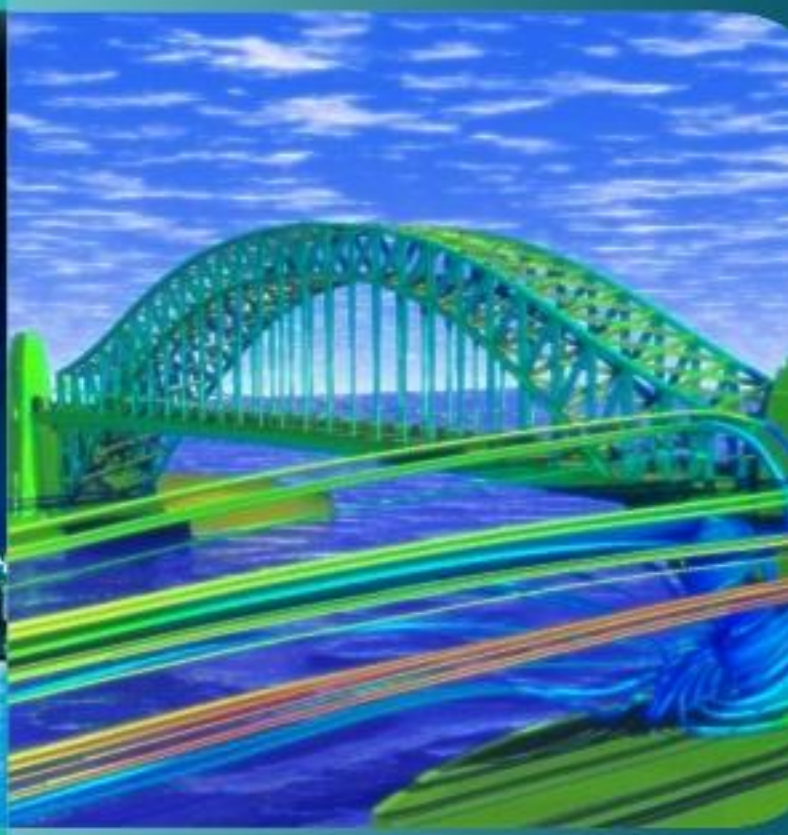
2010

Método dos Elementos Finitos Aplicados à Engenharia de Estruturas



Profª. Mildred B. Hecke
Universidade Federal do Paraná

Versão 1.0.0.0

INTRODUÇÃO AO ANSYS WORKBENCH - ANÁLISE DE UM IMPLANTE ORTODÔNTICO

INTRODUÇÃO AO ANSYS WORKBENCH – ANÁLISE DE UM IMPLANTE ORTODÔNTICO

INTRODUÇÃO

Este tutorial serve como um breve guia para a utilização do software de elementos finitos ANSYS WORKBENCH. Será realizada uma análise estática de um implante ortodôntico.

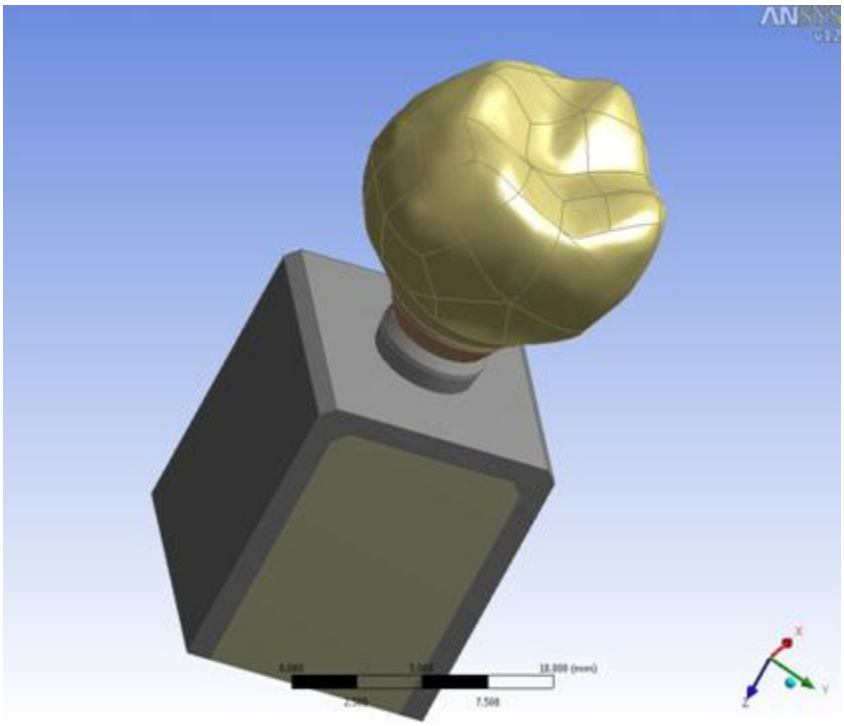


Figura 1 – Geometria do implante que será analisado.

A geometria do implante será importada de outro software em formato Parasolid e as propriedades dos materiais que constituem o modelo estão a seguir.

PROPRIEDADES DOS MATERIAIS

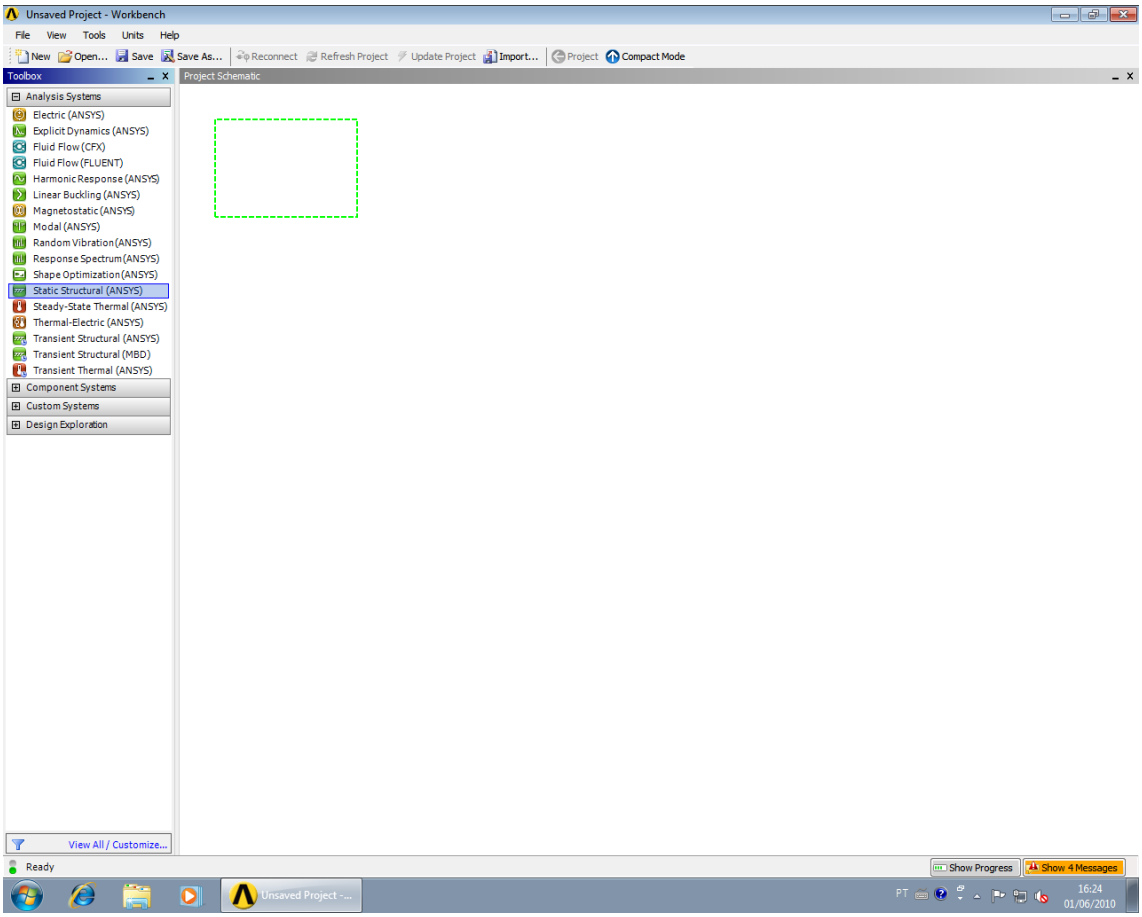
- Cimento:
  - Módulo de Elasticidade = 2.24E10 Pa;
  - Coeficiente de Poisson = 0.25;
  - Densidade = 2300 kg/m³;
- Guta Percha:
  - Módulo de Elasticidade = 6.9E5 Pa;
  - Coeficiente de Poisson = 0.45;
- Coping (liga cromo-cobalto):
  - Módulo de Elasticidade = 2.18E11 Pa;
  - Coeficiente de Poisson = 0.33;

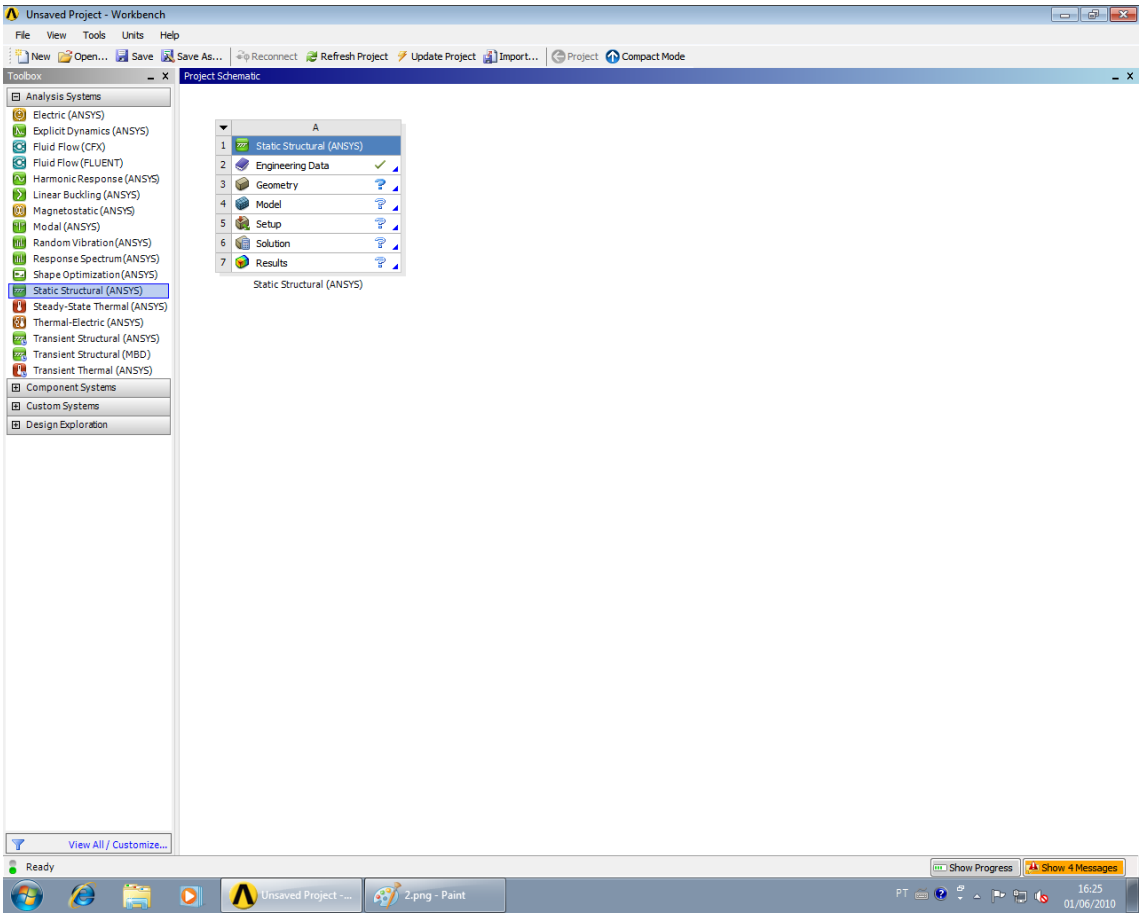
- Porcelana Feldspática:
  - Módulo de Elasticidade = 6.9E10 Pa;
  - Coeficiente de Poisson = 0.30;
- Titânio:
  - Módulo de Elasticidade = 1.1E11Pa;
  - Coeficiente de Poisson = 0.35;
- Osso trabecular:
  - Módulo de Elasticidade = 2.13E6 Pa;
  - Coeficiente de Poisson = 0.30;
- Osso Cortical (ortotrópico):
  - Módulo de Elasticidade (E_x) = 1.15E10 Pa;
  - Módulo de Elasticidade (E_y) = 1.15E10 Pa;
  - Módulo de Elasticidade (E_z) = 1.70E10 Pa;
  - Coeficiente de Poisson (v_{xy}) = 0.51;
  - Coeficiente de Poisson (v_{yz}) = 0.31;
  - Coeficiente de Poisson (v_{xz}) = 0.31;
  - Mód. Elasticidade Transversal (G_{xy}) = 3.6E9 Pa;
  - Mód. Elasticidade Transversal (G_{yz}) = 3.3E9 Pa;
  - Mód. Elasticidade Transversal (G_{xz}) = 3.3E9 Pa;

COMANDOS ANSYS®9.0ED

1. INÍCIO DA ANÁLISE

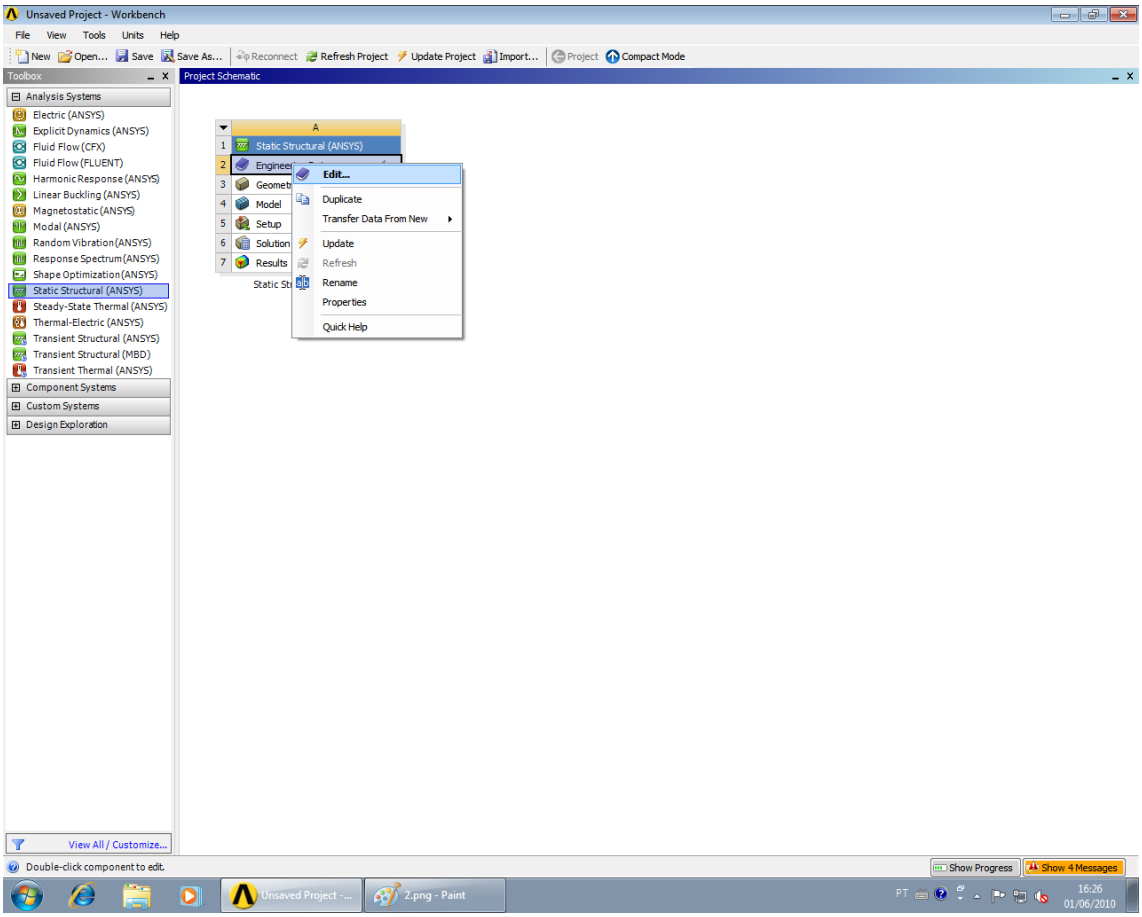
- ✓ O primeiro passo é escolher o tipo de análise que será executada;
- ✓ Deve-se inserir no ambiente de projeto do Ansys Workbench uma análise estática estrutural (Static Structural);
- ✓ Para isso, deve-se arrastar o ícone “Static Structural” para a área em branco da região “Project Schematic”;


Unsaved Project - Workbench
File View Tools Units Help
New Open... Save Save As... Reconnect Refresh Project Update Project Import... Project Compact Mode
Toolbox
Analysis Systems
Electric (ANSYS)
Explicit Dynamics (ANSYS)
Fluid Flow (CFX)
Fluid Flow (FLUENT)
Harmonic Response (ANSYS)
Linear Buckling (ANSYS)
Magnetostatic (ANSYS)
Modal (ANSYS)
Random Vibration (ANSYS)
Response Spectrum (ANSYS)
Shape Optimization (ANSYS)
Static Structural (ANSYS)
Steady-State Thermal (ANSYS)
Thermal-Electric (ANSYS)
Transient Structural (ANSYS)
Transient Structural (MBD)
Transient Thermal (ANSYS)
Component Systems
Custom Systems
Design Exploration
View All / Customize...
Project Schematic
Ready
Show Progress
Show 4 Messages
Unsaved Project -...
PT
16:24
01/06/2010

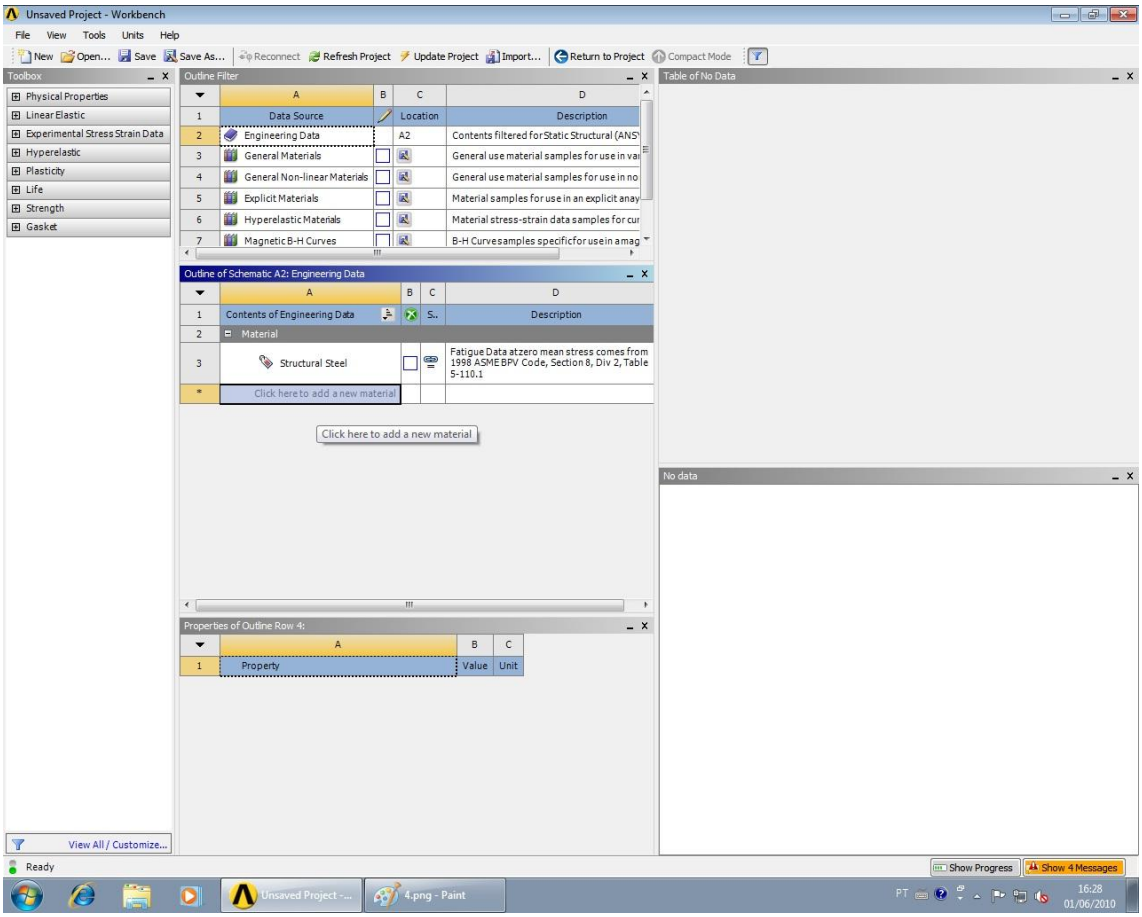


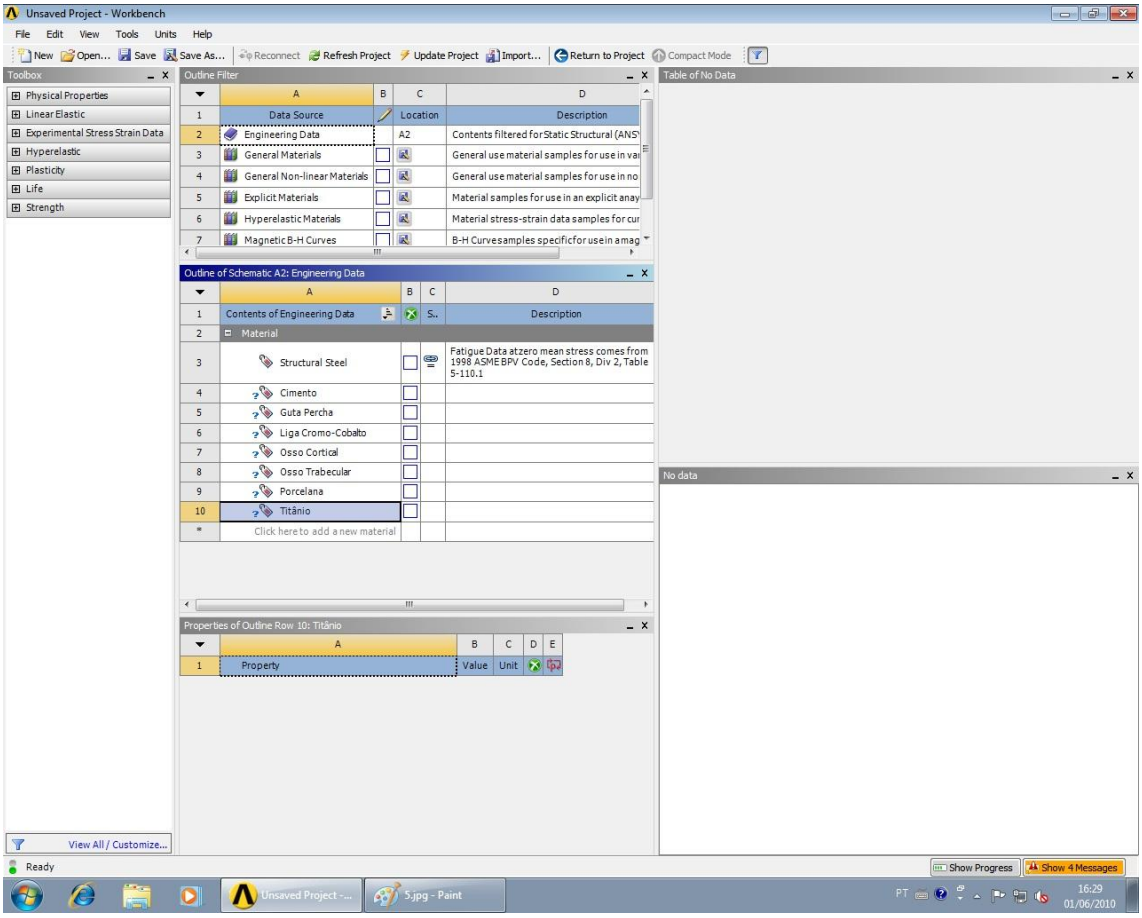
2. INSERIR MATERIAIS E ATRIBUIR SUAS PROPRIEDADES

- ✓ Um novo menu irá aparecer na área “Project Schematic”;
- ✓ Deve-se então clicar com o botão direito em “Engineering Data” e, logo após em “Edit”;



- ✓ Deve-se então clicar em “Click here to add a new material” no menu “Outline of Schematic A” e inserir os novos materiai;
- ✓ Inserir:
  - **Cimento;**
  - **Guta Percha;**
  - **Liga Cromo-Cobalto;**
  - **Osso Cortical;**
  - **Osso Trabecular;**
  - **Porcelana;**
  - **Titânio;**


