

# Моделирование состояния биметаллических конструкций

# Порядок выполнения работы:

Моделирование биметаллических конструкций при статической нагрузке  
(Static Structural)

- Создание биметаллической конструкции согласно заданию.
- Задание материалов.
- Генерация сети конечных элементов.
- Задание граничных условий.
- Проведение расчета.
- Интерпретация результатов.

Определение частот и форм собственных колебаний  
(Modal)

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Reconnect Refresh Project Update Project Return to Project Compact Mode

Toolbox

- Physical Properties
- Linear Elastic
- Experimental Stress Strain Data
- Hyperelastic
- Plasticity
- Life
- Strength
- Gasket

	A	B	C	D
1	Data Source		Location	Description
2	Engineering Data		A2	Contents filtered for Static Structural (ANSYS).
3	General Materials	<input type="checkbox"/>		General use material samples for use in various analyses.
4	General Non-linear Materials	<input type="checkbox"/>		General use material samples for use in non-linear analyses.
5	Explicit Materials	<input type="checkbox"/>		Material samples for use in an explicit analysis.
6	Hyperelastic Materials	<input type="checkbox"/>		Material stress-strain data samples for curve fitting.

Outline of Schematic A2: Engineering Data

	A	B	C	D
1	Contents of Engineering Data		S.	Description
2	Material			
3	Structural Steel	<input type="checkbox"/>		Fatigue Data at zero 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:

	A	B	C
1	Property	Value	Unit

View All / Customize...

Ready

Show Progress Show 1 Messages

A

- Static Structural (ANSYS)
- Engineering Data ✓
- Geometry ?
- Model ?
- Setup ?
- Solution ?
- Results ?

Static Structural (ANSYS)

Шаг 1

Здание свойств нового материала для пластины

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Reconnect Refresh Project Update Project Return to Project Compact Mode

Toolbox

- Physical Properties
  - Density
  - Isotropic Shear Coefficient
  - Orthotropic Shear Coefficient
  - Isotropic Instantaneous Coeff
  - Orthotropic Instantaneous Coef
  - Constant Damping Coefficient
  - Damping Factor (β)
- Linear Elastic
  - Isotropic Elasticity
  - Orthotropic Elasticity
  - Anisotropic Elasticity
- Experimental Stress Strain Data
- Hyperelastic
- Plasticity
- Life
- Strength

Outline Filter

	A	B	C	D
1	Data Source		Location	Description
2	Engineering Data		A2	Contents filtered for Static Structural (ANSYS).
3	General Materials			General use material samples for use in various analyses.
4	General Non-linear Materials			General use material samples for use in non-linear analyses.
5	Explicit Materials			Material samples for use in an explicit analysis.
6	Hyperelastic Materials			Material stress-strain data samples for curve fitting.

Outline of Schematic A2: Engineering Data

	A	B	C	D
1	Contents of Engineering Data		S..	Description
2	Material			
3	Structural Steel			Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
4				
*				

Температура испытания	Модуль нормальной упругости	Модуль упругости при сдвиге кручением	Коэффициент Пуассона
t, °C	E, Па	G, Па	μ
20	2,15E+11	8,40E+10	0,2798
100	2,13E+11	8,30E+10	0,2831
200	2,07E+11	8,00E+10	0,2938
300	2E+11	7,70E+10	0,2987
400	1,8E+11	7,00E+10	0,2857
500	1,7E+11	6,50E+10	0,3077
600	1,54E+11	5,80E+10	0,3276
700	1,36E+11	5,10E+10	0,3333
800	1,28E+11	4,80E+10	0,3333

$$E = 2(1 + \mu)G$$

Table of Properties Row 5: Isotropic Elasticity

	A	B	C	D
1	Temperature (C)	Young's Modulus (Pa)	Poisson's Ratio	Bulk Modulus (Pa)
2	20	2,15E+11	0,2798	1,6273E+11
3	100	2,13E+11	0,2831	1,6367E+11
4	200	2,07E+11	0,2938	1,6731E+11
5	300	2E+11	0,2987	1,6559E+11
6	400	1,8E+11	0,2857	1,3999E+11
7	500	1,7E+11	0,3077	1,4734E+11
8	600	1,54E+11	0,3276	1,4888E+11
9	700	1,36E+11	0,3333	1,3597E+11
10	800	1,28E+11	0,3333	1,2797E+11
*				

Chart of Properties Row 5: Isotropic Elasticity

Properties of Outline R

	Property
1	Property
2	De
3	Is
4	Young
5	Young
6	Poiss
7	Poiss
8	Bulk Modulus: Scale

Ready

Show Progress Show 1 Messages

Шаг 2

Здание зависимости прочностных свойств от температуры

	A	
1	Static Structural (ANSYS)	
2	Engineering Data	✓
3	Geometry	?
4	Model	?
5	Setup	?
6	Solution	?
7	Results	?

Static Structural (ANSYS)

Outline Filter				
	A	B	C	D
1	Data Source		Location	Description
2	Engineering Data		A2	Contents filtered for Static Structural (ANSYS).
3	General Materials			General use material samples for use in various analyses.
4	General Non-linear Materials			General use material samples for use in non-linear analyses.
5	Explicit Materials			Material samples for use in an explicit analysis.
6	Hyperelastic Materials			Material stress-strain data samples for curve fitting.

