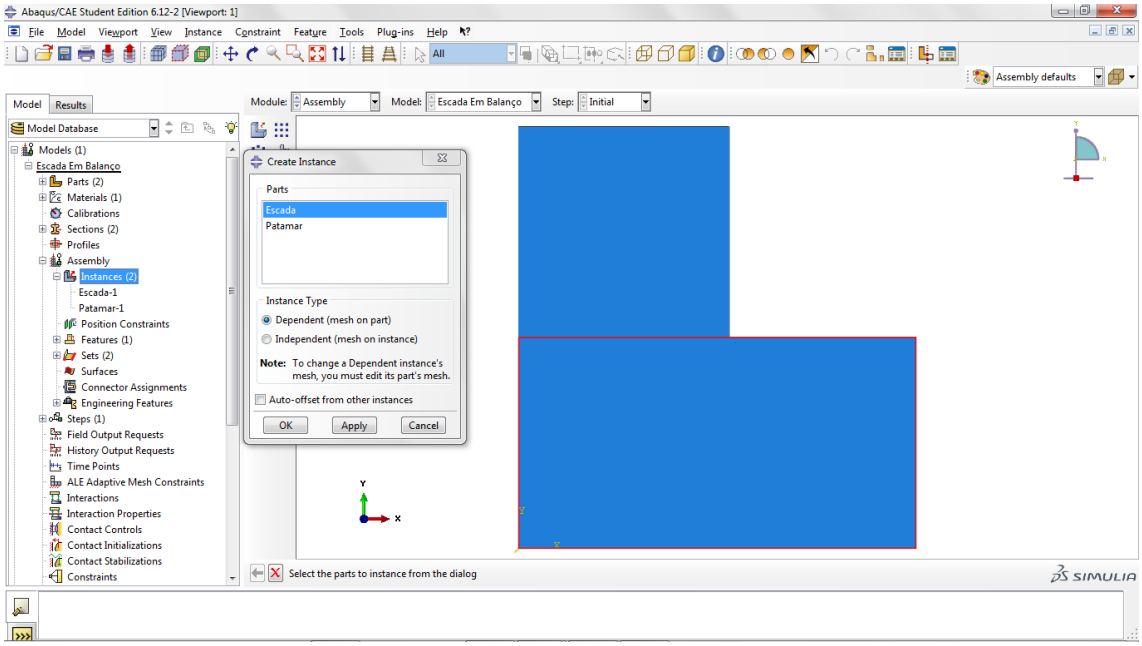

✓ Na caixa de ferramentas, **clique** em **Assign Section.** **Selecione** a *Escada* e **clique** em **Done.** **Selecione** *Seção Escada* em **Section:** e **clique** em **OK.**



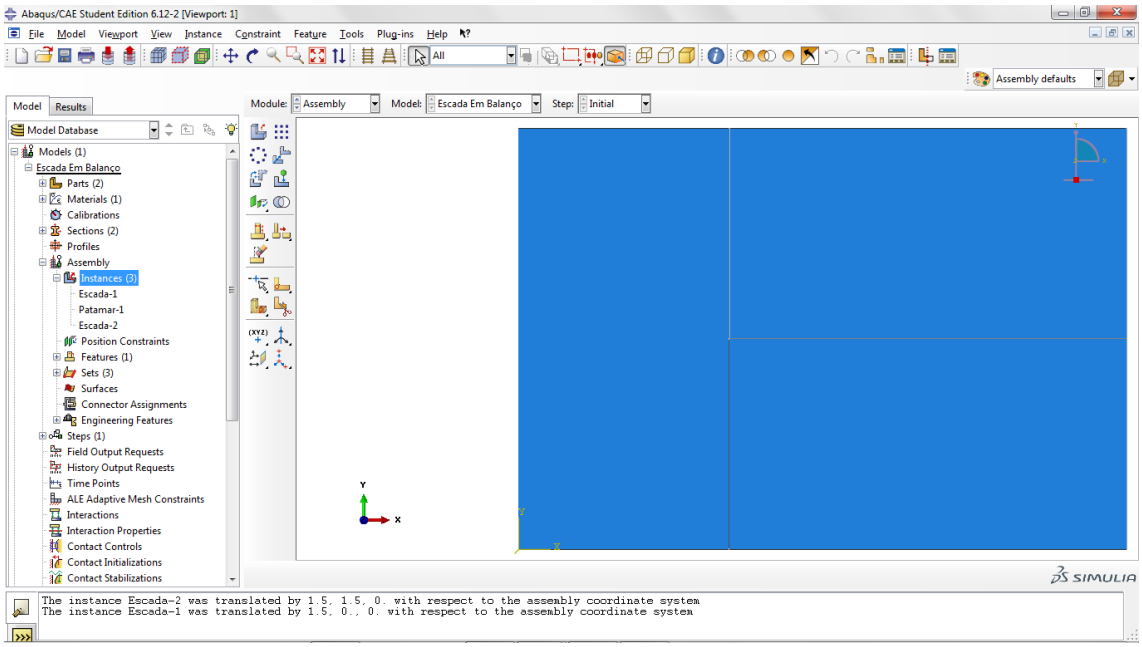

✓ **Repita** esse procedimento para a parte *Patamar,* associando à *Seção Patamar.*



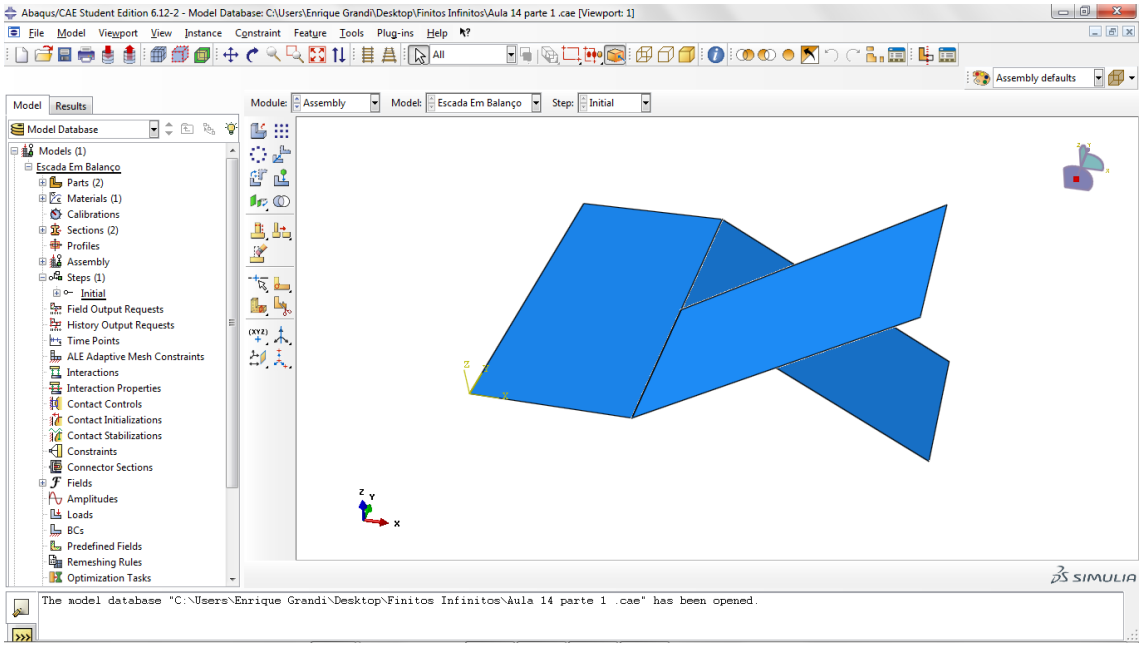

✓ No menu **Model** à esquerda, **abra Assembly,** **dê** duplo clique em **Instances. Dê** duplo clique uma vez no Patamar, e uma vez na Escada, **selecione** Escada e **clique** em **OK.**



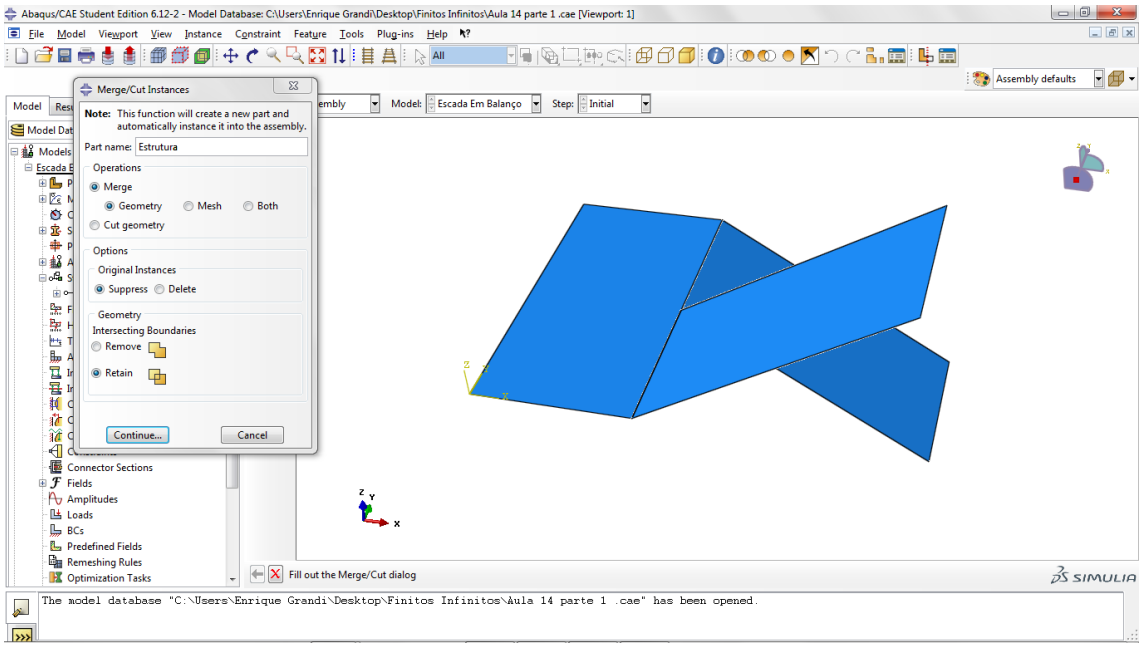

✓ Utilizando a ferramenta **Translate Instance**, **posicione** as partes conforme a imagem.