Unsaved Project - Workbench
File View Tools Units Help
New Open... Save Save As... Reconnect Refresh Project Update Project Import... Return to Project Compact Mode
Toolbox
Physical Properties
Linear Elastic
Experimental Stress Strain Data
Hyperelastic
Plasticity
Life
Strength
Gasket
View All / Customize...
Outline Filter
Data Source
Location
Description
Engineering Data
A2
Contents filtered for Static Structural (ANS
General Materials
General use material samples for use in va
General Non-linear Materials
General use material samples for use in no
Explicit Materials
Material samples for use in an explicit anay
Hyperelastic Materials
Material stress-strain data samples for cu
Magnetic B-H Curves
B-H Curvesamples specificfor use in amag
Outline of Schematic A2: Engineering Data
Contents of Engineering Data
Material
Structural Steel
Fatigue Data atzero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
Click here to add a new material
Properties of Outline Row 4:
Property
Value
Unit
Table of No Data
No data
Ready
Show Progress
Show 4 Messages
Unsaved Project -...
4.png - Paint
16:28
01/06/2010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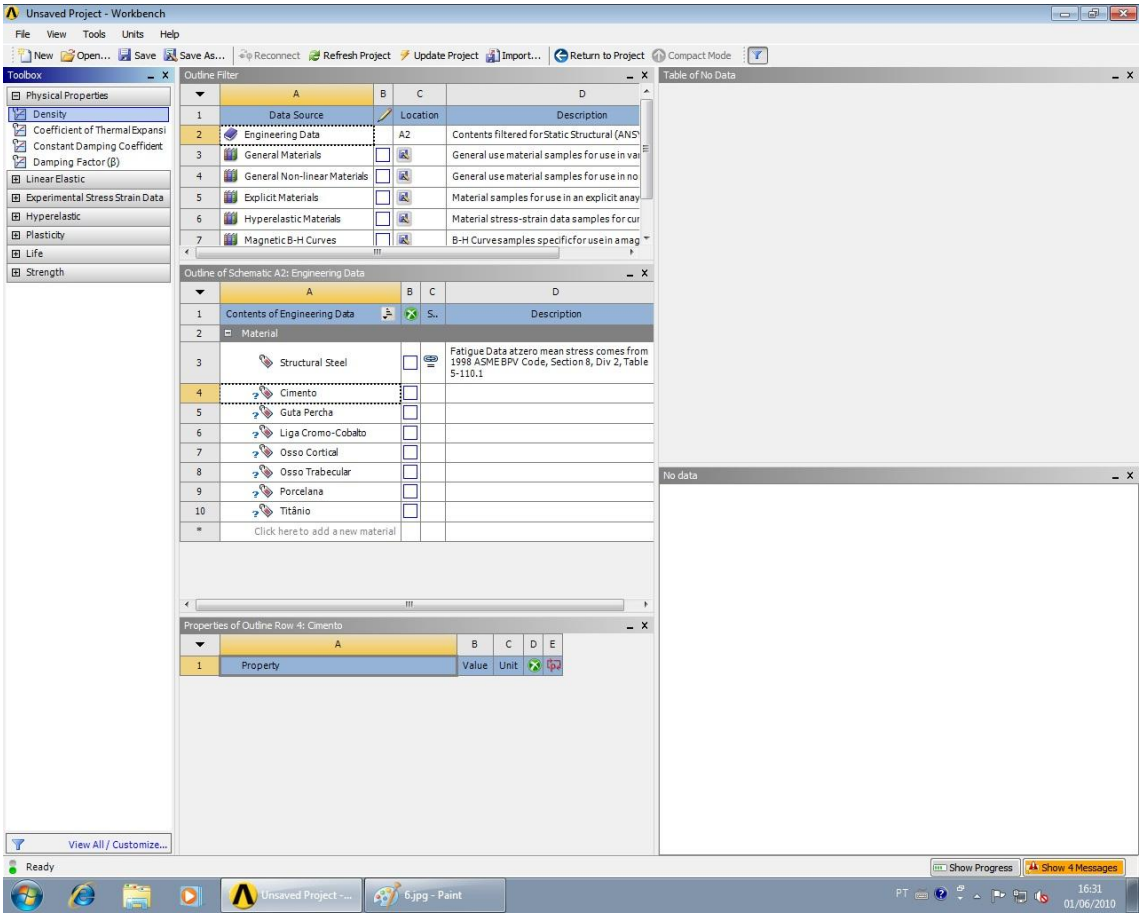
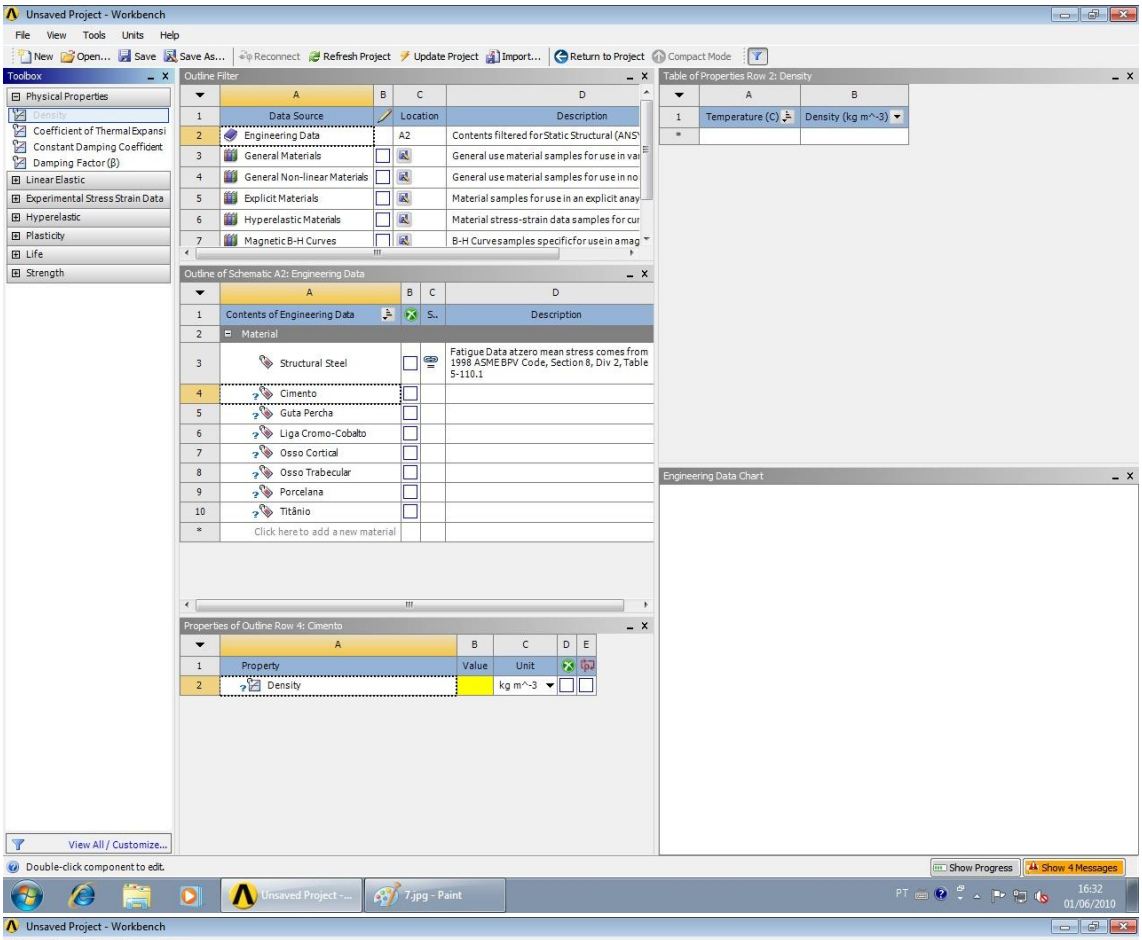
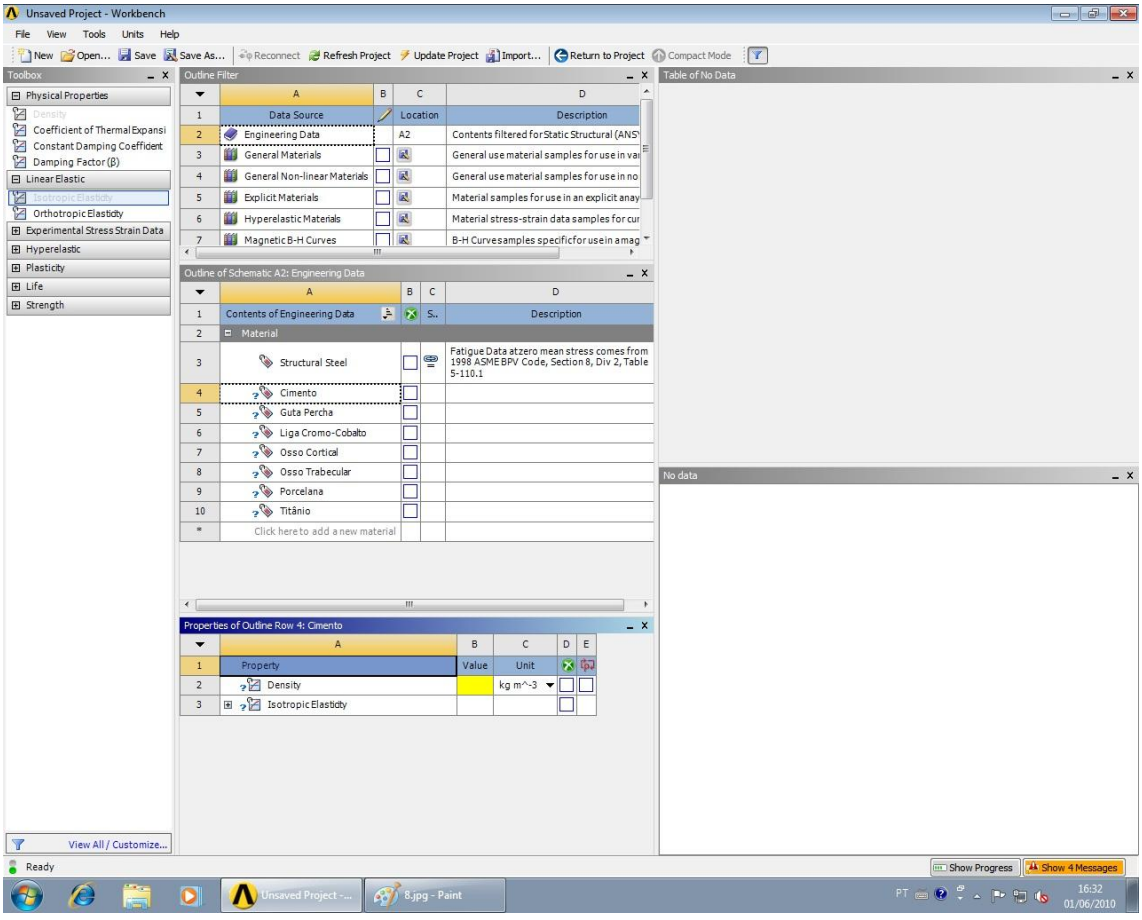
File Edit View Tools Units Help
New Open... Save Save As... Reconnect Refresh Project Update Project Import... Return to Project Compact Mode
Toolbox
Physical Properties
Linear Elastic
Experimental Stress Strain Data
Hyperelastic
Plasticity
Life
Strength
View All / Customize...
Outline Filter
Data Source
Location
Description
Engineering Data
A2
Contents filtered for Static Structural (ANS
General Materials
General use material samples for use in va
General Non-linear Materials
General use material samples for use in no
Explicit Materials
Material samples for use in an explicit anay
Hyperelastic Materials
Material stress-strain data samples for cu
Magnetic B-H Curves
B-H Curvesamples specificfor use in amag
Outline of Schematic A2: Engineering Data
Contents of Engineering Data
Material
Structural Steel
Fatigue Data atzero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
Cimento
Guta Percha
Liga Cromo-Cobalto
Osso Cortical
Osso Trabecular
Porcelana
Titânio
Click here to add a new material
Properties of Outline Row 10: Titânio
Property
Value
Unit
Table of No Data
No data
Ready
Show Progress
Show 4 Messages
Unsaved Project -...
5.jpg - Paint
16:29
01/06/2010

- ✓ Para cada material deve-se escolher quais propriedades físicas serão assumidas;
- ✓ Para isso, deve-se clicar no material criado, e arrastar do “Toolbox” até a região “Properties of Outline Row” os parâmetros físico que serão considerados para este material na análise;
- ✓ Para o **cimento** serão adicionados:
  - Density;
  - Isotropic Elasticity;



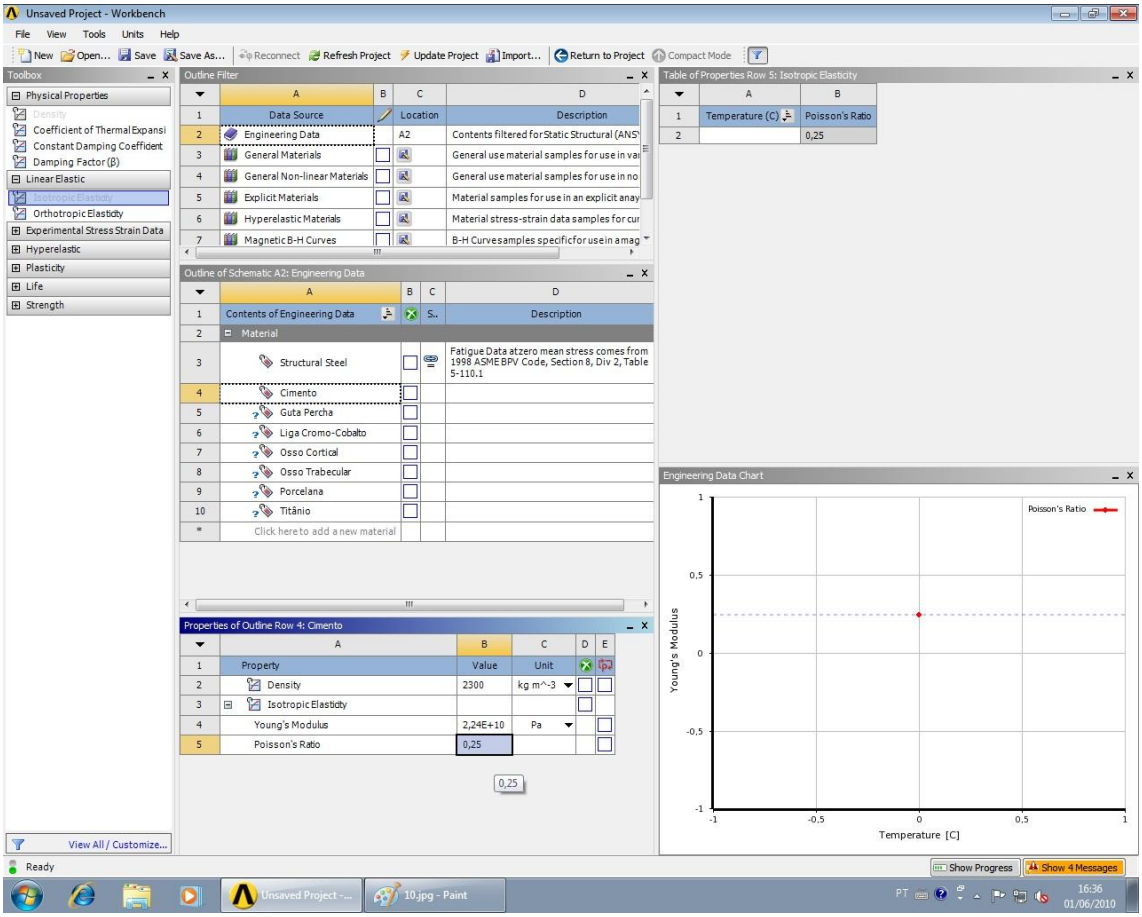

Unsaved Project - Workbench
File View Tools Units Help
New Open... Save Save As... Reconnect Refresh Project Update Project Import... Return to Project Compact Mode
Toolbox
Physical Properties
Density
Coefficient of Thermal Expansi
Constant Damping Coefficient
Damping Factor (β)
Linear Elastic
Experimental Stress Strain Data
Hyperelastic
Plasticity
Life
Strength
View All / Customize...
Outline Filter
Data Source
Location
Description
Engineering Data
A2
Contents filtered for Static Structural (ANS
General Materials
General use material samples for use in va
General Non-linear Materials
General use material samples for use in no
Explicit Materials
Material samples for use in an explicit anay
Hyperelastic Materials
Material stress-strain data samples for cu
Magnetic B-H Curves
B-H Curve samples specific for use in a mag
Table of Properties Row 2: Density
Temperature (C)
Density (kg m^-3)
Outline of Schematic A2: Engineering Data
Contents of Engineering Data
Material
Structural Steel
Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
Cimento
Guta Percha
Liga Cromo-Cobalto
Osso Cortical
Osso Trabecular
Porcelana
Titânio
Click here to add a new material
Engineering Data Chart
Properties of Outline Row 4: Cimento
Property
Value
Unit
Density
kg m^-3
Double-click component to edit.
Show Progress
Show 4 Messages
Unsaved Project -...
7.jpg - Paint
16:32
01/06/2010

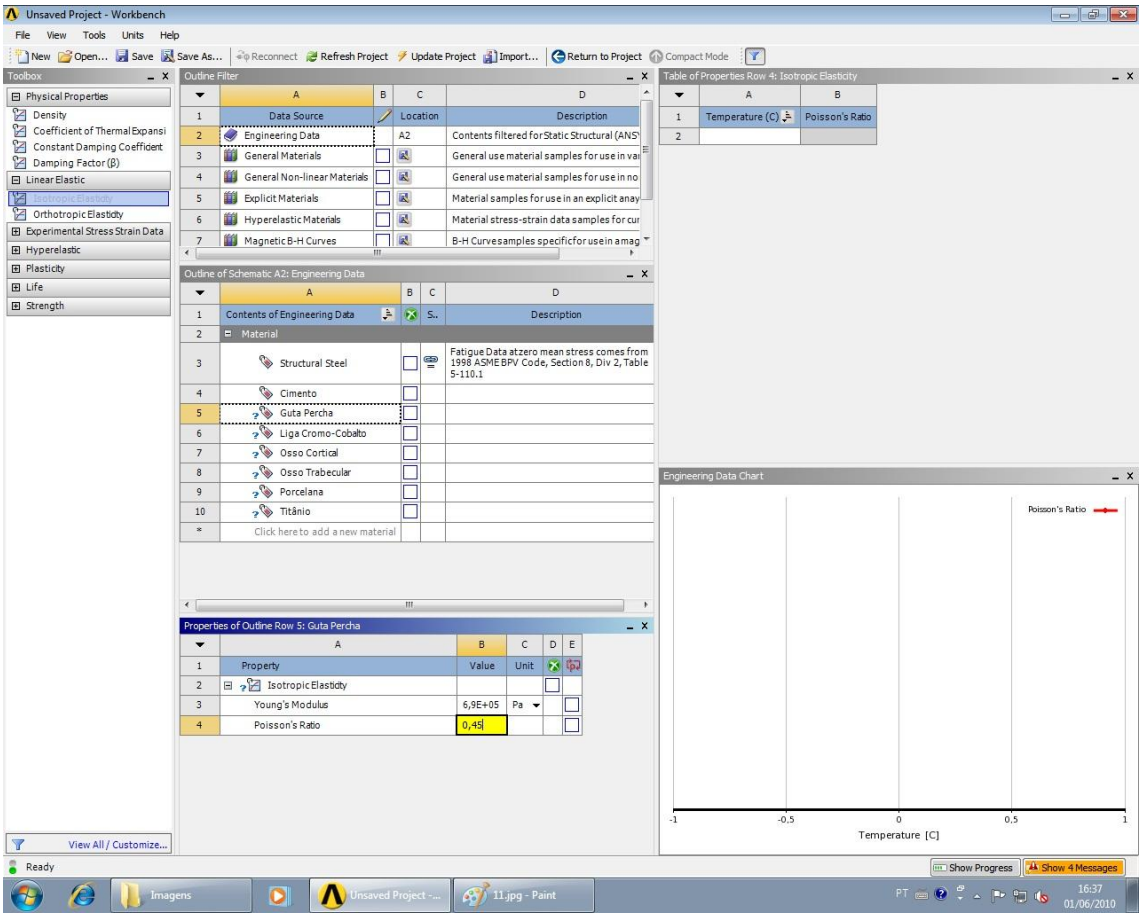

Unsaved Project - Workbench
File View Tools Units Help
New Open... Save Save As... Reconnect Refresh Project Update Project Import... Return to Project Compact Mode
Toolbox
Physical Properties
Density
Coefficient of Thermal Expansi
Constant Damping Coefficient
Damping Factor (β)
Linear Elastic
Isotropic Elasticity
Orthotropic Elasticity
Experimental Stress Strain Data
Hyperelastic
Plasticity
Life
Strength
View All / Customize...
Outline Filter
Data Source
Location
Description
Engineering Data
A2
Contents filtered for Static Structural (ANS
General Materials
General use material samples for use in va
General Non-linear Materials
General use material samples for use in no
Explicit Materials
Material samples for use in an explicit anay
Hyperelastic Materials
Material stress-strain data samples for cu
Magnetic B-H Curves
B-H Curve samples specific for use in a mag
Table of No Data
Outline of Schematic A2: Engineering Data
Contents of Engineering Data
Material
Structural Steel
Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
Cimento
Guta Percha
Liga Cromo-Cobalto
Osso Cortical
Osso Trabecular
Porcelana
Titânio
Click here to add a new material
No data
Properties of Outline Row 4: Cimento
Property
Value
Unit
Density
kg m^-3
Isotropic Elasticity
Ready
Show Progress
Show 4 Messages
Unsaved Project -...
8.jpg - Paint
16:32
01/06/2010

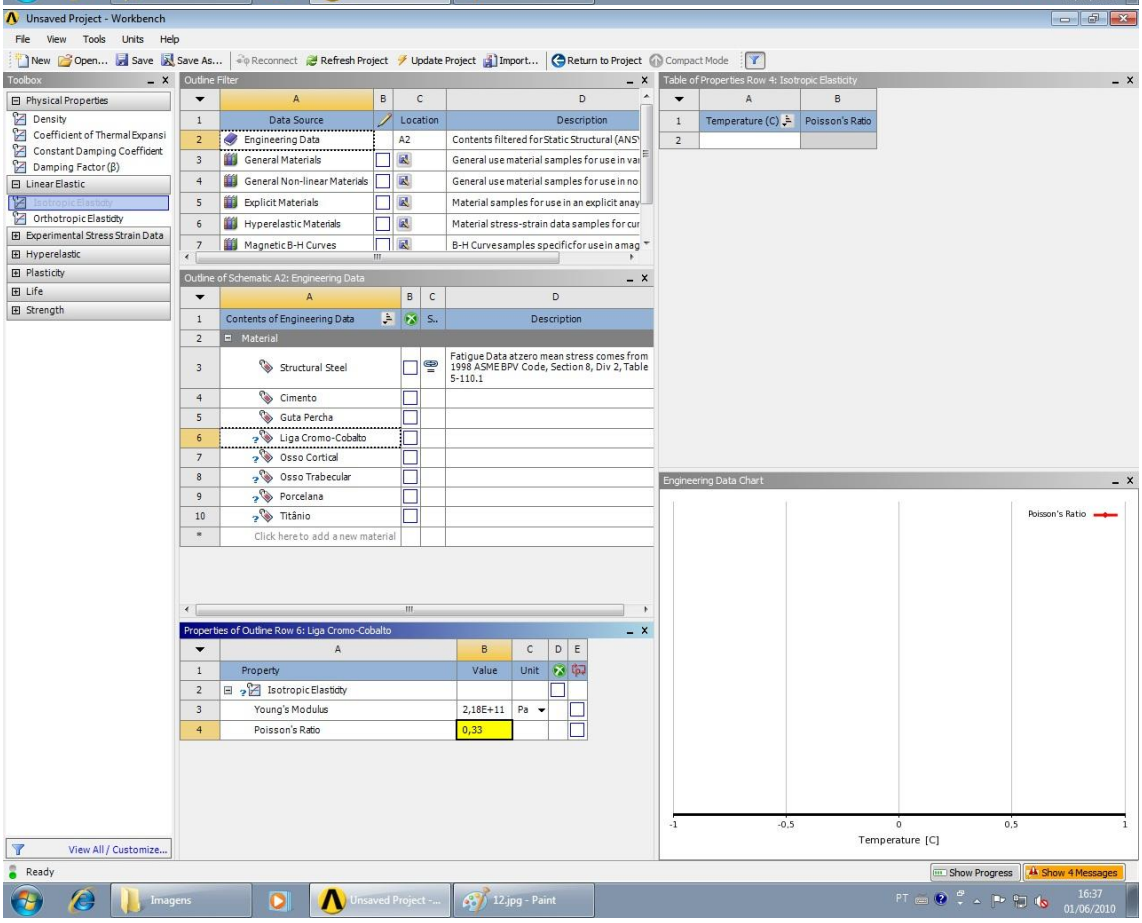
- ✓ Para os demais materiais deve-se inserir:
  - Guta Percha:
    - Isotropic Elasticity;
  - Liga Cromo-Cobalto:
    - Isotropic Elasticity;
  - Porcelana:
    - Isotropic Elasticity;
  - Titânio:
    - Isotropic Elasticity;
  - Osso Trabecular:
    - Isotropic Elasticity;
  - Osso Cortical:
    - Orthotropic Elasticity;
- ✓ Então deve-se clicar em cada material e inserir em "Properties of Outline Row" os valores das propriedades físicas adicionadas;
- ✓ Inserir:
  - Cimento:
    - Módulo de Elásticidade = 2.24E10 Pa;
    - Coeficiente de Poisson = 0.25;
    - Densidade = 2300 kg/m³;
  - Guta Percha:
    - Módulo de Elasticidade = 6.9E5 Pa;
    - Coeficiente de Poisson = 0.45;
  - Coping (liga cromo-cobalto):
    - Módulo de Elasticidade = 2.18E11 Pa;
    - Coeficiente de Poisson = 0.33;
  - Porcelana Feldspática:
    - Módulo de Elasticidade = 6.9E10 Pa;
    - Coeficiente de Poisson = 0.30;
  - Titânio:
    - Módulo de Elasticidade = 1.1E11Pa;
    - Coeficiente de Poisson = 0.35;
  - Osso trabecular:
    - Módulo de Elasticidade = 2.13E6 Pa;
    - Coeficiente de Poisson = 0.30;
  - Osso Cortical (ortotrópico):
    - Módulo de Elasticidade (E_x) = 1.15E10 Pa;
    - Módulo de Elasticidade (E_y) = 1.15E10 Pa;
    - Módulo de Elasticidade (E_z) = 1.70E10 Pa;
    - Coeficiente de Poisson (v_{xy}) = 0.51;
    - Coeficiente de Poisson (v_{yz}) = 0.31;
    - Coeficiente de Poisson (v_{xz}) = 0.31;
    - Mód. Elasticidade Transversal (G_{xy}) = 3.6E9 Pa;
    - Mód. Elasticidade Transversal (G_{yz}) = 3.3E9 Pa;

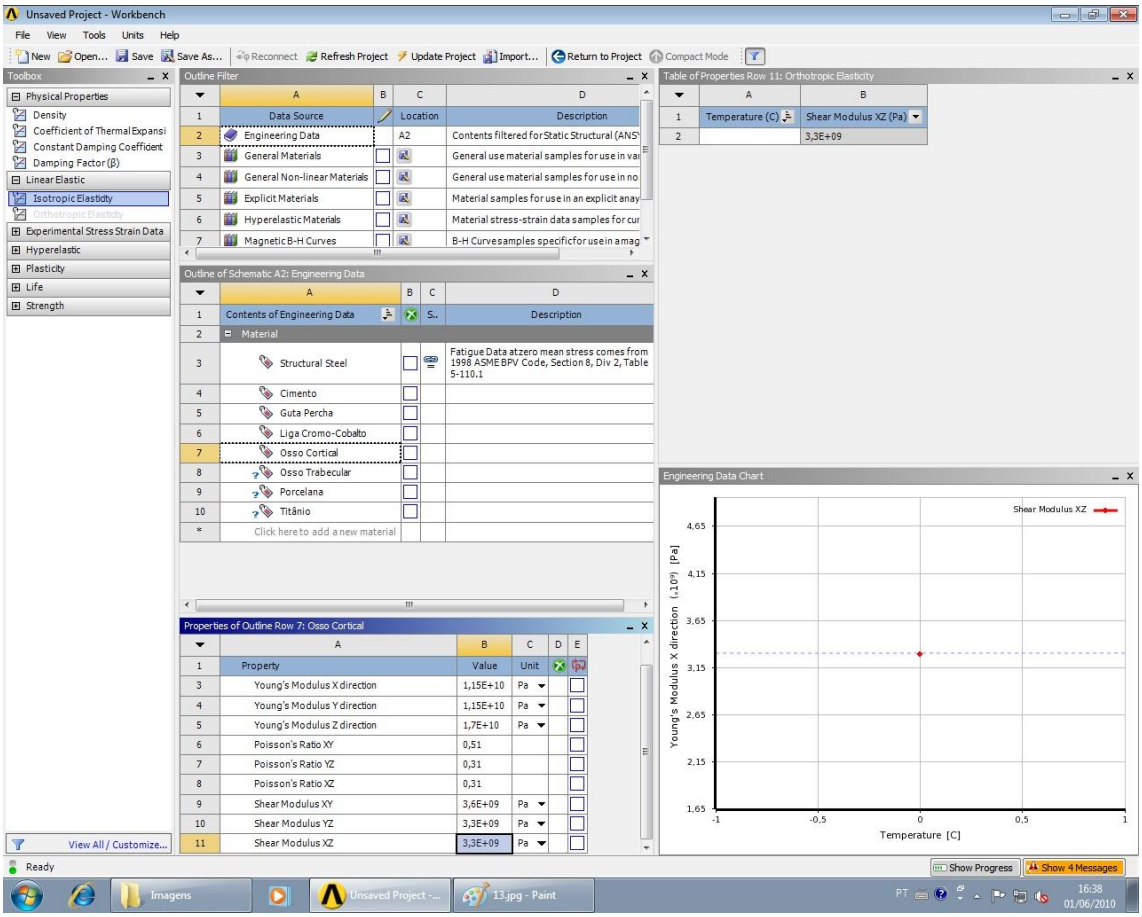
- Mód. Elasticidade Transversal (G_{xz}) = 3.3E9 Pa;