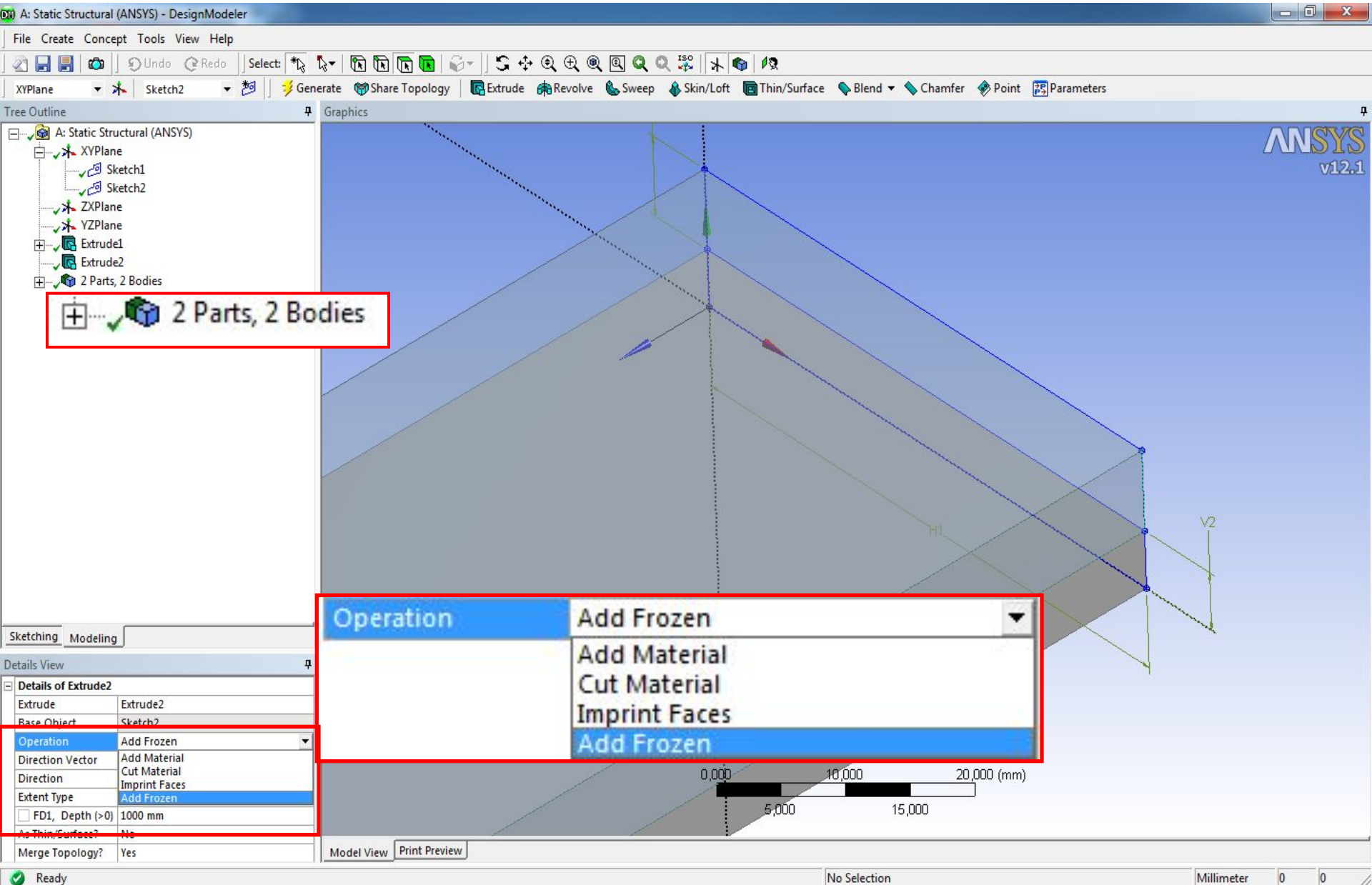
Outline Filter				
	A	B	C	D
1	Data Source		Location	Description
2	Engineering Data		A2	Contents filtered for Static Structural (ANSYS).
3	General Materials			General use material samples for use in various analyses.
4	General Non-linear Materials			General use material samples for use in non-linear analyses.
5	Explicit Materials			Material samples for use in an explicit analysis.
6	Hyperelastic Materials			Material stress-strain data samples for curve fitting.

Outline of Schematic A2: Engineering Data				
	A	B	C	D
1	Contents of Engineering Data		S..	Description
2	Material			
3	Copper Alloy			
4	Structural Steel			Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
*	Click here to add a new material			

Outline of General Materials					
	A	B	C	D	E
1	Contents of General Materials	Add	S..		Description
2	Material				
3	Air	+			General properties for air.
4	Aluminum Alloy	+			General aluminum alloy. Fatigue properties come from MIL-HDBK-5H, page 3-277.
5	Concrete	+			
6	Copper Alloy	+			
7	Gray Cast Iron	+			
8	Magnesium Alloy	+			
9	Polyethylene	+			
10	Silicon Anisotropic	+			
11	Stainless Steel	+			

Properties of Outline Row 3: Copper Alloy				
	A	B	C	D
1	Property	Value	Unit	
2	Density	8300	kg m <sup>-3</sup>	
3	Isotropic Secant Coefficient of Thermal Expansion			
4	Coefficient of Thermal Expansion	1,8E-05	C <sup>-1</sup>	
5	Reference Temperature	22	C	
6	Isotropic Elasticity			
7	Derive from	Young's Modulus and Poisson's Ratio		
8	Young's Modulus	1,1E+11	Pa	

Properties of Outline Row 3: Air			
	A	B	C
1	Property	Value	Unit



Шаг 4

Моделирование геометрии двух биметаллических пластин

ANSYS v12.1

A : Static Structural (ANSYS) - Mechanical [ANSYS Multiphysics]

File Edit View Units Tools Help Solve Worksheet Mesh Update Mesh Mesh Control Metric Graph Options

Outline

- Project
  - Model (A4)
    - Geometry
      - Solid
      - Solid
    - Coordinate Systems
    - Connections
    - Mesh
      - Edge Sizing
      - Edge Sizing 2
    - Static Structural (A5)
      - Analysis Settings
      - Solution (A6)
        - Solution Information

Details of "Mesh"

Defaults

Physics Preference	Mechanical
Relevance	0

Sizing

Inflation

Advanced

Pinch

Statistics

Section Planes

Geometry | Print Preview | Report Preview

Messages

Text	Association	Timestamp
Warning: The CFX-Mesh Method has been superseded by the Patch Conforming Tetrahedral Me	Project	9/4/2013 6:28:07 PM

Press F1 for Help | 1 Message | No Selection | Metric (m, kg, N, s, V, A) Degrees rad/s Celsius

**Шаг 5** Создание неравномерной расчетной сетки двух биметаллических пластин

**Project**

- Model (B4, C4)
  - Geometry
  - Coordinate Systems
  - Connections
  - Mesh
  - Steady-State Thermal (B5)
    - Initial Temperature
    - Analysis Settings
    - Temperature
    - Temperature 2
  - Solution (B6)
  - Static Structural (C5)
    - Analysis Settings
    - Fixed Support
    - Imported Load (Solution 1)
      - Imported Body Temperature
  - Solution (C6)
    - Solution Information
    - Total Deformation
    - Equivalent Stress