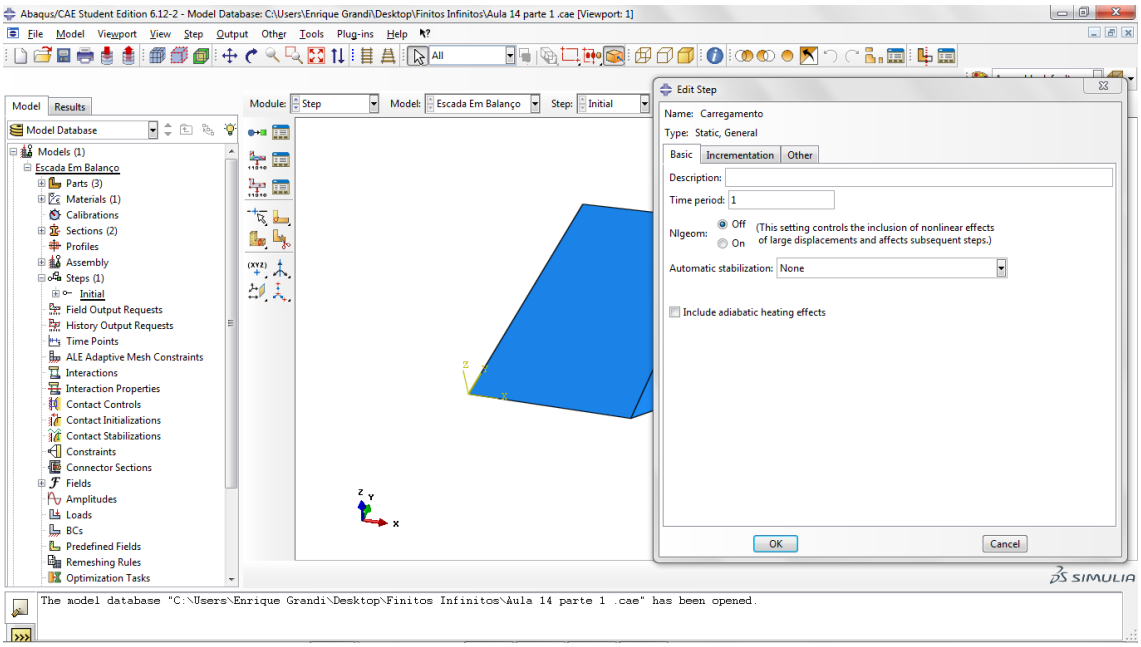

✓ Com a ferramenta **Rotate Instance**, **rotacione** as partes Escada com a inclinação de 32 graus, conforme a imagem.



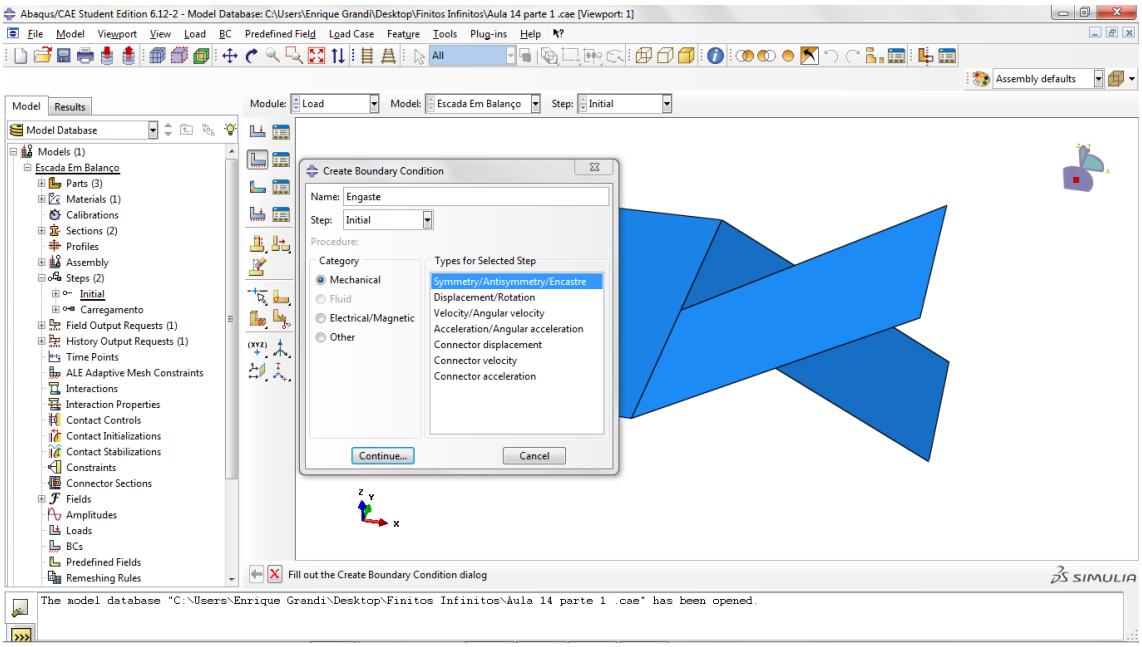

✓ Na caixa de ferramentas, **clique** em **Merge/Cut Instances**. **Nomeie-a** *Estrutura*, e em **Geometry marque Retain**. **Selecione** todas as Instances e **clique** em **Done.**



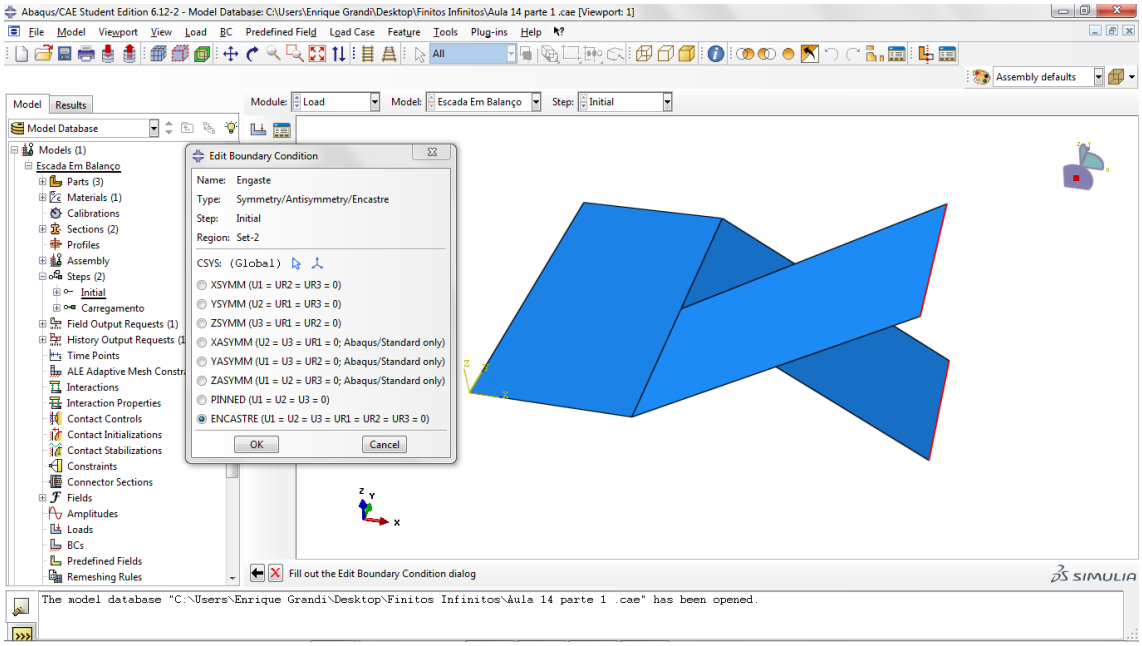

✓ No menu **model** à esquerda, **dê** duplo clique em **Steps**. **Digite** *Carregamento* no campo **Name:** e **Clique** em **Continue**... Então **clique OK** na nova janela que se abre.



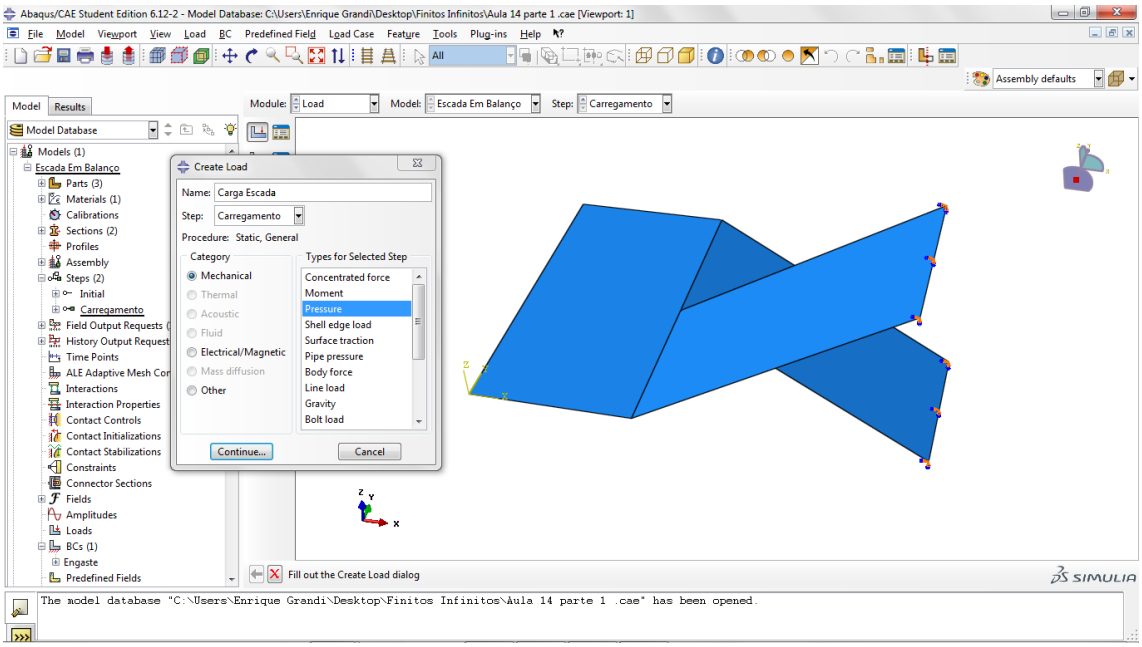

✓ No menu **model** à esquerda, **dê** duplo clique em **BCs**. Na janela **Create Boundary Condition**, **altere** o campo **Name** para *Engaste*, **Step** para **Initial** e **Types for Selected Step** para Symmetry/Antisymmetry/Encastre. **Clique** em **Continue**...