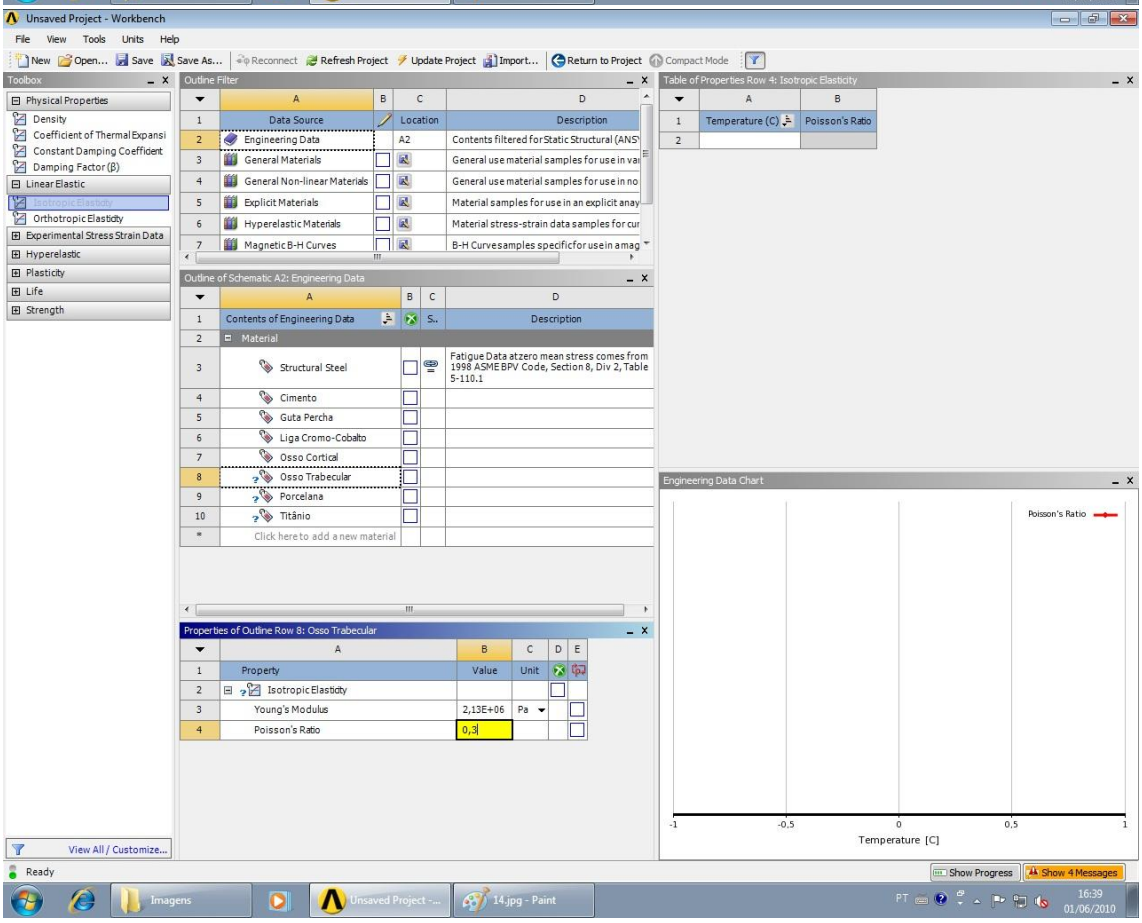
✓ Deve-se tormar cuidado com as unidades;




Unsaved Project - Workbench
Outline Filter
Table of Properties Row 4: Isotropic Elasticity
Outline of Schematic A2: Engineering Data
Properties of Outline Row 5: Guta Percha
Engineering Data Chart
Poisson's Ratio
Temperature [C]
Ready


Unsaved Project - Workbench
Outline Filter
Table of Properties Row 4: Isotropic Elasticity
Outline of Schematic A2: Engineering Data
Properties of Outline Row 6: Liga Cromo-Cobalto
Engineering Data Chart
Poisson's Ratio
Temperature [C]
Ready


Unsaved Project - Workbench
File View Tools Units Help
New Open... Save Save As... Reconnect Refresh Project Update Project Import... Return to Project Compact Mode
Toolbox
Physical Properties
Density
Coefficient of Thermal Expansi
Constant Damping Coefficient
Damping Factor (β)
Linear Elastic
Isotropic Elasticity
Orthotropic Elasticity
Experimental Stress Strain Data
Hyperelastic
Plasticity
Life
Strength
View All / Customize...
Outline Filter
Data Source | Location | Description
Engineering Data | A2 | Contents filtered for Static Structural (ANS
General Materials | General use material samples for use in va
General Non-linear Materials | General use material samples for use in no
Explicit Materials | Material samples for use in an explicit anay
Hyperelastic Materials | Material stress-strain data samples for cu
Magnetic B-H Curves | B-H Curve samples specific for use in a mag
Outline of Schematic A2: Engineering Data
Contents of Engineering Data | Description
Material
Structural Steel | Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
Cimento
Guta Percha
Liga Cromo-Cobalto
Osso Cortical
Osso Trabecular
Porcelana
Titânio
Click here to add a new material
Properties of Outline Row 7: Osso Cortical
Property | Value | Unit
Young's Modulus X direction | 1,15E+10 | Pa
Young's Modulus Y direction | 1,15E+10 | Pa
Young's Modulus Z direction | 1,7E+10 | Pa
Poisson's Ratio XY | 0,51
Poisson's Ratio YZ | 0,31
Poisson's Ratio XZ | 0,31
Shear Modulus XY | 3,6E+09 | Pa
Shear Modulus YZ | 3,3E+09 | Pa
Shear Modulus XZ | 3,3E+09 | Pa
Table of Properties Row 11: Orthotropic Elasticity
Temperature (C) | Shear Modulus XZ (Pa)
3,3E+09
Engineering Data Chart
Shear Modulus XZ
Young's Modulus X direction (...10⁹) [Pa]
4,65
4,15
3,65
3,15
2,65
2,15
1,65
-1
-0,5
0
0,5
1
Temperature [C]
Ready
Show Progress
Show 4 Messages
Imagens
Unsaved Project -...
13.jpg - Paint
PT
16:38
01/06/2010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File View Tools Units Help
New Open... Save Save As... Reconnect Refresh Project Update Project Import... Return to Project Compact Mode
Toolbox
Physical Properties
Density
Coefficient of Thermal Expansi
Constant Damping Coefficient
Damping Factor (β)
Linear Elastic
Isotropic Elasticity
Orthotropic Elasticity
Experimental Stress Strain Data
Hyperelastic
Plasticity
Life
Strength
View All / Customize...
Outline Filter
Data Source | Location | Description
Engineering Data | A2 | Contents filtered for Static Structural (ANS
General Materials | General use material samples for use in va
General Non-linear Materials | General use material samples for use in no
Explicit Materials | Material samples for use in an explicit anay
Hyperelastic Materials | Material stress-strain data samples for cu
Magnetic B-H Curves | B-H Curve samples specific for use in a mag
Outline of Schematic A2: Engineering Data
Contents of Engineering Data | Description
Material
Structural Steel | Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
Cimento
Guta Percha
Liga Cromo-Cobalto
Osso Cortical
Osso Trabecular
Porcelana
Titânio
Click here to add a new material
Properties of Outline Row 8: Osso Trabecular
Property | Value | Unit
Isotropic Elasticity
Young's Modulus | 2,13E+06 | Pa
Poisson's Ratio | 0,3
Table of Properties Row 4: Isotropic Elasticity
Temperature (C) | Poisson's Ratio
Engineering Data Chart
Poisson's Ratio
-1
-0,5
0
0,5
1
Temperature [C]
Ready
Show Progress
Show 4 Messages
Imagens
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14.jpg - Paint
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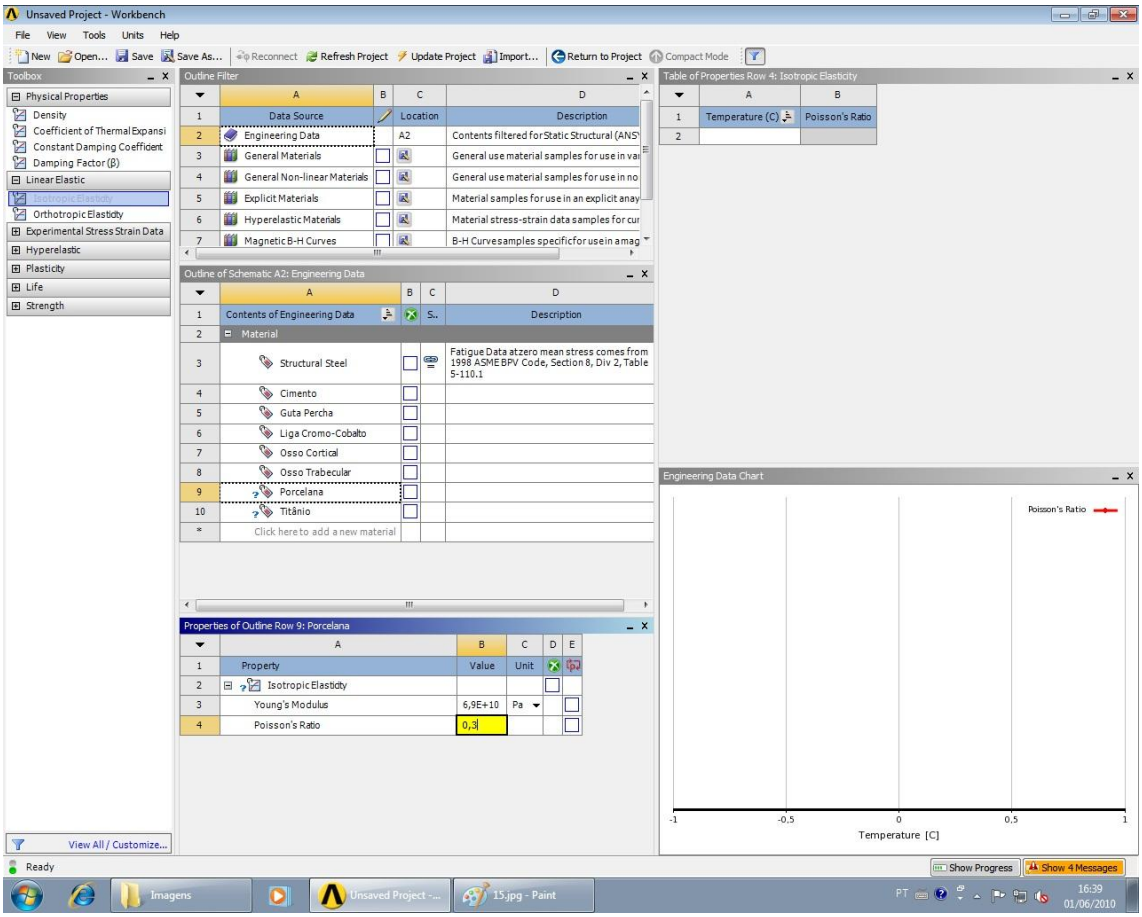
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Physical Properties
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Coefficient of Thermal Expansi
Constant Damping Coefficient
Damping Factor (β)
Linear Elastic
Isotropic Elasticity
Orthotropic Elasticity
Experimental Stress Strain Data
Hyperelastic
Plasticity
Life
Strength
View All / Customize...
Outline Filter
Data Source
Location
Description
Engineering Data
General Materials
General Non-linear Materials
Explicit Materials
Hyperelastic Materials
Magnetic B-H Curves
Outline of Schematic A2: Engineering Data
Contents of Engineering Data
Material
Structural Steel
Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
Cimento
Guta Percha
Liga Cromo-Cobalto
Osso Cortical
Osso Trabecular
Porcelana
Titânio
Click here to add a new material
Properties of Outline Row 9: Porcelana
Property
Value
Unit
Isotropic Elasticity
Young's Modulus
6,9E+10
Pa
Poisson's Ratio
0,3
Table of Properties Row 4: Isotropic Elasticity
Temperature (C)
Poisson's Ratio
Engineering Data Chart
Poisson's Ratio
-1
-0,5
0
0,5
1
Temperature [C]
Ready
Show Progress
Show 4 Messages
Imagens
Unsaved Project -...
15.jpg - Paint
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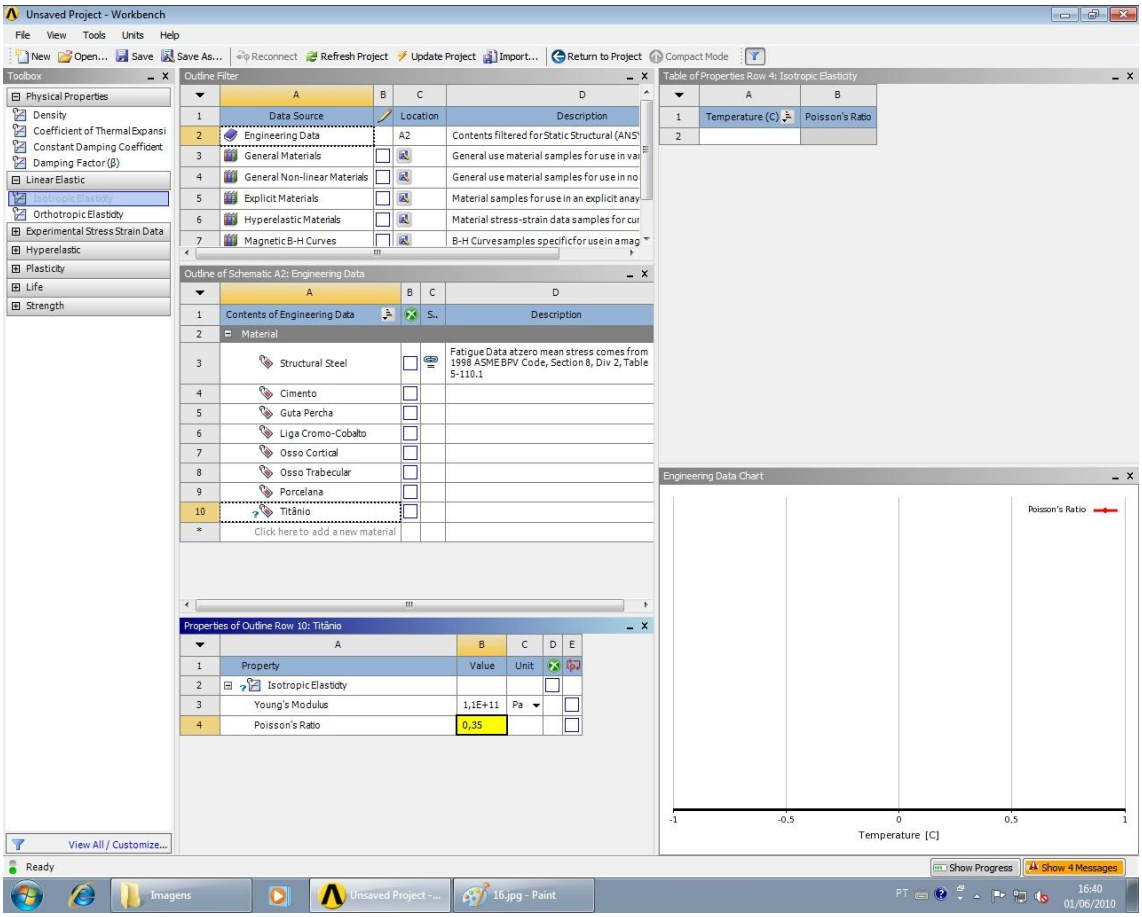
16:39
01/06/2010


Unsaved Project - Workbench
File View Tools Units Help
New Open... Save Save As... Reconnect Refresh Project Update Project Import... Return to Project Compact Mode
Toolbox
Physical Properties
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Coefficient of Thermal Expansi
Constant Damping Coefficient
Damping Factor (β)
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Orthotropic Elasticity
Experimental Stress Strain Data
Hyperelastic
Plasticity
Life
Strength
View All / Customize...
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Data Source
Location
Description
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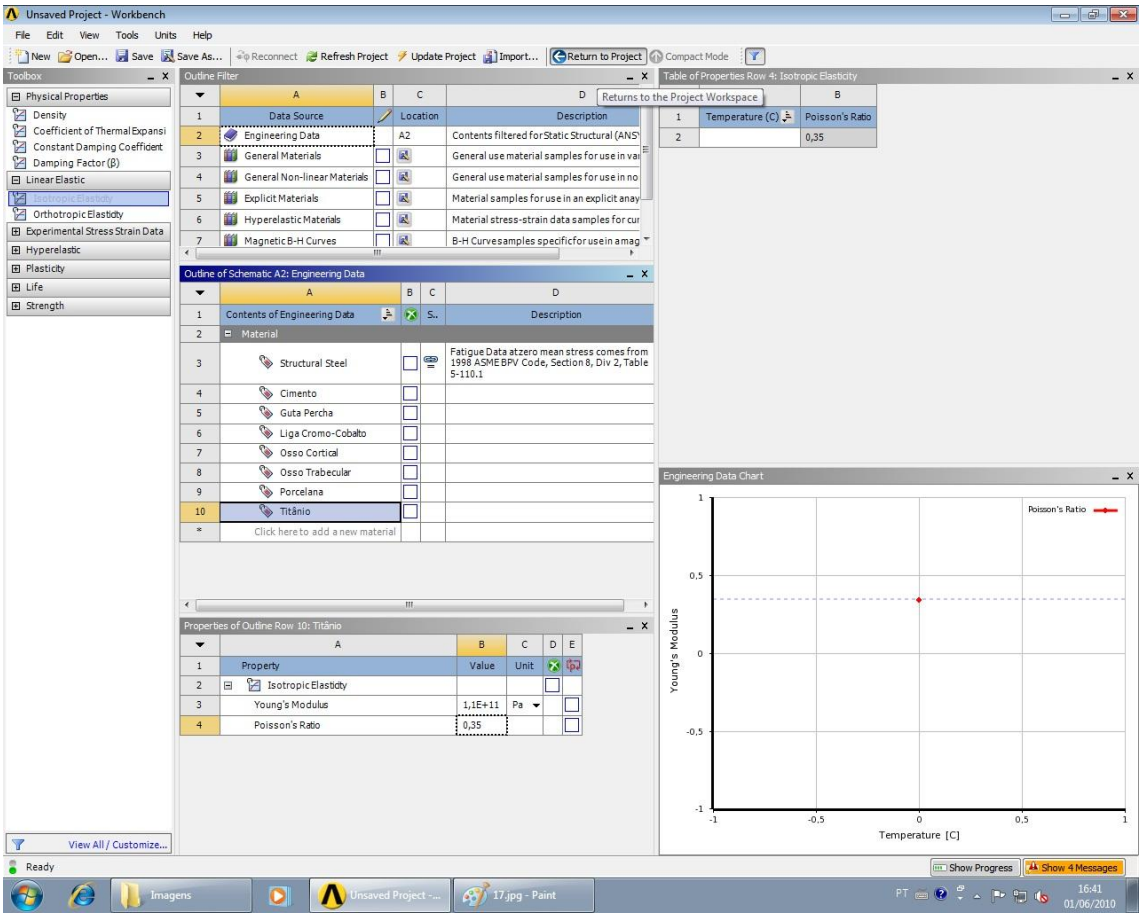
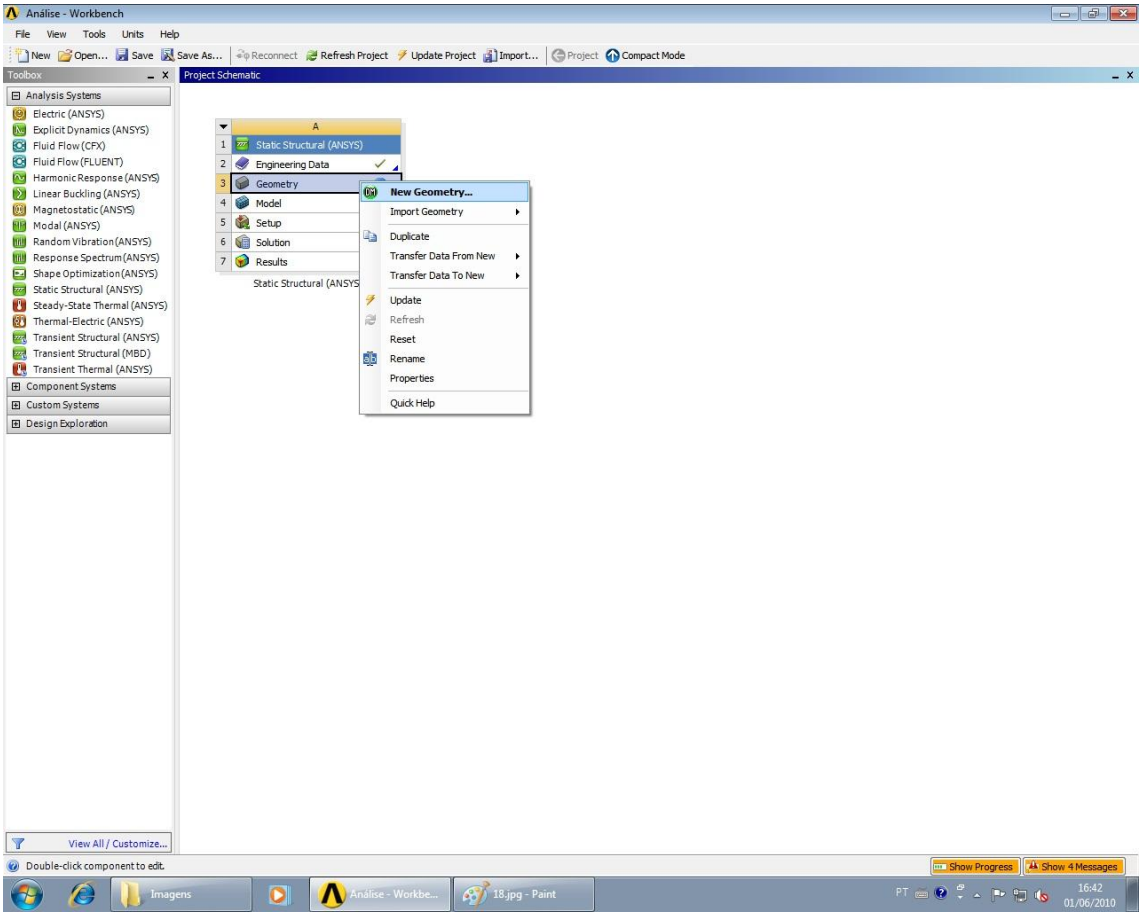
Contents filtered for Static Structural (ANS
General Materials
General use material samples for use in va
General Non-linear Materials
General use material samples for use in no
Explicit Materials
Material samples for use in an explicit anay
Hyperelastic Materials
Material stress-strain data samples for cu
Magnetic B-H Curves
B-H Curves samples specific for use in amag
Table of Properties Row 4: Isotropic Elasticity
Temperature (C)
Poisson's Ratio
Outline of Schematic A2: Engineering Data
Contents of Engineering Data
Description
Material
Structural Steel
Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
Cimento
Guta Percha
Liga Cromo-Cobalto
Osso Cortical
Osso Trabecular
Porcelana
Titânio
Click here to add a new material
Properties of Outline Row 10: Titânio
Property
Value
Unit
Isotropic Elasticity
Young's Modulus
1,1E+11
Pa
Poisson's Ratio
0,35
Engineering Data Chart
Poisson's Ratio
-1
-0,5
0
0,5
1
Temperature [C]
Ready
Show Progress
Show 4 Messages
Imagens
Unsaved Project -...
16.jpg - Paint
PT
16:40
01/06/2010

✓ Clicar então em “Return to Project”;

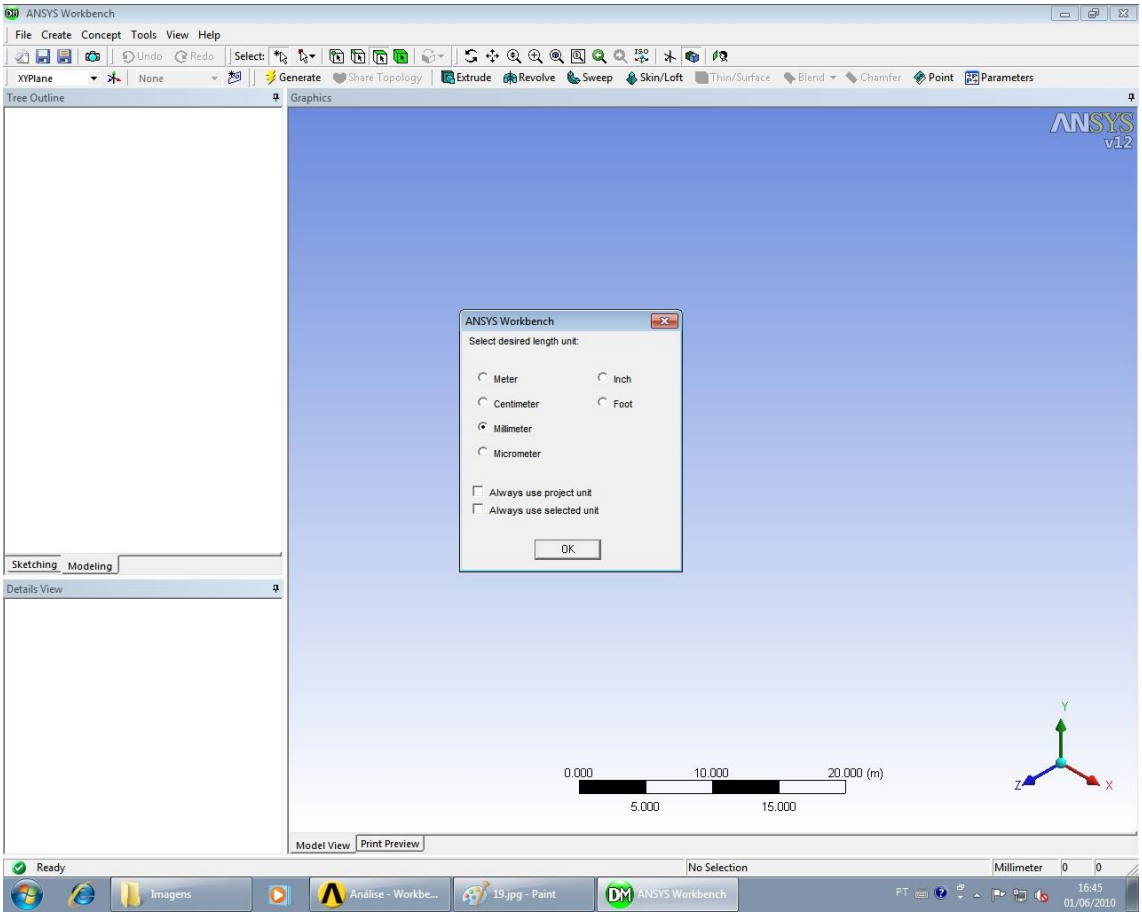


3. IMPORTANTO A GEOMETRIA

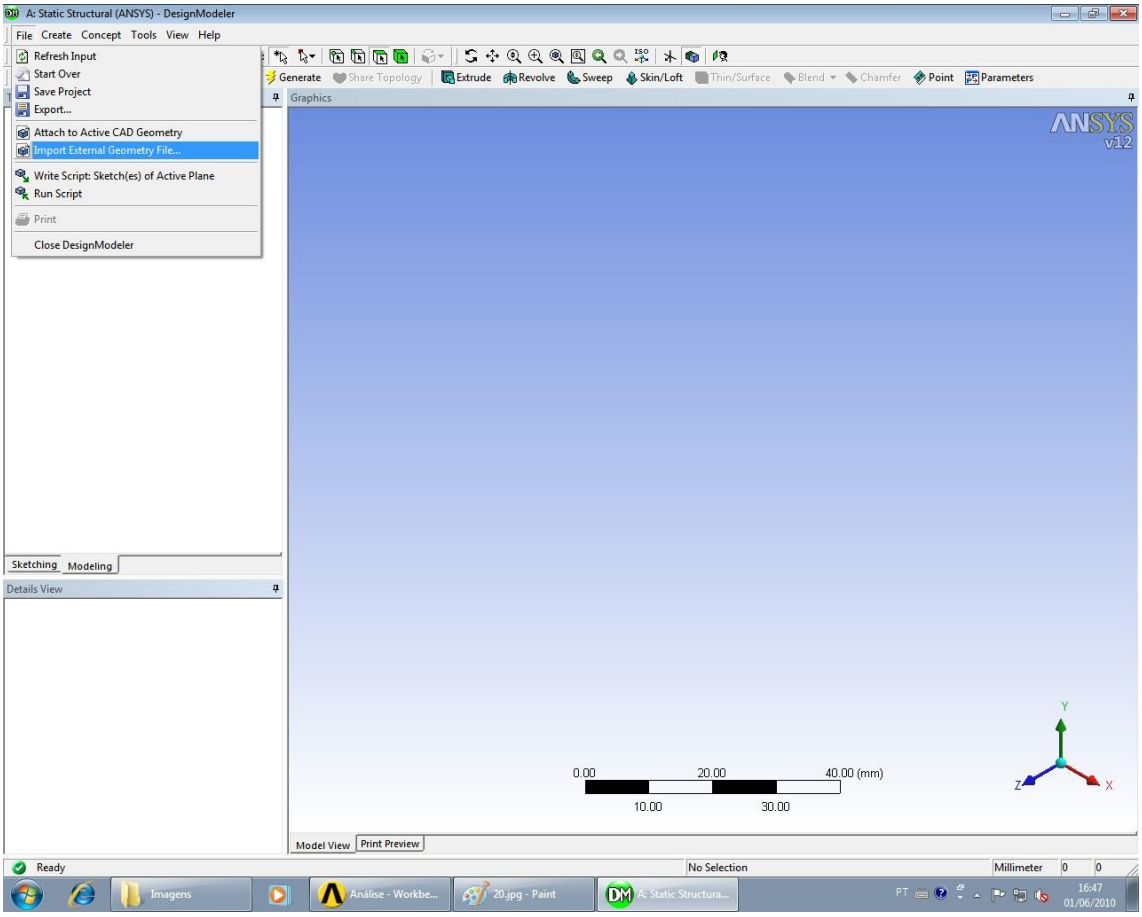
✓ Deve-se então clicar com o botão direito em “Geometry” e, logo após em “New Geometry...”;