**Outline**

- Project
  - Model (A4)
    - Geometry
      - Solid
      - Solid
    - Coordinate Systems
    - Connections
    - Mesh
      - Edge Sizing
      - Edge Sizing 2
    - Static Structural (A5)
      - Analysis Settings
      - Thermal Condition
      - Thermal Condition 2
    - Solution (A6)
      - Solution Information

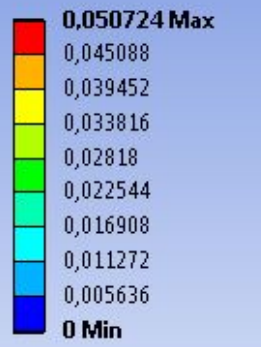
- Fixed Support
- Displacement
- Remote Displacement
- Velocity
- Impedance Boundary
- Frictionless Support
- Compression Only Support
- Cylindrical Support
- Simply Supported
- Fixed Rotation
- Elastic Support
- Coupling
- Constraint Equation

Details of "Imported Body Temperature"

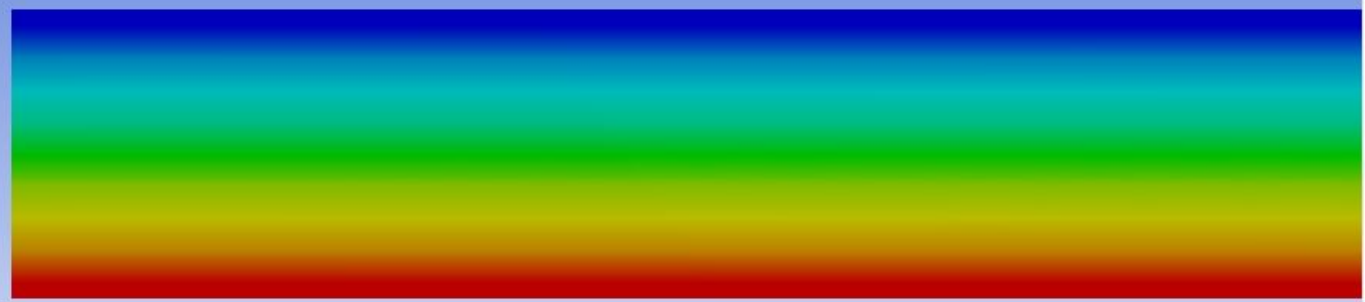
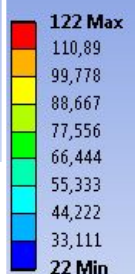
Scope	
Scoping Method	Geometry Selection
Geometry	2 Bodies

- Insert
- Suppress
- Import Load
- Clean
- Delete
- Rename

**C: Static Structural (ANSYS)**  
 Total Deformation  
 Type: Total Deformation  
 Unit: m  
 Time: 1  
 28.09.2015 9:33



**B: Steady-State Thermal (ANSYS)**  
 Temperature  
 Type: Temperature  
 Unit: °C  
 Time: 1  
 28.09.2015 9:34





# Применение программного комплекса ANSYS Workbench для расчета задач стержневых систем

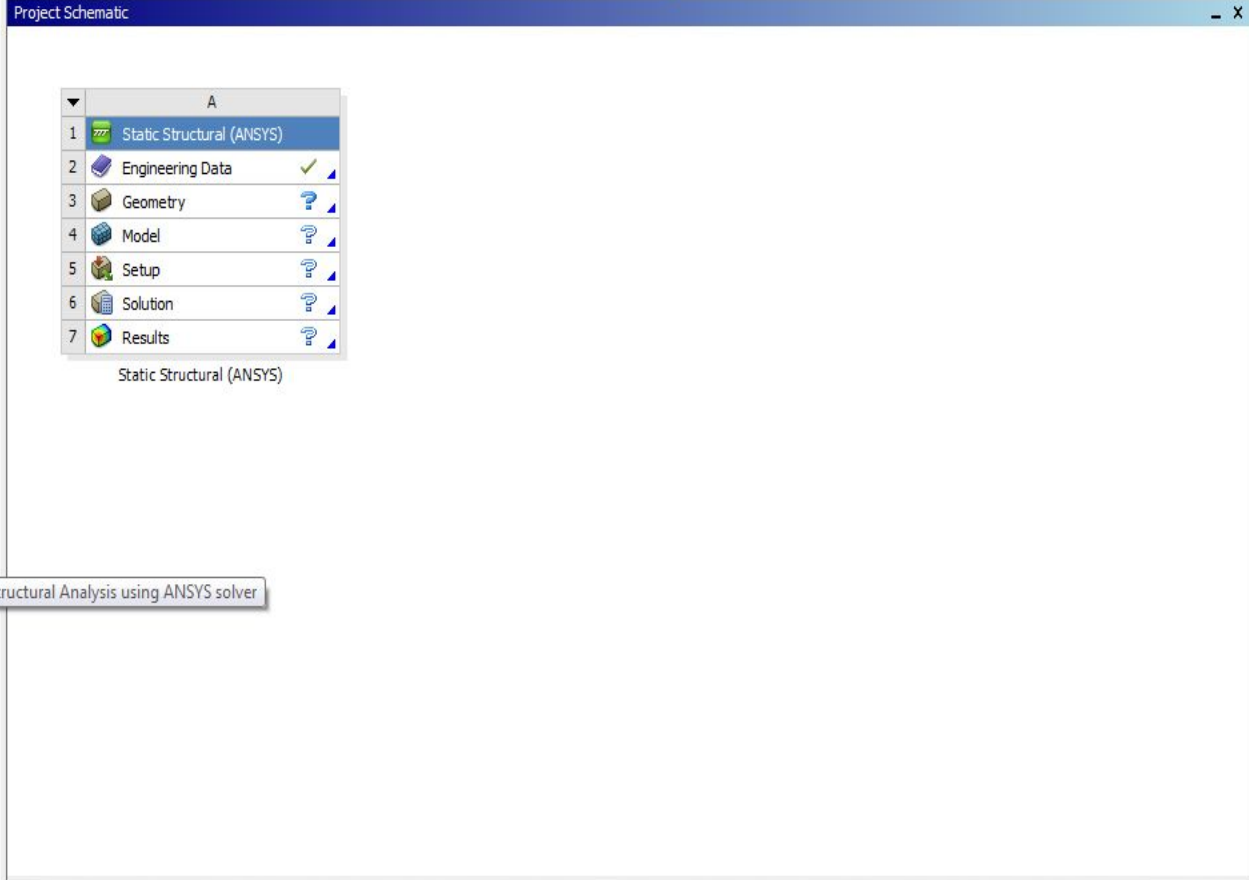
# Порядок выполнения работы:

Моделирование неразрезной балки  
при статической нагрузке  
(Static Structural)

- Создание схемы балки согласно заданию.
- Задание материалов.
- Генерация сети балочных элементов.
- Задание граничных условий.
- Проведение расчета.
- Интерпретация результатов.