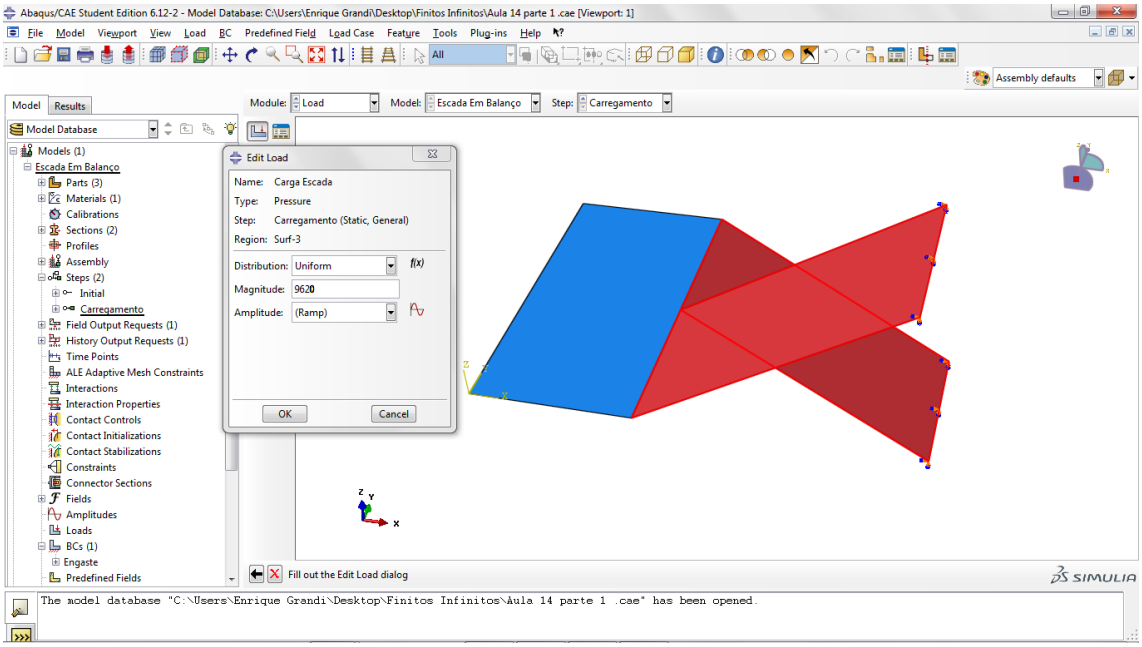

✓ **Selecione** os bordos livres conforme a imagem e **clique** em **Done**. **Marque ENCASTRE** na janela **Edit Boundary Condition** e **clique** em **OK.**



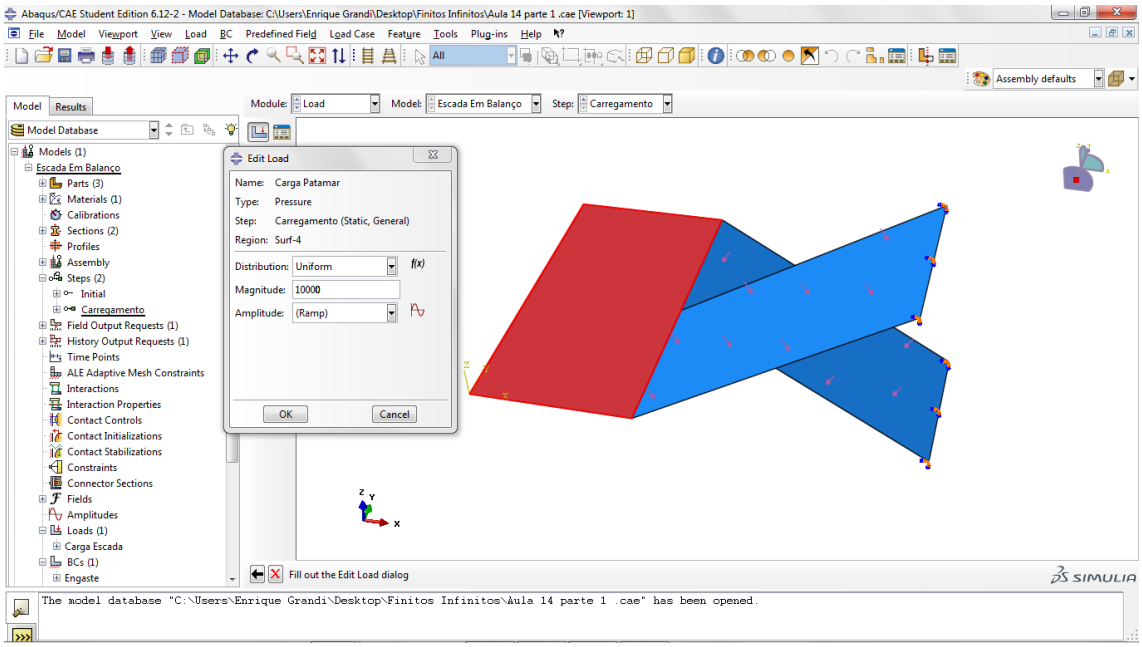

✓ Na caixa de ferramentas, **clique** em **Create Load**. Na janela Create Load, no campo **Name digite** *CargaEscada*, **selecione** o **Step** *Carregamento***,** em **Types for Selected Step selecione Pressure** e **clique** em **Continue**....



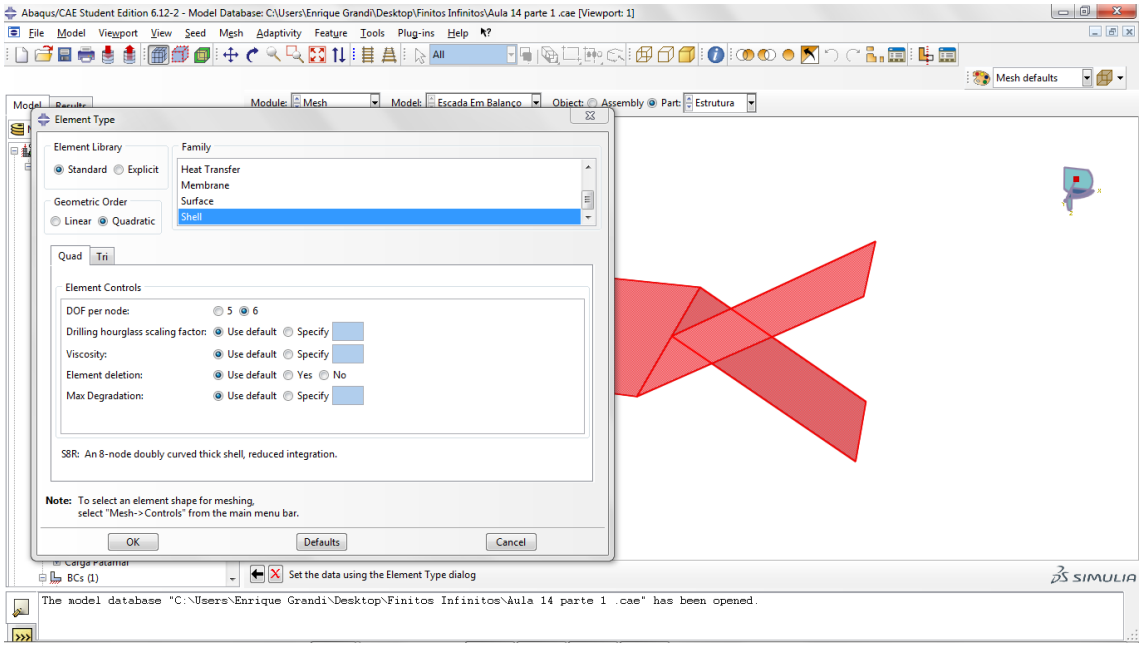

✓ **Selecione** as partes Escada e **clique** em **Done**. **Clique** em Brown. Na janela **Edit Load**, **digite** *9620* no campo **Magnitude** e **clique** em **OK.**



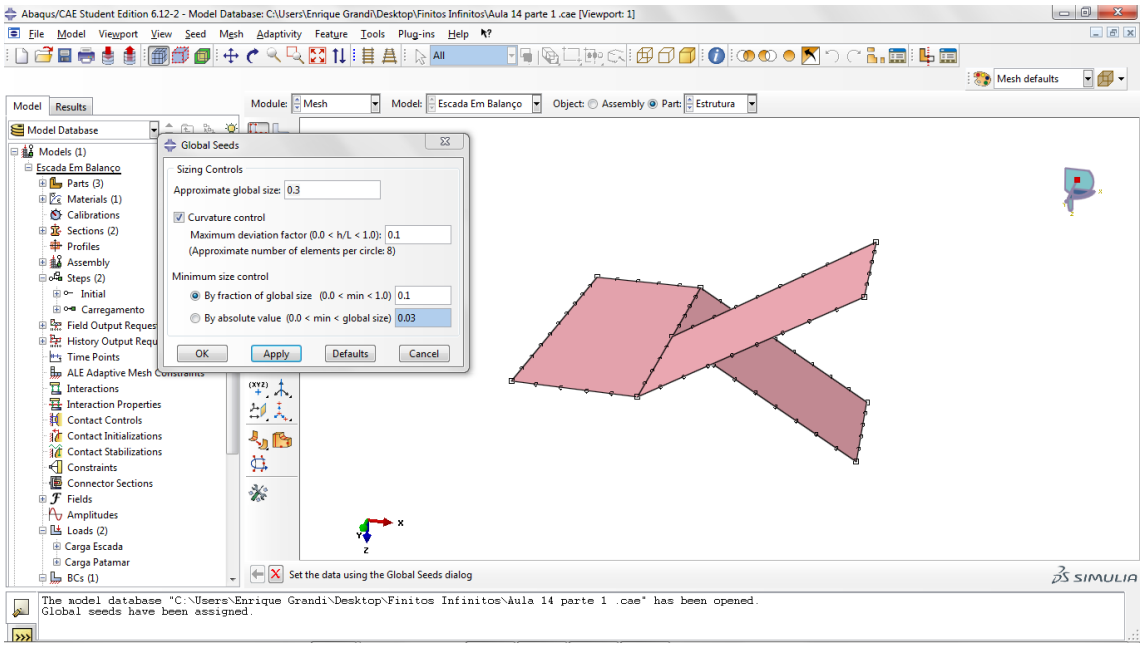

✓ **Repita** esse procedimento para criar a Carga Patamar, aplicada no patamar, de magnitude de 10000.



