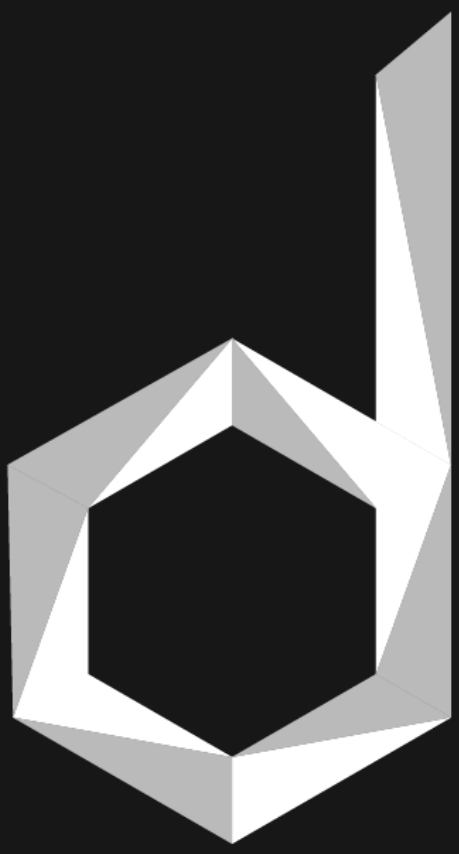
INGENIERÍA MECATRÓNICA



DI_CERO

DIEGO CERVANTES RODRÍGUEZ

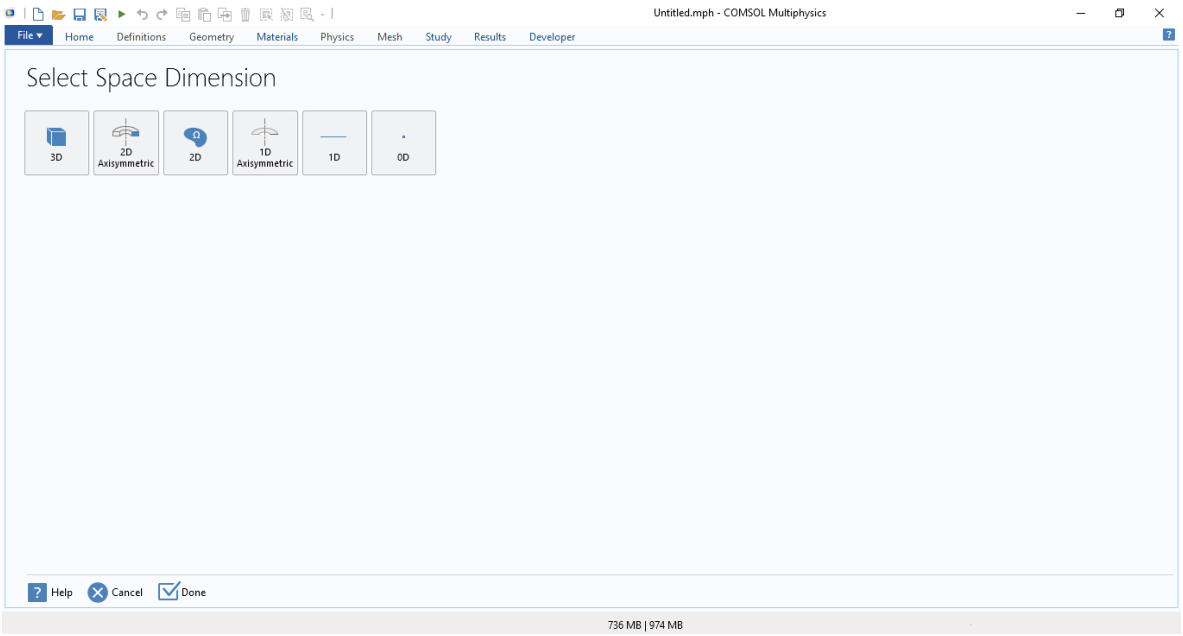
INGENIERÍA ASISTIDA POR COMPUTADORA

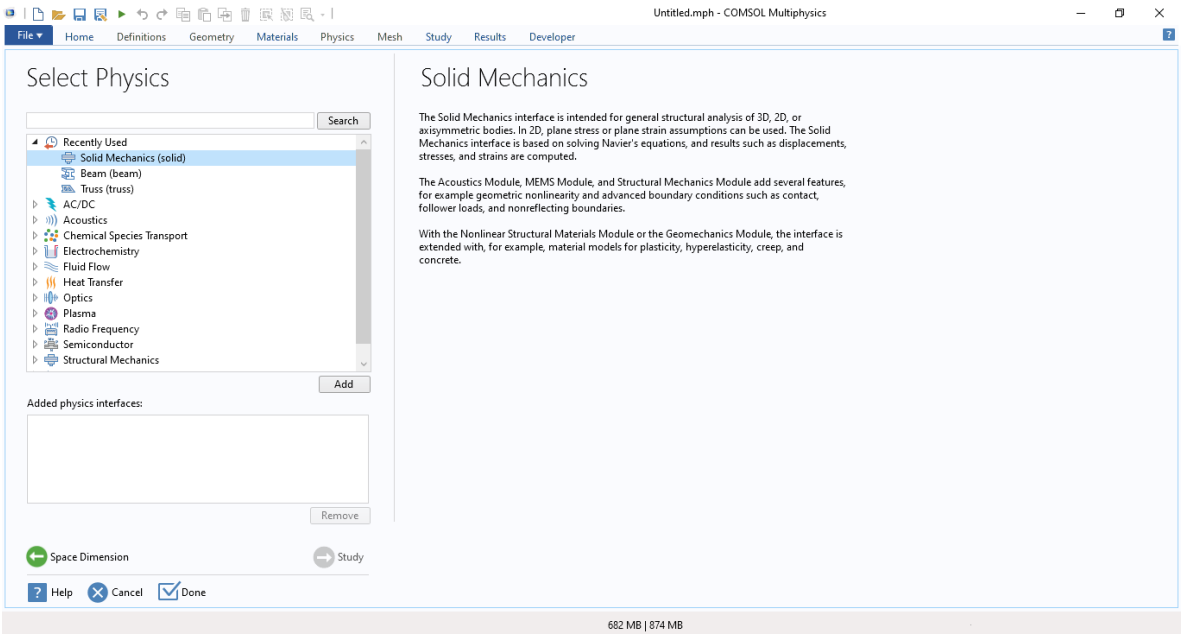
COMSOL MULTIPHYSICS 5.6

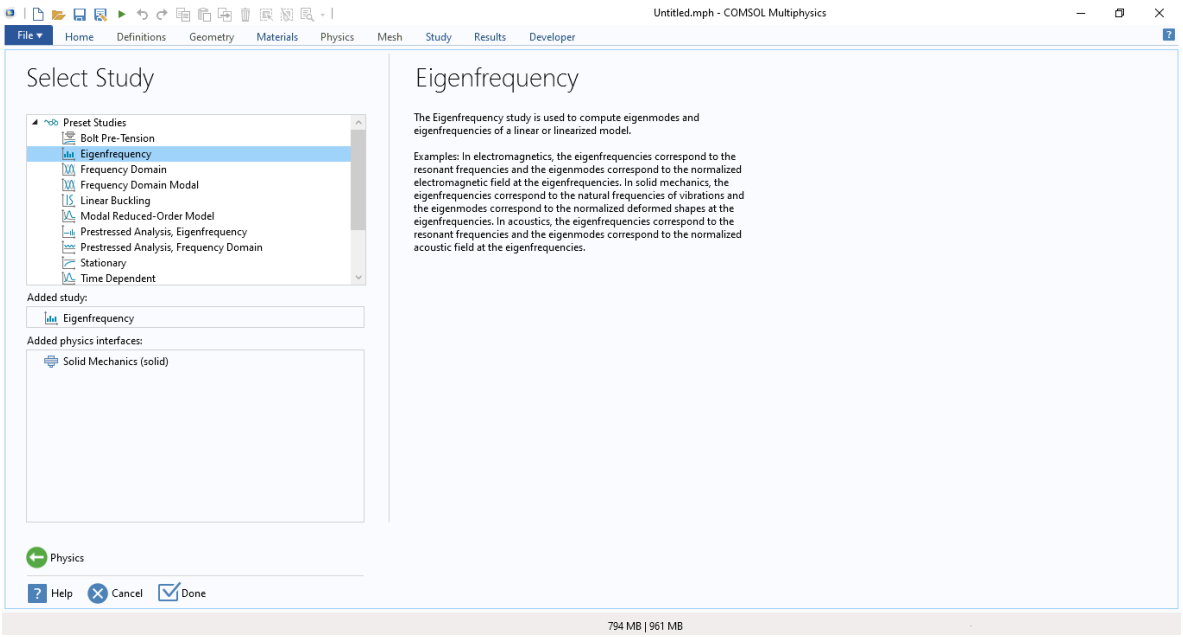
11: Vibración en Vigas - Frecuencias Armónicas

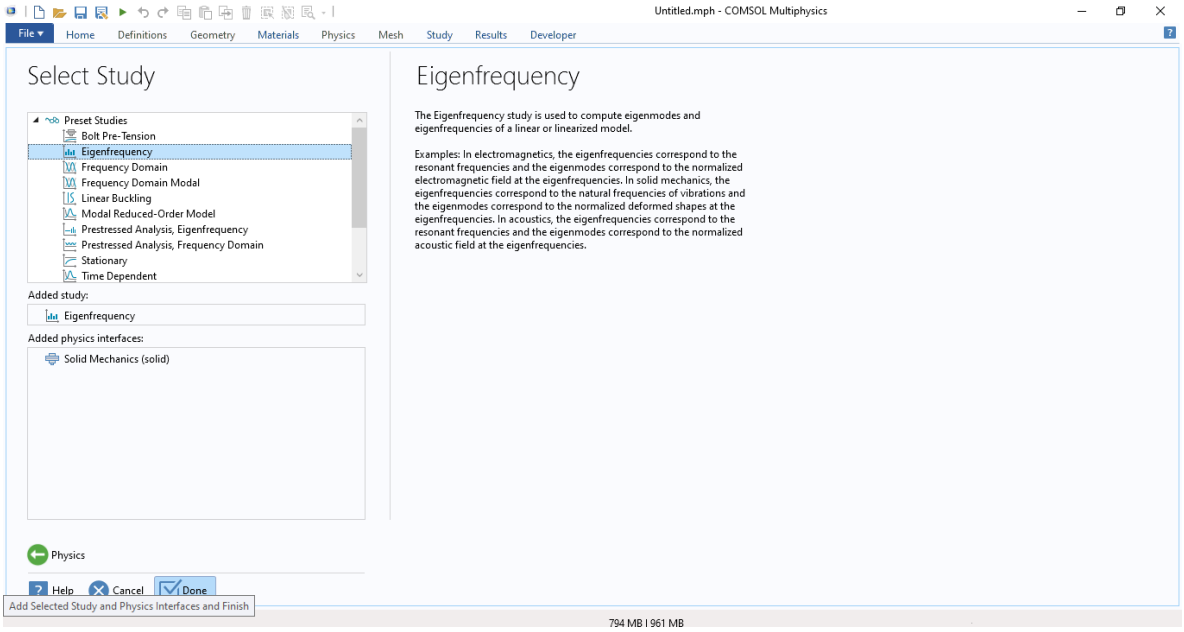
Contenido

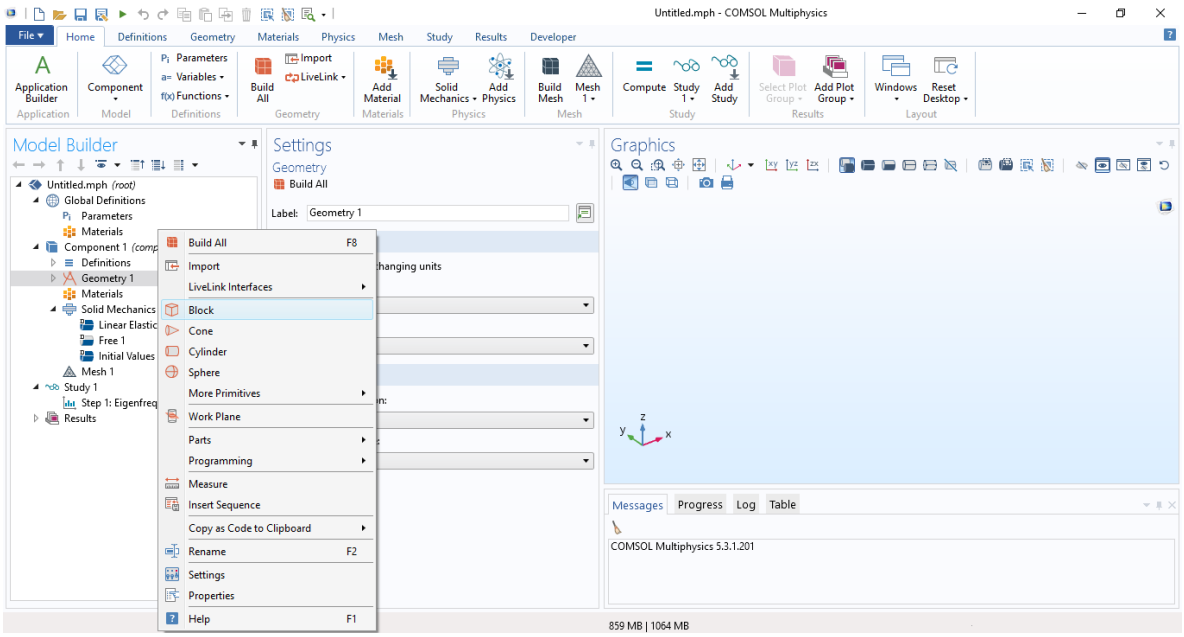
CREACIÓN DE LA PIEZA EN COMSOL:

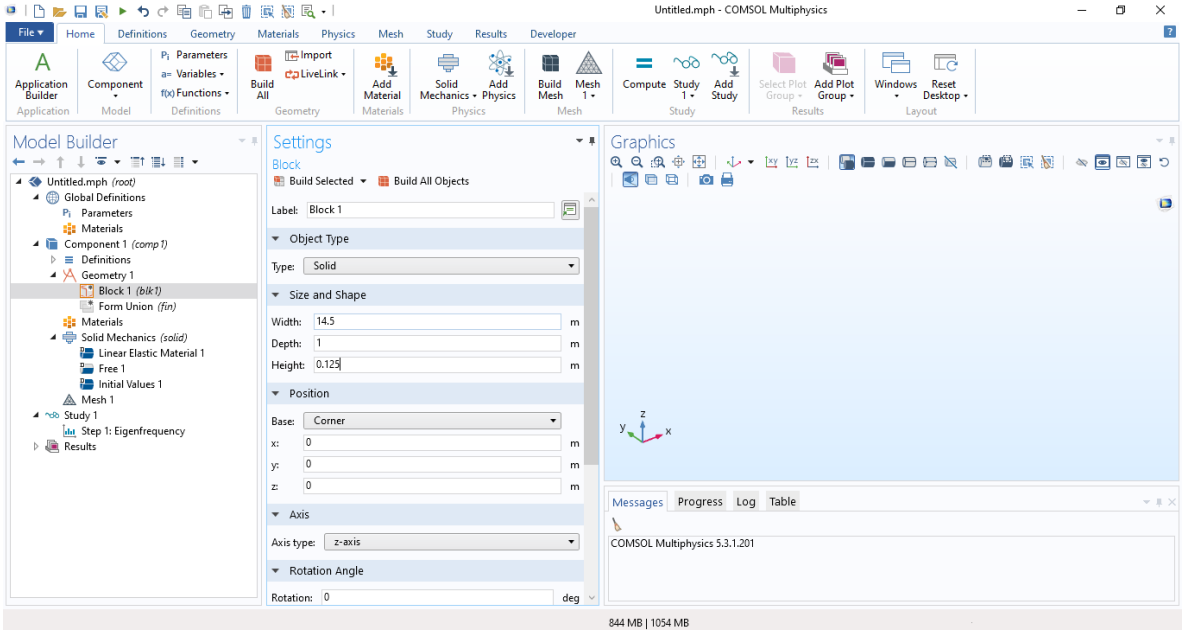


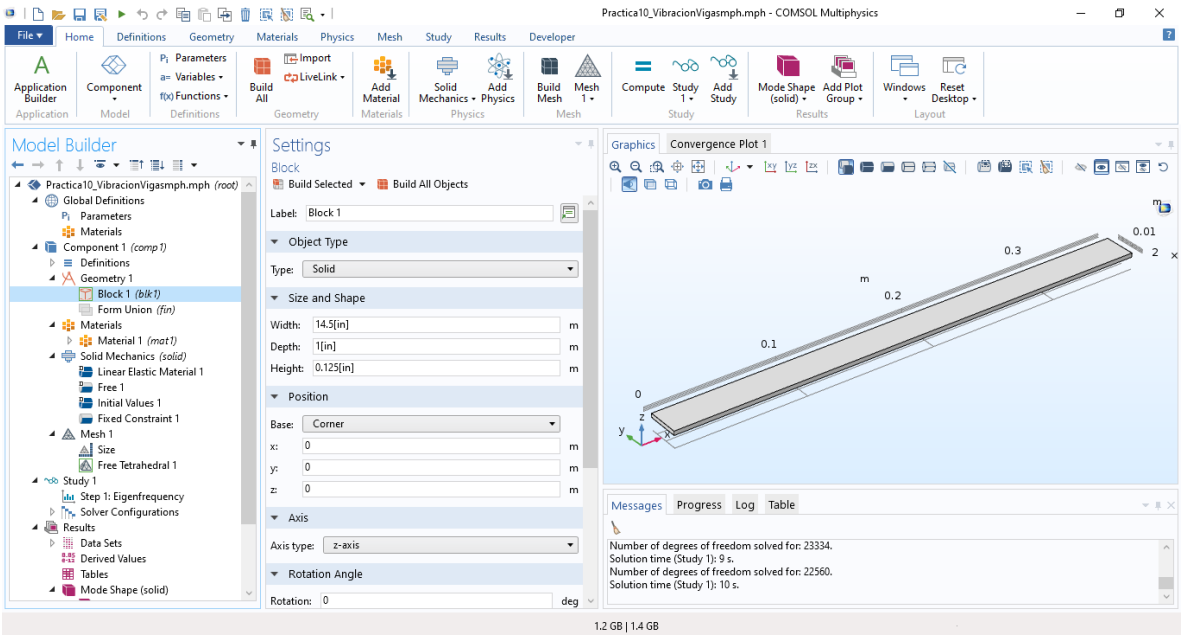


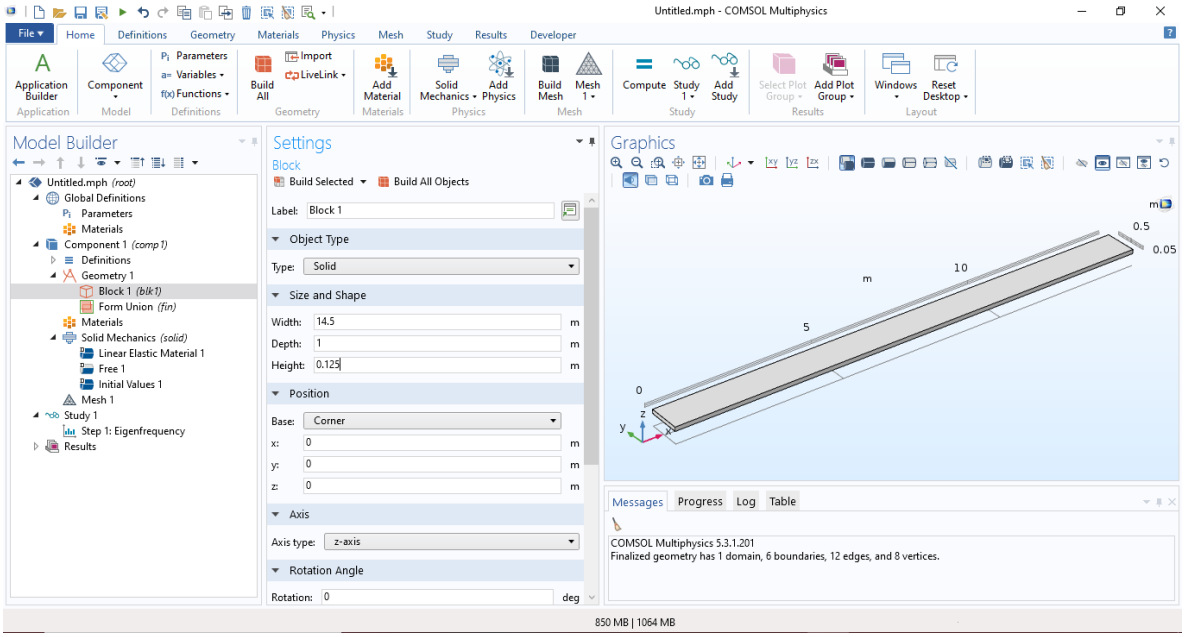

Untitled.mph - COMSOL Multiphysics
File
Home
Definitions
Geometry
Materials
Physics
Mesh
Study
Results
Developer
Select Study
Preset Studies
Bolt Pre-Tension
Eigenfrequency
Frequency Domain
Frequency Domain Modal
Linear Buckling
Modal Reduced-Order Model
Prestressed Analysis, Eigenfrequency
Prestressed Analysis, Frequency Domain
Stationary
Time Dependent
Added study:
Eigenfrequency
Added physics interfaces:
Solid Mechanics (solid)
Physics
Help
Cancel
Done
Eigenfrequency
The Eigenfrequency study is used to compute eigenmodes and eigenfrequencies of a linear or linearized model.
Examples: In electromagnetics, the eigenfrequencies correspond to the resonant frequencies and the eigenmodes correspond to the normalized electromagnetic field at the eigenfrequencies. In solid mechanics, the eigenfrequencies correspond to the natural frequencies of vibrations and the eigenmodes correspond to the normalized deformed shapes at the eigenfrequencies. In acoustics, the eigenfrequencies correspond to the resonant frequencies and the eigenmodes correspond to the normalized acoustic field at the eigenfrequencies.
794 MB | 961 MB

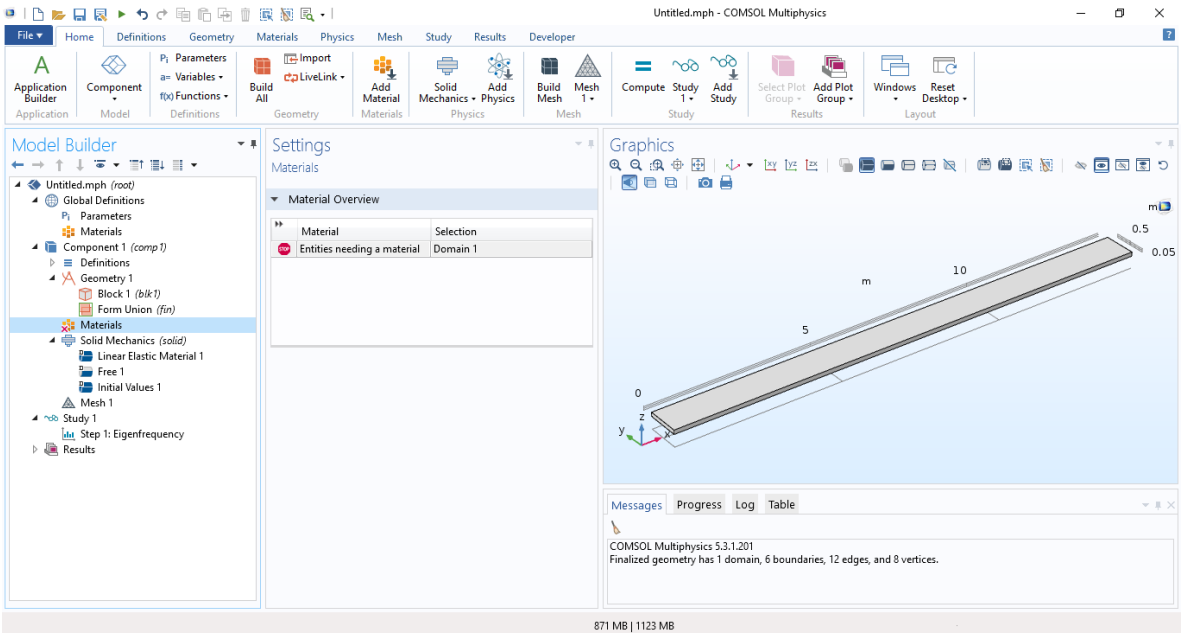

Untitled.mph - COMSOL Multiphysics
File
Home
Definitions
Geometry
Materials
Physics
Mesh
Study
Results
Developer
Select Study
Preset Studies
Bolt Pre-Tension
Eigenfrequency
Frequency Domain
Frequency Domain Modal
Linear Buckling
Modal Reduced-Order Model
Prestressed Analysis, Eigenfrequency
Prestressed Analysis, Frequency Domain
Stationary
Time Dependent
Added study:
Eigenfrequency
Added physics interfaces:
Solid Mechanics (solid)
Physics
Help
Cancel
Done
Add Selected Study and Physics Interfaces and Finish
Eigenfrequency
The Eigenfrequency study is used to compute eigenmodes and eigenfrequencies of a linear or linearized model.
Examples: In electromagnetics, the eigenfrequencies correspond to the resonant frequencies and the eigenmodes correspond to the normalized electromagnetic field at the eigenfrequencies. In solid mechanics, the eigenfrequencies correspond to the natural frequencies of vibrations and the eigenmodes correspond to the normalized deformed shapes at the eigenfrequencies. In acoustics, the eigenfrequencies correspond to the resonant frequencies and the eigenmodes correspond to the normalized acoustic field at the eigenfrequencies.
794 MB | 961 MB

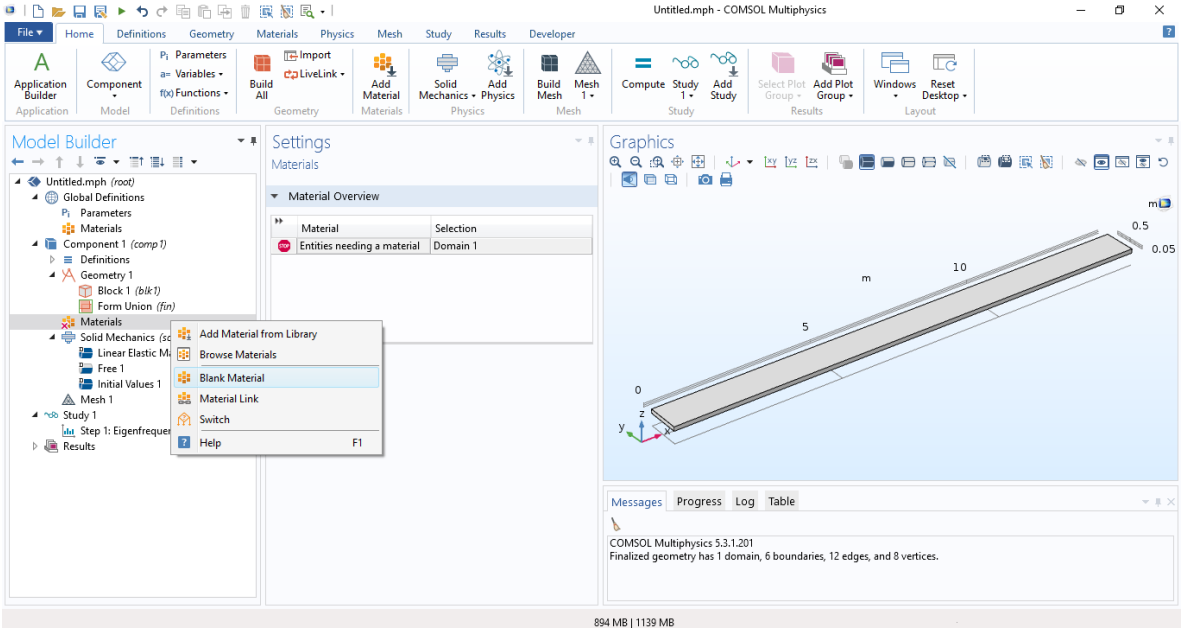

Untitled.mph - COMSOL Multiphysics
Model Builder
Settings
Geometry
Graphics
Build All F8
Import
LiveLink Interfaces
Block
Cone
Cylinder
Sphere
More Primitives
Work Plane
Parts
Programming
Measure
Insert Sequence
Copy as Code to Clipboard
Rename F2
Settings
Properties
Help F1
COMSOL Multiphysics 5.3.1.201
859 MB | 1064 MB

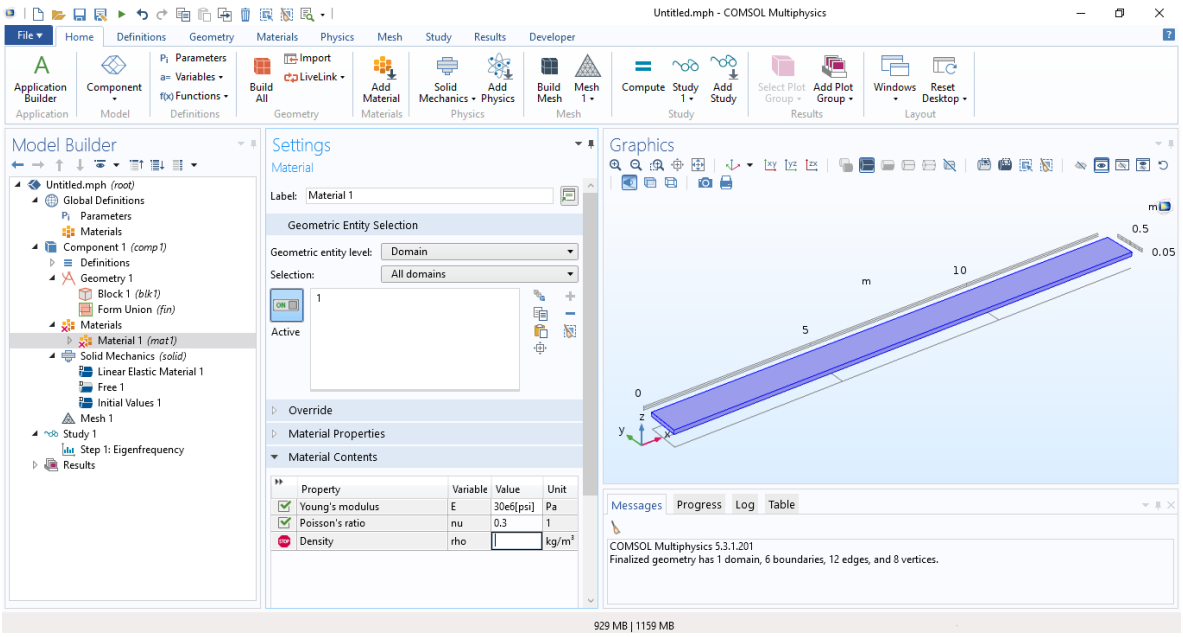

Untitled.mph - COMSOL Multiphysics
Model Builder
Settings
Block
Graphics
Label: Block 1
Object Type
Type: Solid
Size and Shape
Width: 14.5 m
Depth: 1 m
Height: 0.125 m
Position
Base: Corner
x: 0 m
y: 0 m
z: 0 m
Axis
Axis type: z-axis
Rotation Angle
Rotation: 0 deg
COMSOL Multiphysics 5.3.1.201
844 MB | 1054 MB


Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Block
Graphics
Convergence Plot 1
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.2 GB | 1.4 GB

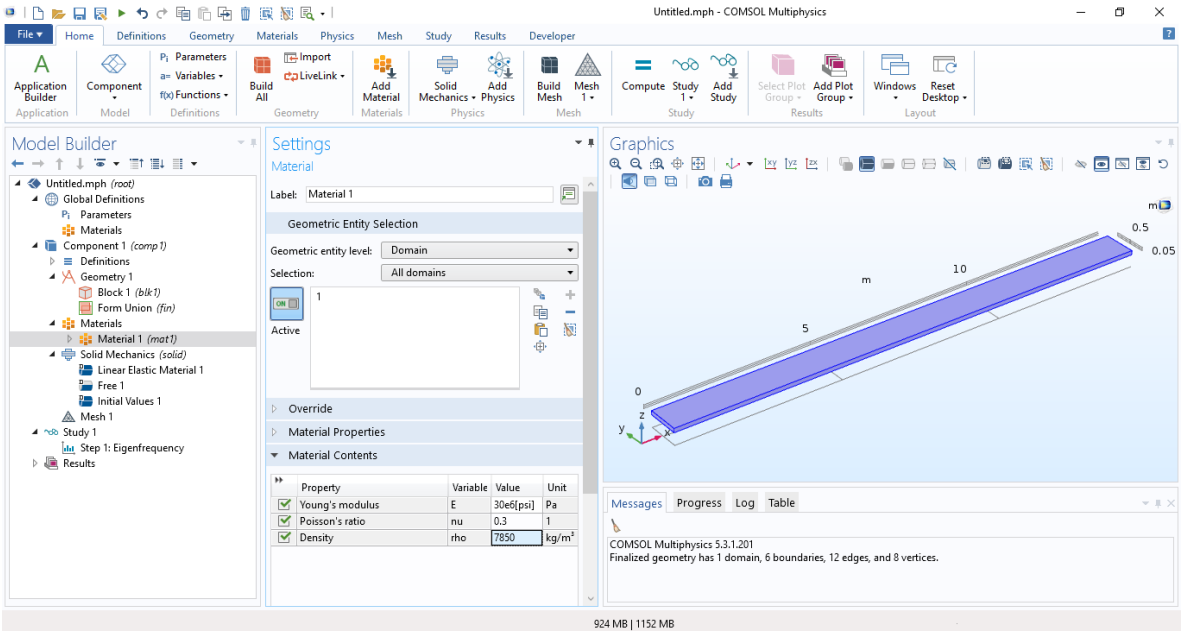

Untitled.mph - COMSOL Multiphysics
Model Builder
Settings
Block
Graphics
Messages
Progress
Log
Table
COMSOL Multiphysics 5.3.1.201
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
850 MB | 1064 MB


Untitled.mph - COMSOL Multiphysics
File
Home
Definitions
Geometry
Materials
Physics
Mesh
Study
Results
Developer
Application Builder
Component
Parameters
Variables
Functions
Build All
Import
LiveLink
Add Material
Solid Mechanics
Add Physics
Build Mesh
Mesh 1
Compute
Study 1
Add Study
Select Plot Group
Add Plot Group
Windows
Reset Desktop
Model Builder
Untitled.mph (root)
Global Definitions
Parameters
Materials
Component 1 (comp 1)
Definitions
Geometry 1
Block 1 (blk1)
Form Union (fin)
Materials
Solid Mechanics (solid)
Linear Elastic Material 1
Free 1
Initial Values 1
Mesh 1
Study 1
Step 1: Eigenfrequency
Results
Settings
Materials
Material Overview
Material
Selection
Entities needing a material
Domain 1
Graphics
m
0.5
0.05
10
5
0
Messages
Progress
Log
Table
COMSOL Multiphysics 5.3.1.201
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
871 MB | 1123 MB

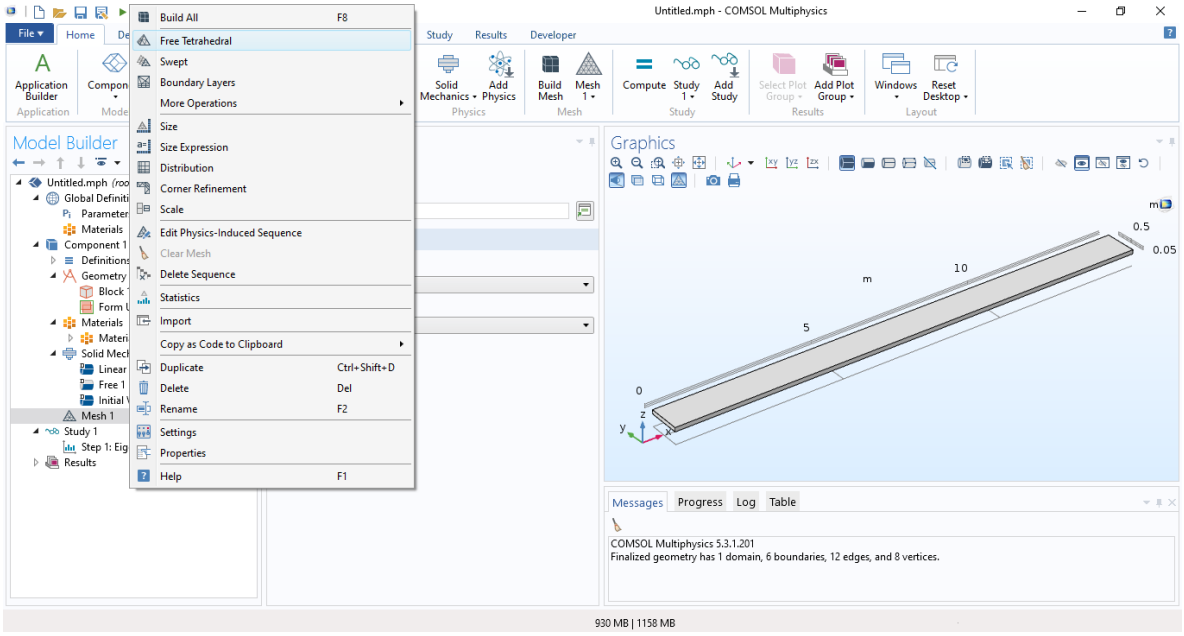

Untitled.mph - COMSOL Multiphysics
Add Material from Library
Browse Materials
Blank Material
Material Link
Switch
Help
F1
894 MB | 1139 MB