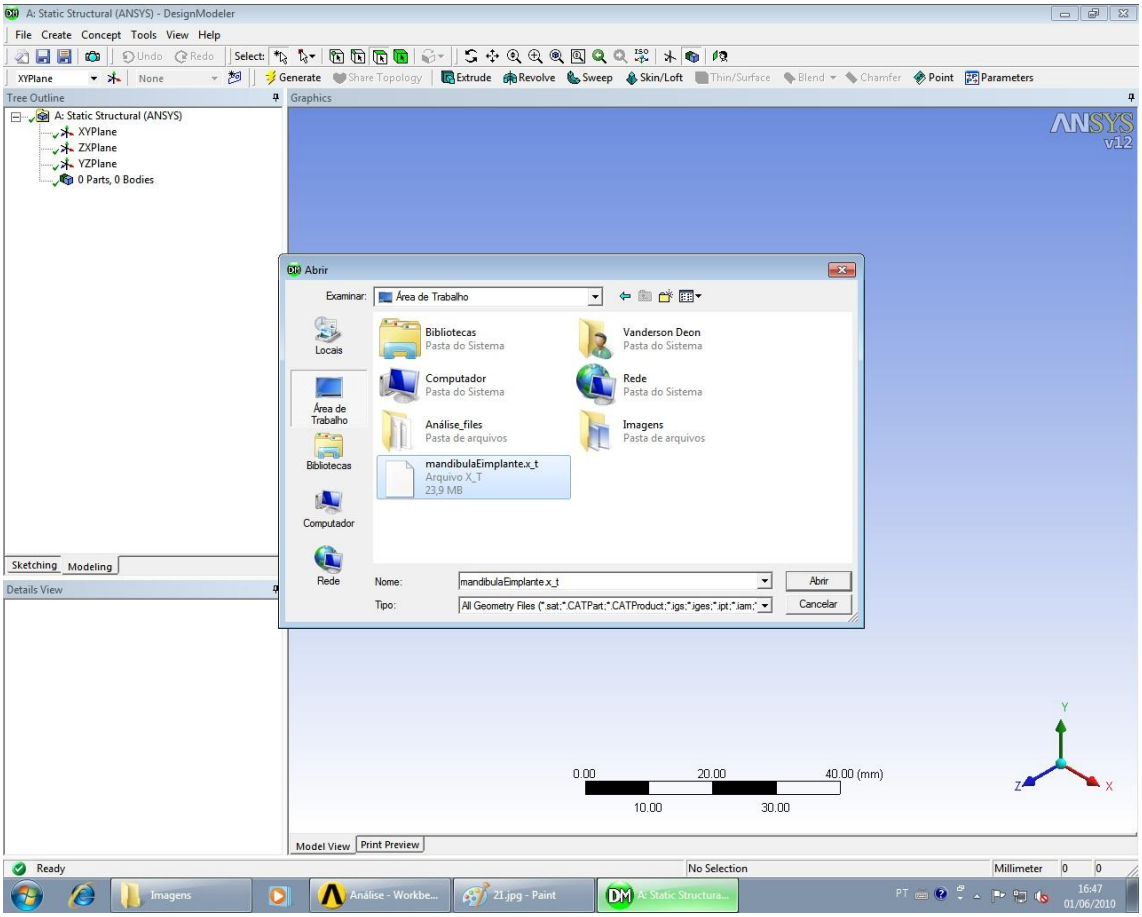
- ✓ Deve-se selecionar a unidade de comprimento que será utilizada;
- ✓ No caso como a geometria será importada, deve-se escolher a unidade compatível com as medidas que o arquivo foi produzido;



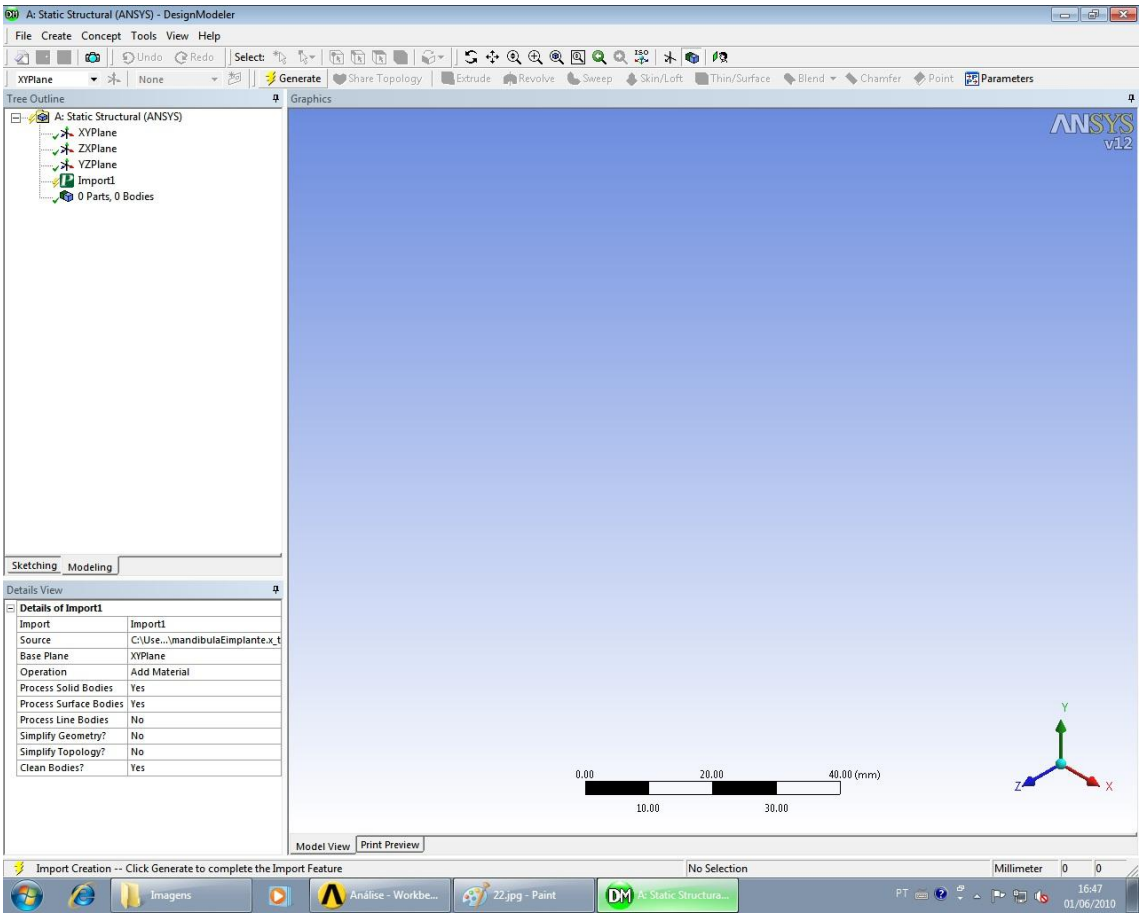
- ✓ Para importar a geometria deve-se clicar em “File”, “Import External Geometry File...”;



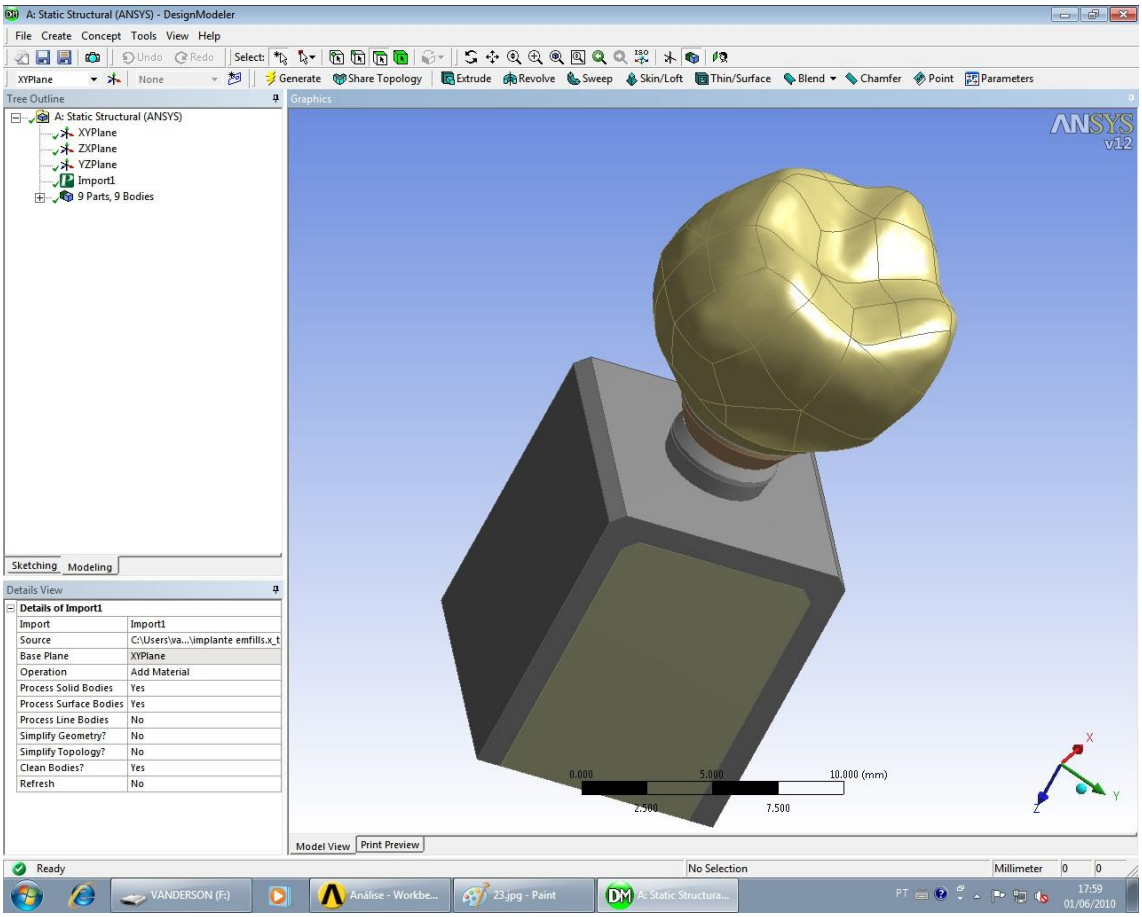
- ✓ Deve-se selecionar o arquivo desejado em formato compatível (no caso parasolid) e clicar em “Abrir”;



- ✓ Quando o arquivo for carregado, clicar em “Generate”;

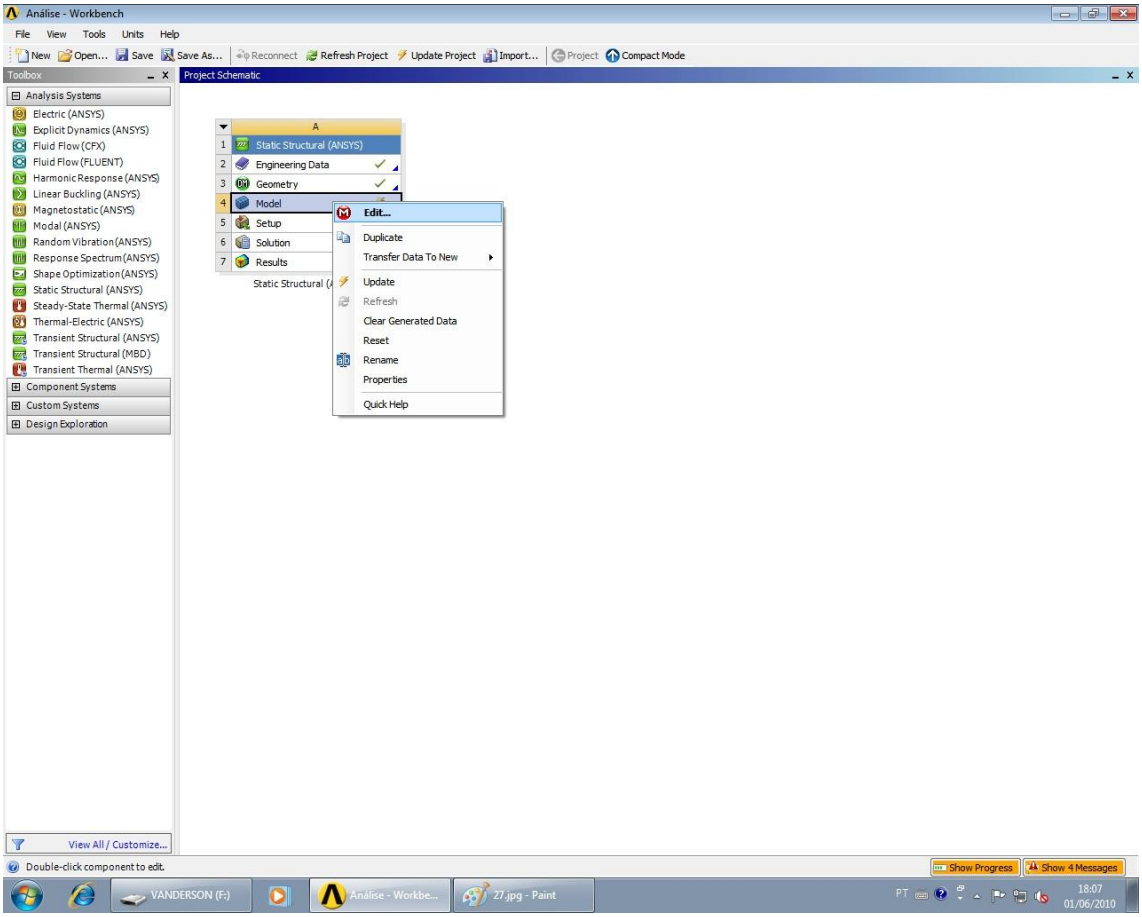


✓ O solido será gerado;

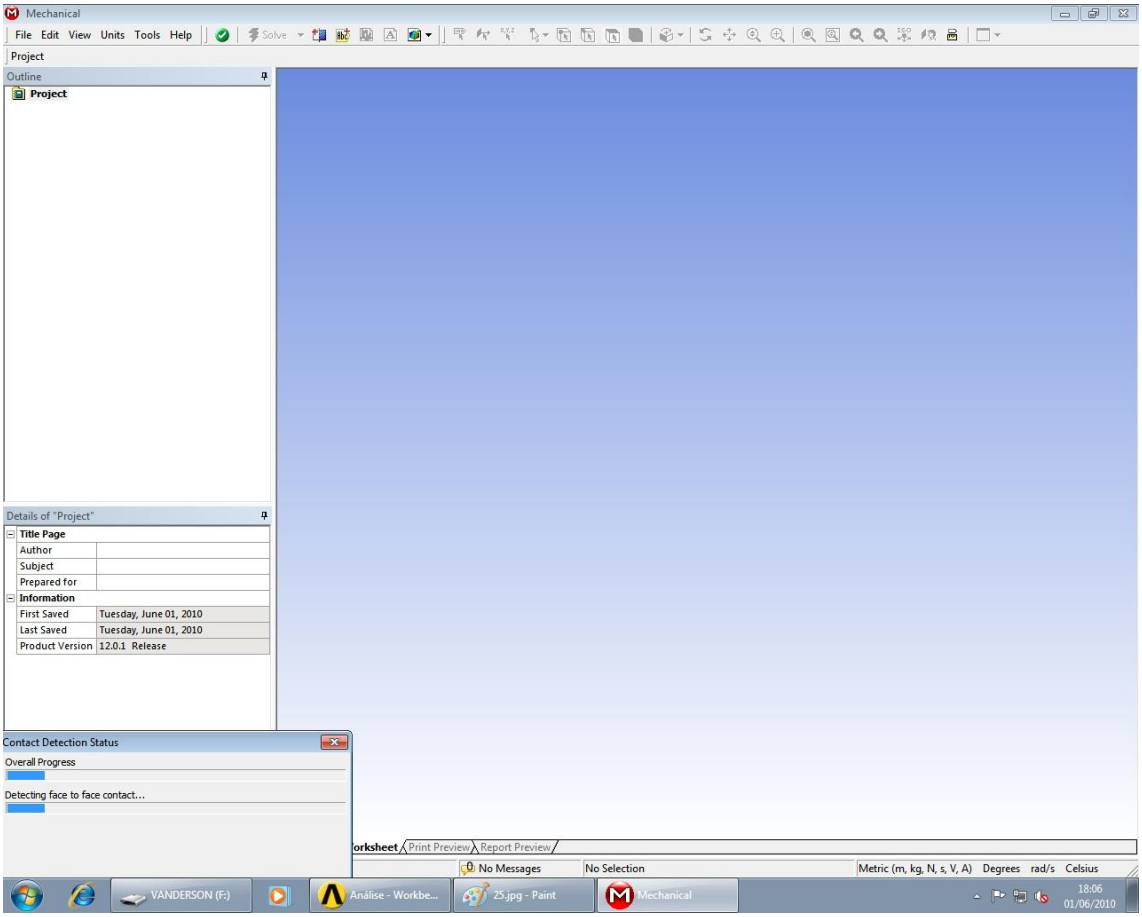


4. CONFIGURAÇÃO DO MODELO

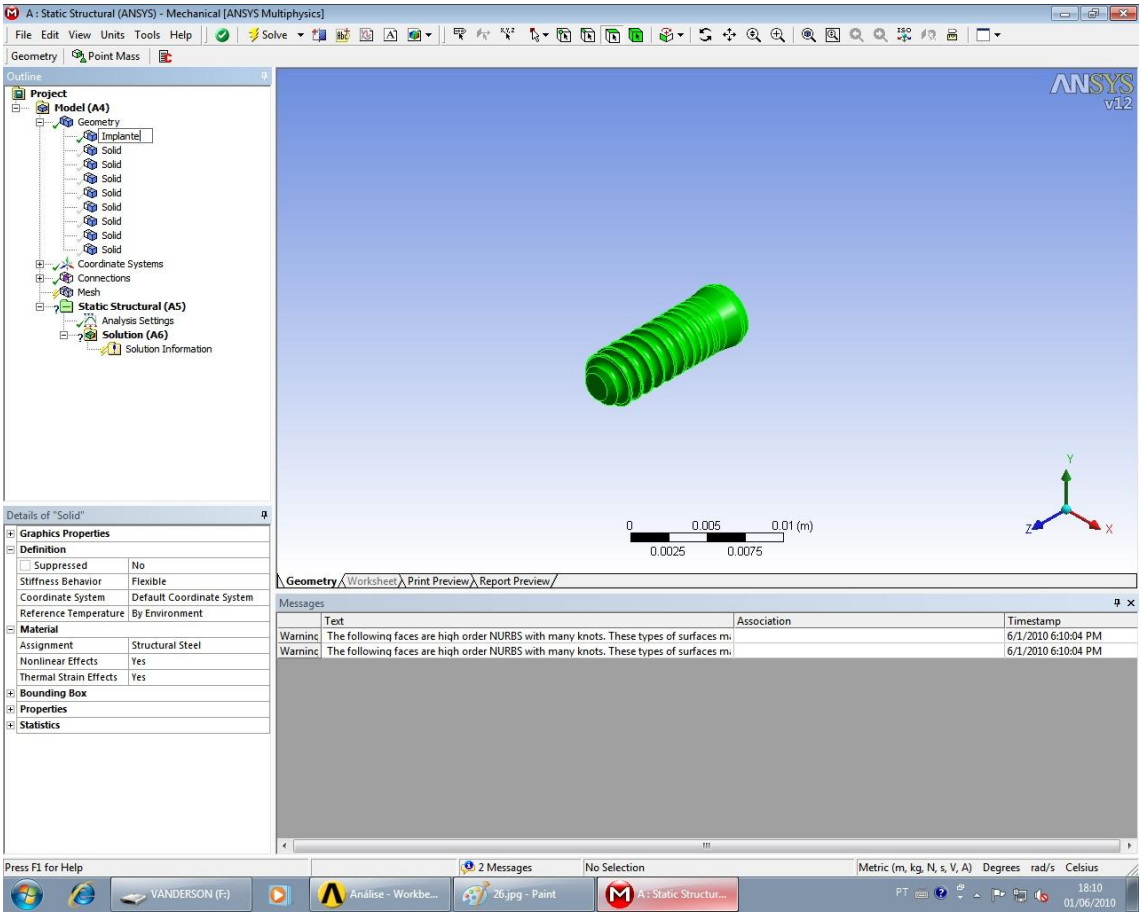
✓ No “Projec Schematic”, clicar com o botão direito em “Model”, “Edit”;

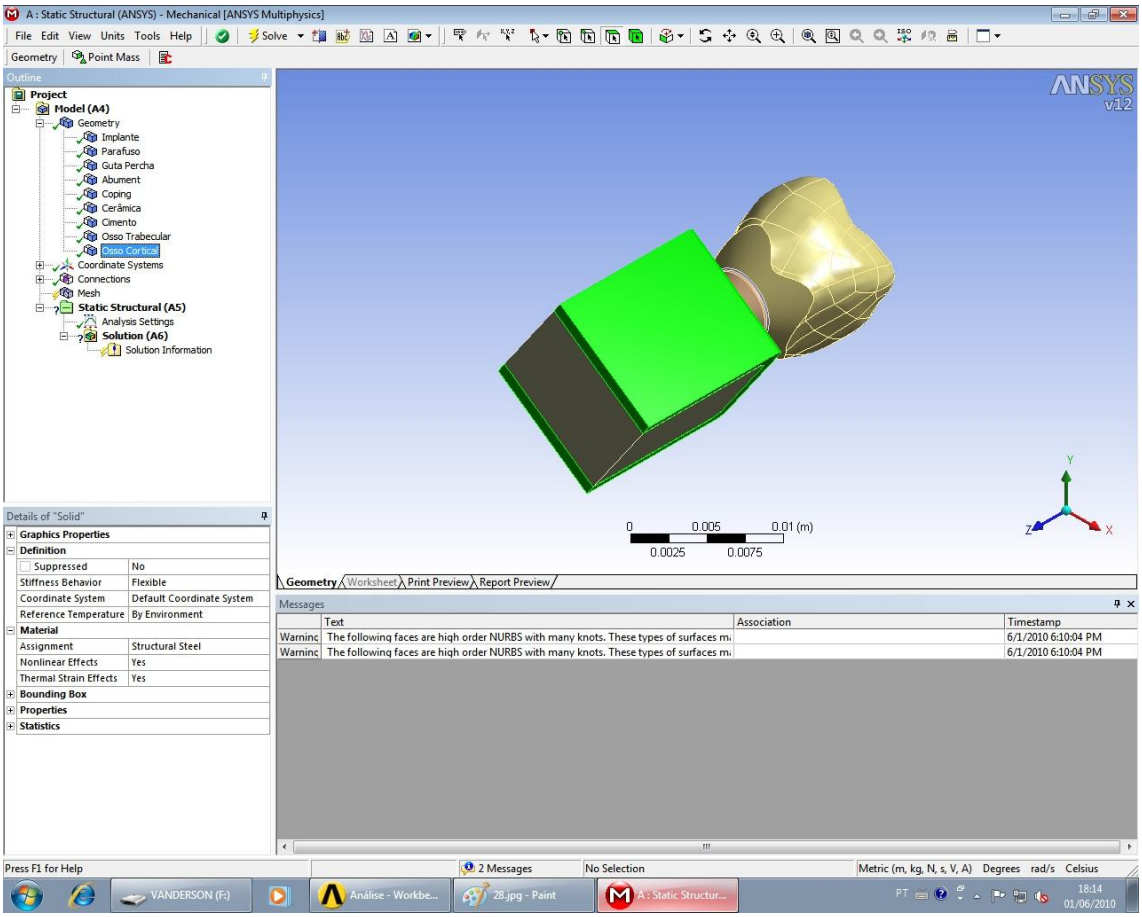


- ✓ O programa automaticamente gerará uma região de contato entre as interfaces das peças existentes;