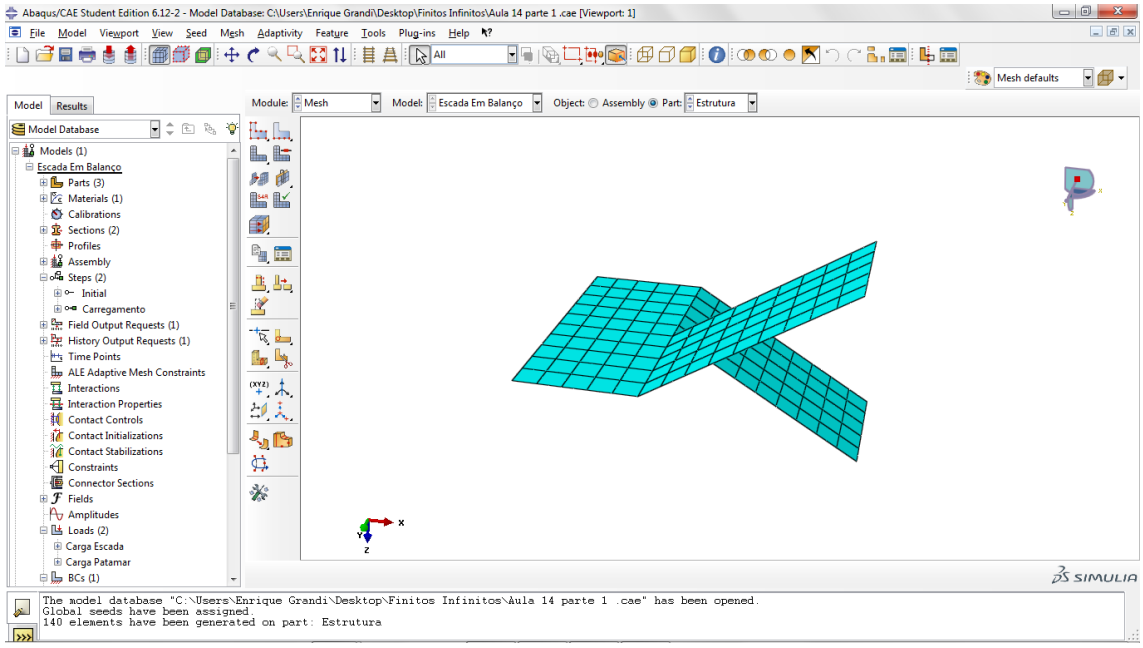

✓ Na barra de contexto, em **Module**, **selecione** **Mesh**, e em **Object,** **selecione** **Part**. **Selecione** a Part estrutura. Na barra do menu principal, **clique** em **Mesh>Element Type** e **selecione** toda a estrutura. **Clique** em **Done**. Abrirá a janela **Element Type**. Em **Family**, **selecione** **Shell** e em **Geometric Order**, **selecione** **Quadratic** e **clique** **OK**.



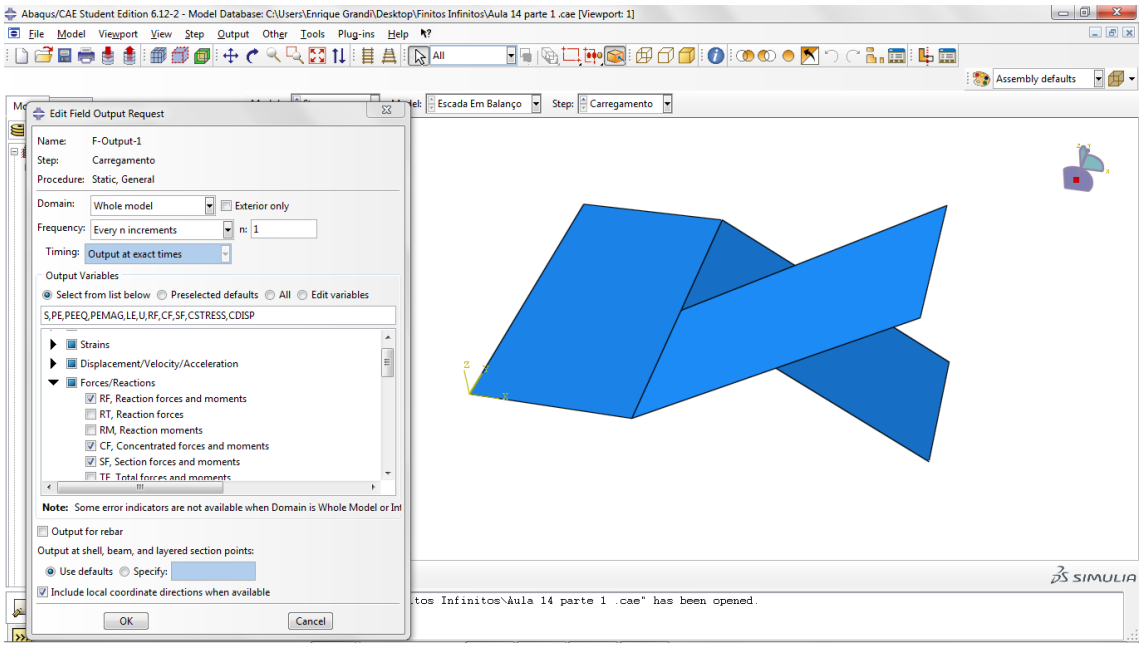

✓ Na barra do menu principal, **clique** em **Seed>Part**. **Clique** em **OK** e em **Done**.




✓ Na barra do menu principal, **clique** em **Mesh>Part** , e **clique** em **Yes**.

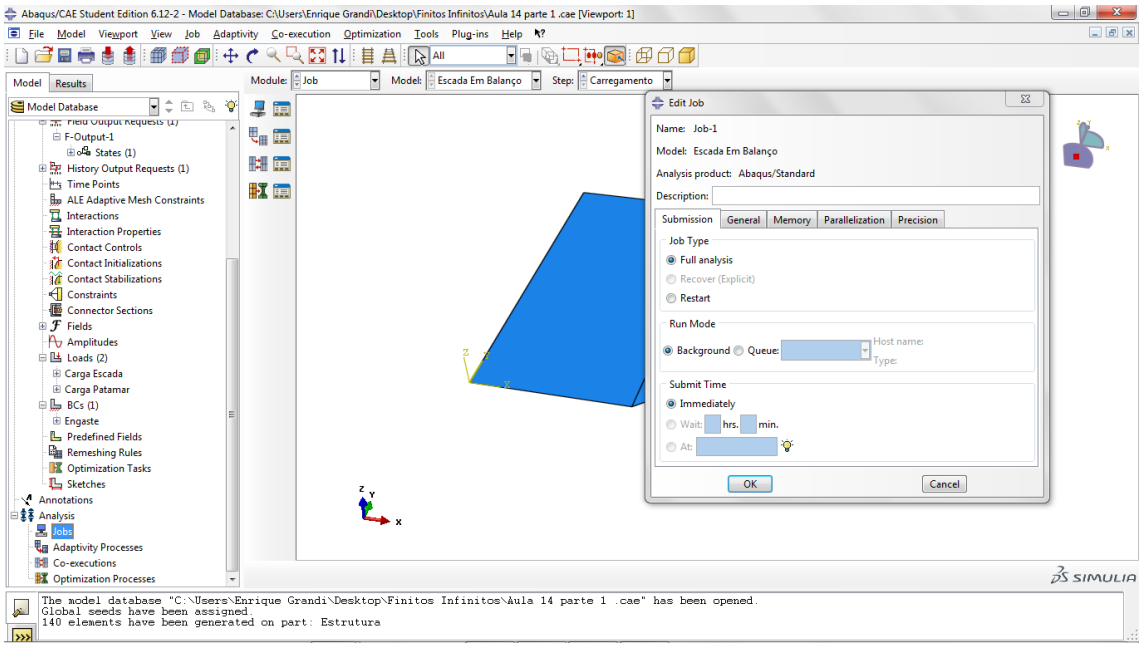



✓ No menu model a esquerda, **abra** **Field Output Requests (1)** e **clique** com o botão direito em **F-Output-1** e **clique** em **Edit**. **Abra** **Forces/Reactions** e **marque** **SF, Section forces and moments** e **clique** em **OK**.



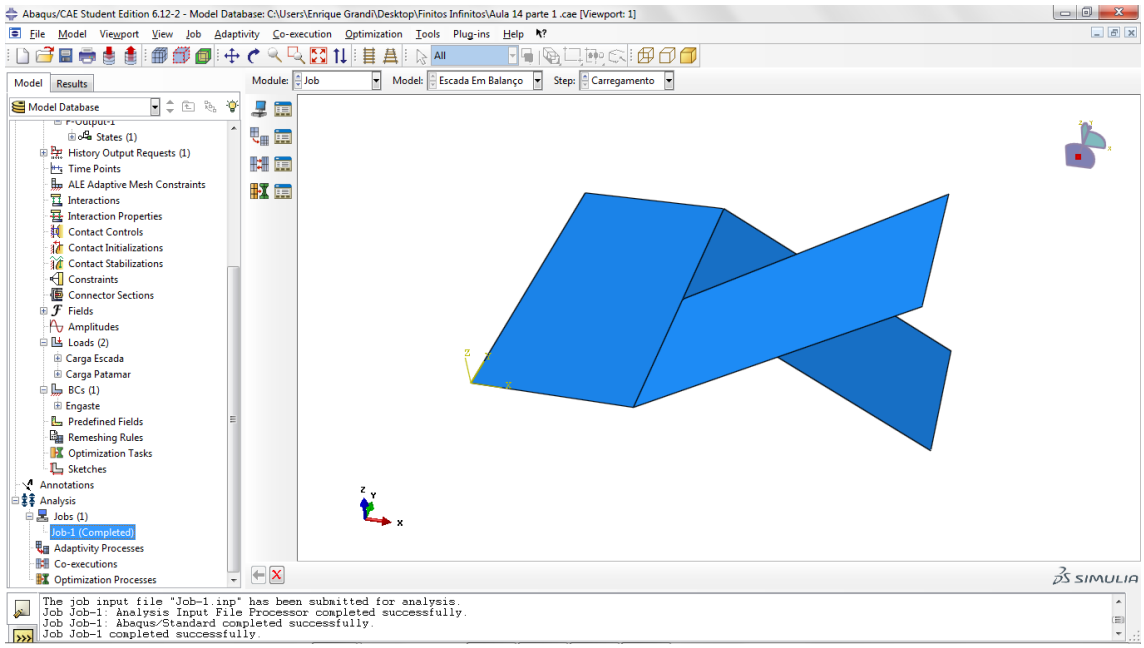

## 2.3. PROCESSAMENTO

✓ No menu **model** à esquerda, **de** duplo clique em **Jobs**. Na janela **Create Job**, apenas **clique** em **Continue**... Na janela **Edit Job**, **clique** em **OK.**