Определение частот и форм  
собственных колебаний  
(Modal)

- Analysis Systems
  - Electric (ANSYS)
  - Explicit Dynamics (ANSYS)
  - Fluid Flow - BlowMolding (F)
  - Fluid Flow - Extrusion (POL)
  - Fluid Flow (CFX)
  - Fluid Flow (FLUENT)
  - Fluid Flow (POLYFLOW)
  - Harmonic Response (ANSYS)
  - Hydrodynamic Diffraction (H)
  - Linear Buckling (ANSYS)
  - Magnetostatic (ANSYS)
  - Modal (ANSYS)
  - Modal (Samcef)
  - Random Vibration (ANSYS)
  - Response Spectrum (ANSYS)
  - Shape Optimization (ANSYS)
  - Static Structural (ANSYS)
  - Static Structural (Samcef)
  - Steady-State Thermal (ANSYS)
  - Thermal-Electric (ANSYS)
  - Transient Structural (ANSYS)
  - Transient Structural (MBD)
  - Transient Thermal (ANSYS)
- Component Systems
  - AUTODYN
  - BladeGen
  - CFX
  - Engineering Data
  - Explicit Dynamics (LS-DYNA)
  - External Connection
  - Finite Element Modeler
  - FLUENT
  - Geometry
  - Icepak
  - Mechanical APDL
  - Mechanical Model
  - Mesh
  - POLYFLOW



Static Structural Analysis using ANSYS solver

	A	B
1	Property	Value

	A	B	C
1	Type	Text	Date/Time
2	Warning!	Problematic URL in 'Custom RSS Feed Address' in 'Project Management' options <a href="http://www.ansys.com/rss/ansys-news.rss">http://www.ansys.com/rss/ansys-news.rss</a>	04.10.2011 19:05:31

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Reconnect Refresh Project Update Project Return to Project Compact Mode

Toolbox

- Physical Properties
- Linear Elastic
- Experimental Stress Strain Data
- Hyperelastic
- Plasticity
- Life
- Strength

Outline Filter

	A	B	C	D
1	Data Source		Location	Description
2	Engineering Data		A2	Contents filtered for Static Structural (ANSYS).
3	General Materials	<input type="checkbox"/>		General use material samples for use in various analyses.
4	General Non-linear Materials	<input type="checkbox"/>		General use material samples for use in non-linear analyses.
5	Explicit Materials	<input type="checkbox"/>		Material samples for use in an explicit analysis.
6	Hyperelastic Materials	<input type="checkbox"/>		Material stress-strain data samples for curve fitting.

Outline of Schematic A2: Engineering Data

	A	B	C	D
1	Contents of Engineering Data		S..	Description
2	Material			
3	Stainless Steel	<input type="checkbox"/>		
4	Structural Steel	<input type="checkbox"/>		Fatigue Data at zero 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 3: Stainless Steel

	A	B	C	D
1	Property	Value	Unit	
2	Density	7750	kg m^-3	
3	Isotropic Secant Coefficient of Thermal Expansion			
6	Isotropic Elasticity			
7	Derive from	Young's Modulus and Poisson's Ratio		
8	Young's Modulus	1,93E+11	Pa	
9	Poisson's Ratio	0,31		
10	Bulk Modulus	1,693E+11	Pa	