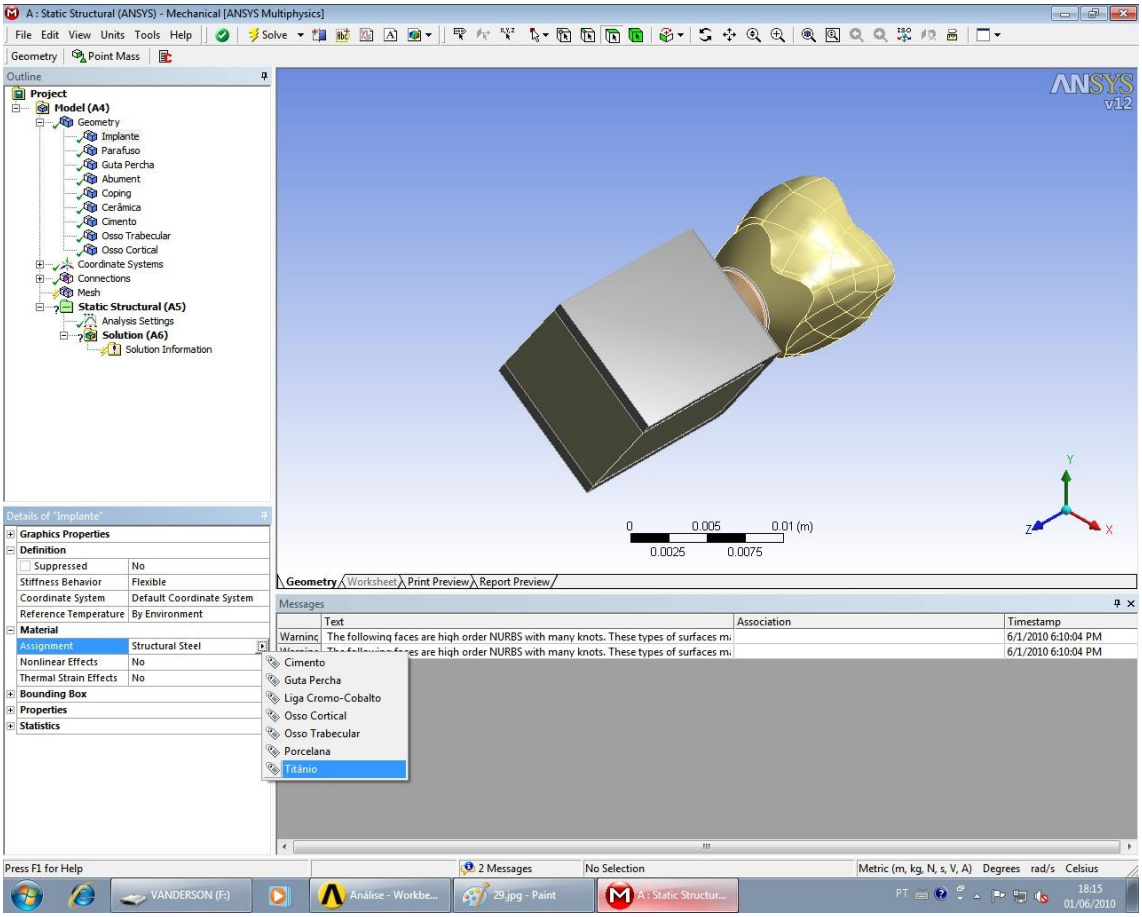


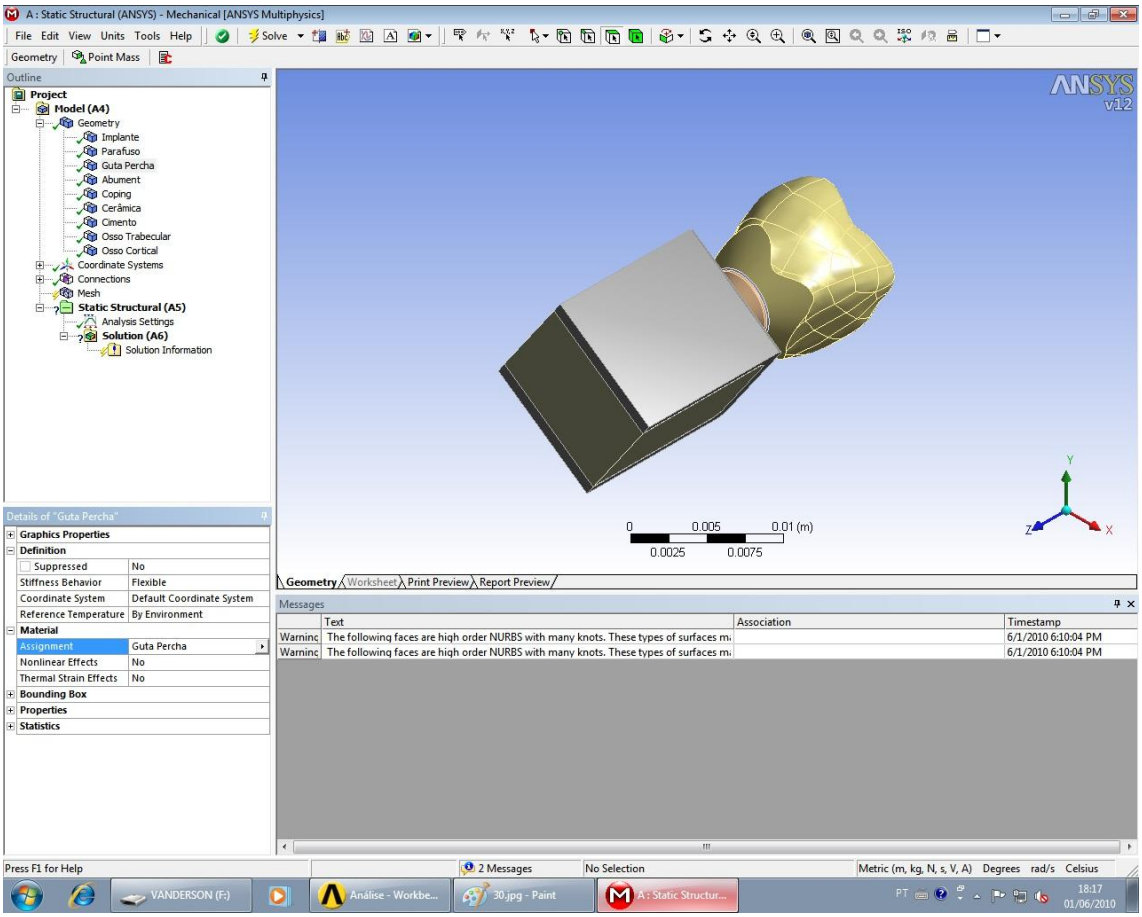
- ✓ No menu “Outline”, “Geometry” deve-se selecionar cada um dos sólidos existentes, clicando com o botão direito, e dar o seu respectivo nome;
- ✓ Para mudar o nome, deve-se apertar a tecla F2;

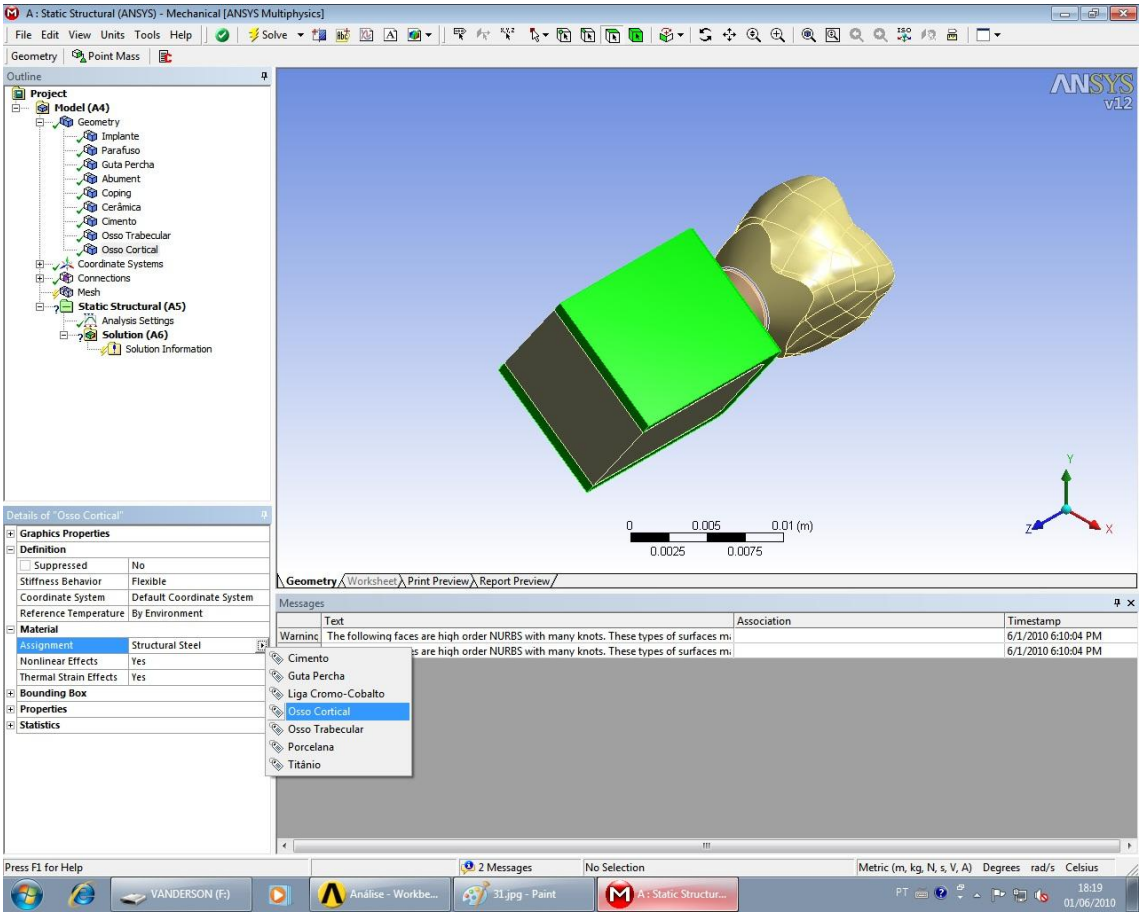



A : Static Structural (ANSYS) - Mechanical [ANSYS Multiphysics]
File Edit View Units Tools Help
Solve
Geometry
Point Mass
Outline
Project
Model (A4)
Geometry
Implante
Parafuso
Guta Percha
Abument
Coping
Cerâmica
Cimento
Osso Trabecular
Osso Cortical
Coordinate Systems
Connections
Mesh
Static Structural (A5)
Analysis Settings
Solution (A6)
Solution Information
ANSYS
v12
0
0.005
0.01 (m)
0.0025
0.0075
Y
Z
X
Geometry
Worksheet
Print Preview
Report Preview
Details of "Solid"
Graphics Properties
Definition
Suppressed
No
Stiffness Behavior
Flexible
Coordinate System
Default Coordinate System
Reference Temperature
By Environment
Material
Assignment
Structural Steel
Nonlinear Effects
Yes
Thermal Strain Effects
Yes
Bounding Box
Properties
Statistics
Messages
Text
Association
Timestamp
Warning
The following faces are high order NURBS with many knots. These types of surfaces m...
6/1/2010 6:10:04 PM
Warning
The following faces are high order NURBS with many knots. These types of surfaces m...
6/1/2010 6:10:04 PM
Press F1 for Help
2 Messages
No Selection
Metric (m, kg, N, s, V, A)
Degrees
rad/s
Celsius
VANDERSON (F:)
Análise - Workbe...
28.jpg - Paint
A : Static Structur...
18:14
01/06/2010

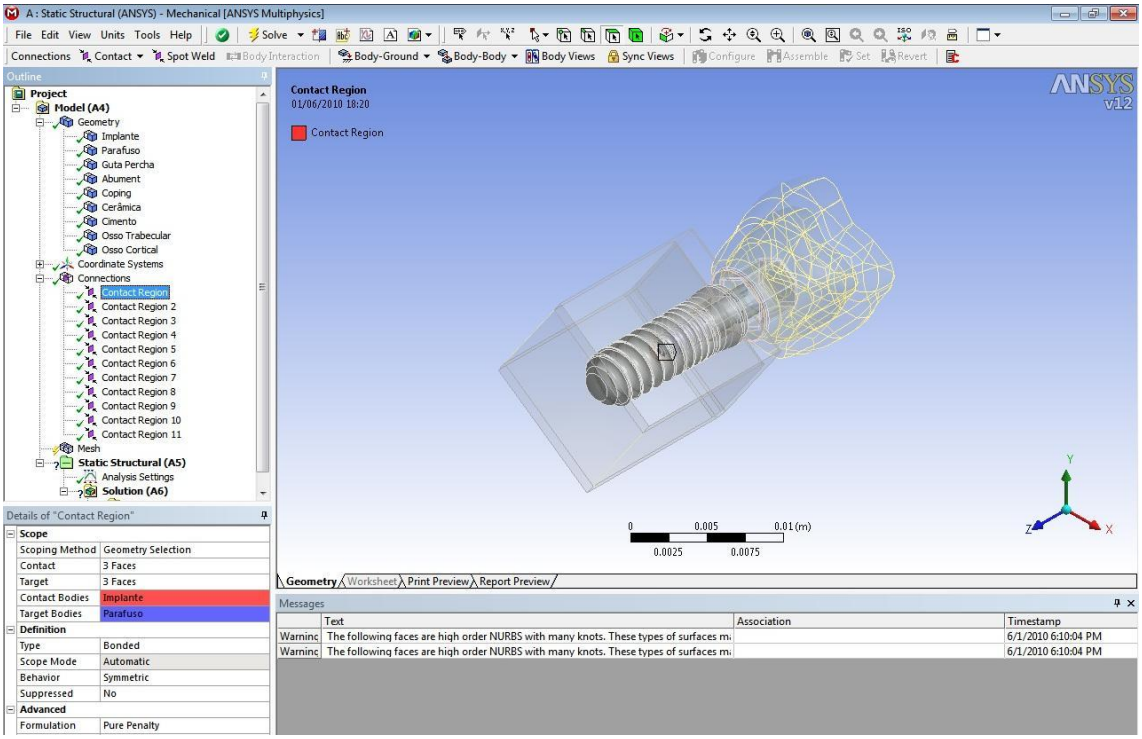
- ✓ Para cada uma das partes do modelo, deve-se atribuir o material desejado, anteriormente criado;




A : Static Structural (ANSYS) - Mechanical [ANSYS Multiphysics]
File Edit View Units Tools Help
Solve
Geometry
Point Mass
Outline
Project
Model (A4)
Geometry
Implante
Parafuso
Guta Percha
Abument
Coping
Cerâmica
Cimento
Osso Trabecular
Osso Cortical
Coordinate Systems
Connections
Mesh
Static Structural (A5)
Analysis Settings
Solution (A6)
Solution Information
Details of "Guta Percha"
Graphics Properties
Definition
Suppressed No
Stiffness Behavior Flexible
Coordinate System Default Coordinate System
Reference Temperature By Environment
Material
Assignment Guta Percha
Nonlinear Effects No
Thermal Strain Effects No
Bounding Box
Properties
Statistics
ANSYS
v12
0 0.005 0.01 (m)
0.0025 0.0075
Geometry Worksheet Print Preview Report Preview
Messages
Text Association Timestamp
Warninc The following faces are high order NURBS with many knots. These types of surfaces m: 6/1/2010 6:10:04 PM
Warninc The following faces are high order NURBS with many knots. These types of surfaces m: 6/1/2010 6:10:04 PM
Press F1 for Help
2 Messages
No Selection
Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
VANDERSON (F:)
Análise - Workbe...
30.jpg - Paint
A : Static Structur...
18:17
01/06/2010

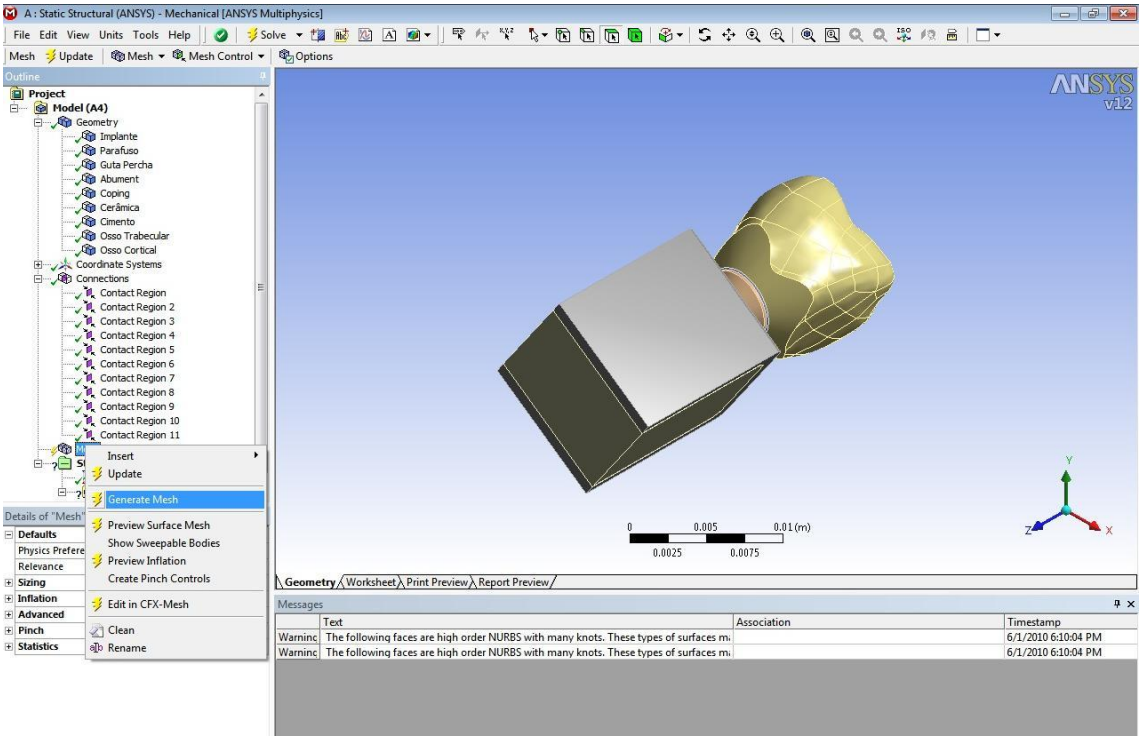

A : Static Structural (ANSYS) - Mechanical [ANSYS Multiphysics]
File Edit View Units Tools Help
Solve
Geometry
Point Mass
Outline
Project
Model (A4)
Geometry
Implante
Parafuso
Guta Percha
Abument
Coping
Cerâmica
Cimento
Osso Trabecular
Osso Cortical
Coordinate Systems
Connections
Mesh
Static Structural (A5)
Analysis Settings
Solution (A6)
Solution Information
Details of "Osso Cortical"
Graphics Properties
Definition
Suppressed No
Stiffness Behavior Flexible
Coordinate System Default Coordinate System
Reference Temperature By Environment
Material
Assignment Structural Steel
Nonlinear Effects Yes
Thermal Strain Effects Yes
Bounding Box
Properties
Statistics
Cimento
Guta Percha
Liga Cromo-Cobalto
Osso Cortical
Osso Trabecular
Porcelana
Titânio
ANSYS
v12
0 0.005 0.01 (m)
0.0025 0.0075
Geometry Worksheet Print Preview Report Preview
Messages
Text Association Timestamp
Warninc The following faces are high order NURBS with many knots. These types of surfaces m: 6/1/2010 6:10:04 PM
6/1/2010 6:10:04 PM
Press F1 for Help
2 Messages
No Selection
Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
VANDERSON (F:)
Análise - Workbe...
31.jpg - Paint
A : Static Structur...
18:19
01/06/2010

- ✓ Então clicar dentro do “Outline” em “Connections”, para verificar se os contatos entre as interfaces criados automaticamente correspondem ao que se deseja;

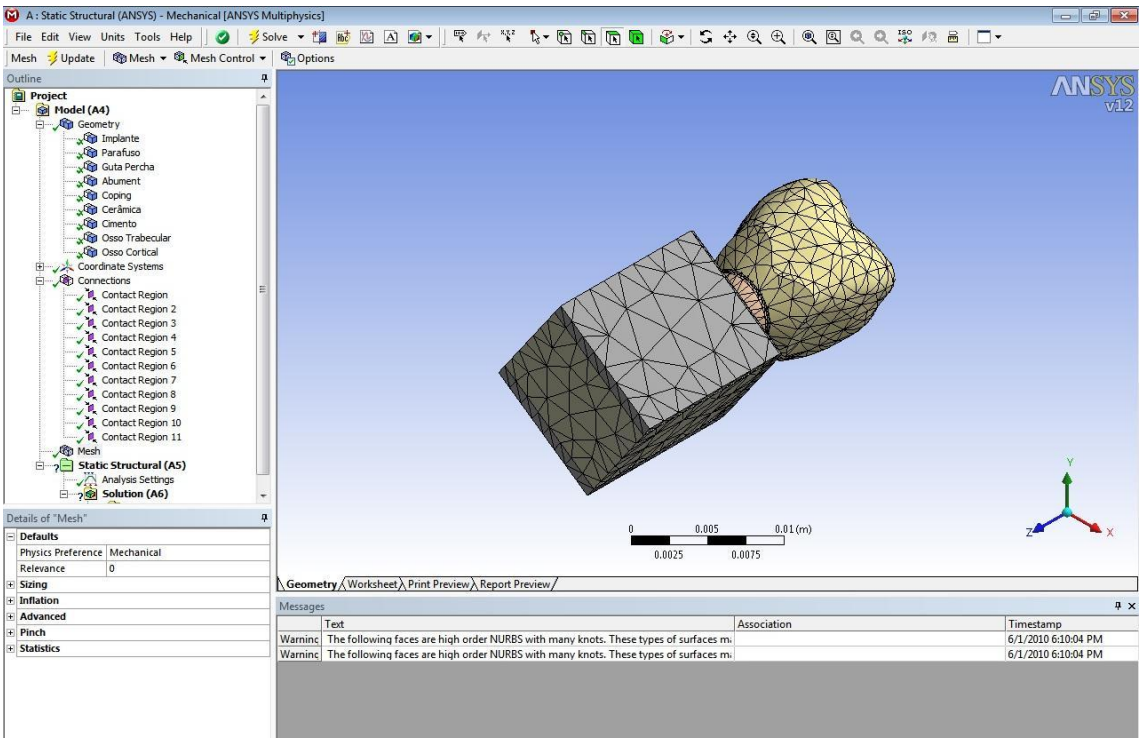


5. GERAÇÃO DA MALHA DE ELEMENTOS FINITOS

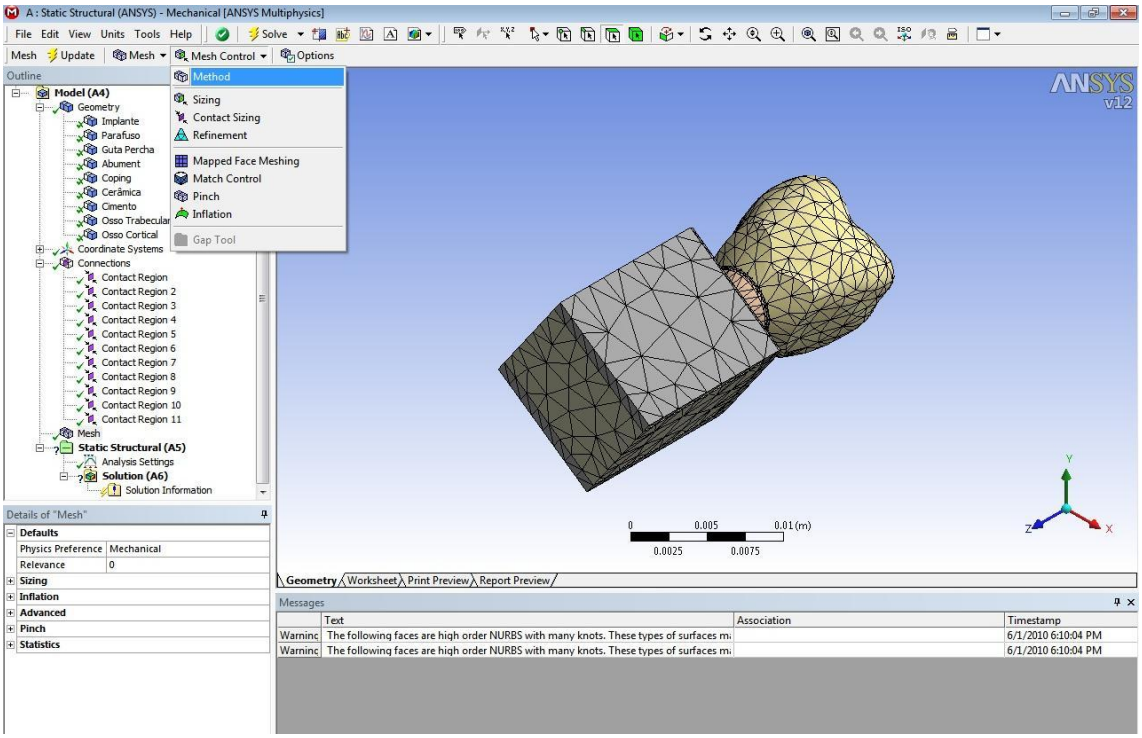
- ✓ Para criar uma malha de elementos finitos automática clica-se como botão direito, dentro do “Outline” em “Mesh”;
- ✓ Clicar em “Generate Mesh”;



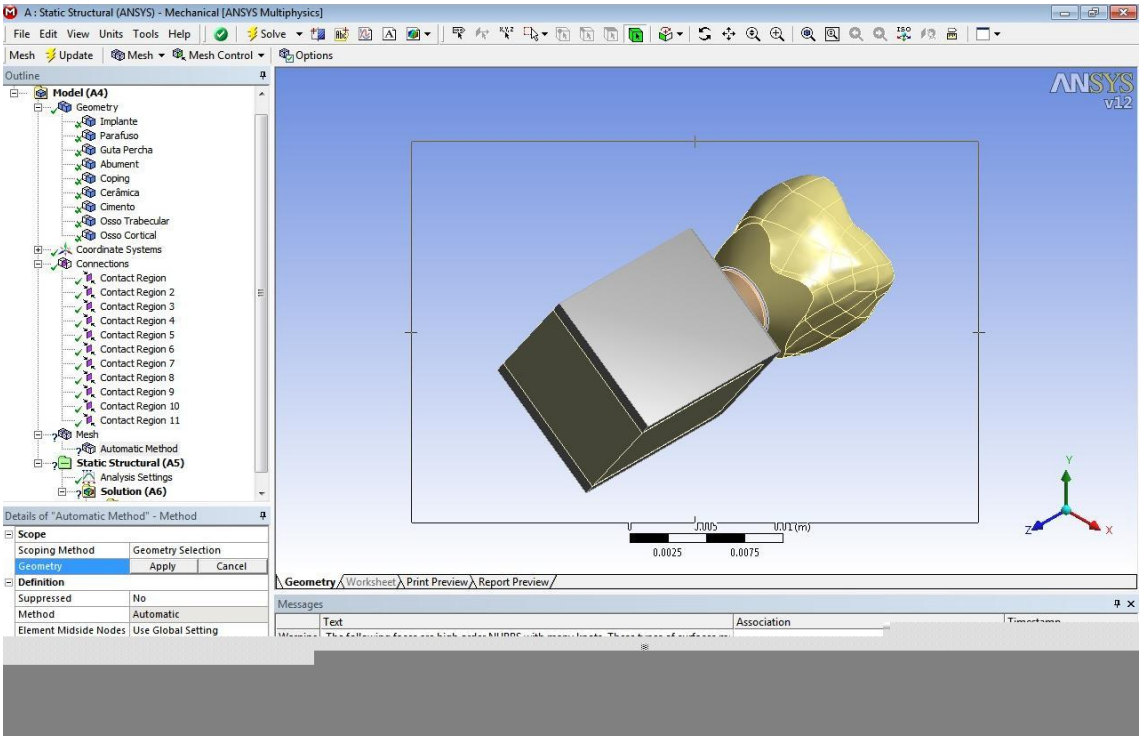
- ✓ Uma malha automática será criada;