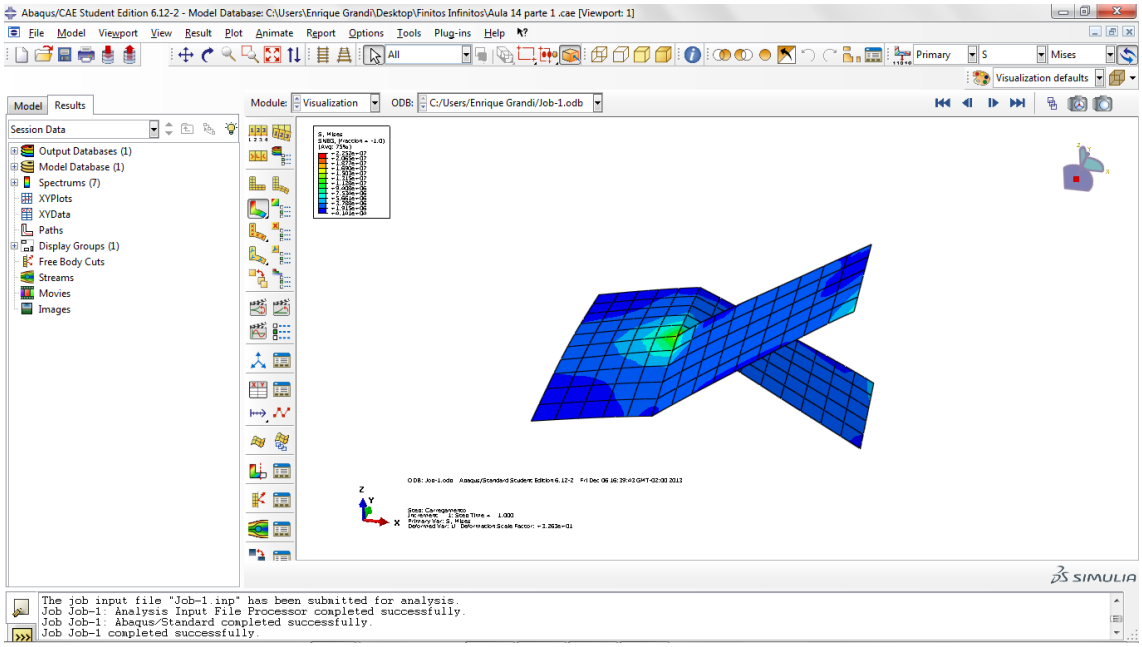

✓ **Abra Jobs** e **clique** com o botão direito em **Job-1**. **Clique** em **Submit**. Se aparecer uma janela dizendo “Job files already exist for Job-1. OK to overwrite?”, **clique OK**. **Aguarde** o processamento dos dados. Estará

concluído quando aparecer “(Completed)” ao lado de **Job-1** no menu **model** à esquerda.

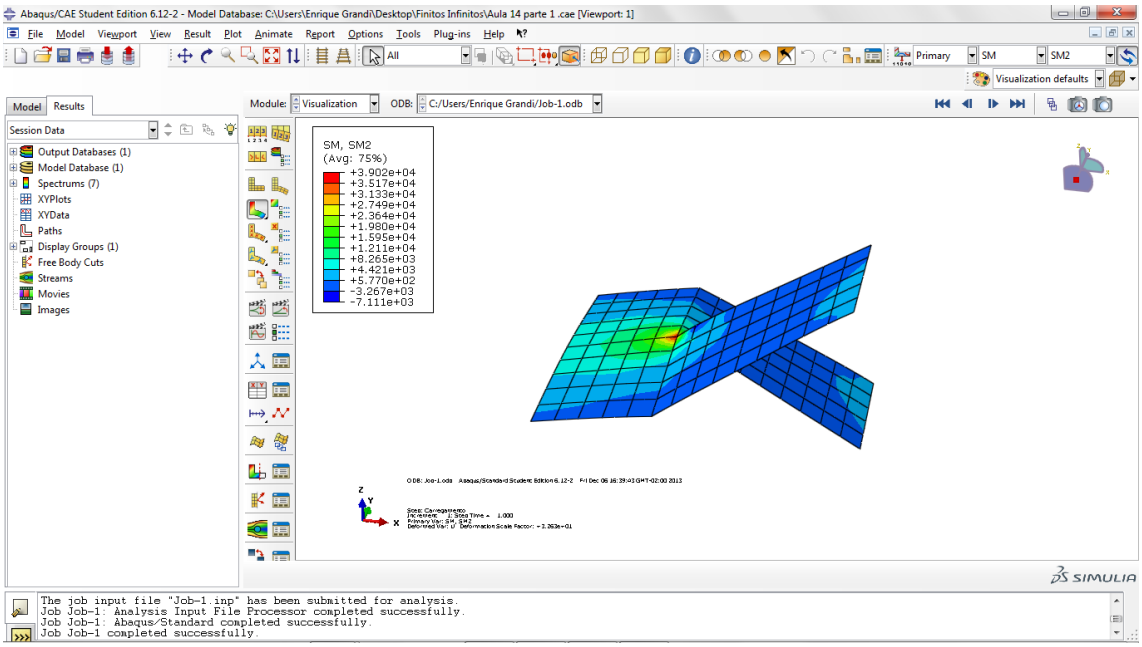



## 2.4. PÓS-PROCESSAMENTO

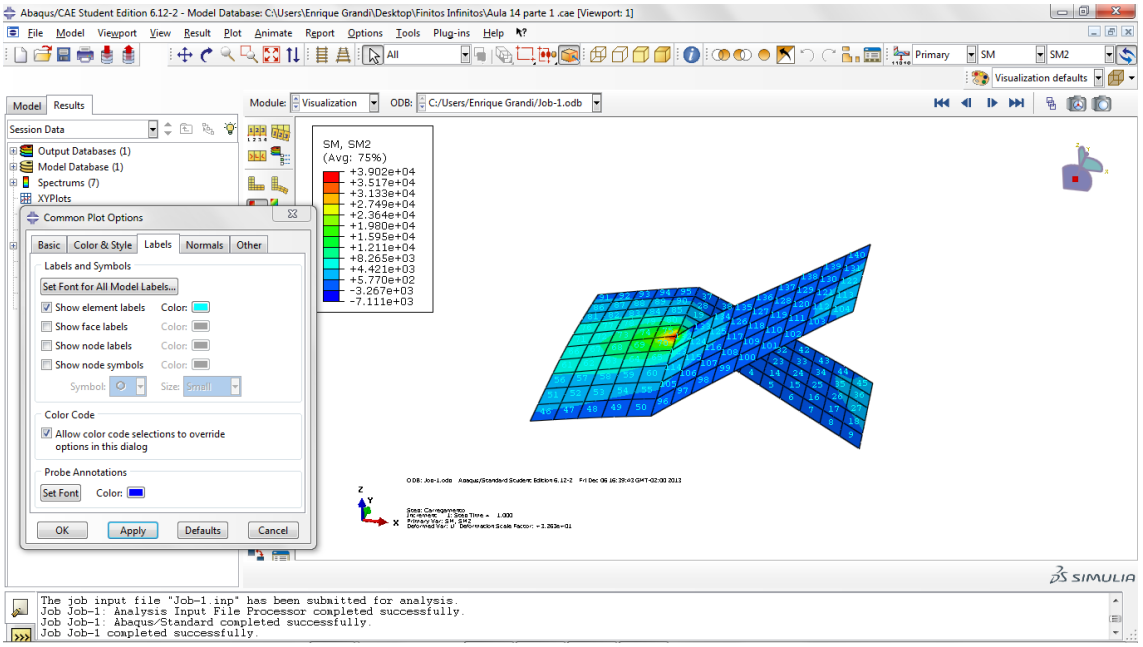
✓ No menu **model** à esquerda, **clique** com o botão direito em **Job-1(Completed)>Results**. A tela de análise de dados se abrirá. Na caixa de ferramentas, **clique** em **Plot Contours on Deformed Shape.**



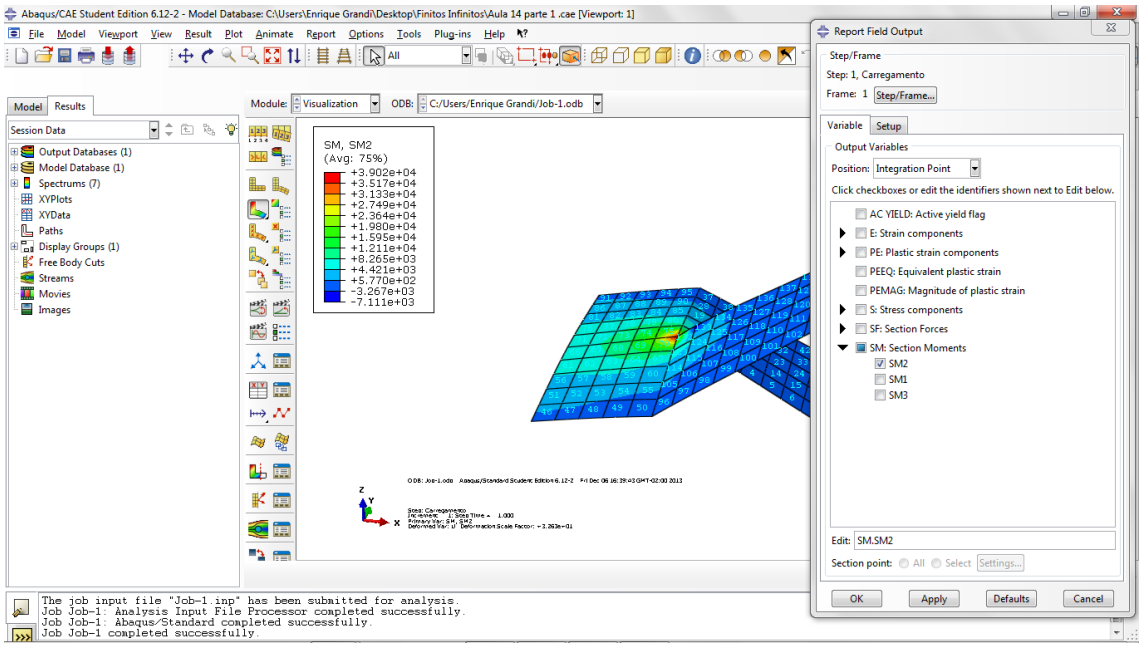
✓ Na barra de ferramentas no canto superior à direita, **selecione** **SM>SM2**. Na barra de menus principal, **clique** em **Viewport>Viewport Annotation Options**.... Na janela aberta, **selecione** a aba **Legend**. **Clique** em **Set Font**. Na nova janela, **altere** **Size** para *14*. **Clique** **OK** nas duas janelas abertas.