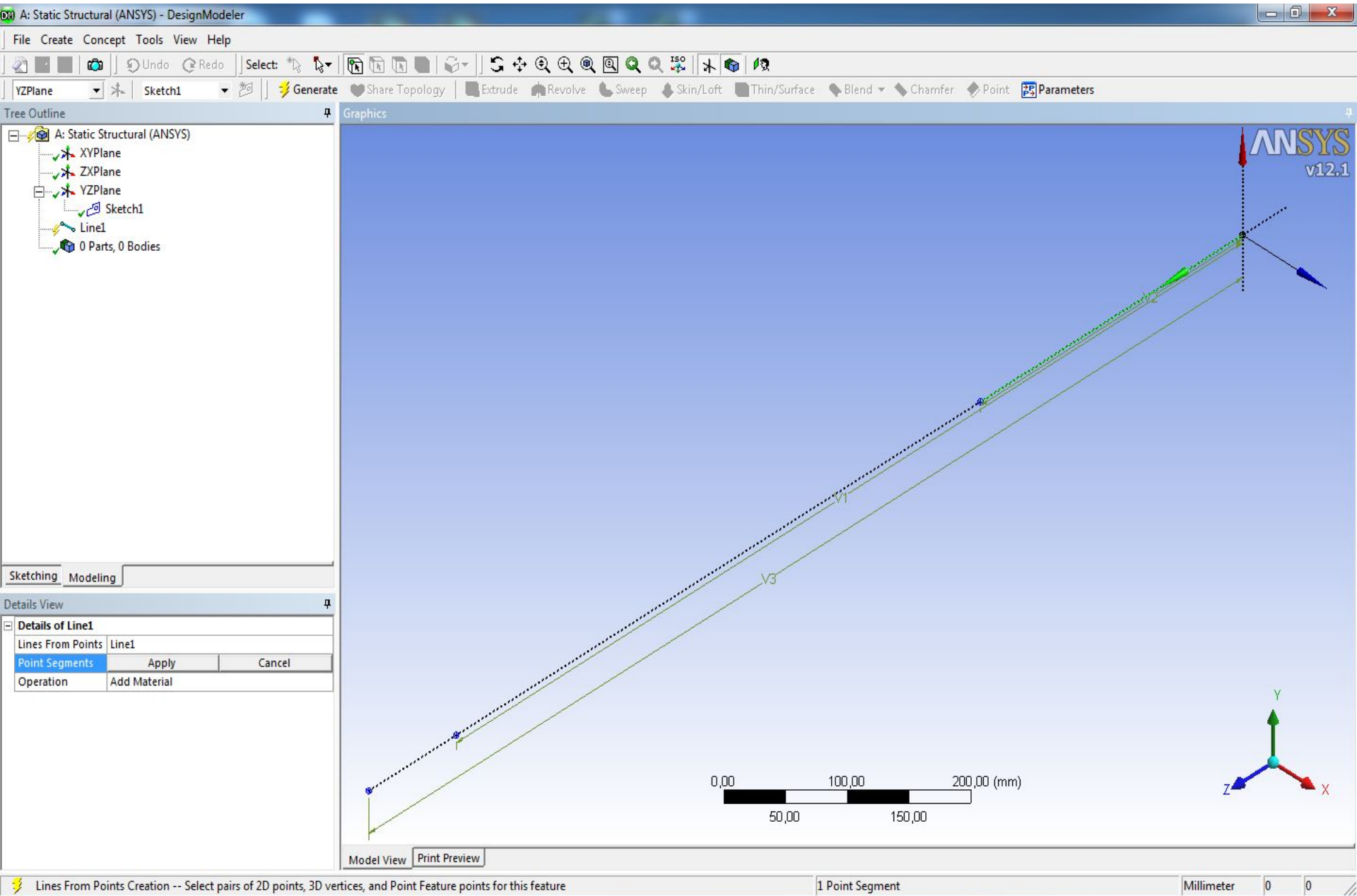
Table of Properties Row 2: Density

	A	B
1	Temperature (C)	Density (kg m^-3)
2		Ascending
		Descending
		Sort Settings...
		Cancel sorting
		K
		<input checked="" type="checkbox"/> C
		R
		F