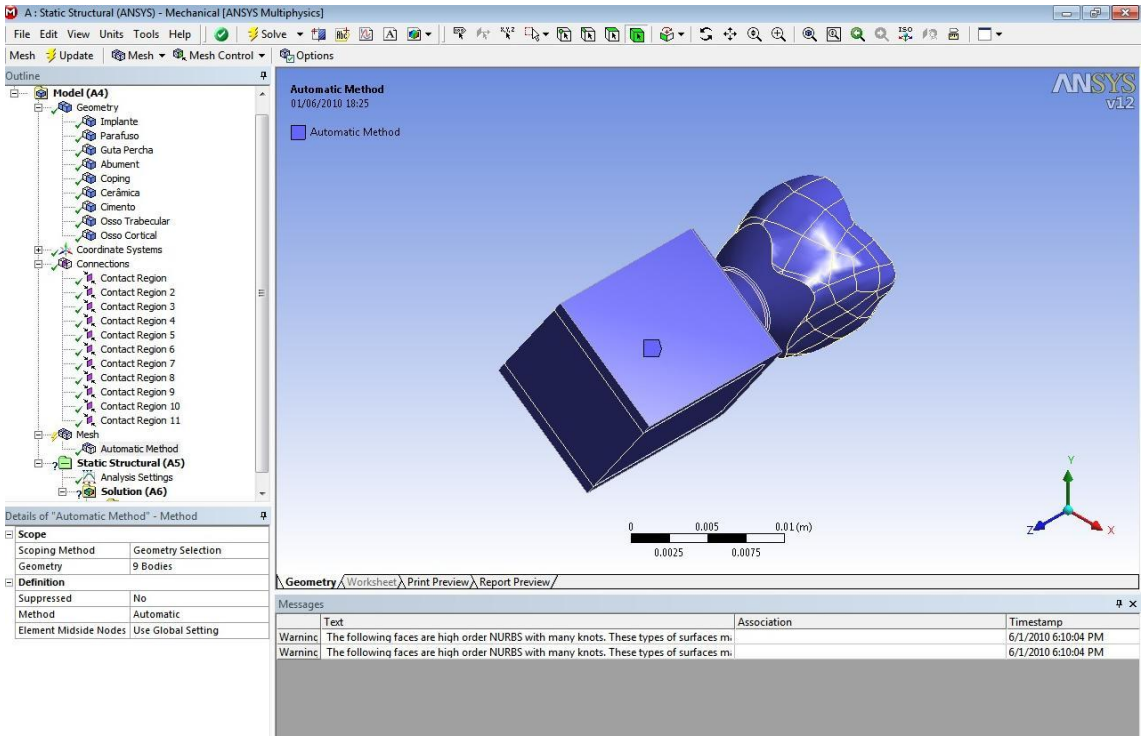


- ✓ Para configurar a malha clicar em “Mesh Control”;
- ✓ Clicar em “Method” para escolher o método de geração da malha;

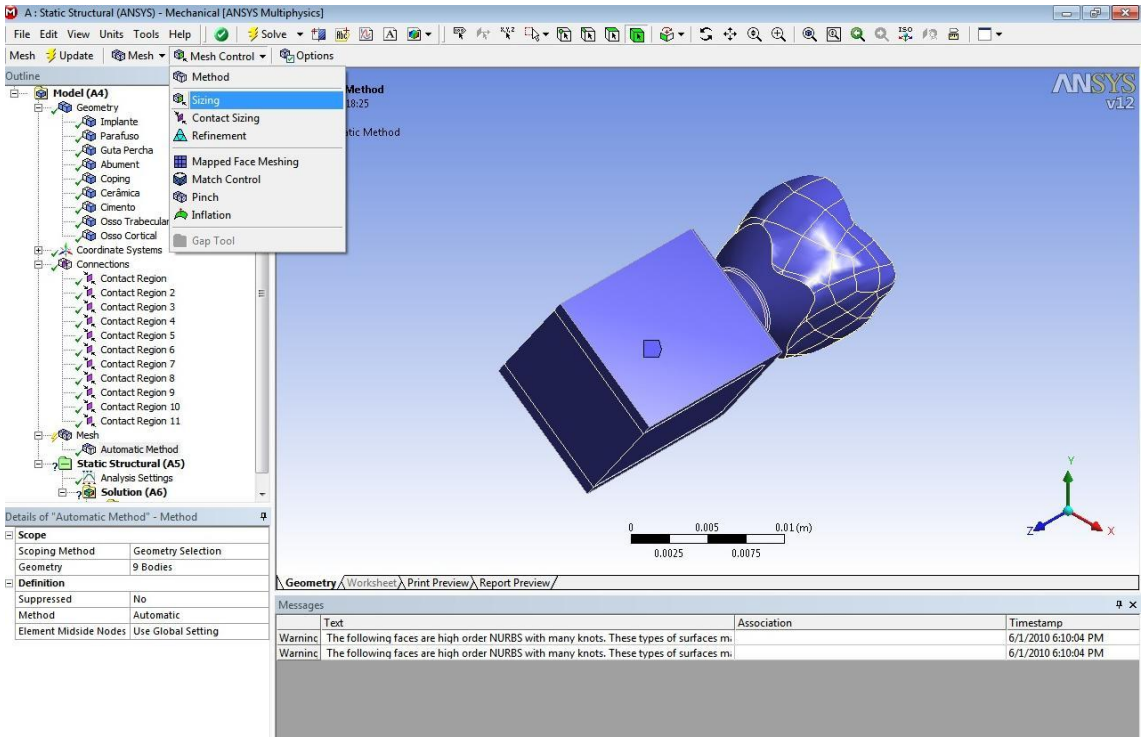


- ✓ Com a ferramenta de seleção, selecionar todo o modelo e clicar em "Apply" no menu "Details of Automatic Method - Method";

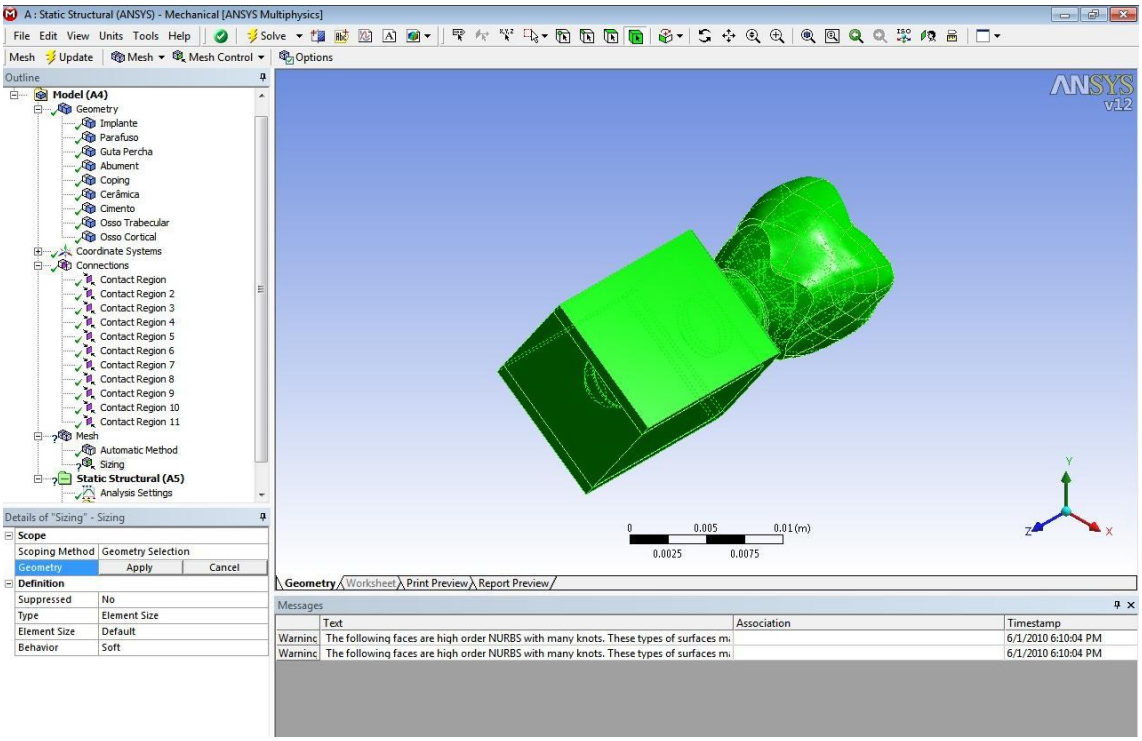




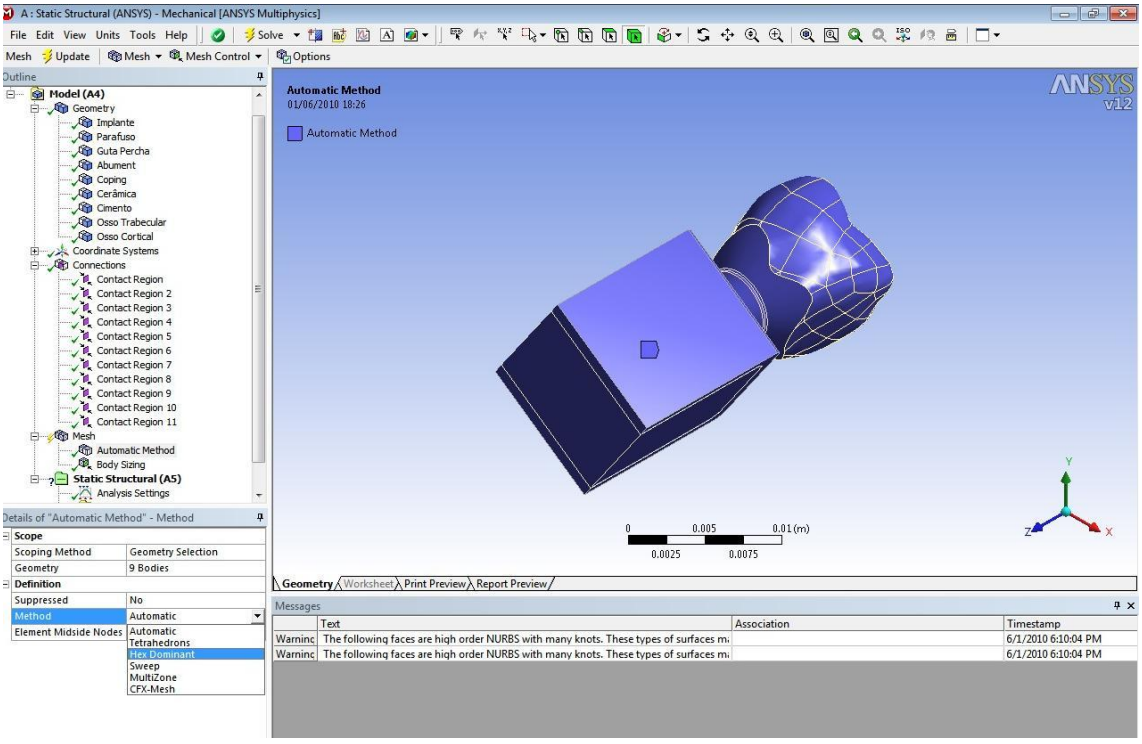
- ✓ Para configurar a malha clicar em “Mesh Control”;
- ✓ Clicar em “Size” para escolher a dimensão dos elementos a serem criados;



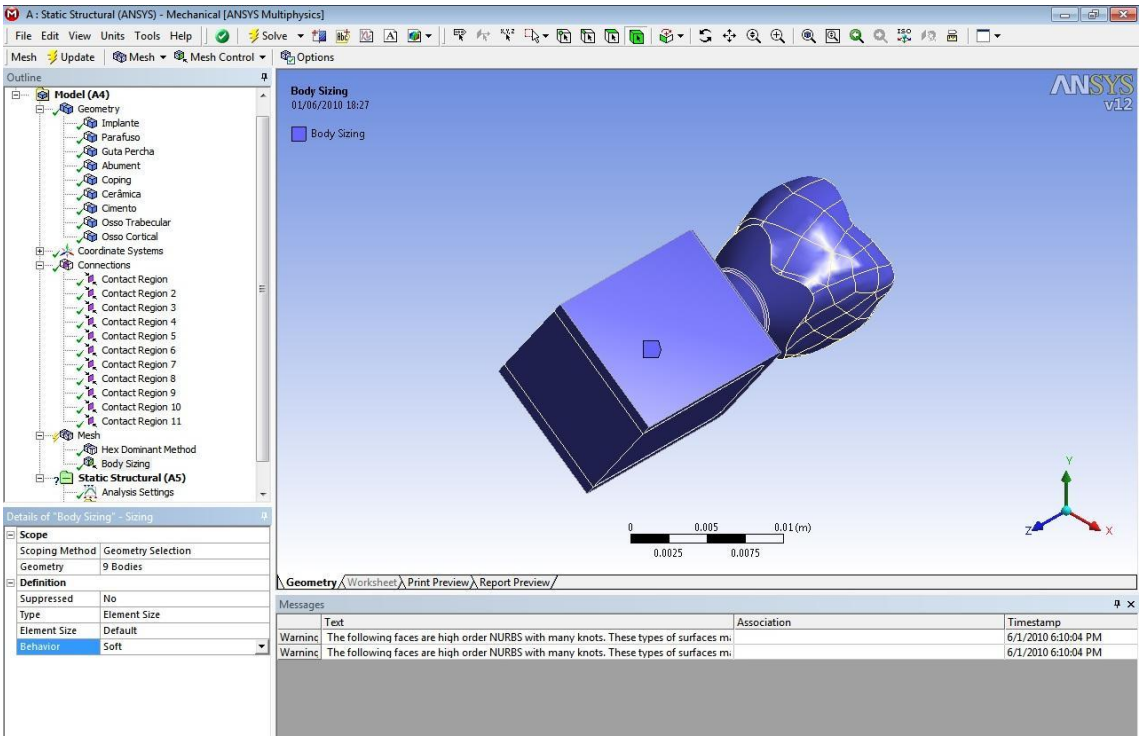
- ✓ Com a ferramenta de seleção, selecionar todo o modelo e clicar em “Apply” no menu “Details of Automatic Method - Method”;



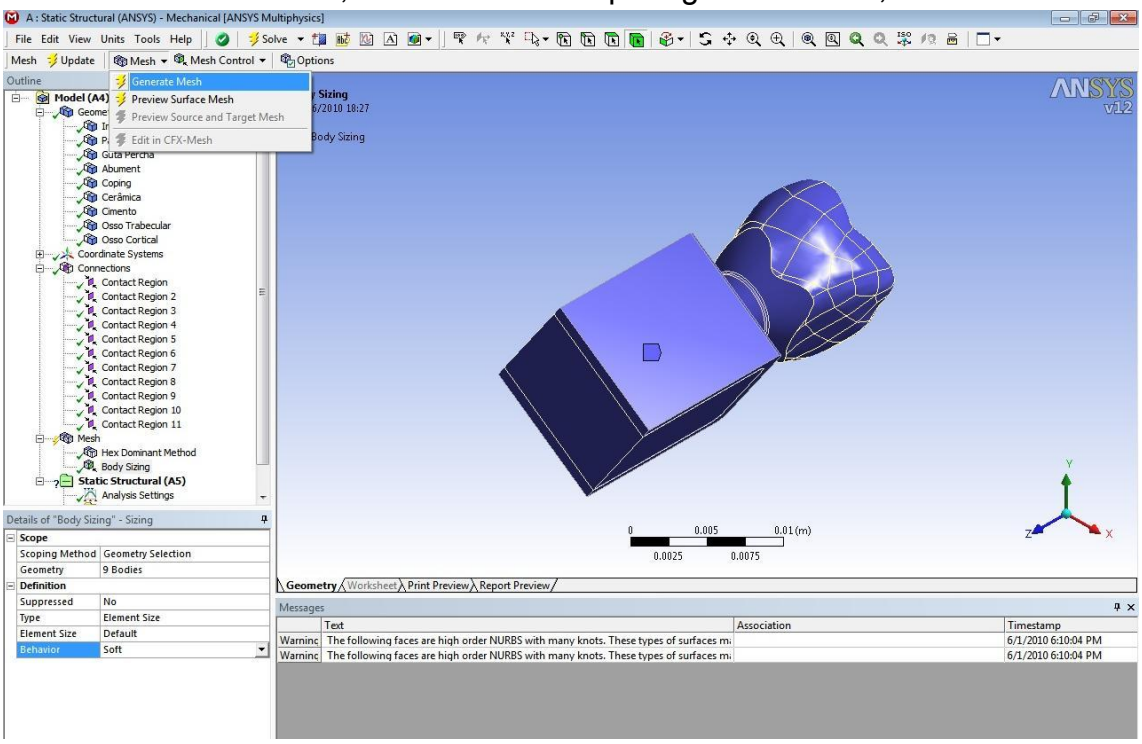
- ✓ Selecionar, dentro do menu “Outline”, “Model”, “Mesh”, “Automatic Mesh”, “Method” a opção “Hex Dominant” para compor uma malha com elementos preferencialmente hexagonais;

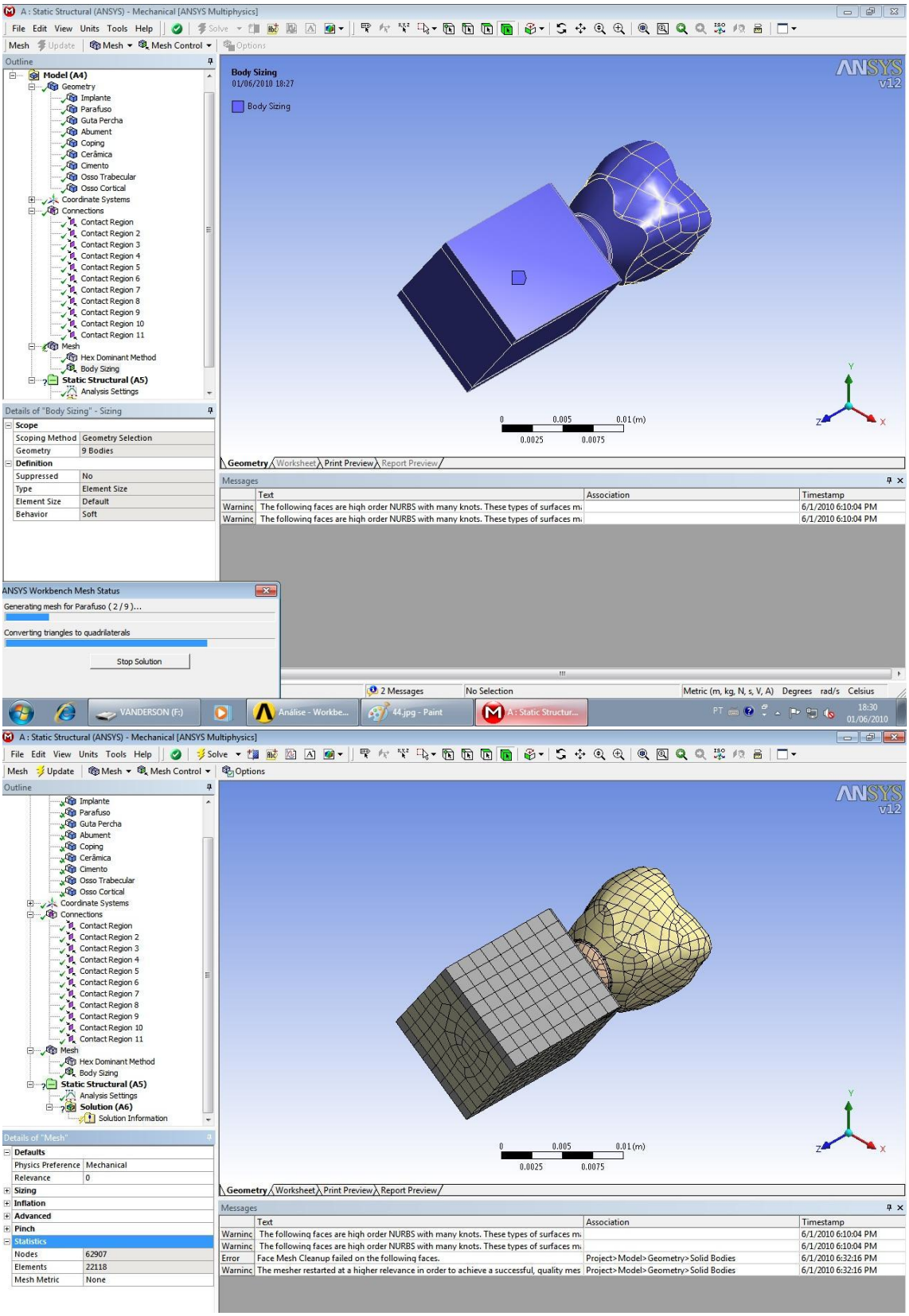


- ✓ Selecionar, dentro do menu “Outline”, “Model”, “Mesh”, “Automatic Mesh”, “Behaviour” a opção “Soft”. Assim a malha, nos cantos e regiões de geometria “crítica”, será mais refinada;

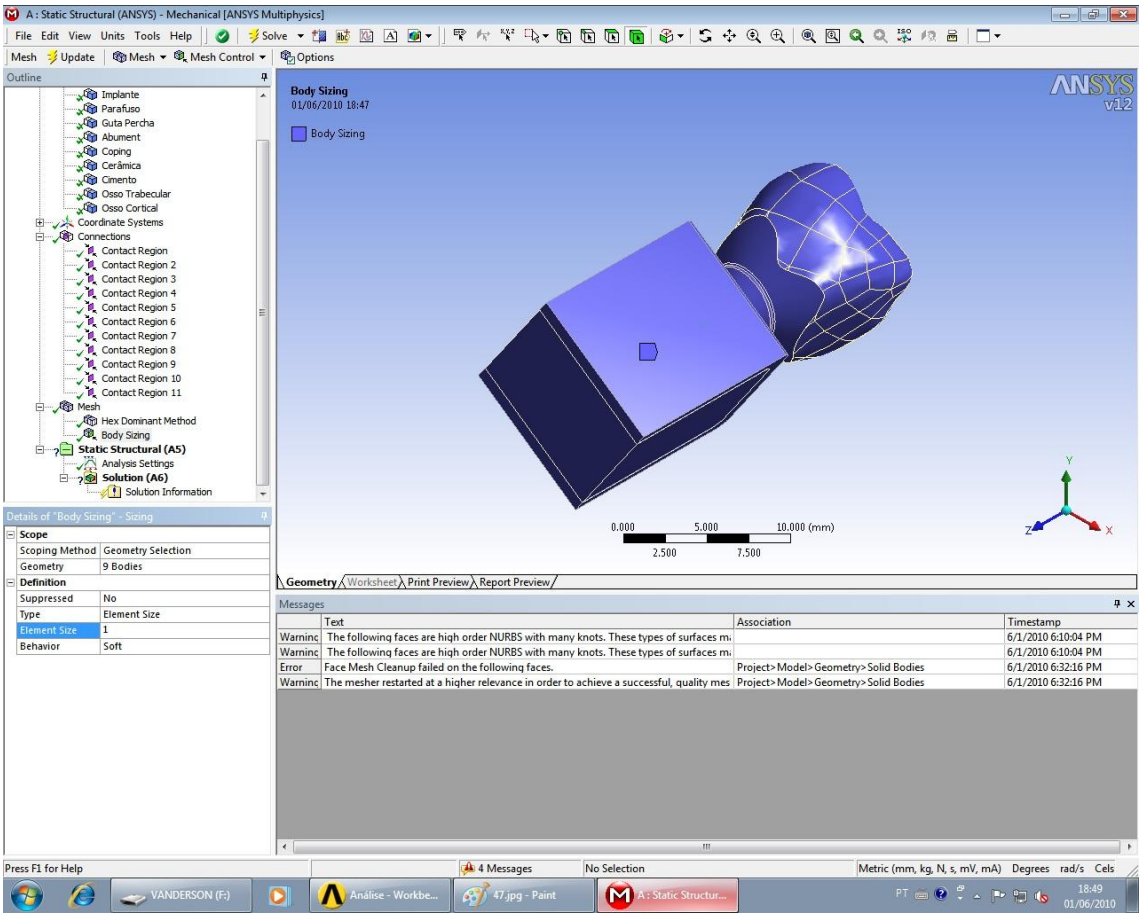


- ✓ Clicar em “Mesh”, “Generate Mesh” para gerar a malha;

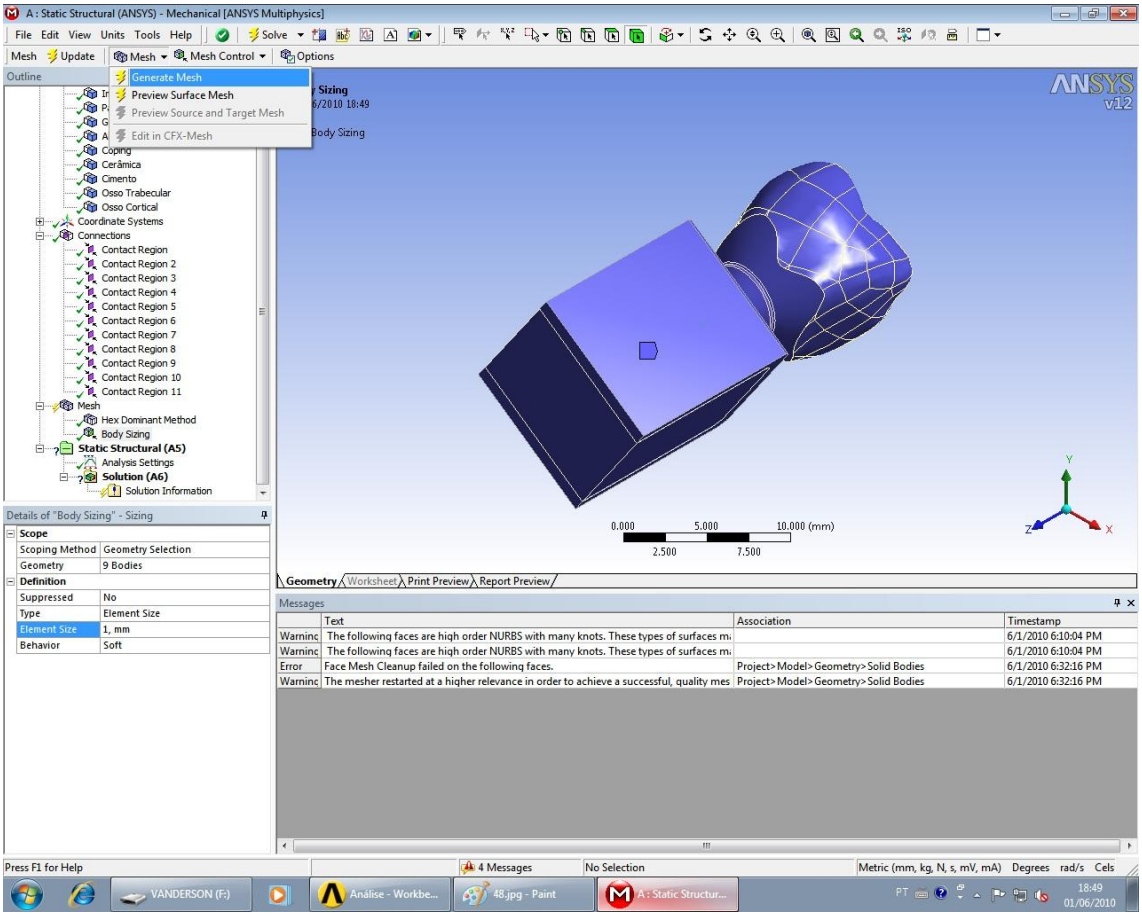


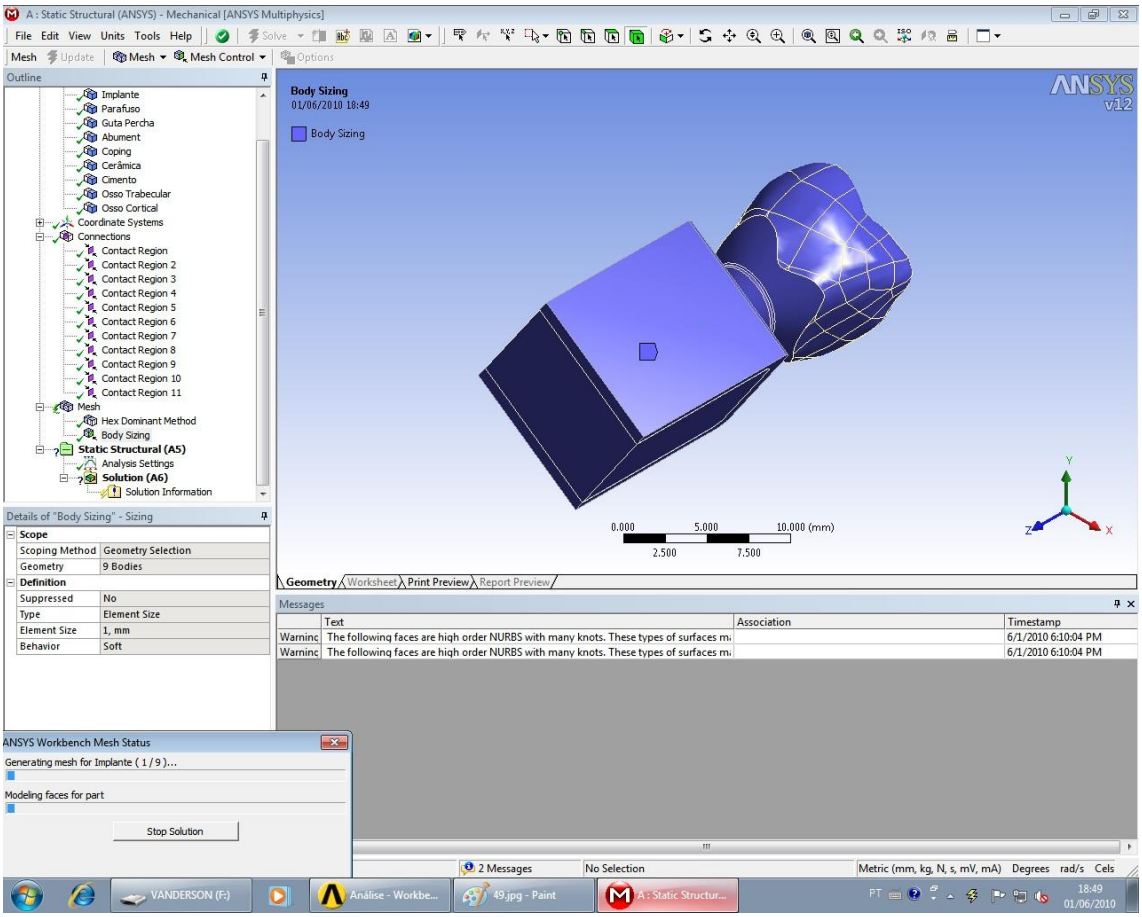


- ✓ Para melhorar a malha criada, selecionar, dentro do menu “Outline”, “Model”, “Mesh”, “Body Sizing”, “Element Size”;
- ✓ Inserir como tamanho do elemento o valor:
  - **1**