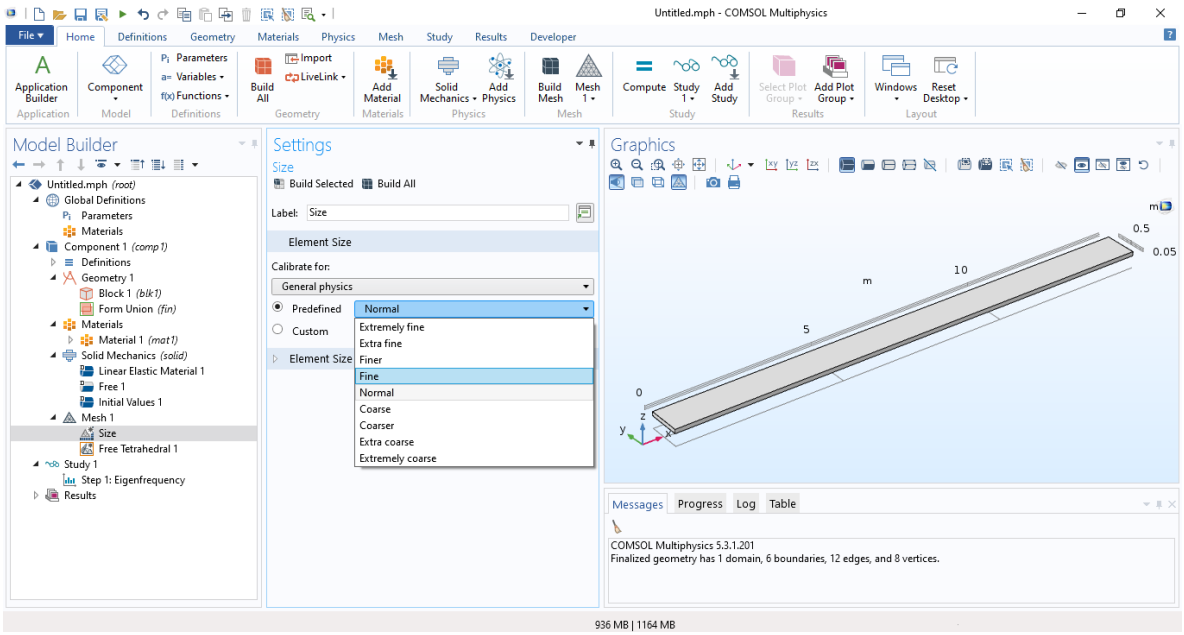


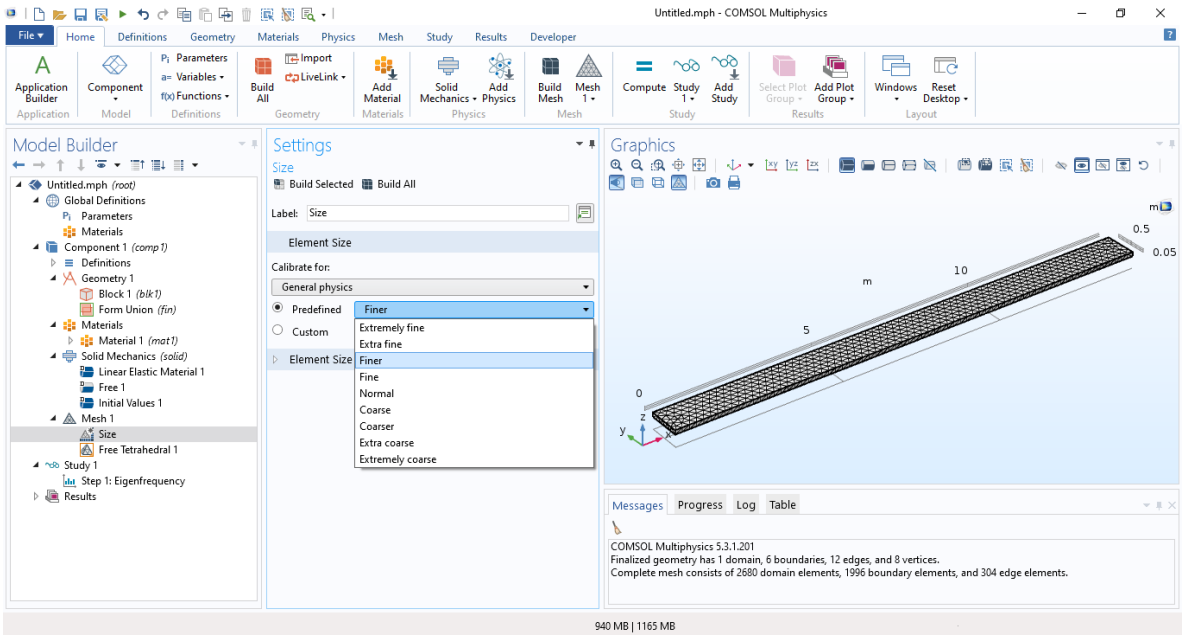
La densidad se puede ingresar con su unidad en el sistema internacional y el programa lo tomará en cuenta para convertirlo en el cálculo.

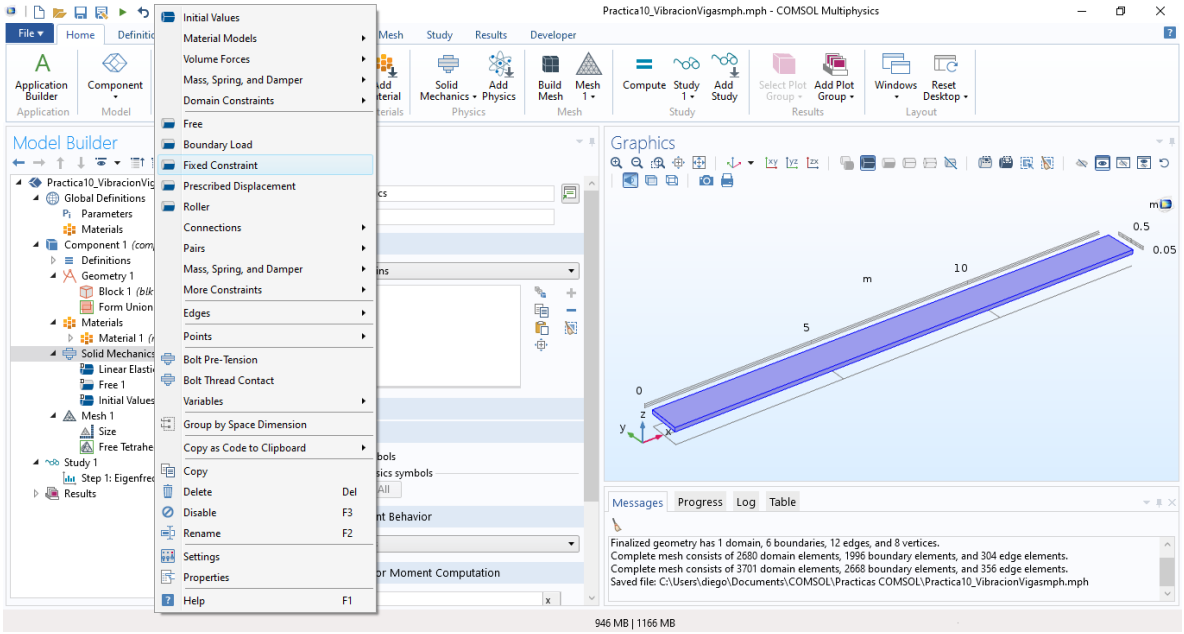


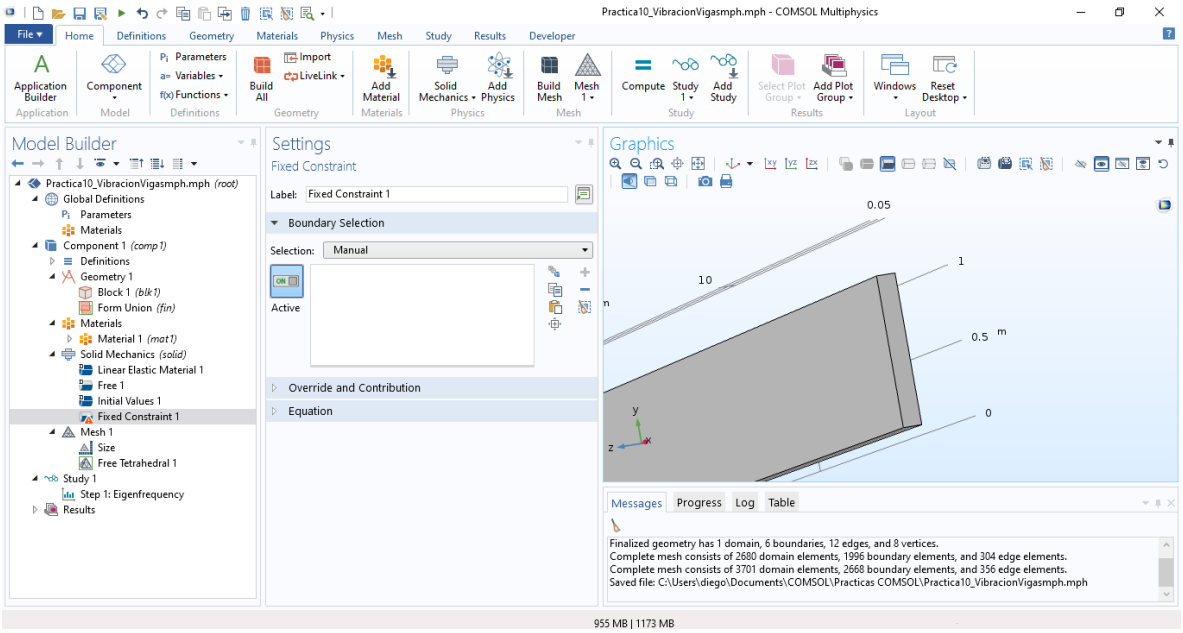
ANÁLISIS MECÁNICO EN COMSOL:

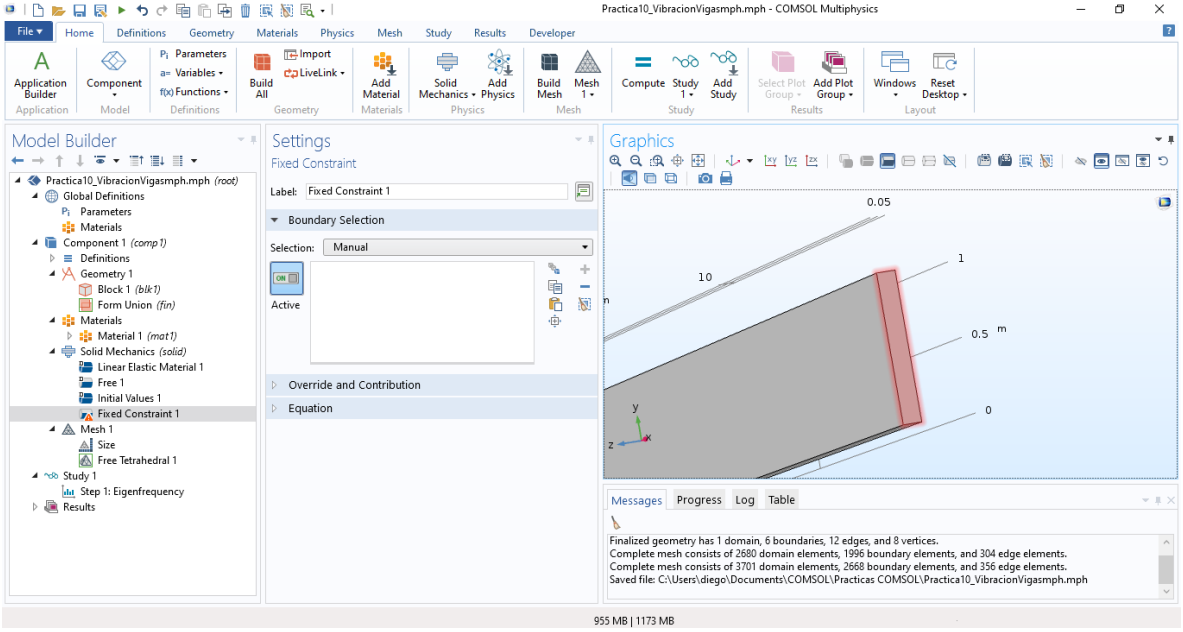


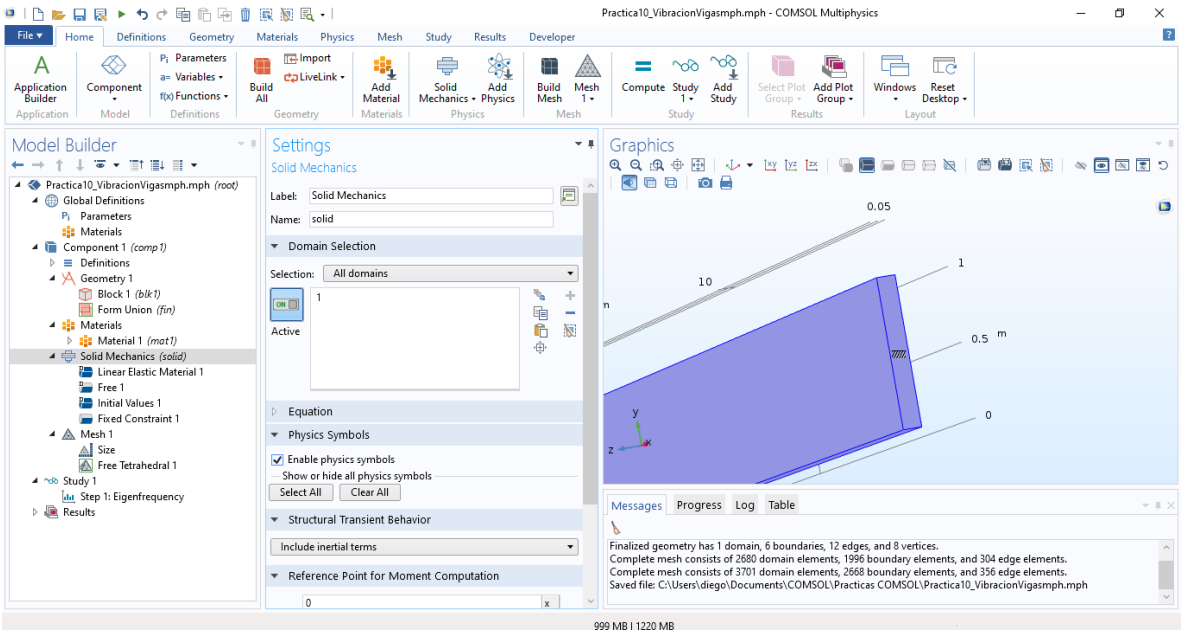


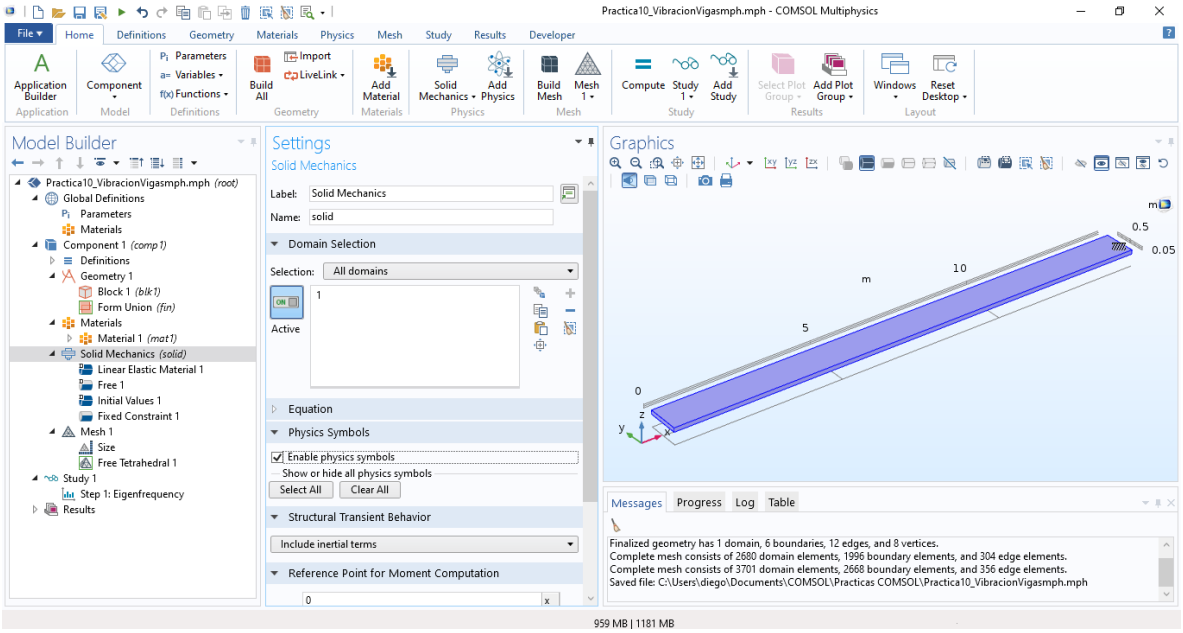

Untitled.mph - COMSOL Multiphysics
Model Builder
Settings
Size
Graphics
Element Size
Calibrate for:
General physics
Predefined
Finer
Custom
Extremely fine
Extra fine
Finer
Fine
Normal
Coarse
Coarser
Extra coarse
Extremely coarse
Messages
Progress
Log
Table
COMSOL Multiphysics 5.3.1.201
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
Complete mesh consists of 2680 domain elements, 1996 boundary elements, and 304 edge elements.
940 MB | 1165 MB


Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Initial Values
Material Models
Volume Forces
Mass, Spring, and Damper
Domain Constraints
Free
Boundary Load
Fixed Constraint
Prescribed Displacement
Roller
Connections
Pairs
Mass, Spring, and Damper
More Constraints
Edges
Points
Bolt Pre-Tension
Bolt Thread Contact
Variables
Group by Space Dimension
Copy as Code to Clipboard
Copy
Delete Del
Disable F3
Rename F2
Settings
Properties
Help F1
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
Complete mesh consists of 2680 domain elements, 1996 boundary elements, and 304 edge elements.
Complete mesh consists of 3701 domain elements, 2668 boundary elements, and 356 edge elements.
Saved file: C:\Users\diego\Documents\COMSOL\Practicas COMSOL\Practica10_VibracionVigasmph.mph
946 MB | 1166 MB

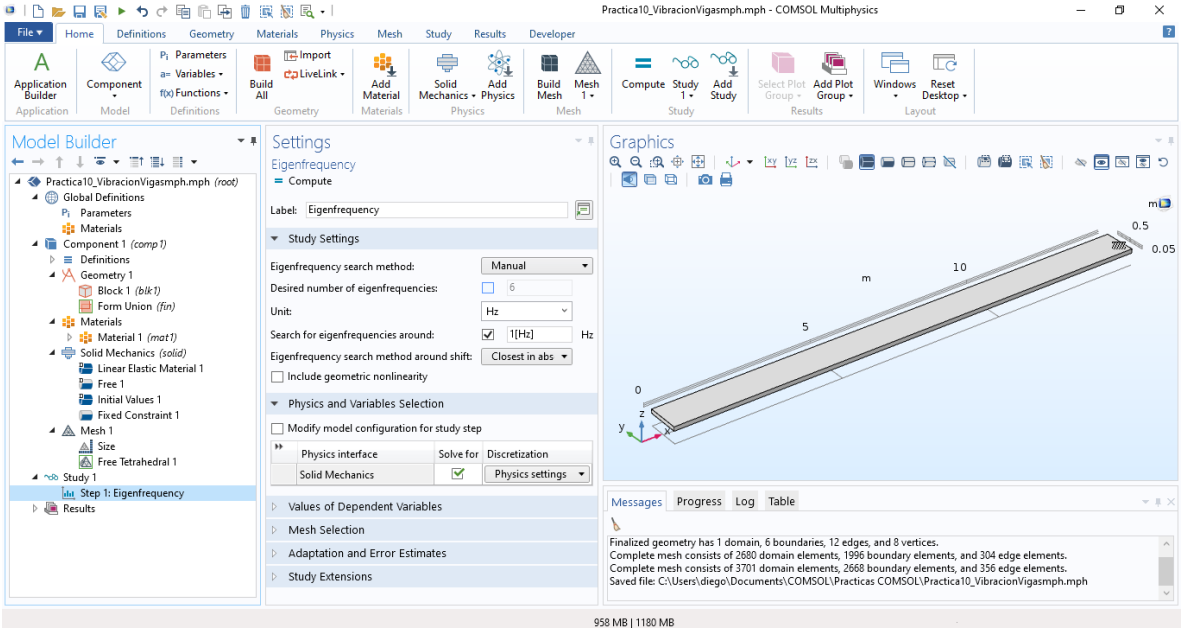

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
File
Home
Definitions
Geometry
Materials
Physics
Mesh
Study
Results
Developer
Application Builder
Component
Parameters
Variables
Functions
Build All
Import
LiveLink
Add Material
Solid Mechanics
Add Physics
Build Mesh
Mesh 1
Compute
Study 1
Add Study
Select Plot Group
Add Plot Group
Windows
Reset Desktop
Model Builder
Practica10_VibracionVigasmph.mph (root)
Global Definitions
Parameters
Materials
Component 1 (comp 1)
Definitions
Geometry 1
Block 1 (blk1)
Form Union (fin)
Materials
Material 1 (mat1)
Solid Mechanics (solid)
Linear Elastic Material 1
Free 1
Initial Values 1
Fixed Constraint 1
Mesh 1
Size
Free Tetrahedral 1
Study 1
Step 1: Eigenfrequency
Results
Settings
Fixed Constraint
Label: Fixed Constraint 1
Boundary Selection
Selection: Manual
Active
Override and Contribution
Equation
Graphics
0.05
10
1
0.5
m
0
y
z
x
Messages
Progress
Log
Table
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
Complete mesh consists of 2680 domain elements, 1996 boundary elements, and 304 edge elements.
Complete mesh consists of 3701 domain elements, 2668 boundary elements, and 356 edge elements.
Saved file: C:\Users\diego\Documents\COMSOL\Practicas COMSOL\Practica10_VibracionVigasmph.mph
955 MB | 1173 MB


Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
File
Home
Definitions
Geometry
Materials
Physics
Mesh
Study
Results
Developer
Application Builder
Component
Parameters
Variables
Functions
Build All
Import
LiveLink
Add Material
Solid Mechanics
Add Physics
Build Mesh
Mesh 1
Compute
Study 1
Add Study
Select Plot Group
Add Plot Group
Windows
Reset Desktop
Model Builder
Practica10_VibracionVigasmph.mph (root)
Global Definitions
Parameters
Materials
Component 1 (comp 1)
Definitions
Geometry 1
Block 1 (blk1)
Form Union (fin)
Materials
Material 1 (mat1)
Solid Mechanics (solid)
Linear Elastic Material 1
Free 1
Initial Values 1
Fixed Constraint 1
Mesh 1
Size
Free Tetrahedral 1
Study 1
Step 1: Eigenfrequency
Results
Settings
Fixed Constraint
Label: Fixed Constraint 1
Boundary Selection
Selection: Manual
Active
Override and Contribution
Equation
Graphics
0.05
10
1
0.5
m
0
y
z
x
Messages
Progress
Log
Table
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
Complete mesh consists of 2680 domain elements, 1996 boundary elements, and 304 edge elements.
Complete mesh consists of 3701 domain elements, 2668 boundary elements, and 356 edge elements.
Saved file: C:\Users\diego\Documents\COMSOL\Practicas COMSOL\Practica10_VibracionVigasmph.mph
955 MB | 1173 MB

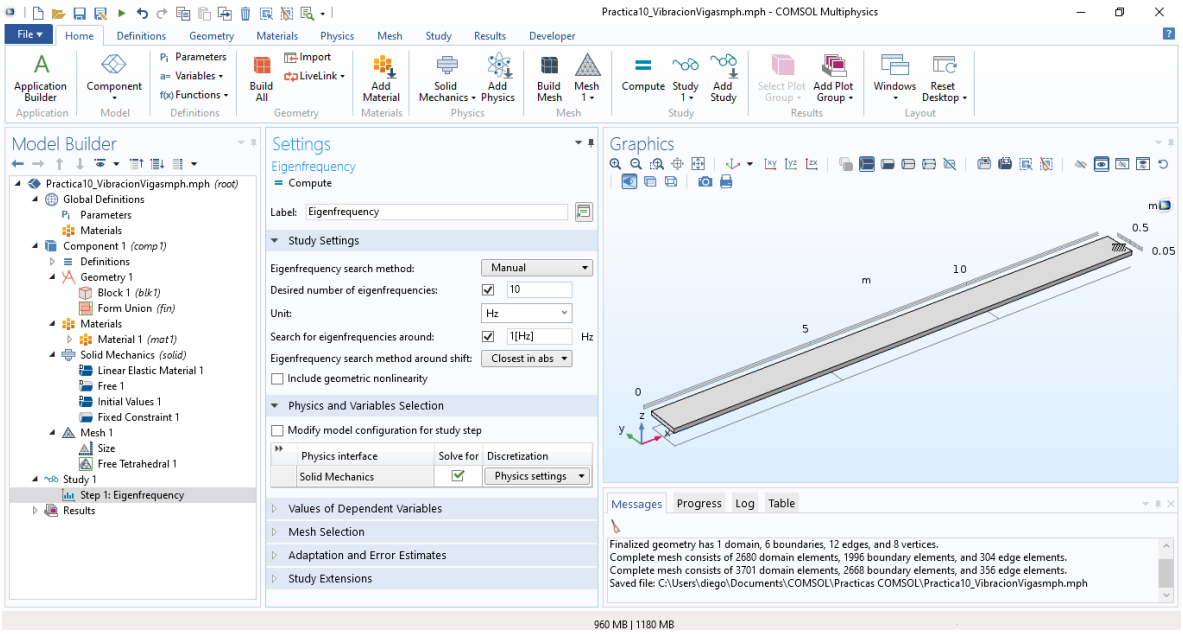

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Solid Mechanics
Graphics
Label: Solid Mechanics
Name: solid
Domain Selection
Selection: All domains
Active
Equation
Physics Symbols
Enable physics symbols
Show or hide all physics symbols
Select All
Clear All
Structural Transient Behavior
Include inertial terms
Reference Point for Moment Computation
Messages
Progress
Log
Table
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
Complete mesh consists of 2680 domain elements, 1996 boundary elements, and 304 edge elements.
Complete mesh consists of 3701 domain elements, 2668 boundary elements, and 356 edge elements.
Saved file: C:\Users\diego\Documents\COMSOL\Practicas COMSOL\Practica10_VibracionVigasmph.mph
999 MB | 1220 MB


Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Solid Mechanics
Graphics
Label: Solid Mechanics
Name: solid
Domain Selection
Selection: All domains
Active
Equation
Physics Symbols
Enable physics symbols
Show or hide all physics symbols
Select All
Clear All
Structural Transient Behavior
Include inertial terms
Reference Point for Moment Computation
Messages
Progress
Log
Table
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
Complete mesh consists of 2680 domain elements, 1996 boundary elements, and 304 edge elements.
Complete mesh consists of 3701 domain elements, 2668 boundary elements, and 356 edge elements.
Saved file: C:\Users\diego\Documents\COMSOL\Practicas COMSOL\Practica10_VibracionVigasmph.mph
959 MB | 1181 MB

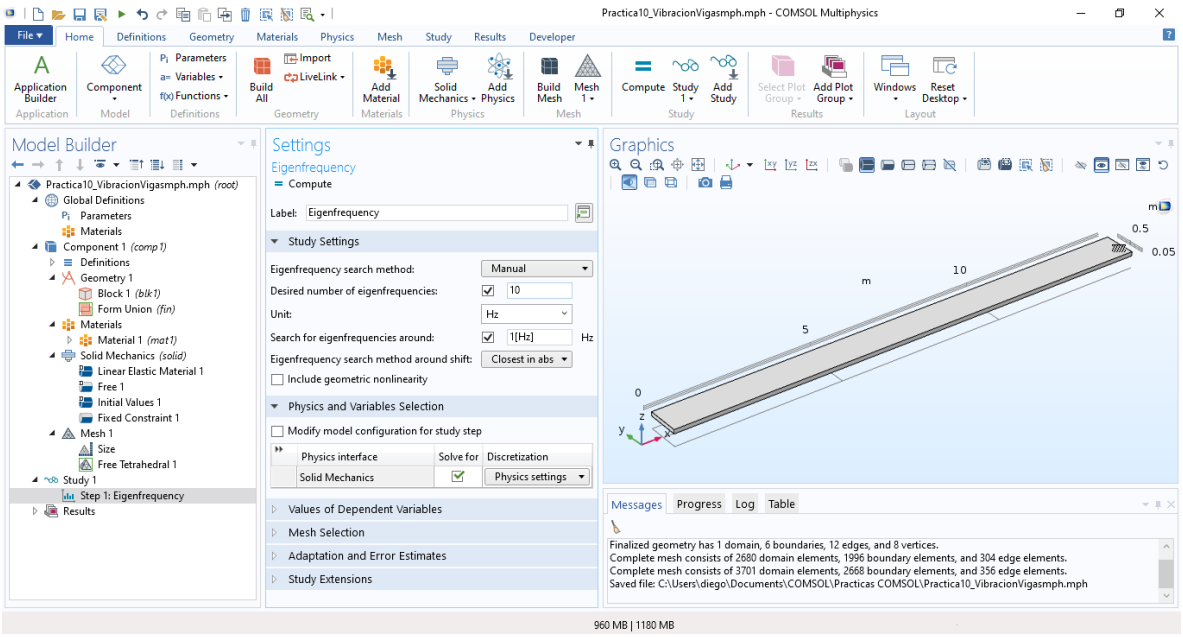
RESULTADO DEL ELEMENTO FINITO EN COMSOL:



En la parte de Settings perteneciente a la pestaña de Step1: Eigenfrecuency donde se encuentra el checkbox que dice *desired number of eigenfrequencies:* al seleccionarla puedo indicar las frecuencias armónicas que quiero que encuentre de mi pieza, ya sea 1, 2, 10, etc.



Por default el programa encuentra 6, pero le puedo decir que calcule más.


Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
File
Home
Definitions
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Physics
Mesh
Study
Results
Developer
Application Builder
Component
Parameters
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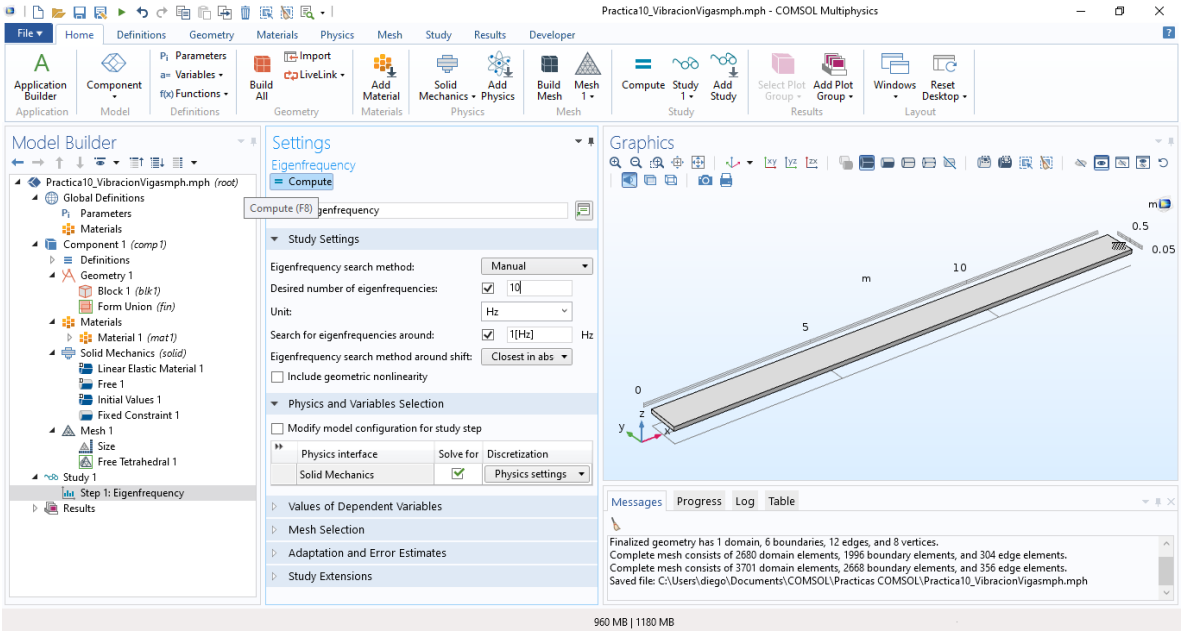
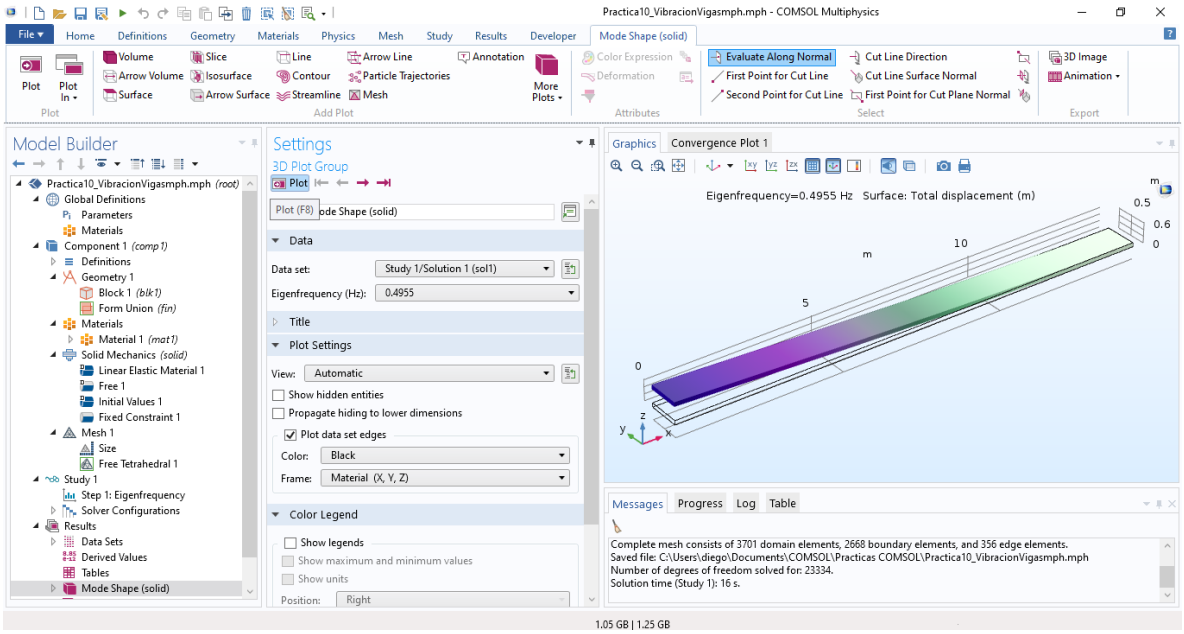
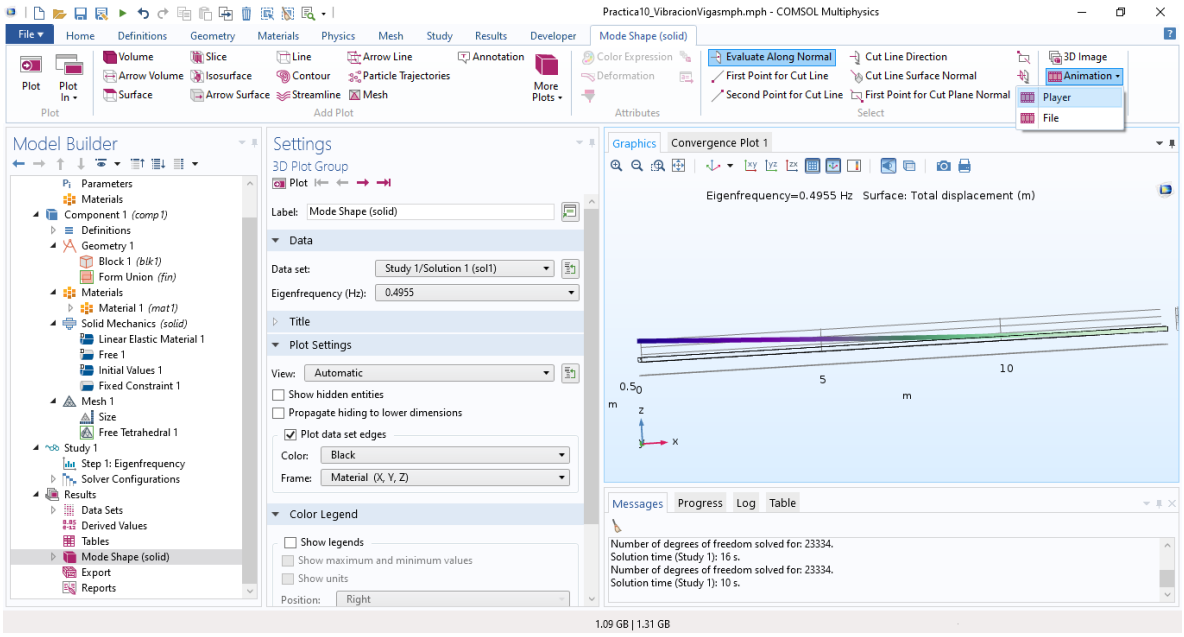
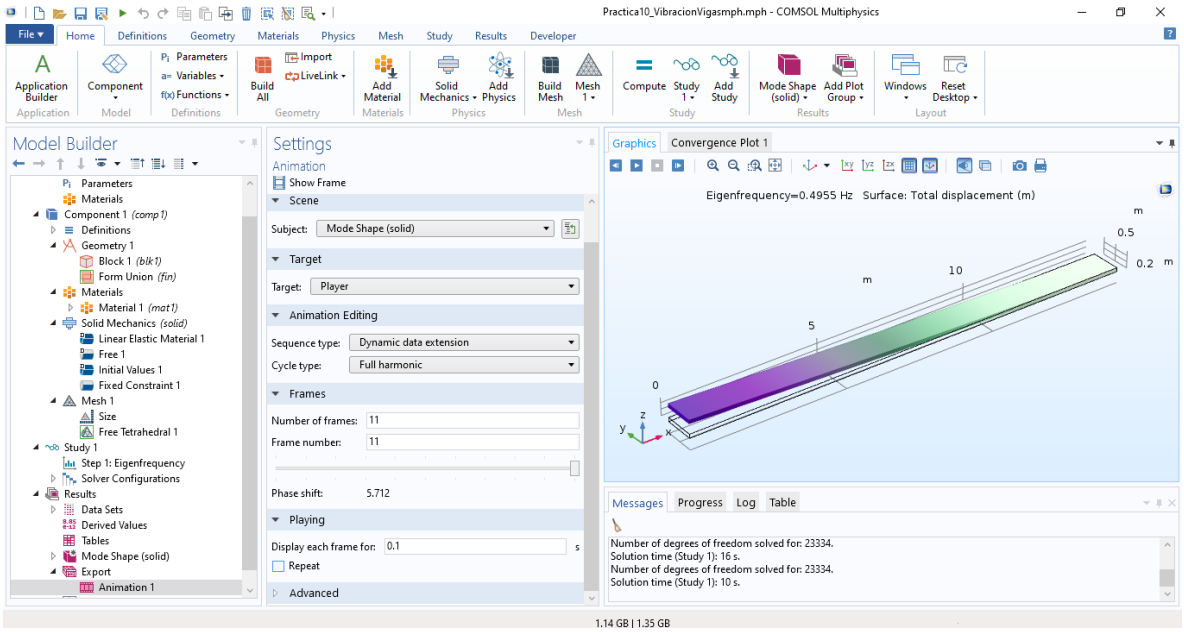
Build All
Import
LiveLink
Add Material
Solid Mechanics
Add Physics
Build Mesh
Mesh 1
Compute
Study 1
Add Study
Select Plot Group
Add Plot Group
Windows
Reset Desktop
Model Builder
Practica10_VibracionVigasmph.mph (root)
Global Definitions
Parameters
Materials
Component 1 (comp1)
Definitions
Geometry 1
Block 1 (blk1)
Form Union (fin)
Materials
Material 1 (mat1)
Solid Mechanics (solid)
Linear Elastic Material 1
Free 1
Initial Values 1
Fixed Constraint 1
Mesh 1
Size
Free Tetrahedral 1
Study 1
Step 1: Eigenfrequency
Results
Settings
Eigenfrequency
Compute
Label: Eigenfrequency
Study Settings
Eigenfrequency search method: Manual
Desired number of eigenfrequencies: 10
Unit: Hz
Search for eigenfrequencies around: 1[Hz]
Eigenfrequency search method around shift: Closest in abs
Include geometric nonlinearity
Physics and Variables Selection
Modify model configuration for study step
Physics interface
Solve for
Discretization
Solid Mechanics
Physics settings
Values of Dependent Variables
Mesh Selection
Adaptation and Error Estimates
Study Extensions
Graphics
m
0.5
0.05
10
5
0
Messages
Progress
Log
Table
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
Complete mesh consists of 2680 domain elements, 1996 boundary elements, and 304 edge elements.
Complete mesh consists of 3701 domain elements, 2668 boundary elements, and 356 edge elements.
Saved file: C:\Users\diego\Documents\COMSOL\Practicas COMSOL\Practica10_VibracionVigasmph.mph
960 MB | 1180 MB

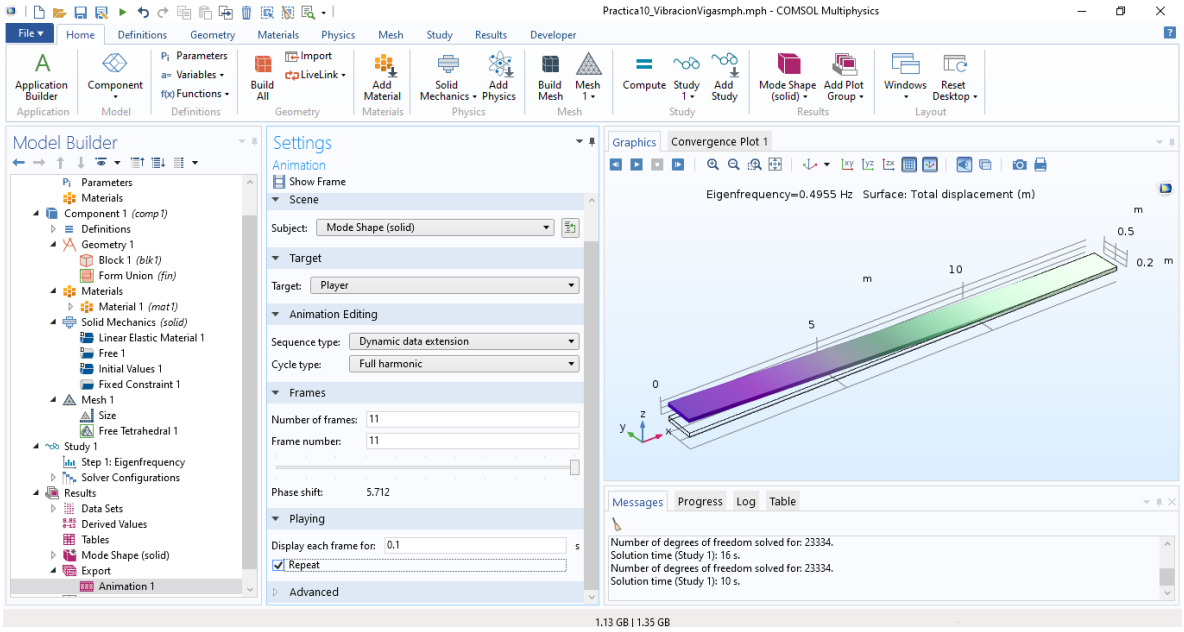

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Compute (F8)
Model Builder
Settings
Eigenfrequency
Compute
Graphics
Study Settings
Eigenfrequency search method: Manual
Desired number of eigenfrequencies: 10
Unit: Hz
Search for eigenfrequencies around: 1[Hz]
Eigenfrequency search method around shift: Closest in abs
Include geometric nonlinearity
Physics and Variables Selection
Modify model configuration for study step
Physics interface
Solve for
Discretization
Solid Mechanics
Physics settings
Values of Dependent Variables
Mesh Selection
Adaptation and Error Estimates
Study Extensions
Messages
Progress
Log
Table
Finalized geometry has 1 domain, 6 boundaries, 12 edges, and 8 vertices.
Complete mesh consists of 2680 domain elements, 1996 boundary elements, and 304 edge elements.
Complete mesh consists of 3701 domain elements, 2668 boundary elements, and 356 edge elements.
Saved file: C:\Users\diego\Documents\COMSOL\Practicas COMSOL\Practica10_VibracionVigasmph.mph
960 MB | 1180 MB

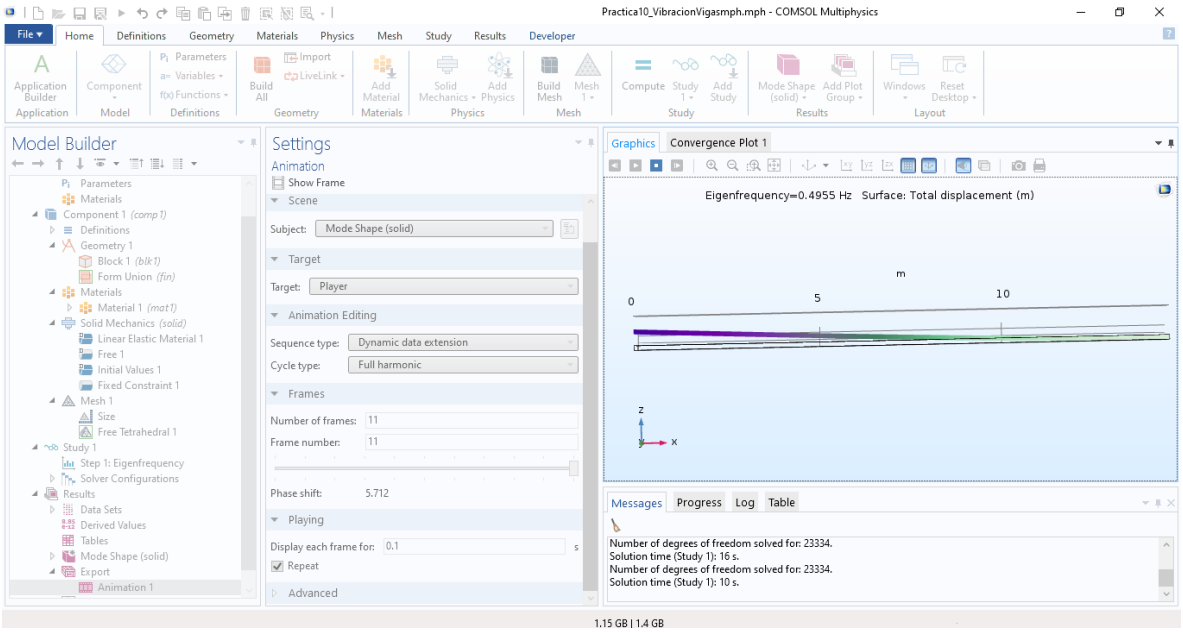
ANÁLISIS DE VIBRACIONES ARMÓNICAS EN COMSOL:



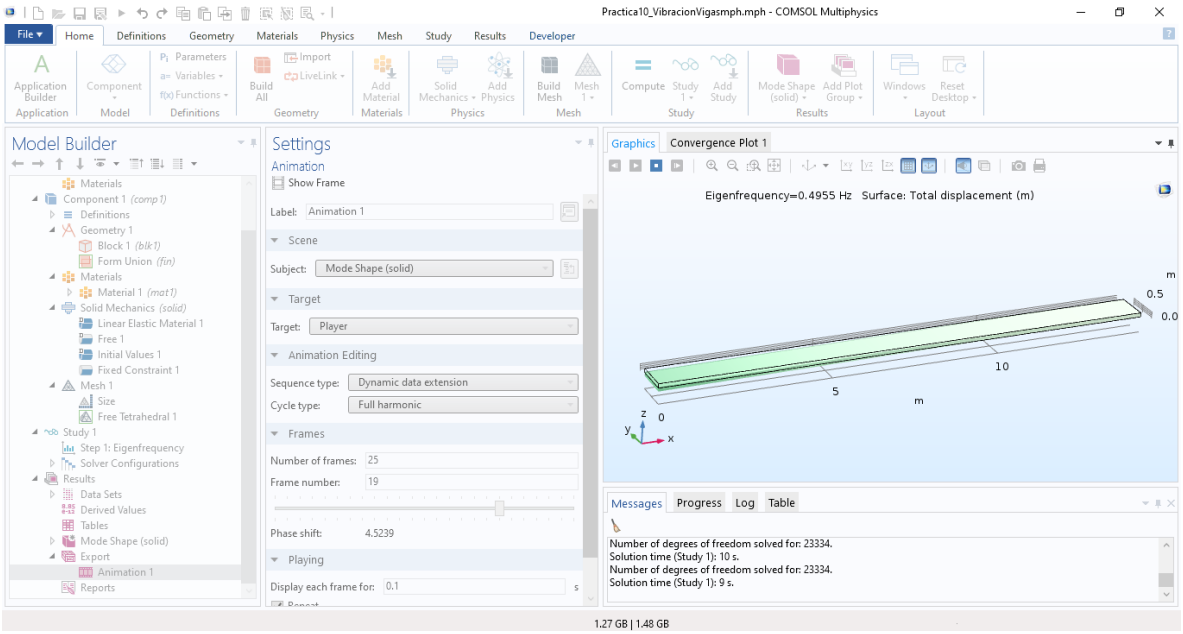


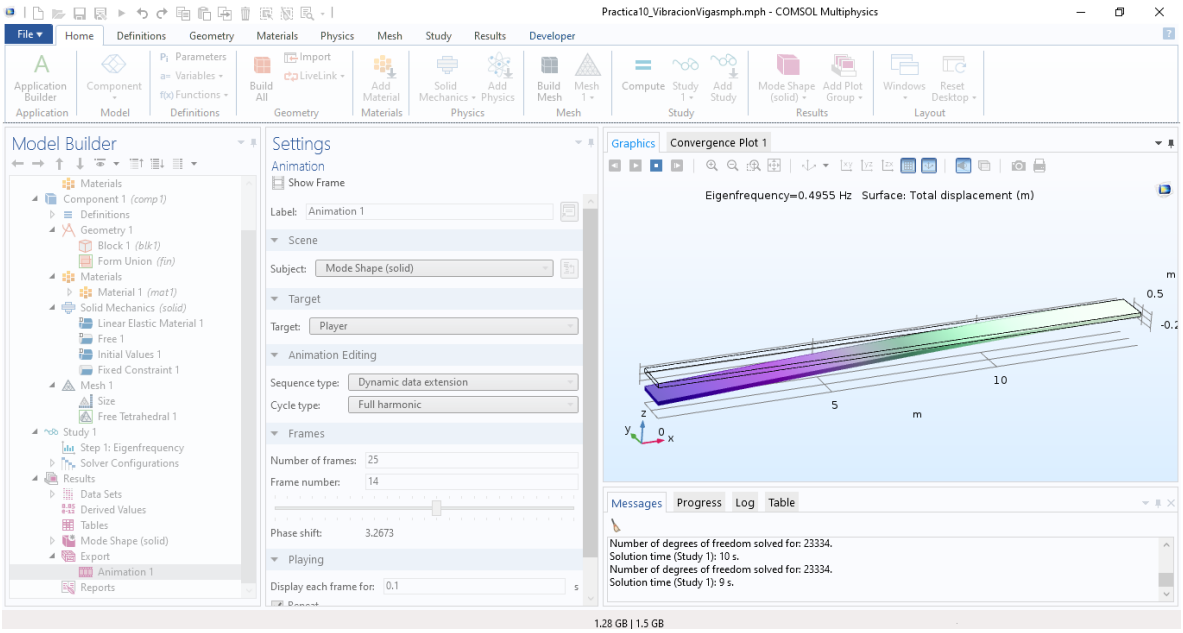

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Animation
Graphics
Convergence Plot 1
Eigenfrequency=0.4955 Hz Surface: Total displacement (m)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 16 s.
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 10 s.
1.14 GB | 1.35 GB


Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Animation
Graphics
Convergence Plot 1
Eigenfrequency=0.4955 Hz Surface: Total displacement (m)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 16 s.
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 10 s.
1.13 GB | 1.35 GB