Chart of Properties Row 2: Density

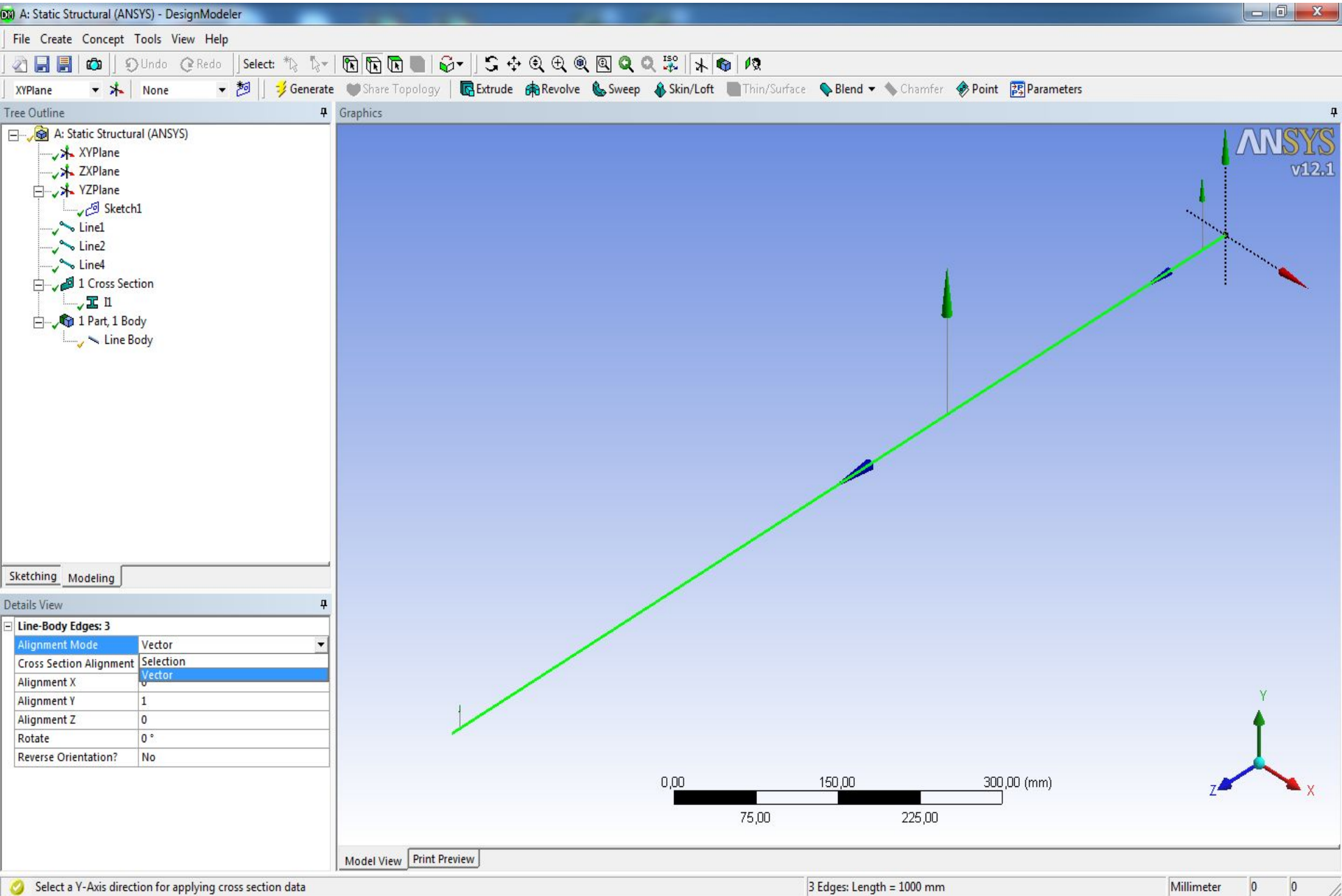
Ready

Show Progress Show 1 Messages



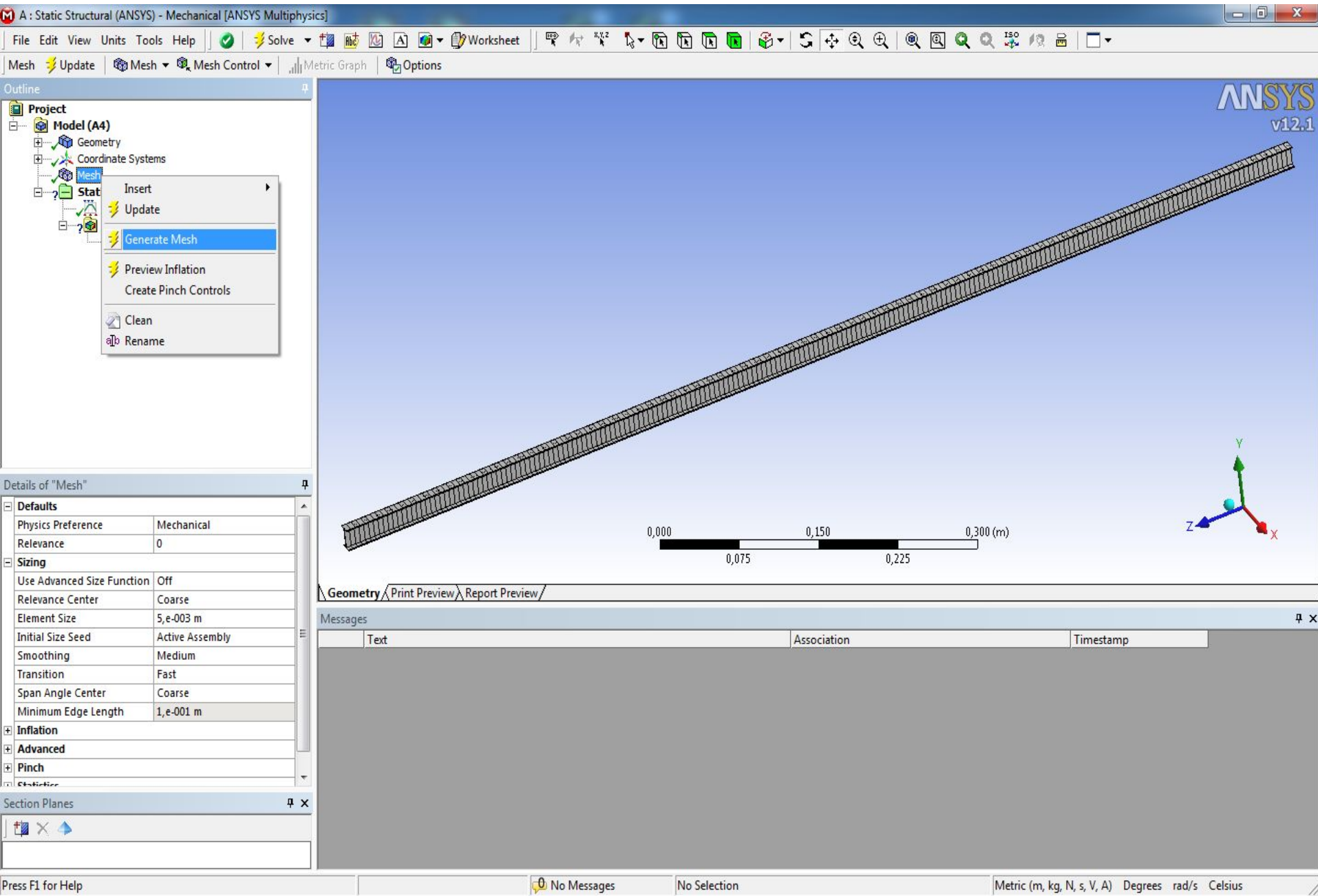
## Шаг 2

Создание конструкционных точек и направляющих линий