✓ Na caixa de ferramentas, **clique** em **Common Options.** Na guia **Labels** **marque** **Show element labels.** **Clique** em **OK.**



✓ Na barra de menu principal, **clique** em **Report>Field Output**. Na janela **Report Field Output**, **clique** em **SM: Section Moments > SM2** e **clique** em **Apply**. A mensagem aparecerá: “The field output report was appended to file “abaqus.rpt”.” O arquivo **abaqus.rpt** pode ser encontrado em C:\Users\”Nome do Usuário”\abaqus.rpt.




✓ **Repita** esse procedimento para obter os valores de **SM1, SM3 (torção)** e **U3.**

✓ Na barra do menu principal, **clique** em **File>Save As**.... **Dê** um nome ao arquivo e **clique** em **OK** (É possível também salvar o arquivo com os resultados já calculados - **job-1.odb**).

## 2.5. RESULTADOS:

abaqus - Bloco de notas

Arquivo Editar Formatar Exibir Ajuda

```
   Frame: Increment      1: Step Time =    1.000

Loc 1 : Integration point values from source 1

Output sorted by column "Element Label".

Field Output reported at integration points for region: ESTRUTURA-1.Region_1

         Element             Int          SM.SM2          SM.SM1          SM.SM3
           Label              Pt          @Loc 1          @Loc 1          @Loc 1
-------------------------------------------------------------------------------
              96               1        -43.7406     3.34979E+03         716.011
              96               2        -86.3168     3.69725E+03     1.16731E+03
              96               3        -226.366     4.32393E+03     1.06694E+03
              96               4        -230.622     4.08560E+03     1.93724E+03
              97               1        -140.819     3.26962E+03     1.32556E+03
              97               2        -93.0751     2.52609E+03     1.55894E+03
              97               3        -241.519     3.65549E+03     2.32736E+03
              97               4        -260.525     2.75318E+03     2.72195E+03
              98               1        -68.9229     1.84362E+03     1.69829E+03
              98               2        -64.5573         966.392     1.83095E+03
              98               3        -243.433     2.03586E+03     2.93024E+03
              98               4        -219.626     1.08208E+03     3.16186E+03
              99               1        -60.2950         380.104     1.91406E+03
              99               2        -50.3562        -222.526     2.00500E+03
              99               3        -200.601         479.152     3.27918E+03
              99               4        -183.635        -161.717     3.40457E+03
             100               1        -42.2553        -512.496     2.06120E+03
             100               2        -26.1840        -635.874     2.11058E+03
             100               3        -163.316        -464.712     3.46966E+03
             100               4        -128.318        -622.565     3.53291E+03
             101               1        -23.1832        -523.697     2.13991E+03
             101               2        -7.83503        -28.4819     2.13360E+03
             101               3        -85.6939        -525.007     3.54727E+03
             101               4         9.94637        -80.4268     3.52000E+03
             102               1         18.9282         587.596     2.11594E+03
             102               2         143.755     1.88357E+03     1.98320E+03
             102               3         83.0582         504.441     3.44782E+03
             102               4         237.463     1.68200E+03     3.27263E+03
             103               1         74.4700     3.14627E+03     1.92494E+03
             103               2        -12.9058     5.55668E+03     1.50825E+03
             103               3         406.675     2.89312E+03     2.99308E+03
             103               4         910.968     5.12935E+03     2.48993E+03
             104               1         329.276     7.92086E+03     1.15999E+03
             104               2     1.94915E+03     12.3864E+03         168.159
             104               3     1.17770E+03     7.27850E+03     1.84770E+03
             104               4     1.96540E+03     11.1589E+03         724.087
             105               1         213.260     5.38656E+03         809.992
             105               2        -84.8656     4.72681E+03     1.57681E+03
             105               3         672.676     6.68868E+03         871.034
             105               4         415.612     5.63984E+03     1.71598E+03
             106               1        -207.098     4.08405E+03     2.01512E+03
```

abaqus - Bloco de notas

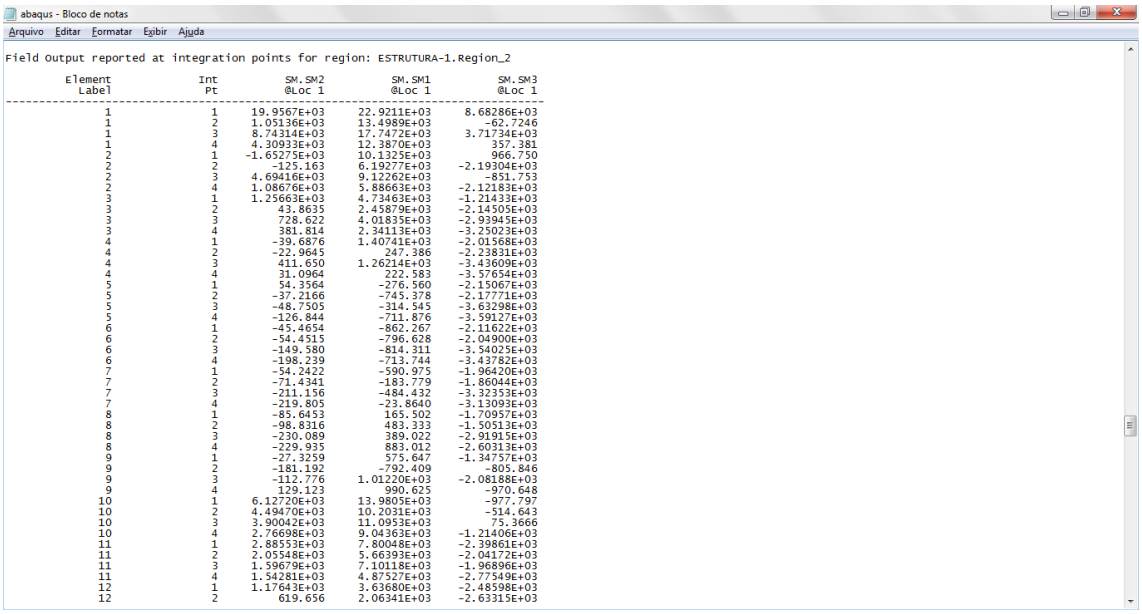
Arquivo Editar Formatar Exibir Ajuda

```
             131               2         785.781     4.23289E+03         693.117
             131               3         75.9017     1.83626E+03     1.57244E+03
             131               4         406.743     2.54770E+03         732.051
             132               1     8.74314E+03     17.7472E+03    -3.71734E+03
             132               2     4.30933E+03     12.3870E+03         -357.381
             132               3     19.9567E+03     22.9211E+03    -8.68286E+03
             132               4     1.05136E+03     13.4989E+03         62.7246
             133               1     4.69416E+03     9.12262E+03         851.752
             133               2     1.08676E+03     5.88663E+03     2.12183E+03
             133               3    -1.65275E+03     10.1325E+03         -966.750
             133               4        -125.163     6.19277E+03     2.19304E+03
             134               1         728.622     4.01835E+03     2.93945E+03
             134               2         381.814     2.34113E+03     3.25023E+03
             134               3     1.25663E+03     4.73463E+03     1.21433E+03
             134               4         43.8635     2.45879E+03     2.14505E+03
             135               1         411.650     1.26214E+03     3.43609E+03
             135               2         31.0964         222.583     3.57654E+03
             135               3        -39.6876     1.40741E+03     2.01568E+03
             135               4        -22.9645         247.386     2.23831E+03
             136               1        -48.7505        -314.545     3.63298E+03
             136               2        -126.844        -711.876     3.59127E+03
             136               3         54.3564        -276.560     2.15067E+03
             136               4        -37.2166        -745.378     2.17771E+03
             137               1        -149.580        -814.311     3.54025E+03
             137               2        -198.239        -713.744     3.43782E+03
             137               3        -45.4654        -862.267     2.11622E+03
             137               4        -54.4515        -796.628     2.04900E+03
             138               1        -211.156        -484.432     3.32353E+03
             138               2        -219.805        -23.8640     3.13093E+03
             138               3        -54.2422        -590.975     1.96420E+03
             138               4        -71.4341        -183.779     1.86044E+03
             139               1        -230.089         389.022     2.91915E+03
             139               2        -229.935         883.012     2.60313E+03
             139               3        -85.6453         165.502     1.70957E+03
             139               4        -98.8316         483.333     1.50513E+03
             140               1        -112.776     1.01220E+03     2.08188E+03
             140               2         129.124         990.625         970.648
             140               3        -27.3258         575.647     1.34757E+03
             140               4        -181.192        -792.409         805.846


 Minimum                          -1.65275E+03        -862.267    -8.68286E+03
     At Element                            133             137             132
         Int Pt                              3               3               3

 Maximum                           19.9567E+03     22.9211E+03     3.63298E+03
     At Element                            132             132             136
         Int Pt                              3               3               1

          Total                    96.2763E+03     477.250E+03     403.929E+03
```