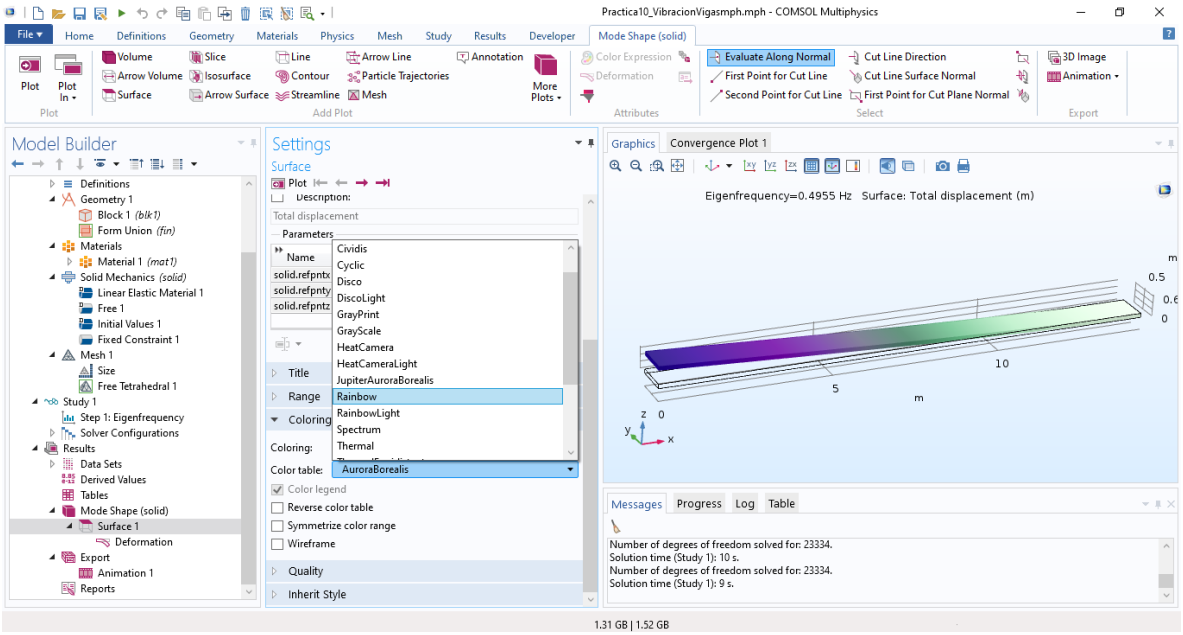


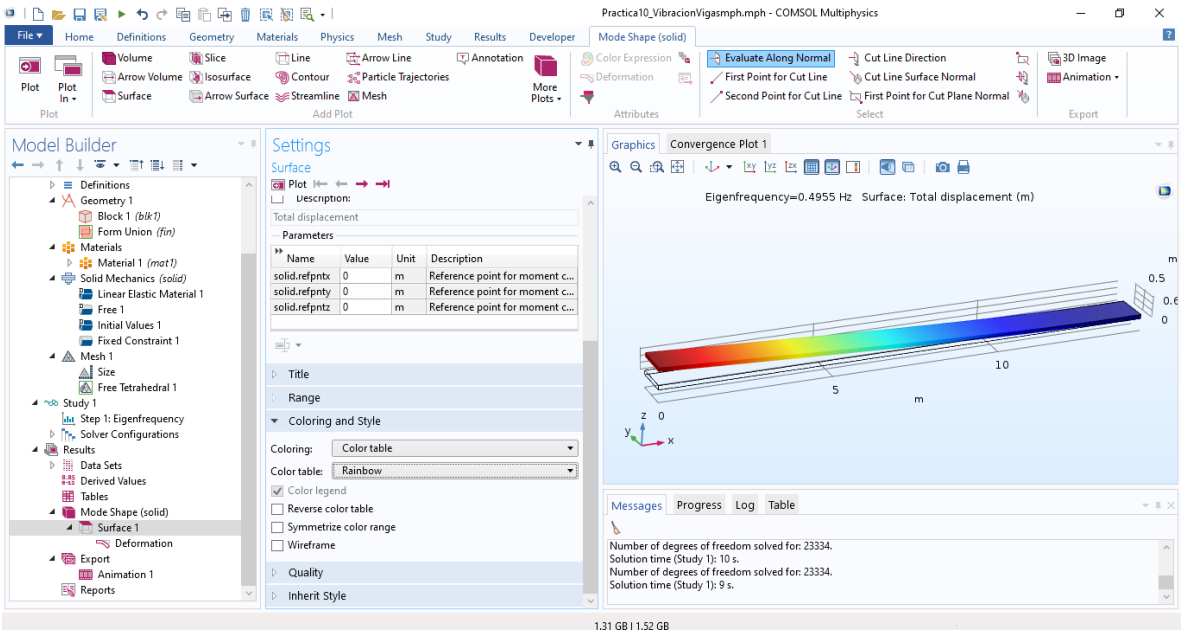
Si aumento el number of frames, se reduce la velocidad en la que se corre la animación.

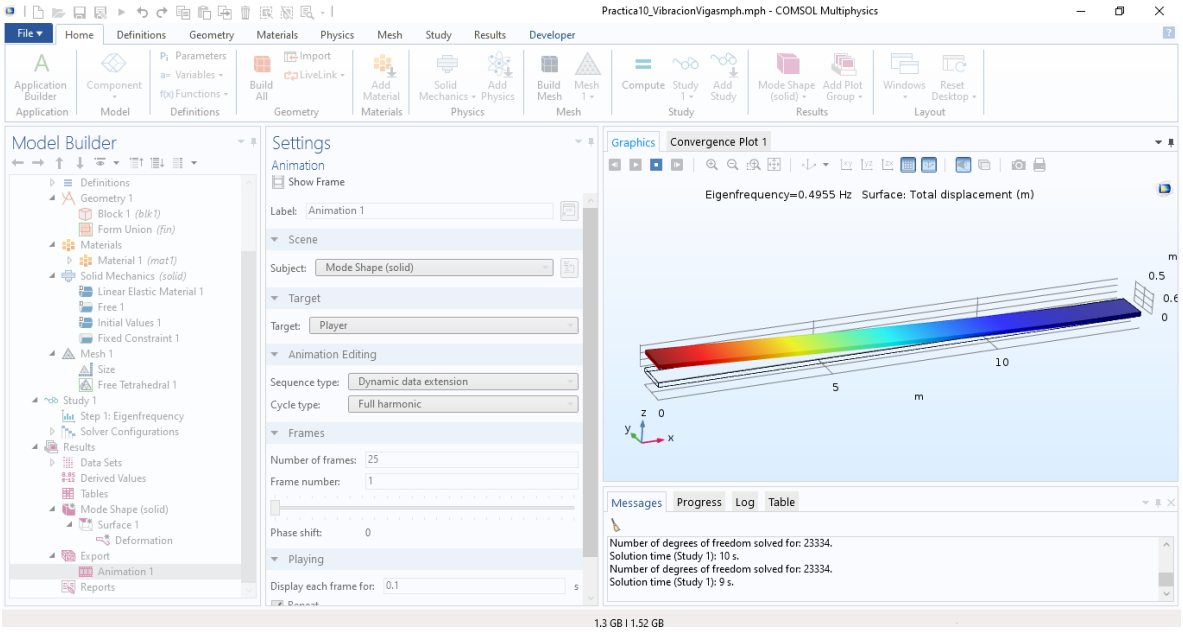


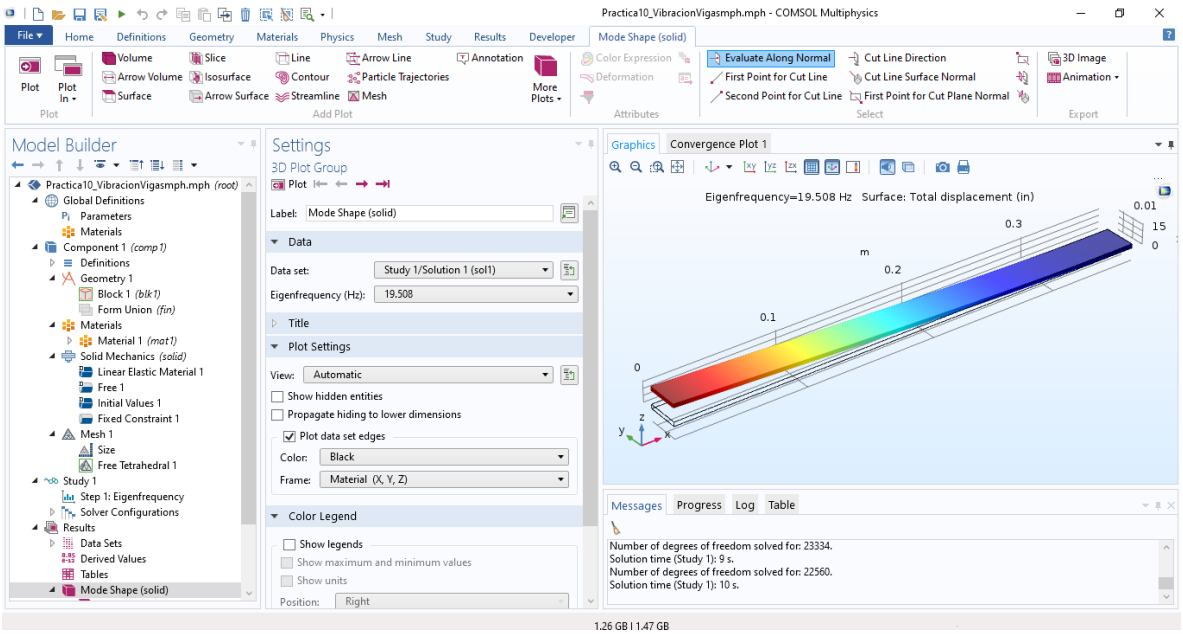


En la opción de *Surface → Coloring → Color table:* le puedo cambiar el color a la pieza cuando se estén mostrando sus frecuencias armónicas.

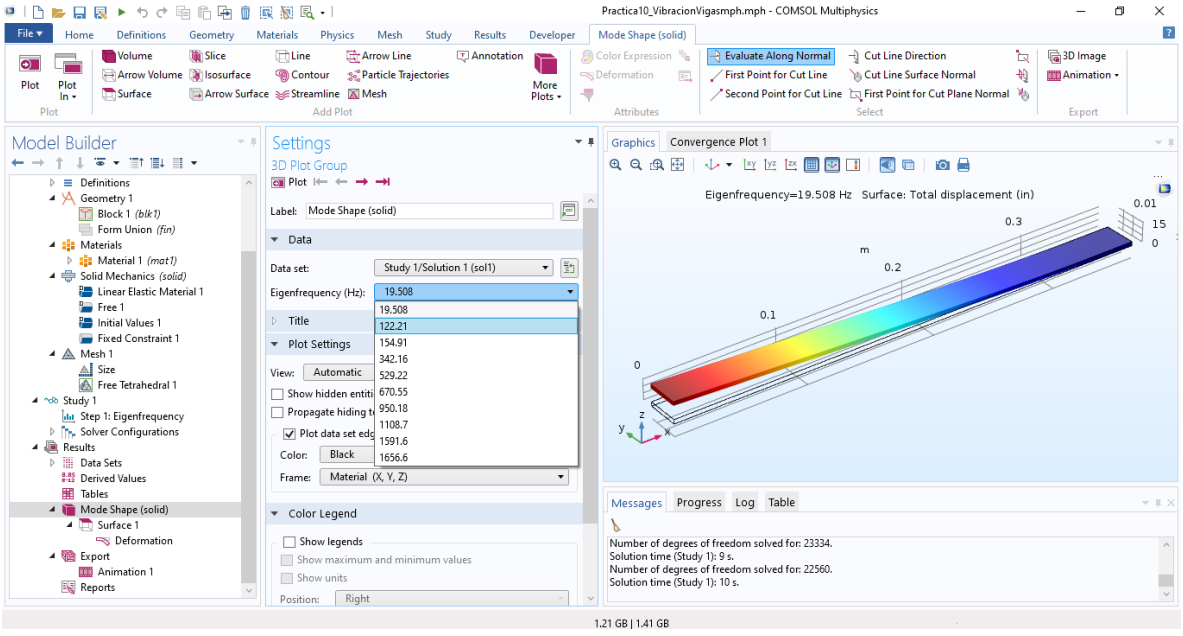


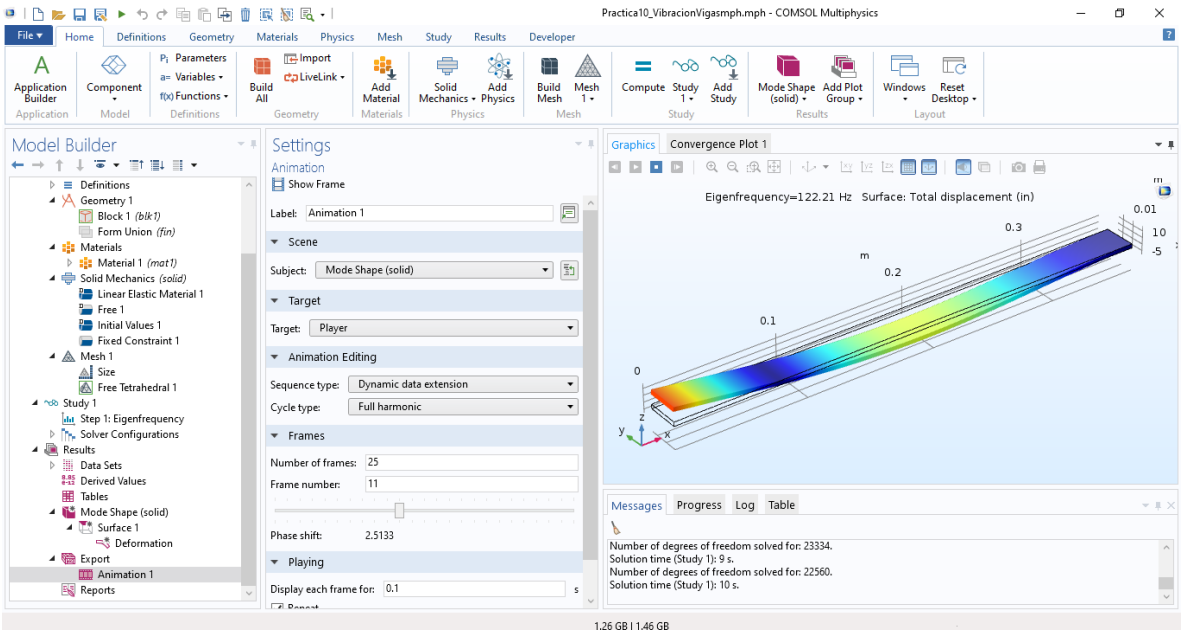

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Surface
Graphics
Convergence Plot 1
Eigenfrequency=0.4955 Hz Surface: Total displacement (m)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 10 s.
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
1.31 GB | 1.52 GB

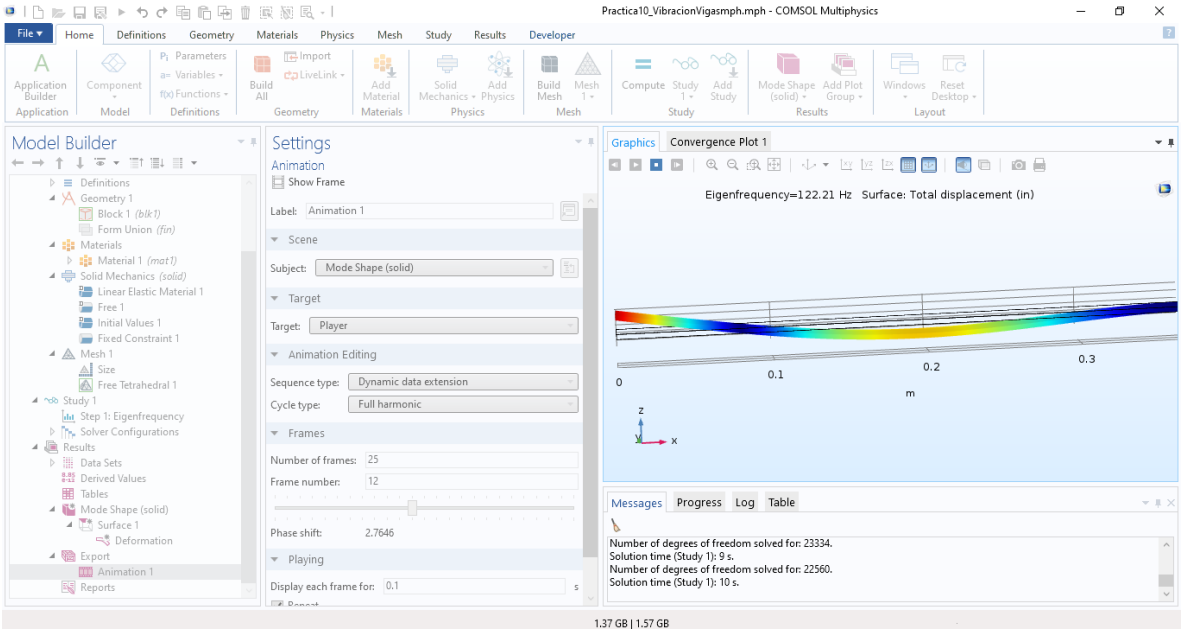

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Animation
Graphics
Convergence Plot 1
Eigenfrequency=0.4955 Hz Surface: Total displacement (m)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 10 s.
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
1.3 GB | 1.52 GB