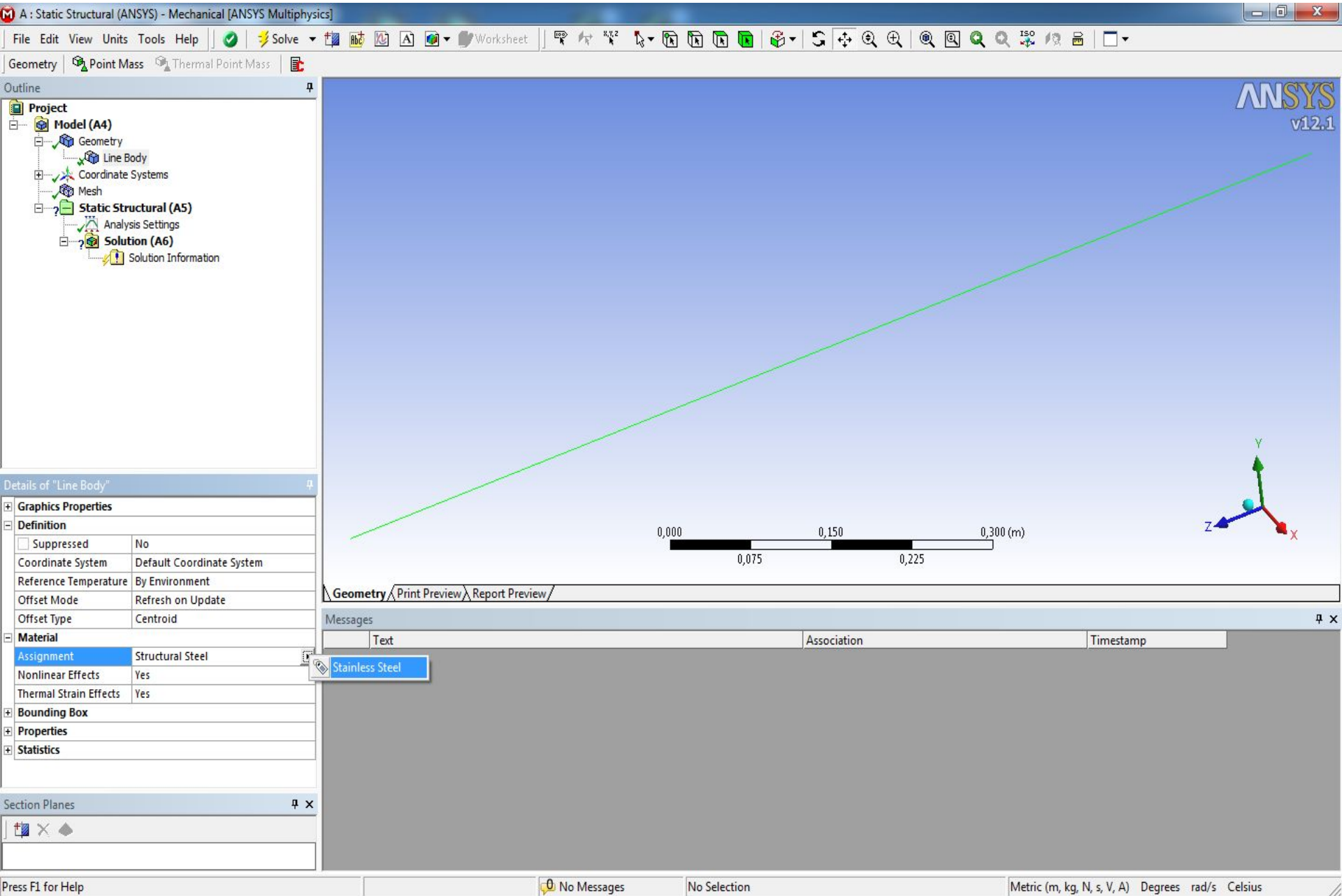
### Шаг 3

Здание поперечного сечения балки



Шаг 4

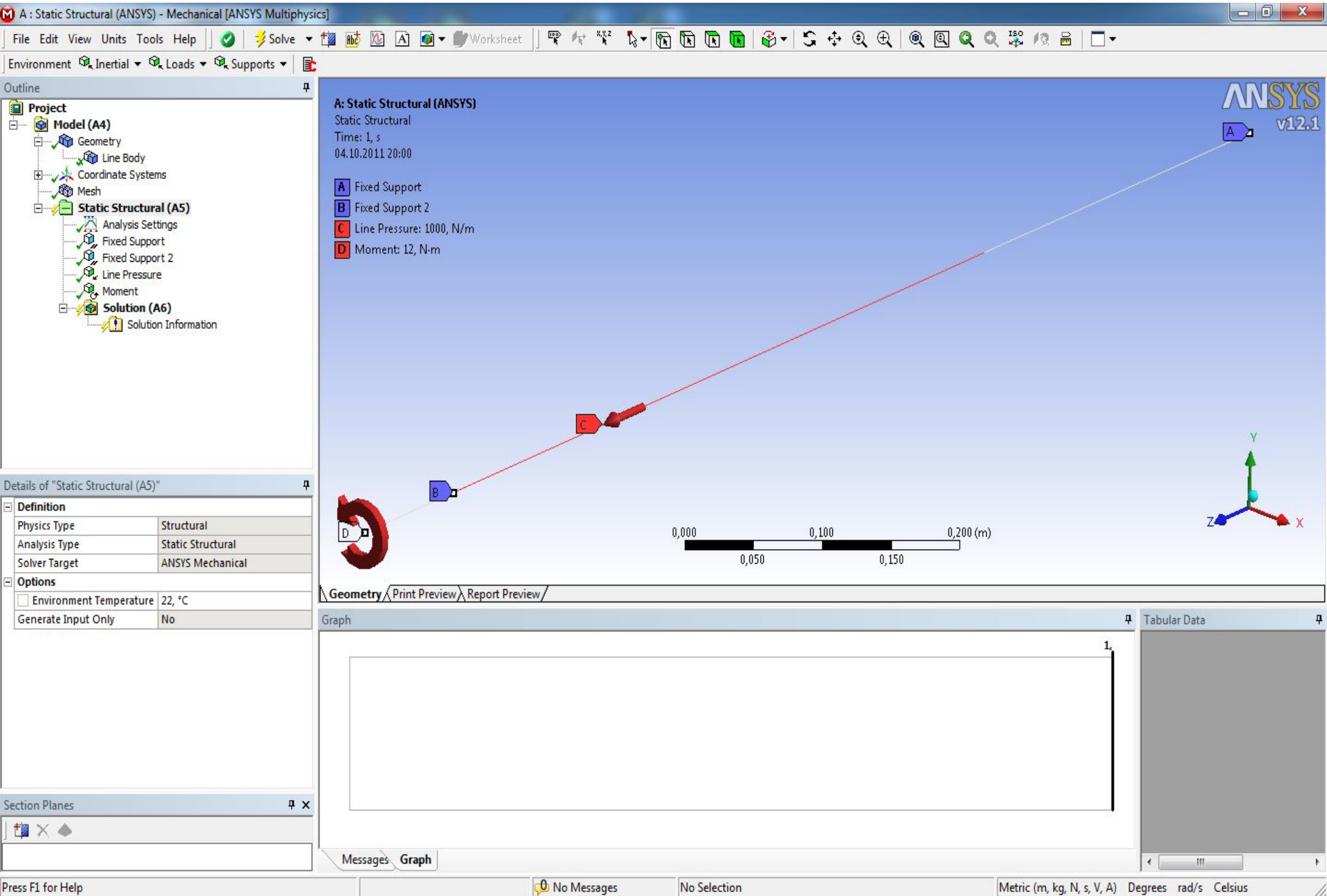
Построение сети конечных элементов

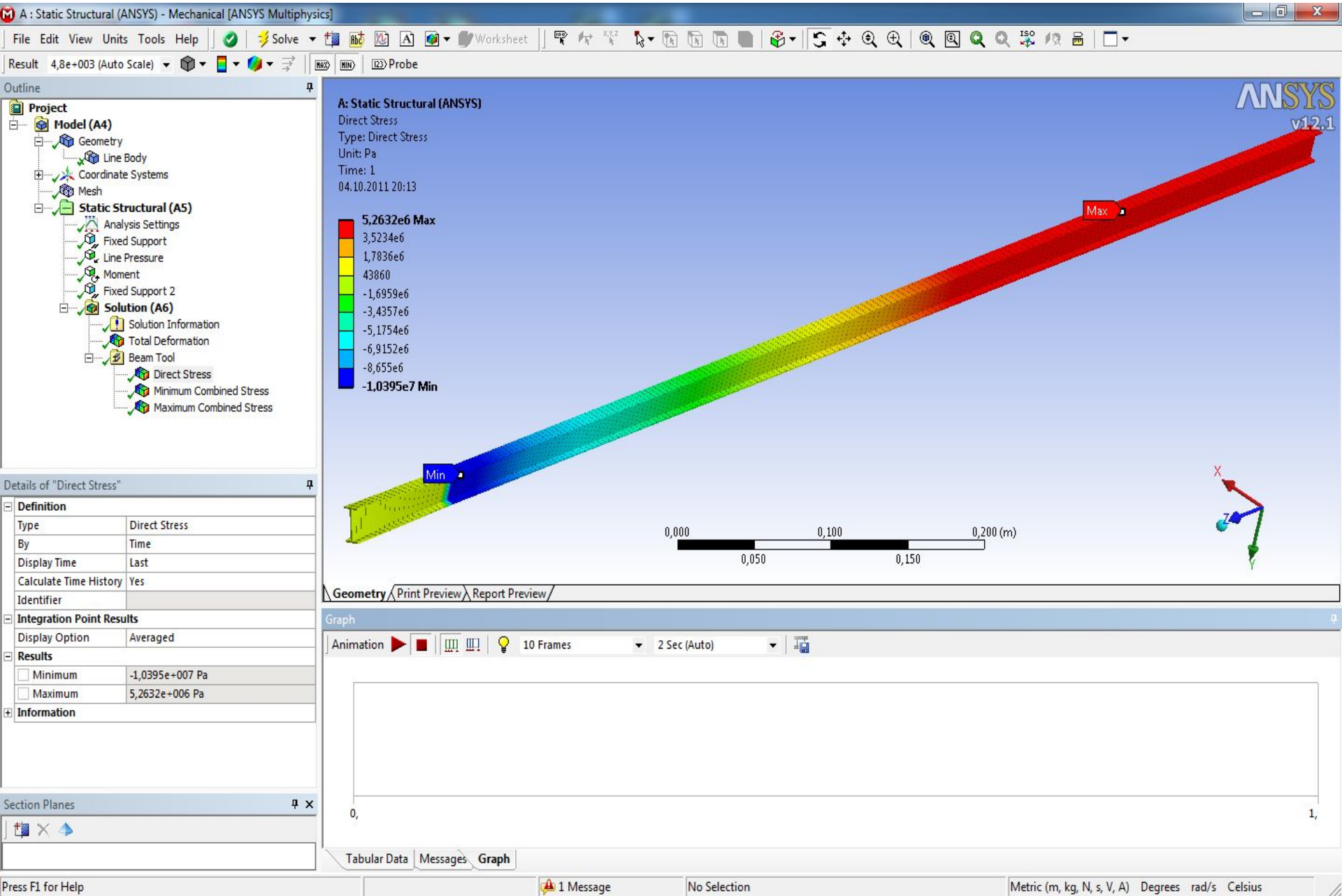