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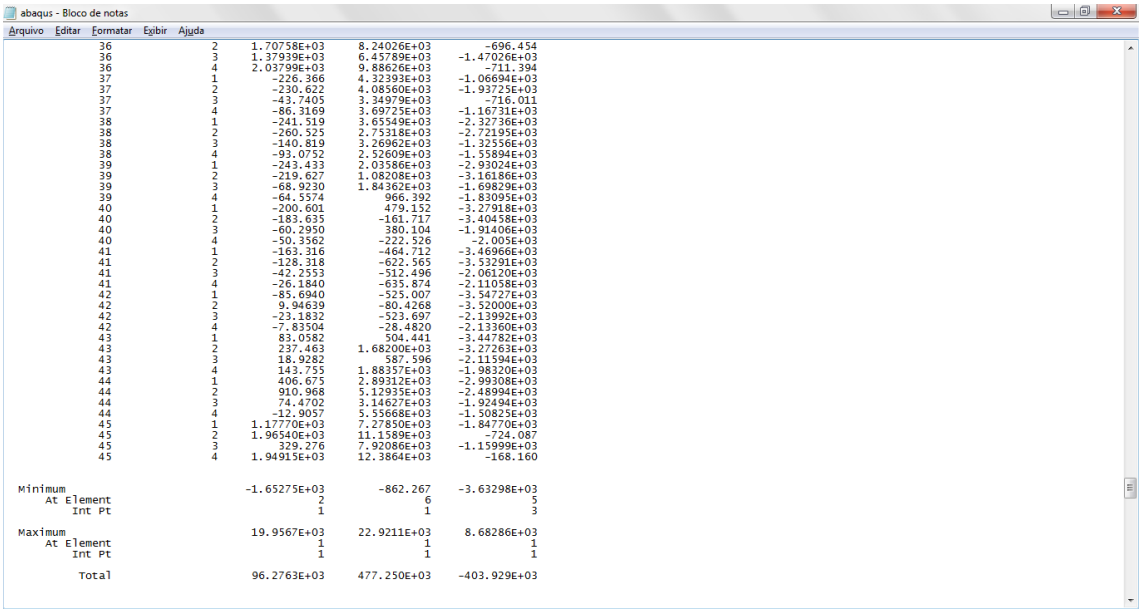
Arquivo Editar Formatar Exibir Ajuda

Field Output reported at integration points for region: ESTRUTURA-1.Region_2

| Element Label | Int Pt | SM.SM2 @Loc 1 | SM.SM1 @Loc 1 | SM.SM3 @Loc 1 |
|---|---|---|---|---|
| 1 | 1 | 19.9567E+03 | 22.9211E+03 | 8.68286E+03 |
| 1 | 2 | 1.05136E+03 | 13.4989E+03 | -62.7246 |
| 1 | 3 | 8.74314E+03 | 17.7472E+03 | 3.71734E+03 |
| 1 | 4 | 4.30933E+03 | 12.3870E+03 | 357.381 |
| 2 | 1 | -1.65275E+03 | 10.1325E+03 | 966.750 |
| 2 | 2 | -125.163 | 6.19277E+03 | -2.19304E+03 |
| 2 | 3 | 4.69416E+03 | 9.12262E+03 | -851.753 |
| 2 | 4 | 1.08676E+03 | 5.88663E+03 | -2.12183E+03 |
| 3 | 1 | 1.25663E+03 | 4.73463E+03 | -1.21433E+03 |
| 3 | 2 | 43.8635 | 2.45879E+03 | -2.14505E+03 |
| 3 | 3 | 728.622 | 4.01835E+03 | -2.93945E+03 |
| 3 | 4 | 381.814 | 2.34113E+03 | -3.25023E+03 |
| 4 | 1 | -39.6876 | 1.40741E+03 | -2.01568E+03 |
| 4 | 2 | -22.9645 | 247.386 | -2.23831E+03 |
| 4 | 3 | 411.650 | 1.26214E+03 | -3.43609E+03 |
| 4 | 4 | 31.0964 | 222.583 | -3.57654E+03 |
| 5 | 1 | 54.3564 | -276.560 | -2.15067E+03 |
| 5 | 2 | -37.2166 | -745.378 | -2.17771E+03 |
| 5 | 3 | -48.7505 | -314.545 | -3.63298E+03 |
| 5 | 4 | -126.844 | -711.876 | -3.59127E+03 |
| 6 | 1 | -45.4654 | -862.267 | -2.11622E+03 |
| 6 | 2 | -54.4515 | -796.628 | -2.04900E+03 |
| 6 | 3 | -149.580 | -814.311 | -3.54025E+03 |
| 6 | 4 | -198.239 | -713.744 | -3.43782E+03 |
| 7 | 1 | -54.2422 | -590.975 | -1.96420E+03 |
| 7 | 2 | -71.4341 | -183.779 | -1.86044E+03 |
| 7 | 3 | -211.156 | -484.432 | -3.32353E+03 |
| 7 | 4 | -219.805 | -23.8640 | -3.13093E+03 |
| 8 | 1 | -85.6453 | 165.502 | -1.70957E+03 |
| 8 | 2 | -98.8316 | 483.333 | -1.50513E+03 |
| 8 | 3 | -230.089 | 389.022 | -2.91915E+03 |
| 8 | 4 | -229.935 | 883.012 | -2.60313E+03 |
| 9 | 1 | -27.3259 | 575.647 | -1.34757E+03 |
| 9 | 2 | -181.192 | -792.409 | -805.846 |
| 9 | 3 | -112.776 | 1.01220E+03 | -2.08188E+03 |
| 9 | 4 | 129.123 | 990.625 | -970.648 |
| 10 | 1 | 6.12720E+03 | 13.9805E+03 | -977.797 |
| 10 | 2 | 4.49470E+03 | 10.2031E+03 | -514.643 |
| 10 | 3 | 3.90042E+03 | 11.0953E+03 | 75.3666 |
| 10 | 4 | 2.76698E+03 | 9.04363E+03 | -1.21406E+03 |
| 11 | 1 | 2.88553E+03 | 7.80048E+03 | -2.39861E+03 |
| 11 | 2 | 2.05548E+03 | 5.66393E+03 | -2.04172E+03 |
| 11 | 3 | 1.59679E+03 | 7.10118E+03 | -1.96896E+03 |
| 11 | 4 | 1.54281E+03 | 4.87527E+03 | -2.77549E+03 |
| 12 | 1 | 1.17643E+03 | 3.63680E+03 | -2.48598E+03 |
| 12 | 2 | 619.656 | 2.06341E+03 | -2.63315E+03 |



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Arquivo Editar Formatar Exibir Ajuda

| | | | | |
|---|---|---|---|---|
| 36 | 2 | 1.70758E+03 | 8.24026E+03 | -696.454 |
| 36 | 3 | 1.37939E+03 | 6.45789E+03 | -1.47026E+03 |
| 36 | 4 | 2.03799E+03 | 9.88626E+03 | -711.394 |
| 37 | 1 | -226.366 | 4.32393E+03 | -1.06694E+03 |
| 37 | 2 | -230.622 | 4.08560E+03 | -1.93725E+03 |
| 37 | 3 | -43.7405 | 3.34979E+03 | -716.011 |
| 37 | 4 | -86.3169 | 3.69725E+03 | -1.16731E+03 |
| 38 | 1 | -241.519 | 3.65549E+03 | -2.32736E+03 |
| 38 | 2 | -260.525 | 2.75318E+03 | -2.72195E+03 |
| 38 | 3 | -140.819 | 3.26962E+03 | -1.32556E+03 |
| 38 | 4 | -93.0752 | 2.52609E+03 | -1.55894E+03 |
| 39 | 1 | -243.433 | 2.03586E+03 | -2.93024E+03 |
| 39 | 2 | -219.627 | 1.08208E+03 | -3.16186E+03 |
| 39 | 3 | -68.9230 | 1.84362E+03 | -1.69829E+03 |
| 39 | 4 | -64.5574 | 966.392 | -1.83095E+03 |
| 40 | 1 | -200.601 | 479.152 | -3.27918E+03 |
| 40 | 2 | -183.635 | -161.717 | -3.40458E+03 |
| 40 | 3 | -60.2950 | 380.104 | -1.91406E+03 |
| 40 | 4 | -50.3562 | -222.526 | -2.0056E+03 |
| 41 | 1 | -163.316 | -464.712 | -3.46966E+03 |
| 41 | 2 | -128.318 | -622.565 | -3.53291E+03 |
| 41 | 3 | -42.2553 | -512.496 | -2.06120E+03 |
| 41 | 4 | -26.1840 | -635.874 | -2.11058E+03 |
| 42 | 1 | -85.6940 | -525.007 | -3.54727E+03 |
| 42 | 2 | 9.94639 | -80.4268 | -3.52000E+03 |
| 42 | 3 | -23.1832 | -523.697 | -2.13992E+03 |
| 42 | 4 | -7.83504 | -28.4820 | -2.13360E+03 |
| 43 | 1 | 83.0582 | 504.441 | -3.44782E+03 |
| 43 | 2 | 237.463 | 1.68200E+03 | -3.27263E+03 |
| 43 | 3 | 18.9282 | 587.596 | -2.11594E+03 |
| 43 | 4 | 143.755 | 1.88357E+03 | -1.98320E+03 |
| 44 | 1 | 406.675 | 2.89312E+03 | -2.99308E+03 |
| 44 | 2 | 910.968 | 5.12935E+03 | -2.48994E+03 |
| 44 | 3 | 74.4702 | 3.14627E+03 | -1.92494E+03 |
| 44 | 4 | -12.9057 | 5.55668E+03 | -1.50825E+03 |
| 45 | 1 | 1.17770E+03 | 7.27850E+03 | -1.84770E+03 |
| 45 | 2 | 1.96540E+03 | 11.1589E+03 | -724.087 |
| 45 | 3 | 329.276 | 7.92086E+03 | -1.15999E+03 |
| 45 | 4 | 1.94915E+03 | 12.3864E+03 | -168.160 |
| Minimum | | -1.65275E+03 | -862.267 | -3.63298E+03 |
| At Element | | 2 | 6 | 5 |
| Int Pt | | 1 | 1 | 3 |
| Maximum | | 19.9567E+03 | 22.9211E+03 | 8.68286E+03 |
| At Element | | 1 | 1 | 1 |
| Int Pt | | 1 | 1 | 1 |
| Total | | 96.2763E+03 | 477.250E+03 | -403.929E+03 |

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Arquivo Editar Formatar Exibir Ajuda