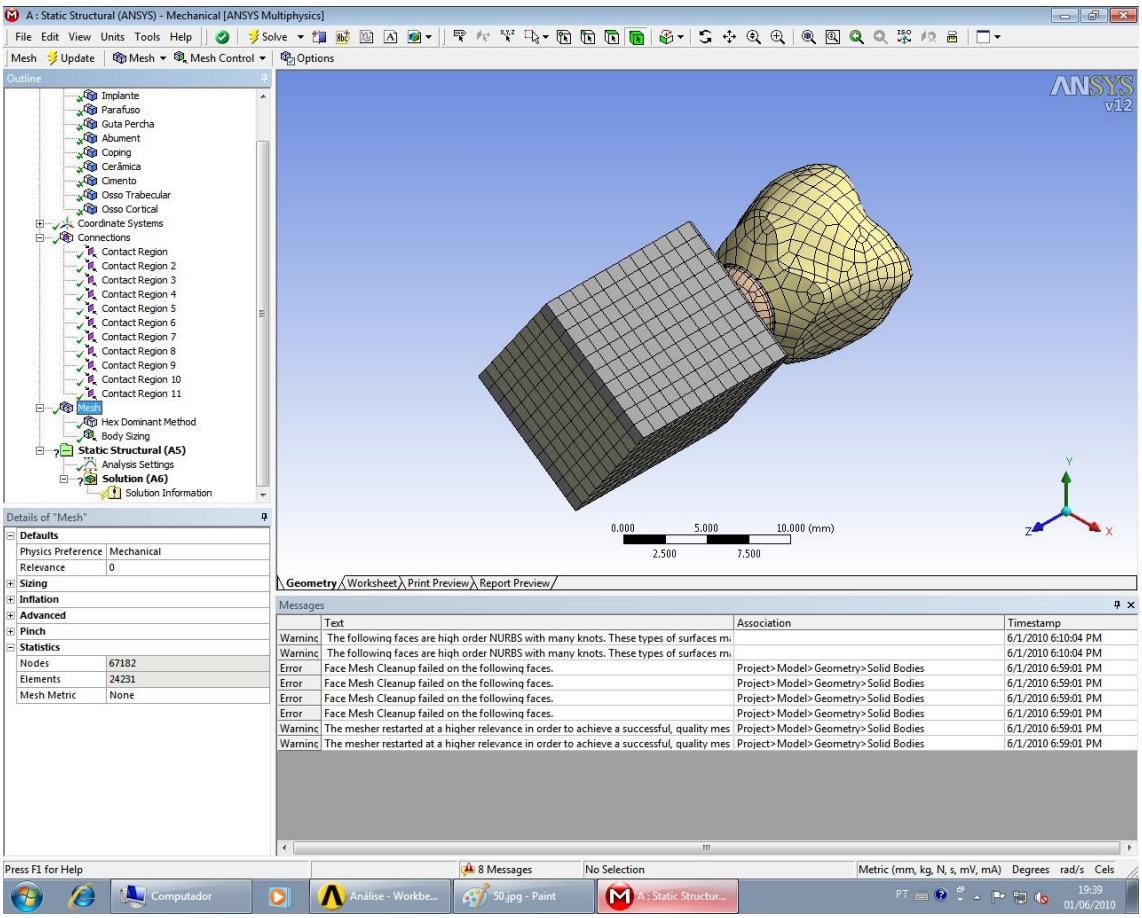


✓ Clicar em “Mesh”, “Generate Mesh” para gerar a malha;





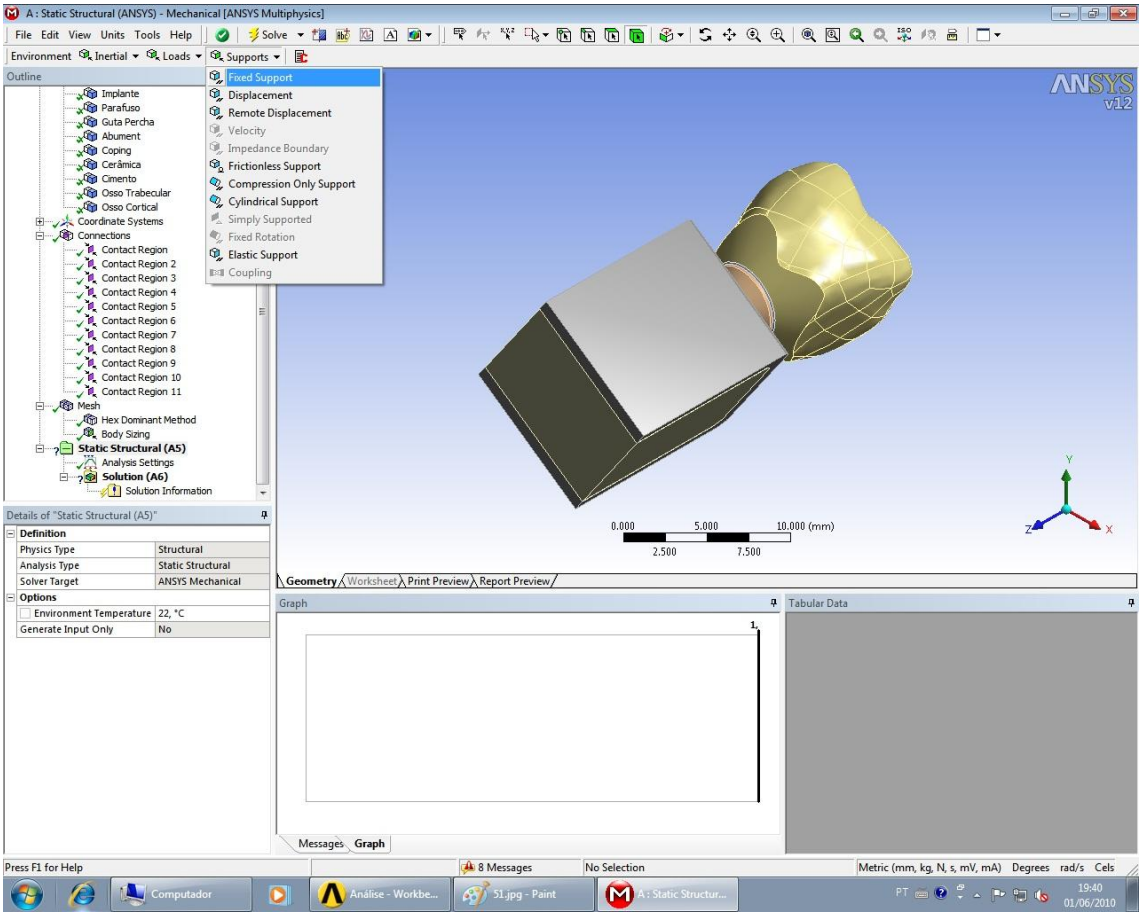
✓ Está é a malha final;



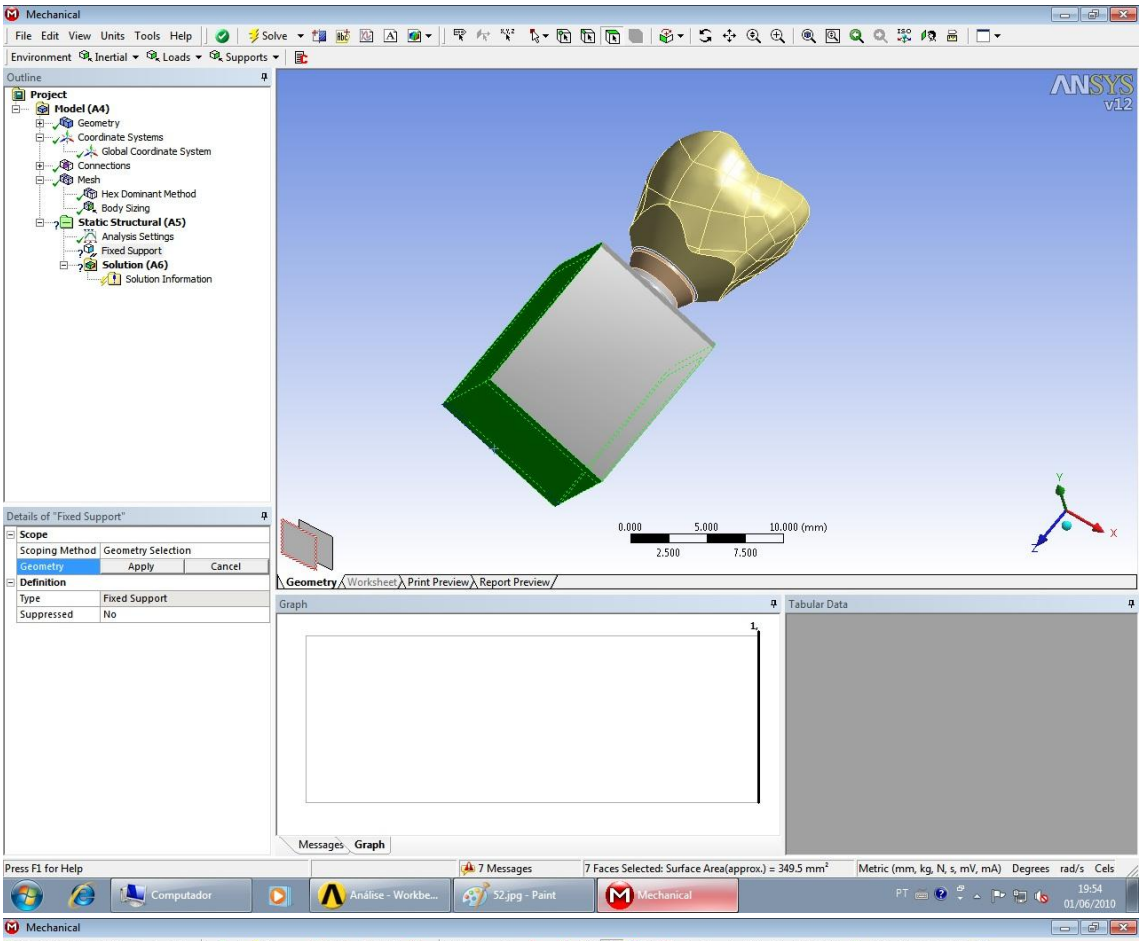
6. INSERIR CONDIÇÕES DE CONTORNO

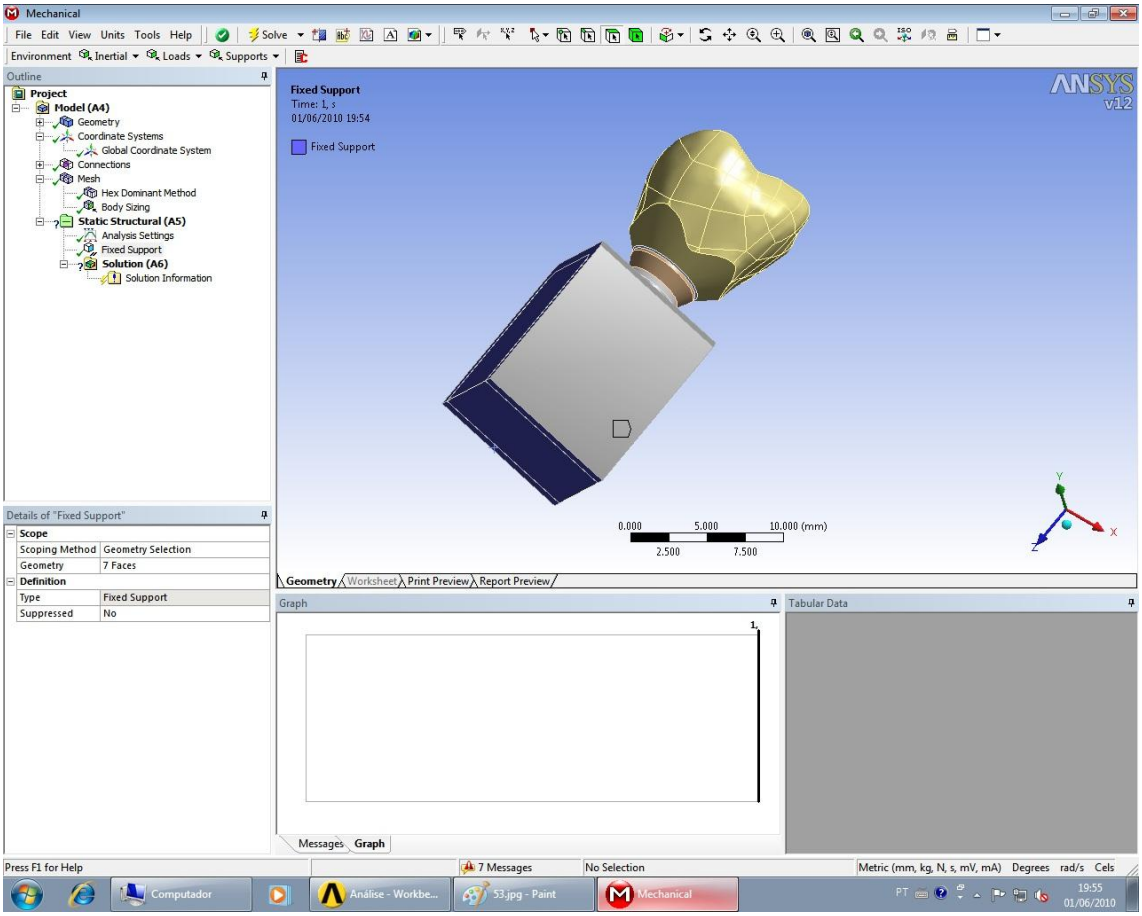
✓ Clicar dentro do “Outline” em “Static Structural”;

✓ Clicar em “Supports”, “Fixed Support”;



✓ Selecionar as faces onde se quer colocar o apoio e clicar em “Apply”;

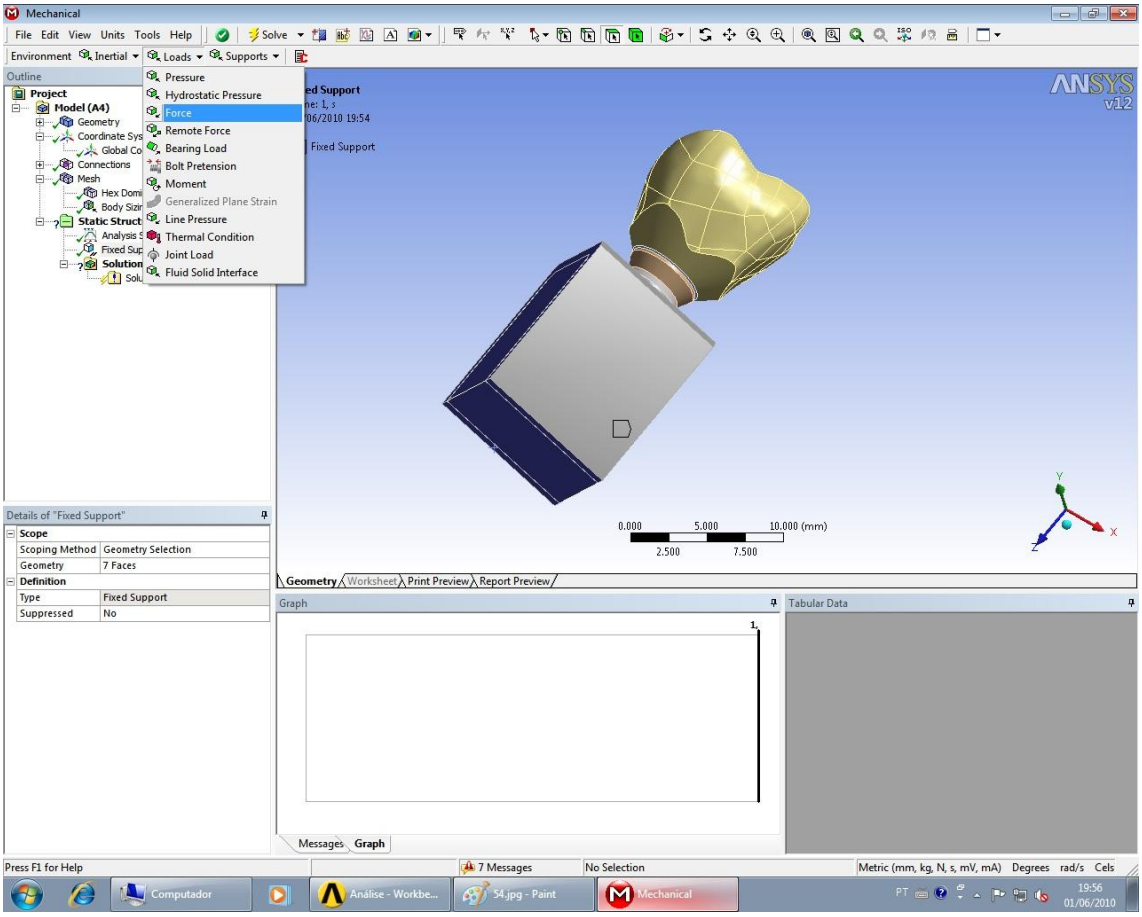




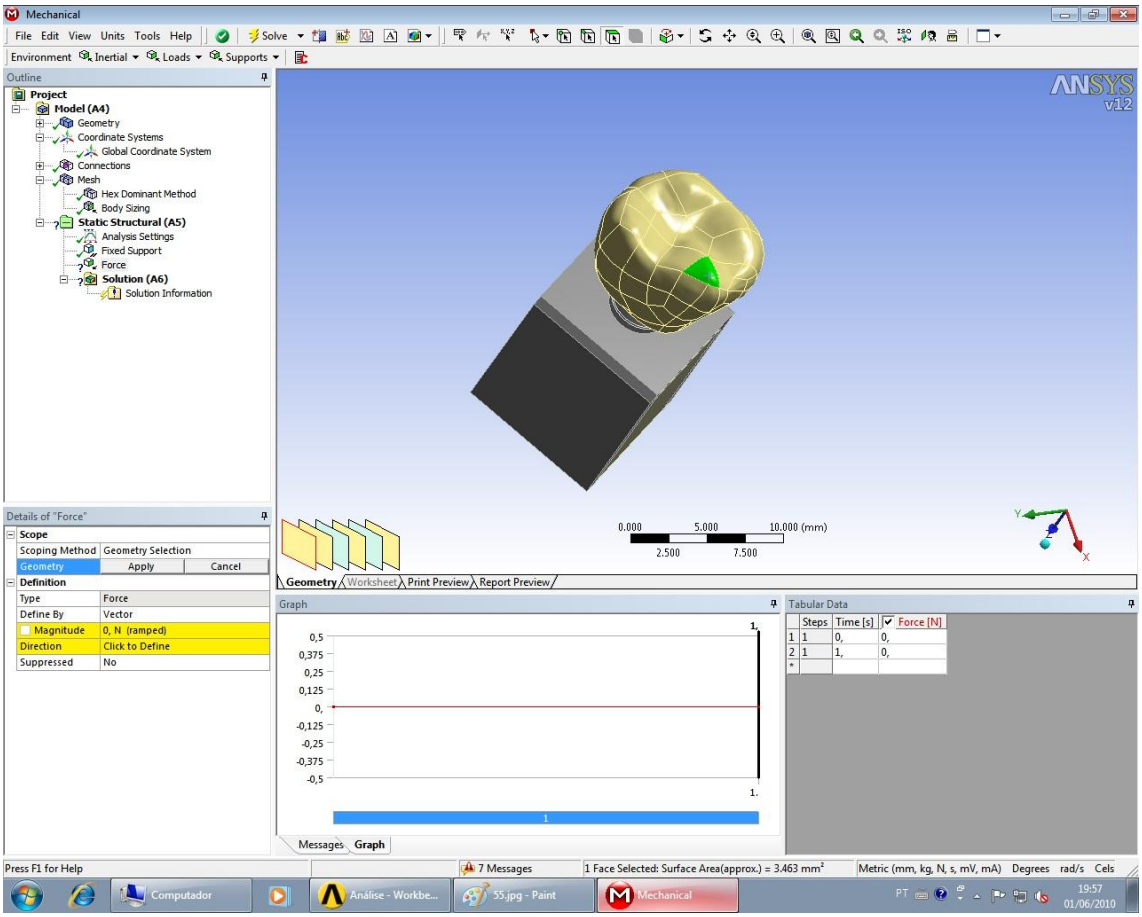
7. INSERIR FORÇAS

✓ Clicar dentro do “Outline” em “Static Structural”;

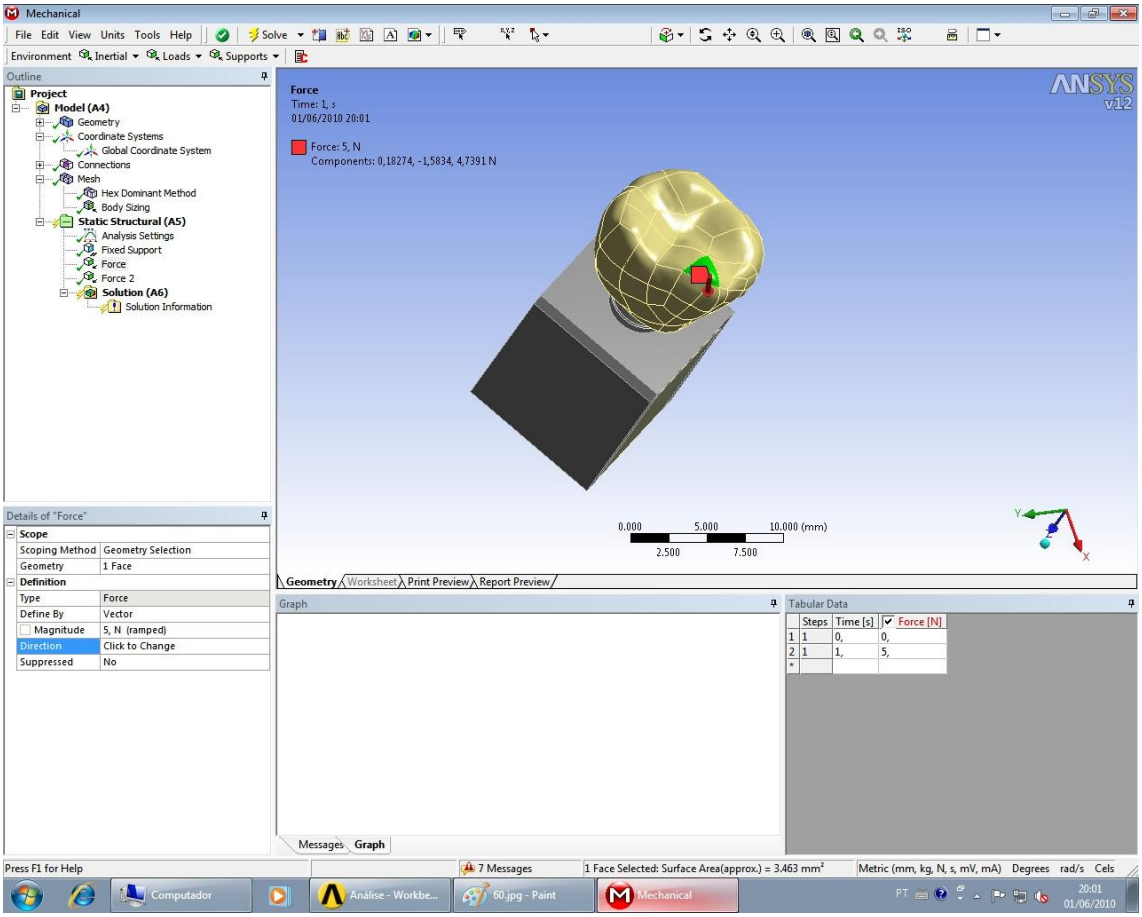
✓ Clicar em “Loads”, “Force” para criar uma força;



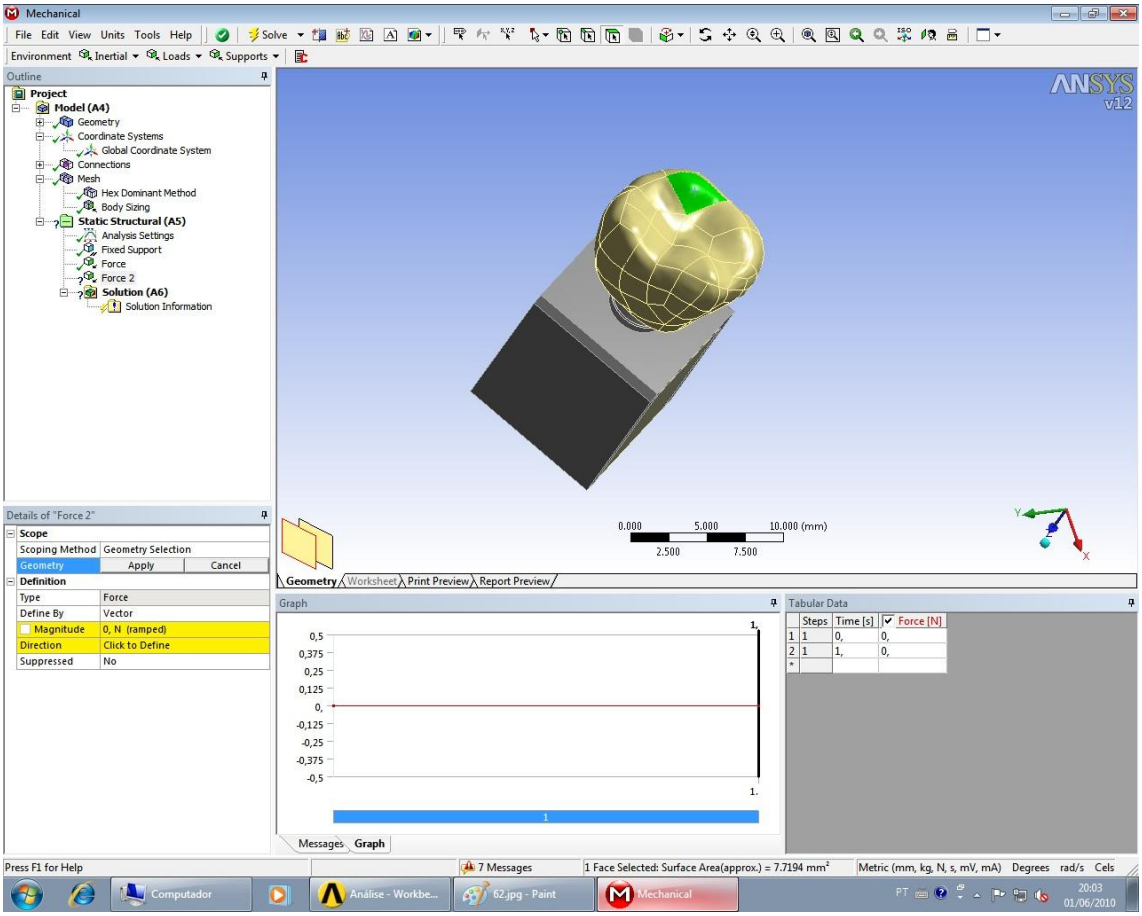
- ✓ Selecionar a face onde se quer aplicar a força;