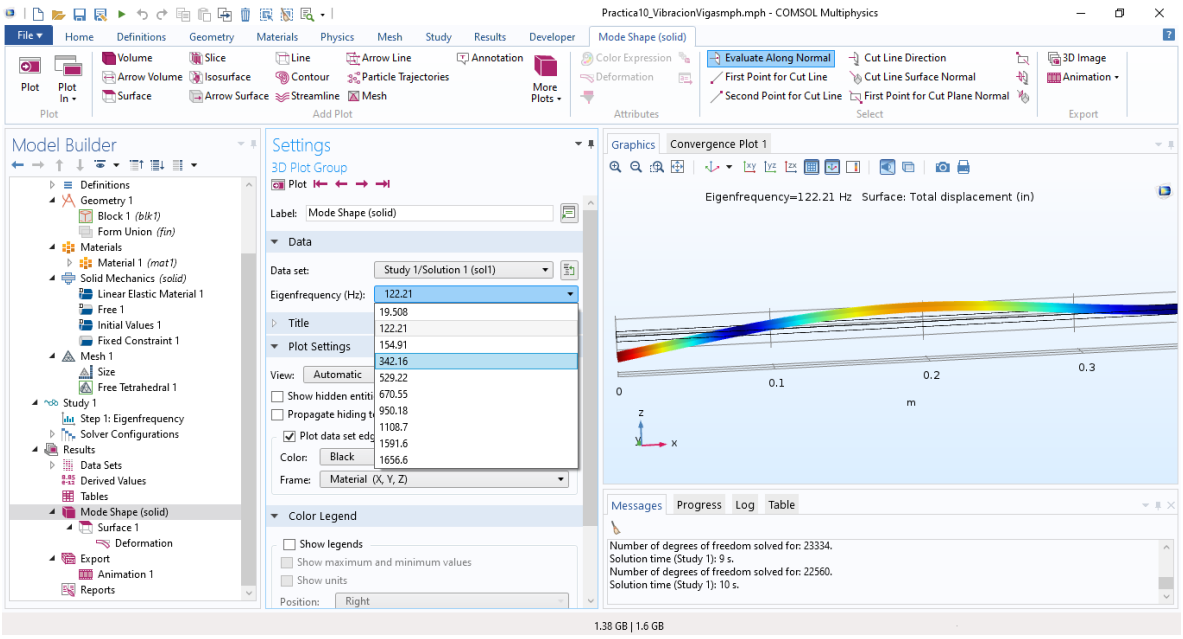


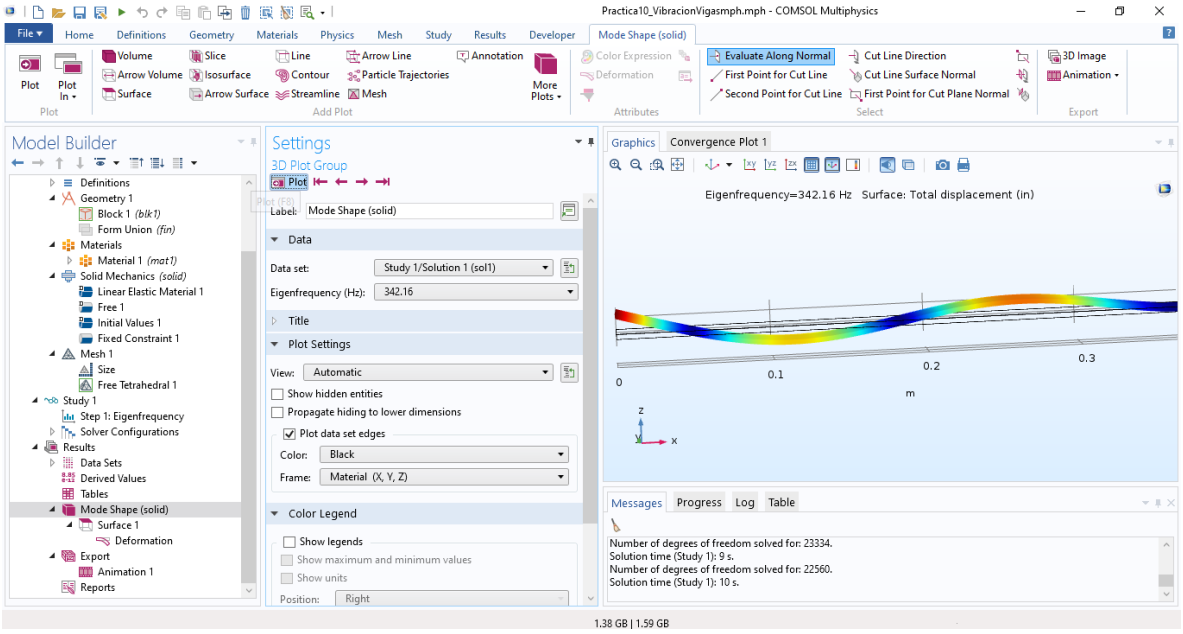
En la opción de *Mode Shape → Data → Eigenfrequency (Hz):* elijo la frecuencia que quiero que sea visualizada en la animación y estas se muestran desde la primera frecuencia armónica de la figura en adelante.

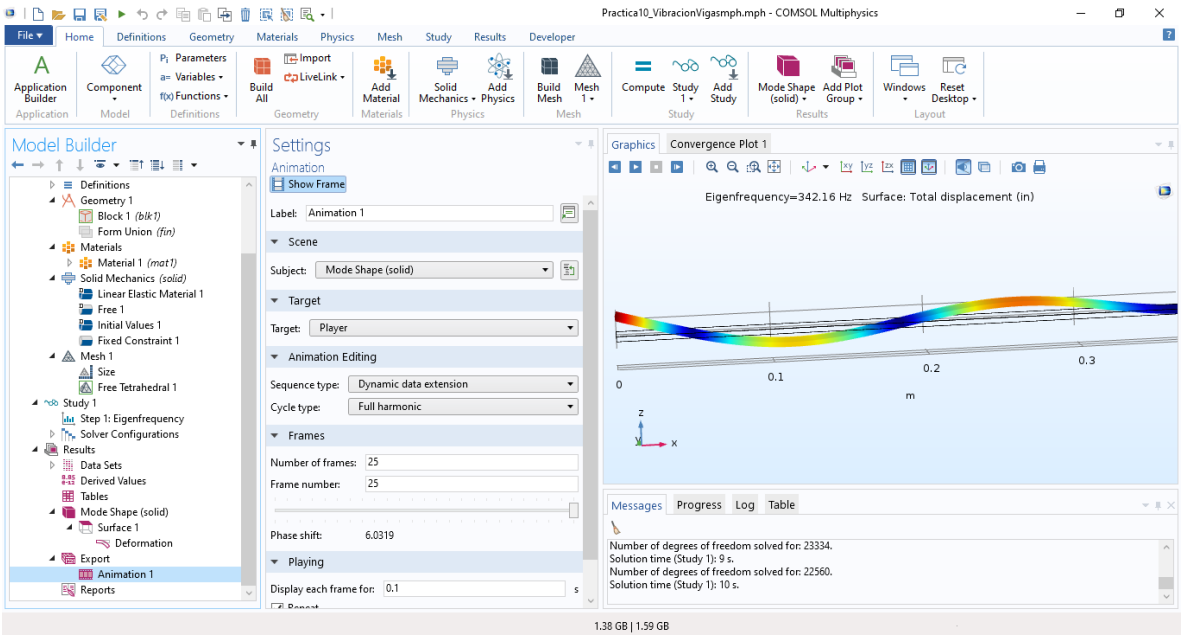


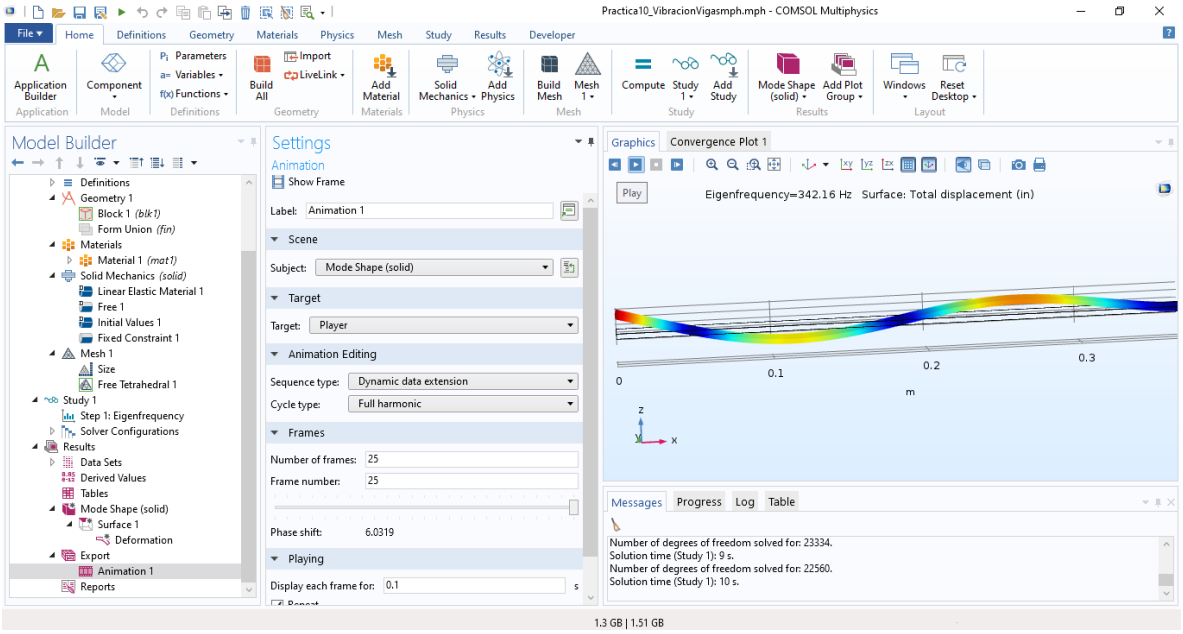

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Animation
Graphics
Convergence Plot 1
Eigenfrequency=122.21 Hz Surface: Total displacement (in)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.26 GB | 1.46 GB

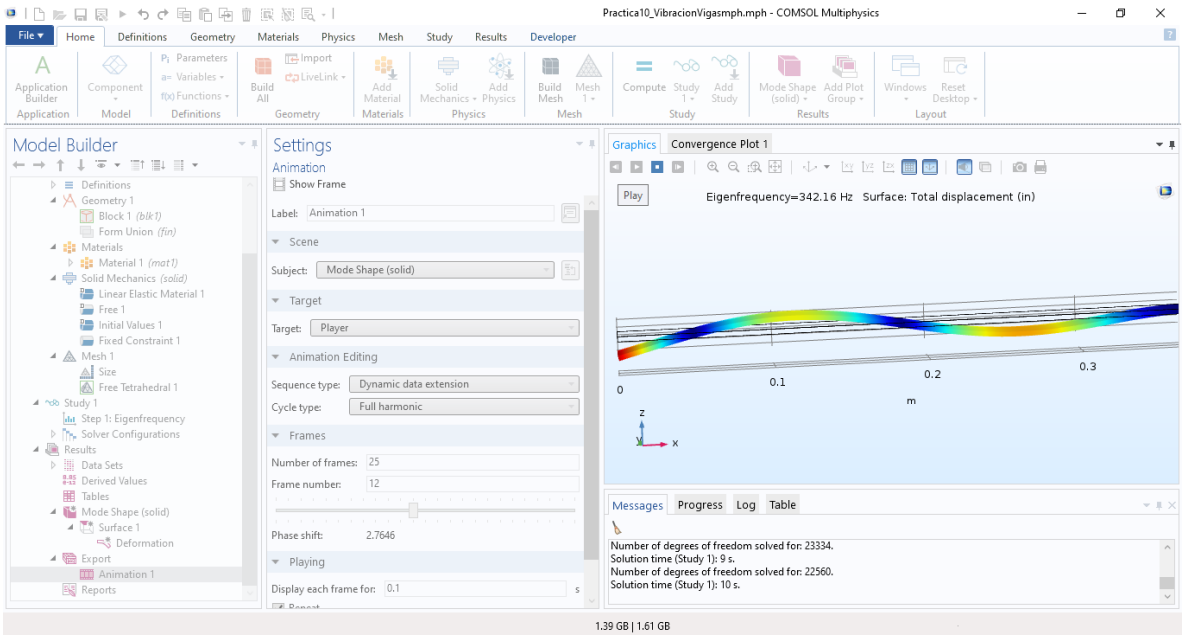

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Animation
Graphics
Convergence Plot 1
Eigenfrequency=122.21 Hz Surface: Total displacement (in)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.37 GB | 1.57 GB

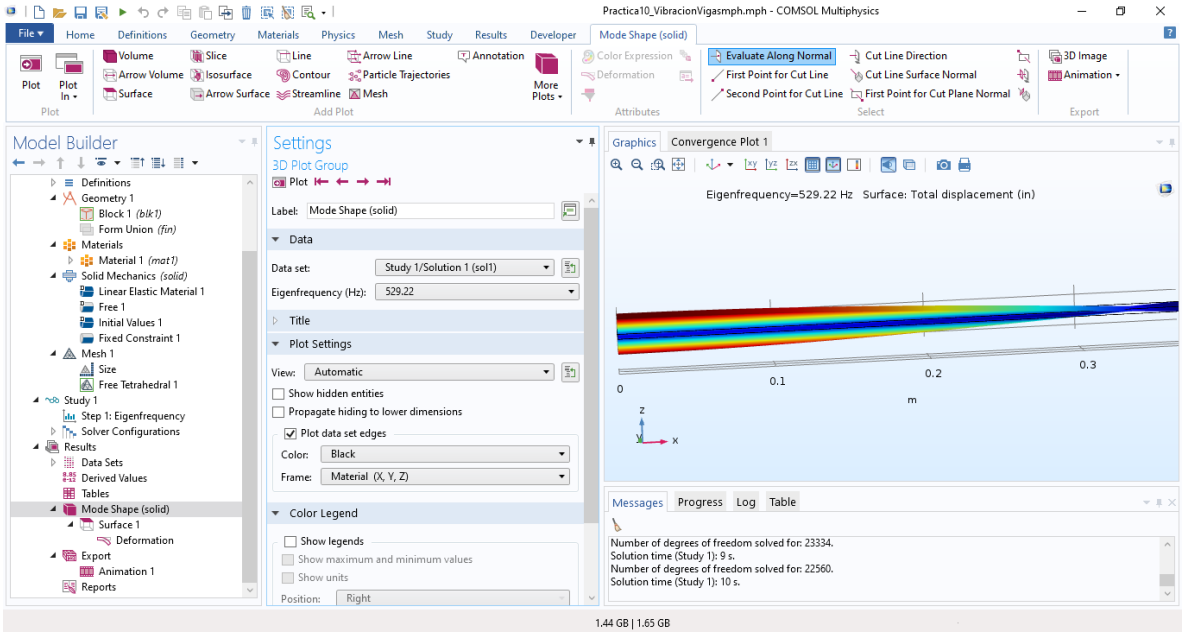

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
3D Plot Group
Label: Mode Shape (solid)
Data
Data set: Study 1/Solution 1 (sol1)
Eigenfrequency (Hz): 122.21
19.508
122.21
154.91
342.16
529.22
670.55
950.18
1108.7
1591.6
1656.6
Plot Settings
View: Automatic
Color: Black
Frame: Material (X, Y, Z)
Color Legend
Graphics
Convergence Plot 1
Eigenfrequency=122.21 Hz Surface: Total displacement (in)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.38 GB | 1.6 GB


Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
3D Plot Group
Label: Mode Shape (solid)
Data
Data set: Study 1/Solution 1 (sol1)
Eigenfrequency (Hz): 342.16
Plot Settings
View: Automatic
Color: Black
Frame: Material (X, Y, Z)
Color Legend
Graphics
Convergence Plot 1
Eigenfrequency=342.16 Hz Surface: Total displacement (in)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.38 GB | 1.59 GB

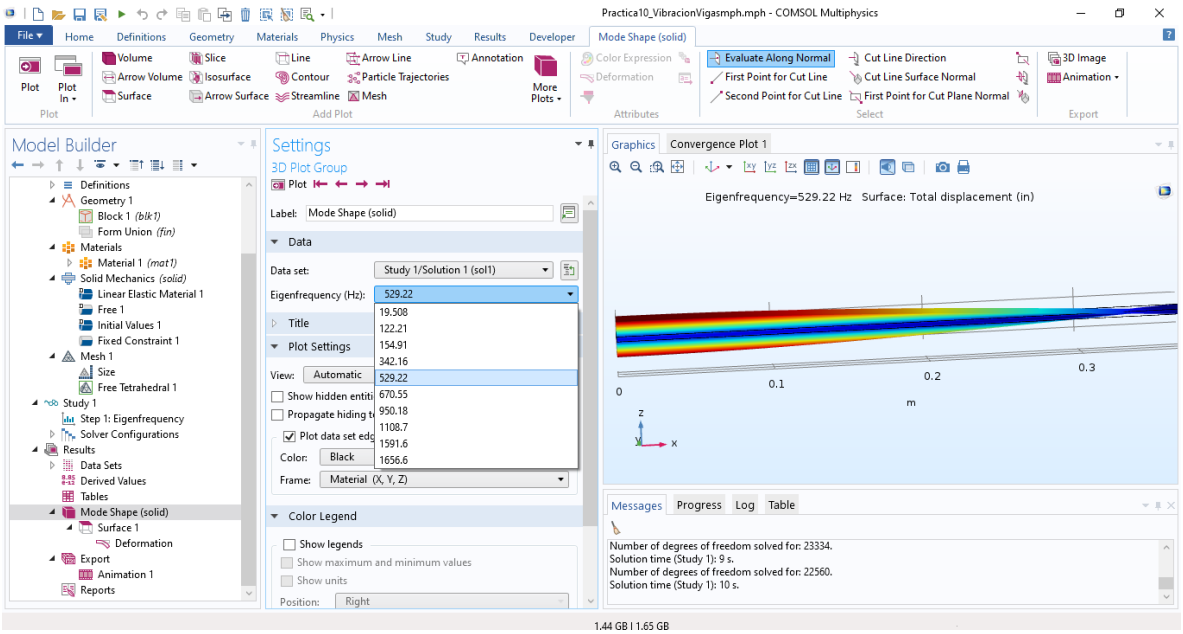

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Animation
Show Frame
Label: Animation 1
Scene
Subject: Mode Shape (solid)
Target
Target: Player
Animation Editing
Sequence type: Dynamic data extension
Cycle type: Full harmonic
Frames
Number of frames: 25
Frame number: 25
Phase shift: 6.0319
Playing
Display each frame for: 0.1 s
Graphics
Convergence Plot 1
Eigenfrequency=342.16 Hz Surface: Total displacement (in)
0
0.1
0.2
0.3
m
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.38 GB | 1.59 GB