Field Output reported at integration points for region: ESTRUTURA-1.Region_3

| Element Label | Int Pt | SM.SM2 @Loc 1 | SM.SM1 @Loc 1 | SM.SM3 @Loc 1 |
|---|---|---|---|---|
| 46 | 1 | 157.522 | 142.228 | -162.586 |
| 46 | 2 | 137.324 | 731.675 | -385.604 |
| 46 | 3 | 844.386 | 119.657 | -370.111 |
| 46 | 4 | 761.432 | 638.682 | -793.587 |
| 47 | 1 | 94.0224 | 1.24316E+03 | -466.721 |
| 47 | 2 | 83.5065 | 1.95244E+03 | -608.546 |
| 47 | 3 | 671.121 | 1.14436E+03 | -899.828 |
| 47 | 4 | 593.082 | 1.89897E+03 | -1.16553E+03 |
| 48 | 1 | 63.7843 | 2.53505E+03 | -661.317 |
| 48 | 2 | 28.3942 | 3.27510E+03 | -700.002 |
| 48 | 3 | 507.073 | 2.51550E+03 | -1.26573E+03 |
| 48 | 4 | 370.632 | 3.36552E+03 | -1.32866E+03 |
| 49 | 1 | -11.7145 | 3.77371E+03 | -663.124 |
| 49 | 2 | -54.7060 | 4.17244E+03 | -529.128 |
| 49 | 3 | 240.511 | 3.92913E+03 | -1.27757E+03 |
| 49 | 4 | 77.6042 | 4.52022E+03 | -1.04761E+03 |
| 50 | 1 | -56.5905 | 4.28507E+03 | -409.776 |
| 50 | 2 | -140.626 | 3.49403E+03 | -14.2410 |
| 50 | 3 | -28.6644 | 4.66652E+03 | -725.787 |
| 50 | 4 | -129.279 | 4.51855E+03 | 112.792 |
| 51 | 1 | 1.47092E+03 | 73.1206 | -432.596 |
| 51 | 2 | 1.38168E+03 | 541.244 | -865.279 |
| 51 | 3 | 2.37806E+03 | 62.3351 | -550.383 |
| 51 | 4 | 2.33651E+03 | 462.229 | -1.09618E+03 |
| 52 | 1 | 1.29797E+03 | 1.05064E+03 | -916.622 |
| 52 | 2 | 1.17717E+03 | 1.83302E+03 | -1.18169E+03 |
| 52 | 3 | 2.27687E+03 | 932.459 | -1.16304E+03 |
| 52 | 4 | 2.19141E+03 | 1.76231E+03 | -1.53013E+03 |
| 53 | 1 | 1.06366E+03 | 2.51253E+03 | -1.28907E+03 |
| 53 | 2 | 870.567 | 3.46259E+03 | -1.38141E+03 |
| 53 | 3 | 2.09253E+03 | 2.50026E+03 | -1.67714E+03 |
| 53 | 4 | 1.91716E+03 | 3.62794E+03 | -1.83278E+03 |
| 54 | 1 | 701.522 | 4.16679E+03 | -1.32305E+03 |
| 54 | 2 | 470.069 | 4.92980E+03 | -1.04558E+03 |
| 54 | 3 | 1.72644E+03 | 4.57624E+03 | -1.80458E+03 |
| 54 | 4 | 1.37350E+03 | 5.60575E+03 | -1.51312E+03 |
| 55 | 1 | 352.708 | 5.29366E+03 | -695.679 |
| 55 | 2 | 202.592 | 5.51855E+03 | -12.6914 |
| 55 | 3 | 1.21147E+03 | 6.26853E+03 | -993.819 |
| 55 | 4 | 1.02935E+03 | 6.88635E+03 | -142.472 |
| 56 | 1 | 3.14150E+03 | 42.8232 | -585.135 |
| 56 | 2 | 3.13010E+03 | 377.560 | -1.16859E+03 |
| 56 | 3 | 4.18368E+03 | 10.4114 | -598.045 |
| 56 | 4 | 4.27043E+03 | 248.050 | -1.20689E+03 |
| 57 | 1 | 3.13337E+03 | 820.703 | -1.24814E+03 |
| 57 | 2 | 3.12005E+03 | 1.67174E+03 | -1.66230E+03 |
| 57 | 3 | 4.36422E+03 | 632.411 | -1.31778E+03 |

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Arquivo Editar Formatar Exibir Ajuda

| | | | | |
|---|---|---|---|---|
| 86 | 3 | 1.47092E+03 | 73.1206 | 432.596 |
| 86 | 4 | 1.38168E+03 | 541.244 | 865.279 |
| 87 | 1 | 2.27687E+03 | 932.459 | 1.16304E+03 |
| 87 | 2 | 2.19141E+03 | 1.76231E+03 | 1.53013E+03 |
| 87 | 3 | 1.29797E+03 | 1.05064E+03 | 916.621 |
| 87 | 4 | 1.17717E+03 | 1.83302E+03 | 1.18169E+03 |
| 88 | 1 | 2.09253E+03 | 2.50026E+03 | 1.67714E+03 |
| 88 | 2 | 1.91716E+03 | 3.62794E+03 | 1.83278E+03 |
| 88 | 3 | 1.06366E+03 | 2.51253E+03 | 1.28907E+03 |
| 88 | 4 | 870.566 | 3.46259E+03 | 1.38141E+03 |
| 89 | 1 | 1.72644E+03 | 4.57624E+03 | 1.80458E+03 |
| 89 | 2 | 1.3735E+03 | 5.60575E+03 | 1.51312E+03 |
| 89 | 3 | 701.521 | 4.16679E+03 | 1.32305E+03 |
| 89 | 4 | 470.069 | 4.92980E+03 | 1.04558E+03 |
| 90 | 1 | 1.21147E+03 | 6.26852E+03 | 993.819 |
| 90 | 2 | 1.02935E+03 | 6.88635E+03 | 142.472 |
| 90 | 3 | 352.707 | 5.29366E+03 | 695.679 |
| 90 | 4 | 202.591 | 5.51855E+03 | 12.6913 |
| 91 | 1 | 844.386 | 119.657 | 370.111 |
| 91 | 2 | 761.432 | 638.682 | 793.587 |
| 91 | 3 | 157.522 | 142.228 | 162.586 |
| 91 | 4 | 137.325 | 731.675 | 385.605 |
| 92 | 1 | 671.121 | 1.14436E+03 | 899.828 |
| 92 | 2 | 593.082 | 1.89897E+03 | 1.16553E+03 |
| 92 | 3 | 94.0227 | 1.24316E+03 | 466.721 |
| 92 | 4 | 83.5067 | 1.95244E+03 | 608.546 |
| 93 | 1 | 507.073 | 2.51550E+03 | 1.26573E+03 |
| 93 | 2 | 370.632 | 3.36552E+03 | 1.32866E+03 |
| 93 | 3 | 63.7845 | 2.53505E+03 | 661.317 |
| 93 | 4 | 28.3943 | 3.27510E+03 | 700.002 |
| 94 | 1 | 240.511 | 3.92913E+03 | 1.27757E+03 |
| 94 | 2 | 77.6042 | 4.52022E+03 | 1.04761E+03 |
| 94 | 3 | -11.7144 | 3.77371E+03 | 663.124 |
| 94 | 4 | -54.7060 | 4.17244E+03 | 529.129 |
| 95 | 1 | -28.6645 | 4.66652E+03 | 725.787 |
| 95 | 2 | -129.280 | 4.51855E+03 | -112.792 |
| 95 | 3 | -56.5905 | 4.28507E+03 | 409.776 |
| 95 | 4 | -140.626 | 3.49403E+03 | 14.2410 |
| | | | | |
| Minimum | | -140.626 | -191.196 | -6.72849E+03 |
| At Element | | 95 | 66 | 70 |
| Int Pt | | 4 | 4 | 2 |
| | | | | |
| Maximum | | 29.9042E+03 | 21.1641E+03 | 6.72849E+03 |
| At Element | | 75 | 70 | 75 |
| Int Pt | | 2 | 4 | 4 |
| | | | | |
| Total | | 941.525E+03 | 750.000E+03 | 1.40190E-03 |

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Arquivo Editar Formatar Exibir Ajuda

```
Field Output reported at nodes for part: ESTRUTURA-1

            Node            U.U3
           Label          @Loc 1
-------------------------------
               1    -931.223E-06
               2    -4.98584E-33
               3     2.26896E-33
               4    -5.32498E-03
               5    -11.9530E-03
               6    -5.32498E-03
               7    -11.9530E-03
               8     2.26896E-33
               9    -4.98584E-33
              10    -46.0077E-06
              11     191.908E-06
              12     208.641E-06
              13     138.152E-06
              14     66.7970E-06
              15     27.2103E-06
              16     17.0467E-06
              17     11.9130E-06
              18    -8.15042E-33
              19    -5.36838E-33
              20    -2.38608E-33
              21     254.741E-36
              22    -227.128E-06
              23    -739.765E-06
              24    -1.35646E-03
              25    -1.98669E-03
              26    -2.59452E-03
              27    -3.18698E-03
              28    -3.80357E-03
              29    -4.50140E-03
              30    -4.40040E-03
              31    -3.43609E-03
              32    -2.46094E-03
              33    -1.53961E-03
              34    -10.4418E-03
              35    -8.97680E-03
              36    -7.60751E-03
              37    -6.38299E-03
              38    -4.40040E-03
              39    -3.43609E-03
              40    -2.46094E-03
              41    -1.53961E-03
              42    -6.38299E-03
              43    -7.60751E-03
              44    -8.97680E-03
              45    -10.4418E-03
              46    -11.2143E-03
```

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Arquivo Editar Formatar Exibir Ajuda

```
             448    -117.781E-06
             449    -188.711E-06
             450    -7.21652E-33
             451    -29.1540E-06
             452    -1.33804E-03
             453    -1.16169E-03
             454    -1.00119E-03
             455    -717.570E-06
             456    -817.416E-06
             457    -525.340E-06
             458    -687.320E-06
             459    -440.773E-06
             460    -553.984E-06
             461    -382.075E-06
             462    -395.442E-06
             463    -304.642E-06
             464    -222.715E-06
             465    -200.959E-06
             466    -73.1554E-06
             467    -92.5868E-06
             468    -13.6721E-33
             469    -16.3026E-06
             470    -486.142E-06
             471    -399.537E-06
             472    -204.305E-06
             473     116.908E-06
             474    -134.740E-06
             475     218.297E-06
             476    -136.818E-06
             477     177.641E-06
             478    -139.804E-06
             479     99.7473E-06
             480    -114.076E-06
             481     42.6044E-06
             482    -64.8963E-06
             483     19.7534E-06
             484    -19.5807E-06
             485     15.3645E-06
             486    -18.6483E-33
             487     3.51749E-06


 Minimum             -11.953E-03
        At Node                7

 Maximum             218.297E-06
        At Node                475

          Total        -1.51905
```