Шаг 5

Задание граничных условий

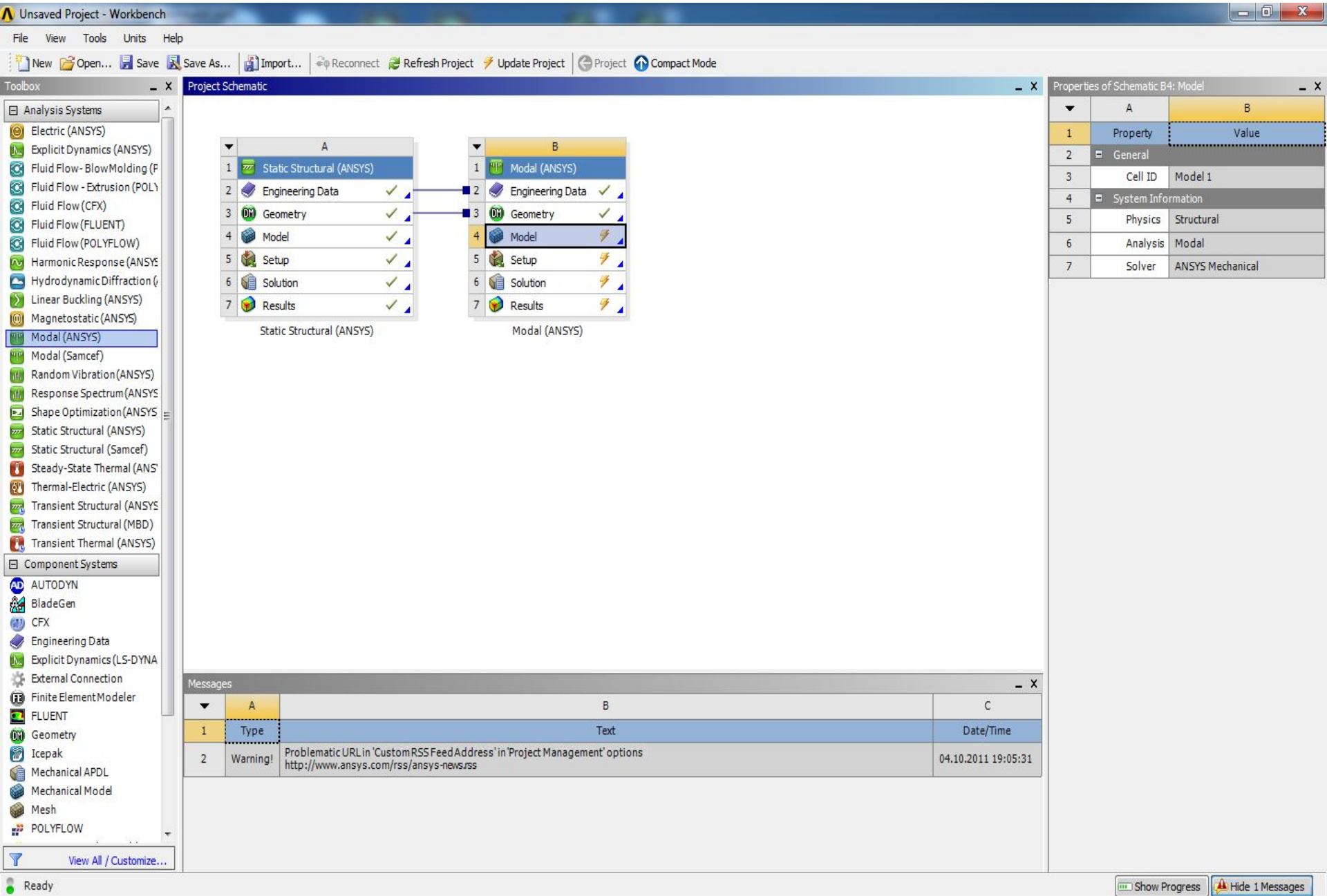






Шаг 6

Результат решения статической задачи прочности



## Шаг 7

## Направление данных в модальный анализ