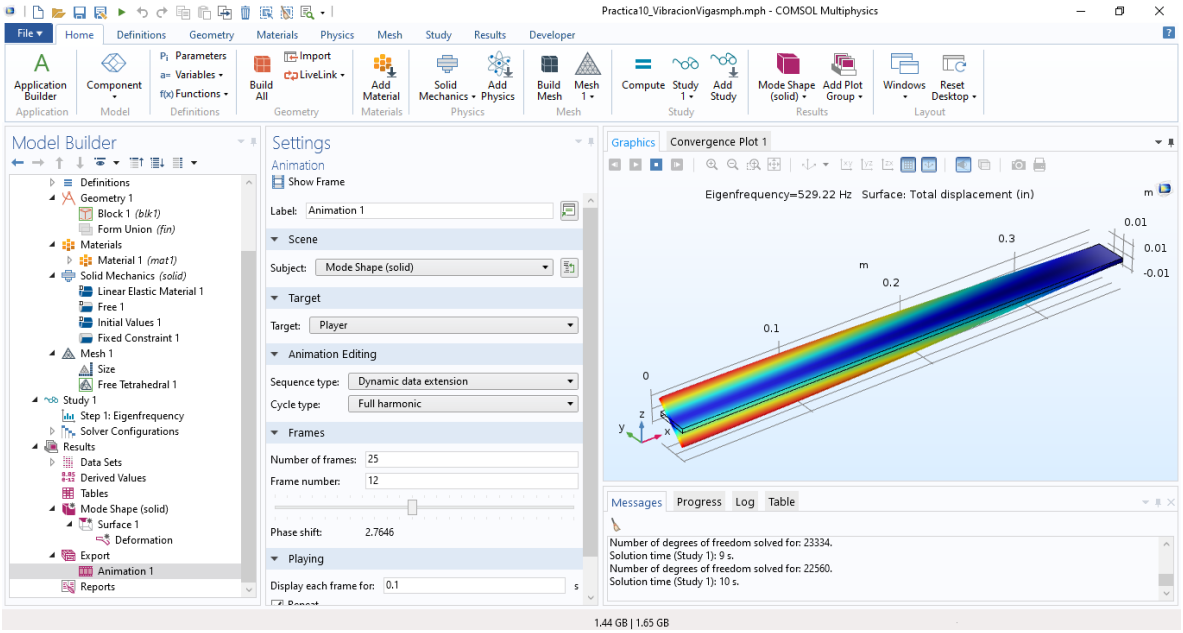

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
Animation
Show Frame
Label: Animation 1
Scene
Subject: Mode Shape (solid)
Target
Target: Player
Animation Editing
Sequence type: Dynamic data extension
Cycle type: Full harmonic
Frames
Number of frames: 25
Frame number: 25
Phase shift: 6.0319
Playing
Display each frame for: 0.1 s
Graphics
Convergence Plot 1
Play
Eigenfrequency=342.16 Hz Surface: Total displacement (in)
0
0.1
0.2
0.3
m
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.3 GB | 1.51 GB



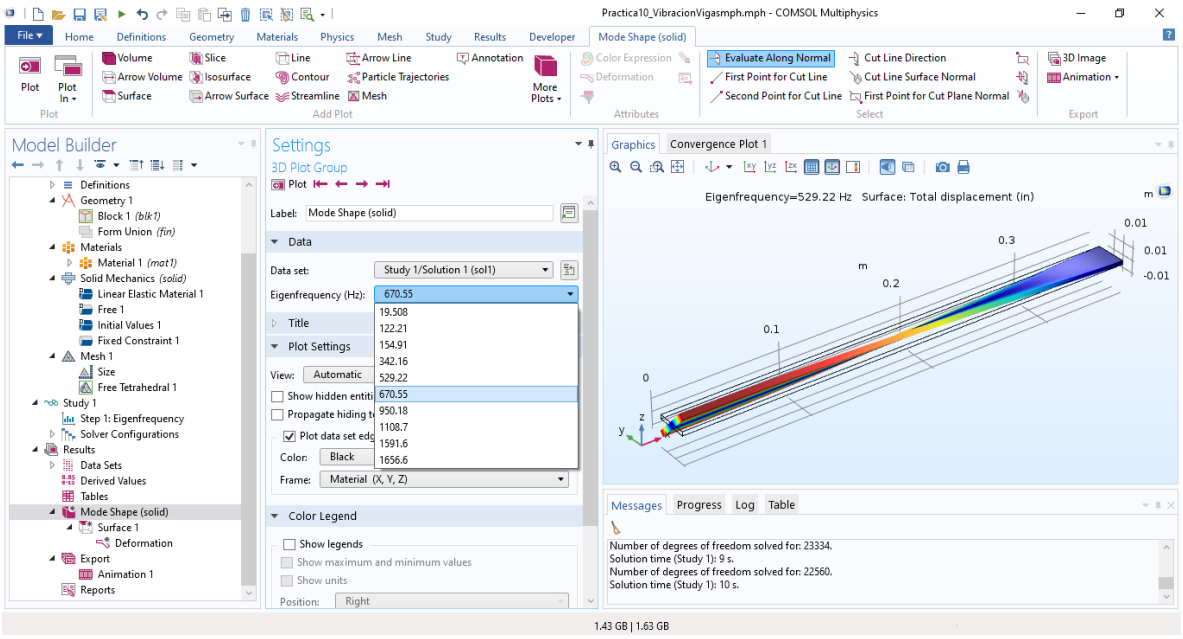


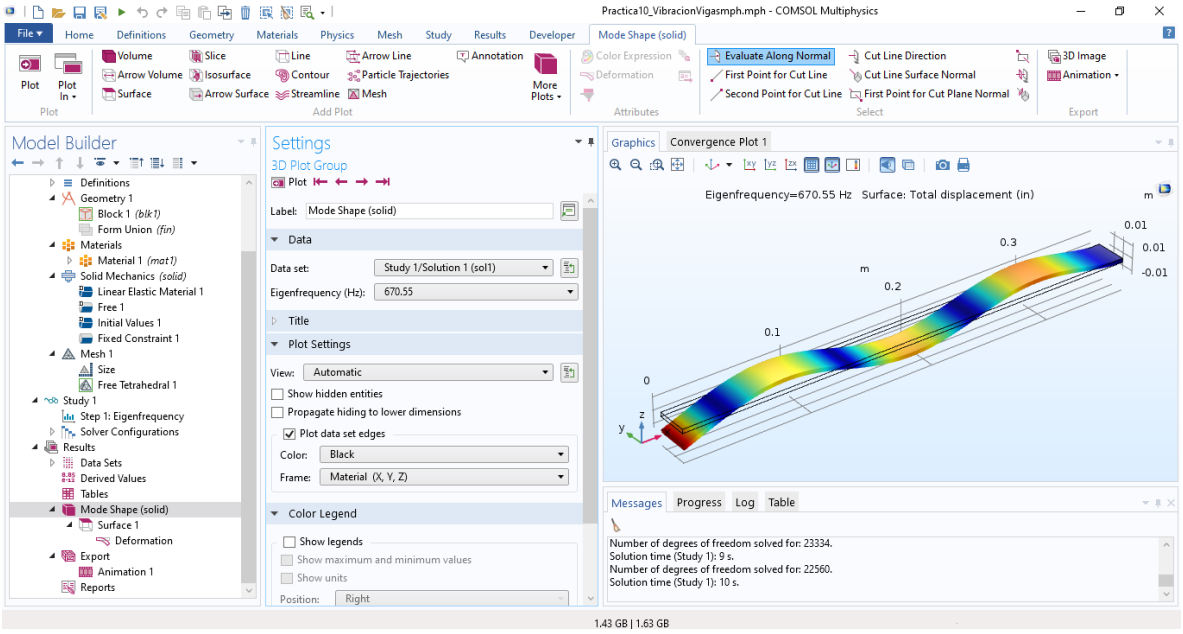
Las diferentes frecuencias me describirán movimientos diferentes, por ejemplo, la quinta frecuencia de esta figura es de un movimiento rotatorio mientras la primera es un movimiento oscilatorio frontal.



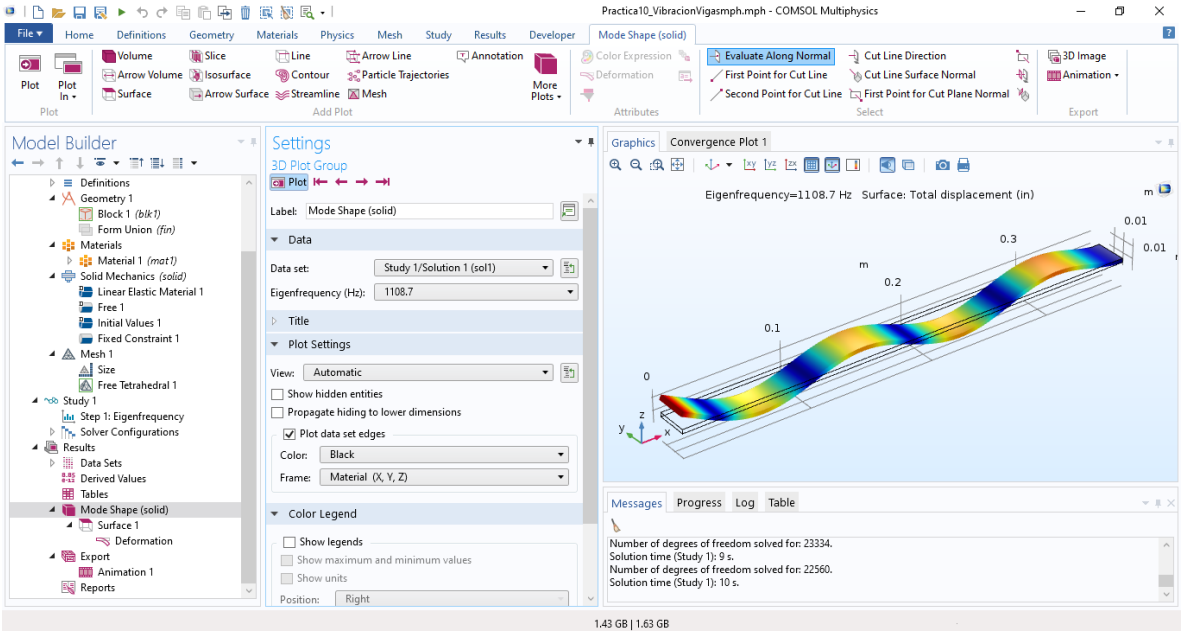


La siguiente frecuencia armónica puede que sea de otro tipo de movimiento, el programa mostrará cual es.

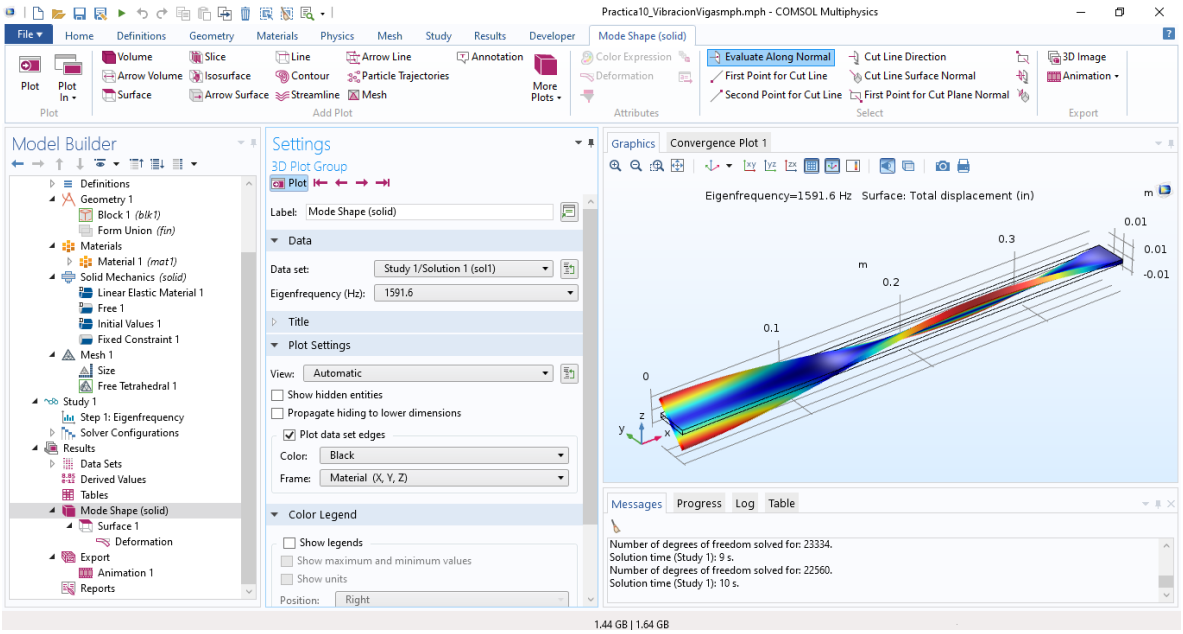

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
3D Plot Group
Label: Mode Shape (solid)
Data
Data set: Study 1/Solution 1 (sol1)
Eigenfrequency (Hz): 670.55
19.508
122.21
154.91
342.16
529.22
670.55
950.18
1108.7
1591.6
1656.6
Plot Settings
View: Automatic
Color: Black
Frame: Material (X, Y, Z)
Color Legend
Show legends
Graphics
Convergence Plot 1
Eigenfrequency=529.22 Hz Surface: Total displacement (in)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.43 GB | 1.63 GB

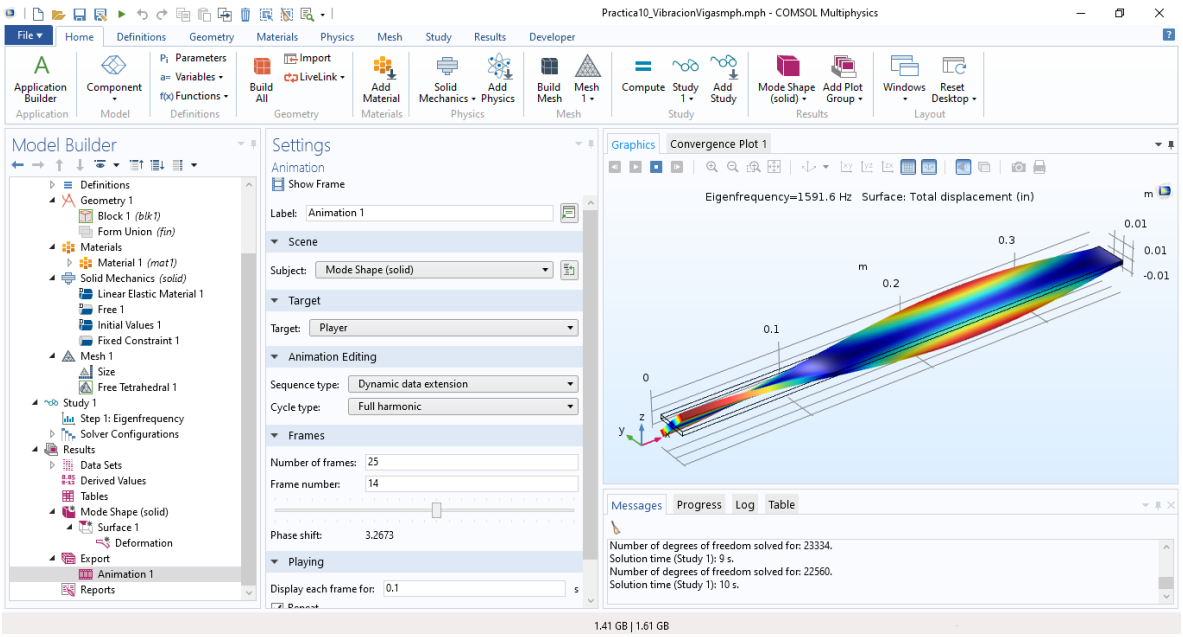

Practica10_VibracionVigasmph.mph - COMSOL Multiphysics
Model Builder
Settings
3D Plot Group
Label: Mode Shape (solid)
Data
Data set: Study 1/Solution 1 (sol1)
Eigenfrequency (Hz): 670.55
Plot Settings
View: Automatic
Show hidden entities
Propagate hiding to lower dimensions
Plot data set edges
Color: Black
Frame: Material (X, Y, Z)
Color Legend
Show legends
Graphics
Convergence Plot 1
Eigenfrequency=670.55 Hz Surface: Total displacement (in)
Messages
Progress
Log
Table
Number of degrees of freedom solved for: 23334.
Solution time (Study 1): 9 s.
Number of degrees of freedom solved for: 22560.
Solution time (Study 1): 10 s.
1.43 GB | 1.63 GB

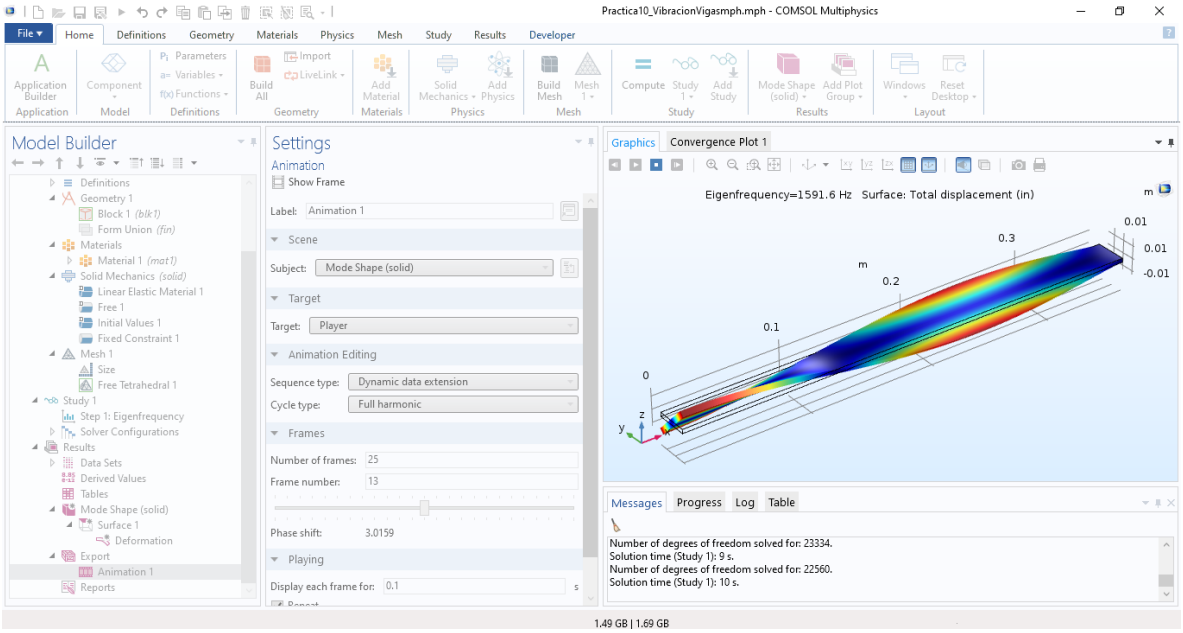
La octava frecuencia armónica de 1108.7 Hz perteneciente a la placa es un movimiento oscilatorio frontal.



La novena frecuencia armónica de 1591.6 Hz perteneciente a la placa es un movimiento oscilatorio que combina dos efectos torsionantes de 2 nodos distintos.







BIBLIOGRAFÍA:

INGENIERÍA MECÁNICA ESTÁTICA (12VA EDICIÓN) – RUSSELL C. HIBBELER.