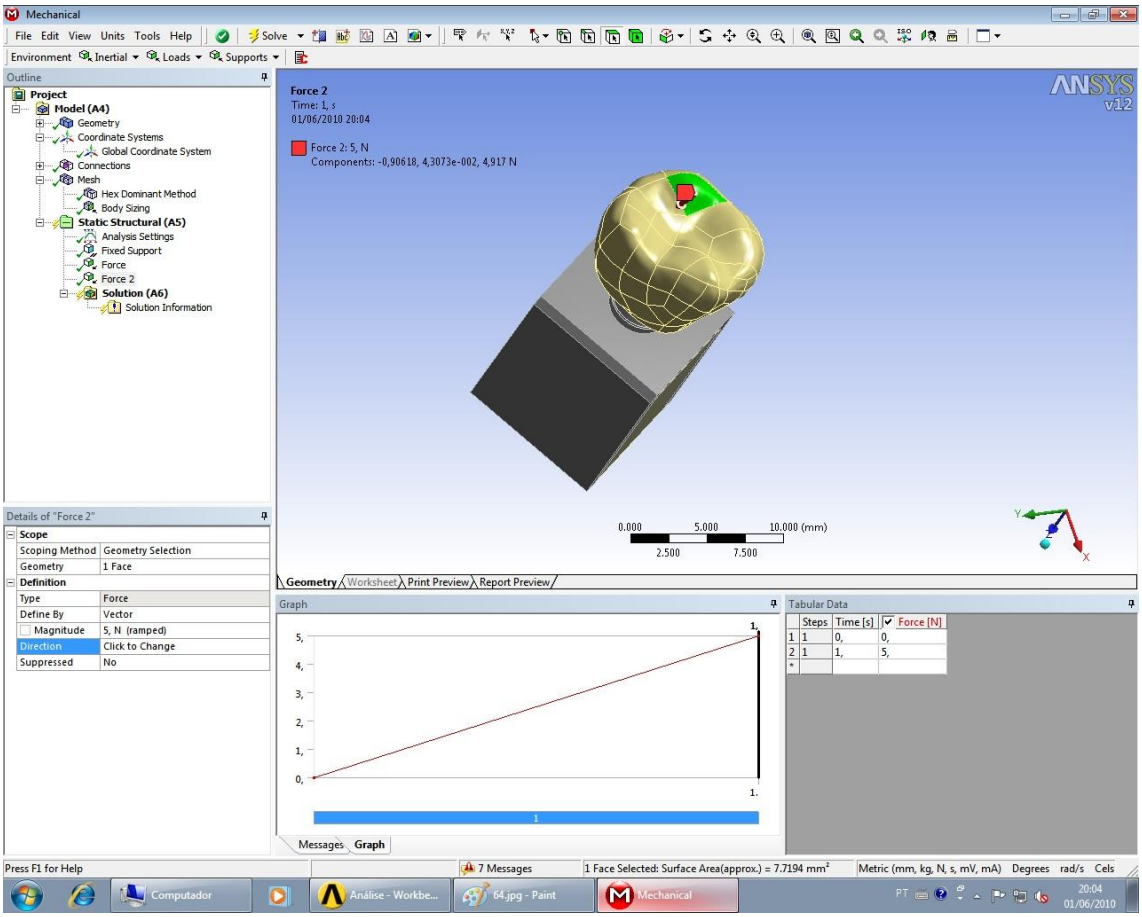


- ✓ Inserir uma força de compressão no valor de 5N, tomando cuidado com o seu sentido;

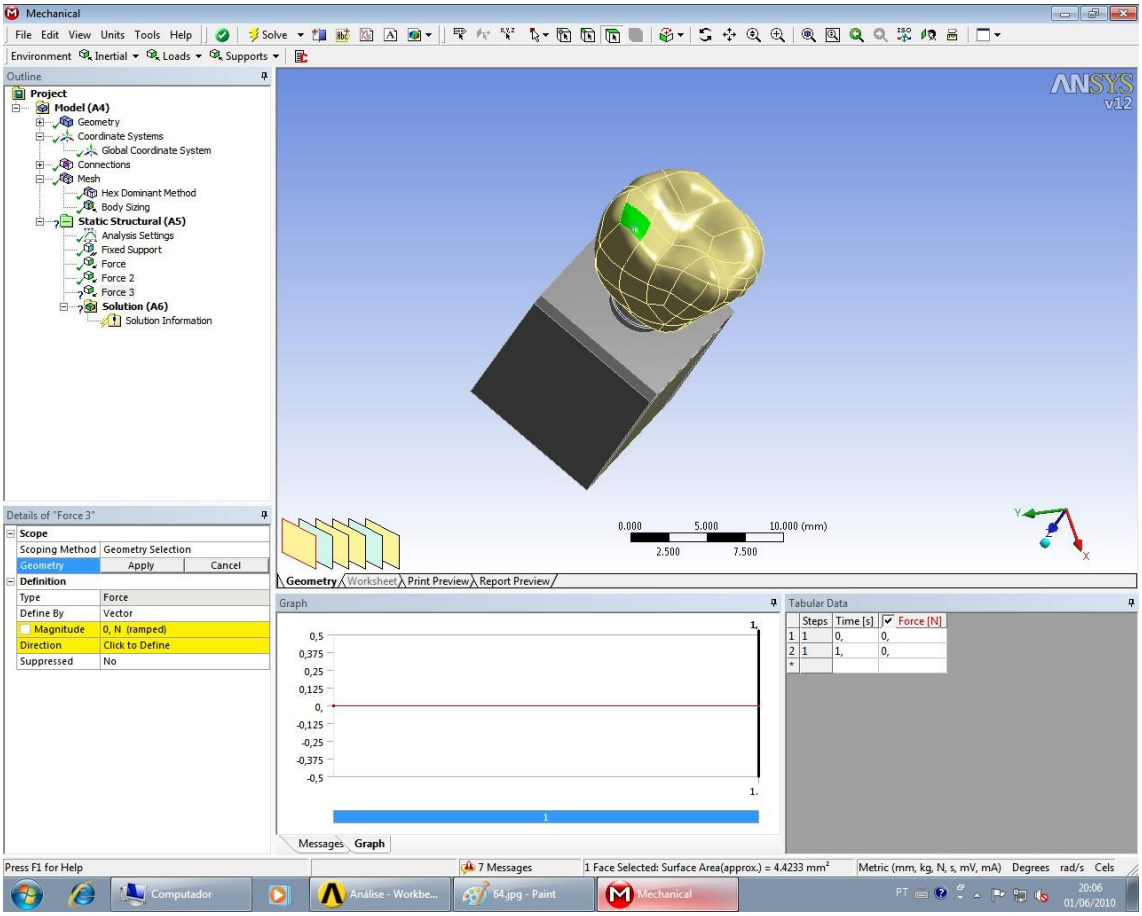


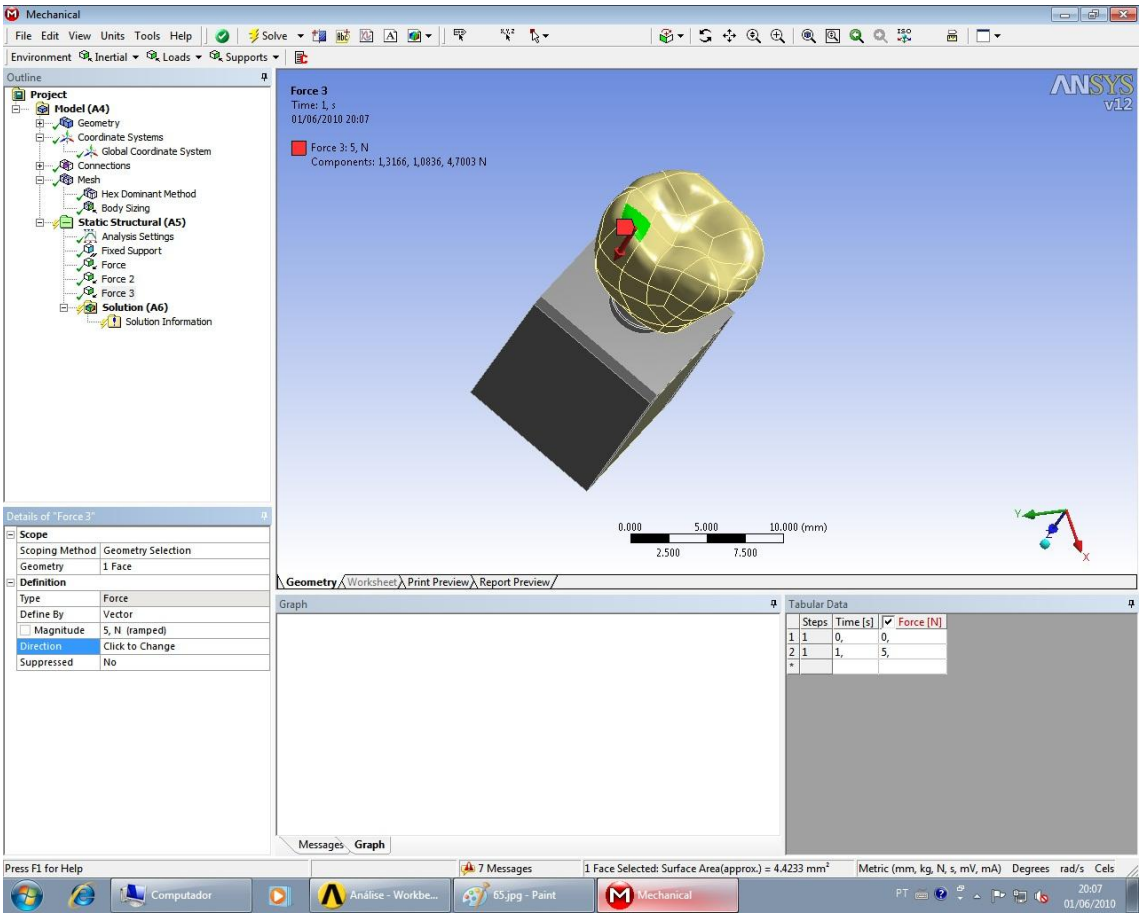
- ✓ Clicar em “Loads”, “Force” para criar outra força;
- ✓ Selecionar a face onde se quer aplicar a força;
- ✓ Inserir uma força de compressão no valor de 5N, tomando cuidado com o seu sentido;




Mechanical
File Edit View Units Tools Help
Solve
Environment Inertial Loads Supports
Outline
Project
Model (A4)
Geometry
Coordinate Systems
Global Coordinate System
Connections
Mesh
Hex Dominant Method
Body Sizing
Static Structural (A5)
Analysis Settings
Fixed Support
Force
Force 2
Solution (A6)
Solution Information
Force 2
Time: 1, s
01/06/2010 20:04
Force 2: 5, N
Components: -0,90618, 4,3073e-002, 4,917 N
ANSYS
v12
0.000 5.000 10.000 (mm)
2.500 7.500
Geometry Worksheet Print Preview Report Preview
Details of "Force 2"
Scope
Scoping Method Geometry Selection
Geometry 1 Face
Definition
Type Force
Define By Vector
Magnitude 5, N (ramped)
Direction Click to Change
Suppressed No
Graph
Tabular Data
Steps Time [s] Force [N]
1 1 0, 0,
2 1 1, 5,
Messages Graph
Press F1 for Help
7 Messages
1 Face Selected: Surface Area(approx.) = 7.7194 mm²
Metric (mm, kg, N, s, mV, mA) Degrees rad/s Cels
Computador
Análise - Workbe...
64.jpg - Paint
Mechanical
20:04
01/06/2010

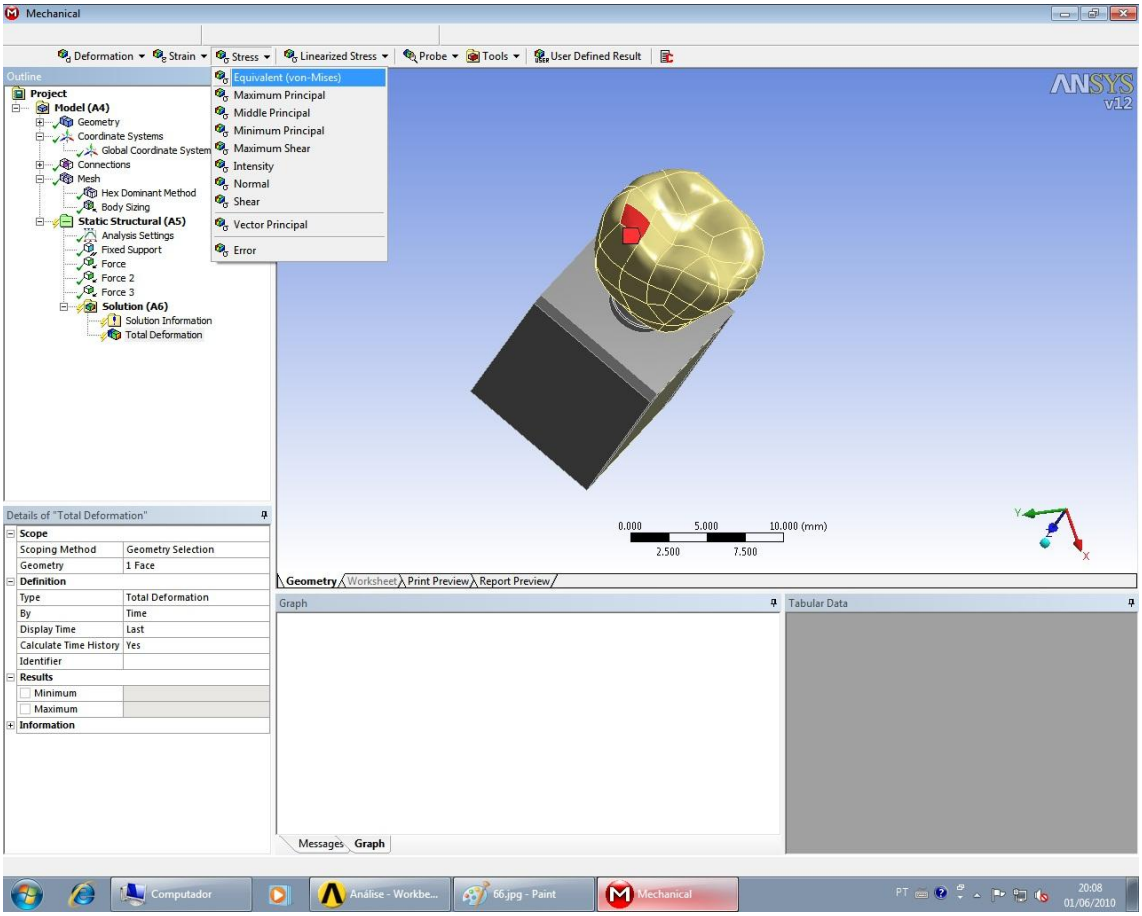
- ✓ Clicar em “Loads”, “Force” para criar outra força;
- ✓ Selecionar a face onde se quer aplicar a força;
- ✓ Inserir uma força de compressão no valor de 5N, tomando cuidado com o seu sentido;



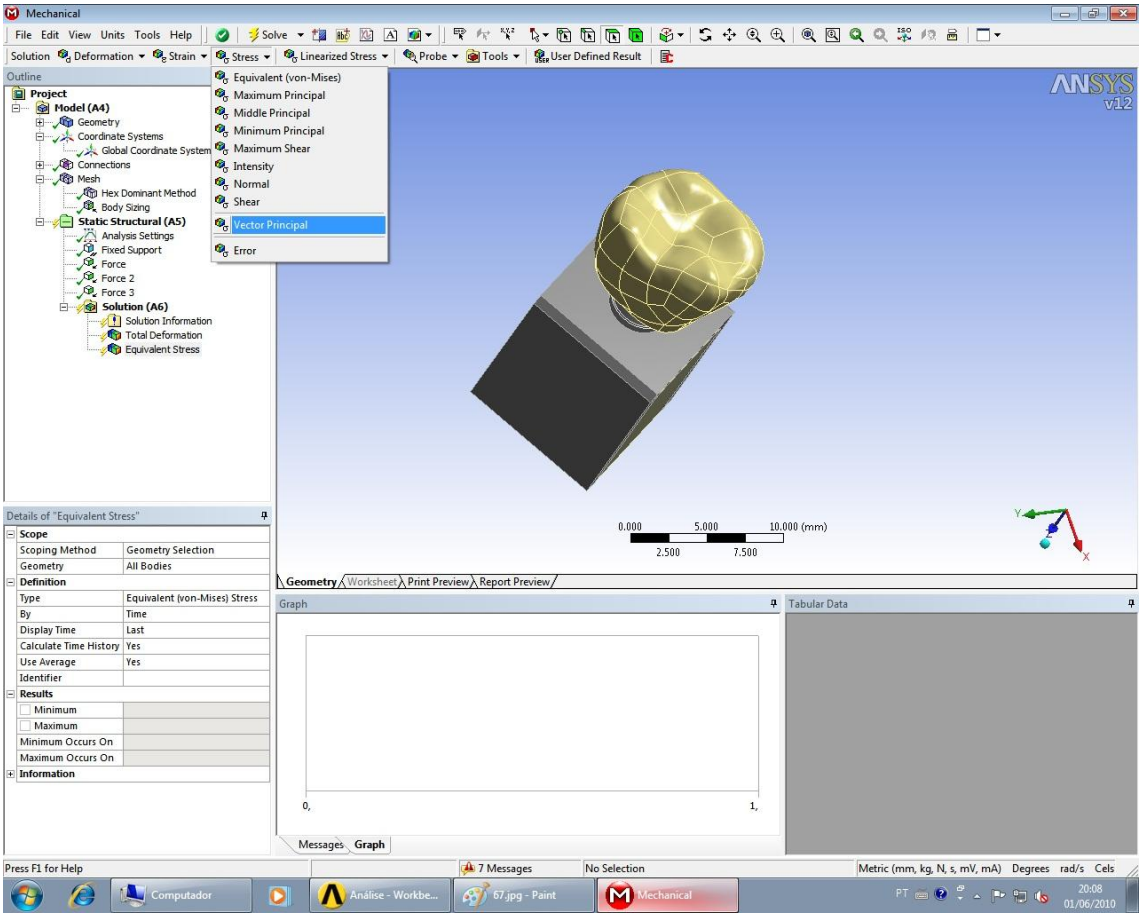

Mechanical
File Edit View Units Tools Help
Solve
Environment Inertial Loads Supports
Outline
Project
Model (A4)
Geometry
Coordinate Systems
Global Coordinate System
Connections
Mesh
Hex Dominant Method
Body Sizing
Static Structural (A5)
Analysis Settings
Fixed Support
Force
Force 2
Force 3
Solution (A6)
Solution Information
Force 3
Time: 1, s
01/06/2010 20:07
Force 3: 5, N
Components: 1,3166, 1,0836, 4,7003 N
ANSYS
v12
0.000 5.000 10.000 (mm)
2.500 7.500
Geometry Worksheet Print Preview Report Preview
Details of "Force 3"
Scope
Scoping Method Geometry Selection
Geometry 1 Face
Definition
Type Force
Define By Vector
Magnitude 5, N (ramped)
Direction Click to Change
Suppressed No
Graph
Messages Graph
Tabular Data
Steps Time [s] Force [N]
1 1 0, 0,
2 1 1, 5,
Press F1 for Help
7 Messages
1 Face Selected: Surface Area(approx.) = 4.4233 mm²
Metric (mm, kg, N, s, mV, mA) Degrees rad/s Cels
Computador
Análise - Workbe...
65.jpg - Paint
Mechanical
20:07
01/06/2010

8. SELECIONAR OS RESULTADOS A SEREM EXIBIDOS DEPOIS DE SOLUCIONADO

- ✓ Clicar em “Deformation”, “Total Deformation”;
- ✓ Clicar em “Stress”, “Equivalent (Von-mises)”;

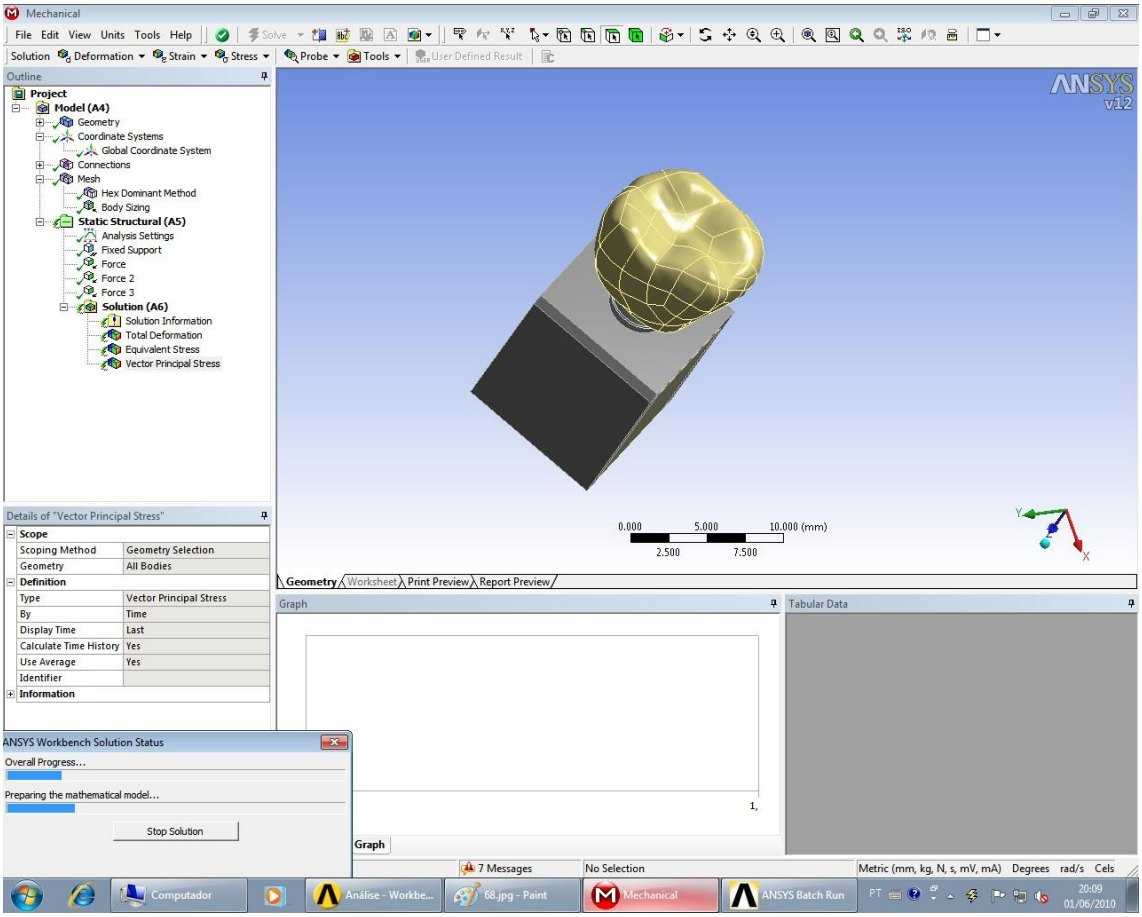


- ✓ Clicar em “Stress”, “Vector Principal”;



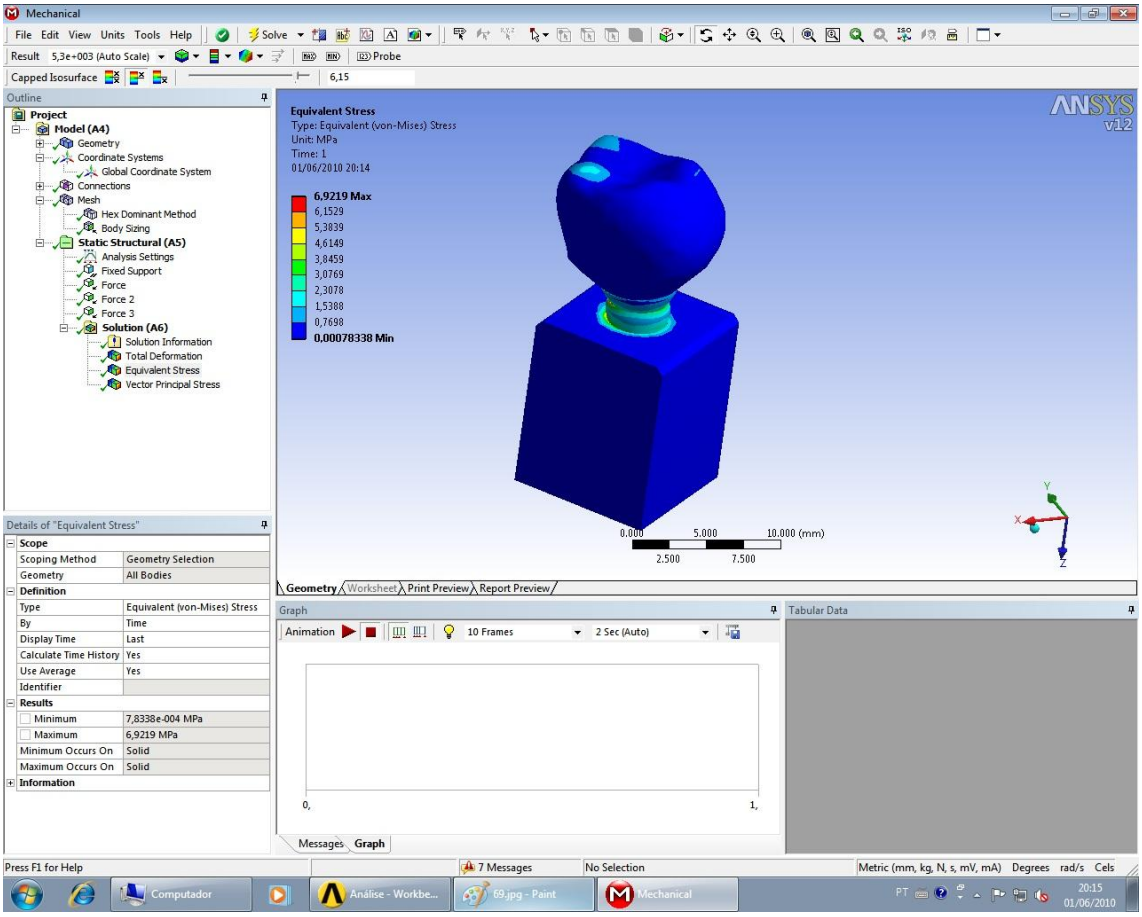
9. RESOLVER ANÁLISE

✓ Clicar em “Solve”;



10. ANÁLISE DE RESULTADOS

- ✓ No “Outline”, clicar em “Solution” e nos resultados que se quer visualizar;
- ✓ Clicar em “Equivalent Stress”;



- ✓ Clicar em “Equivalent Stress”;