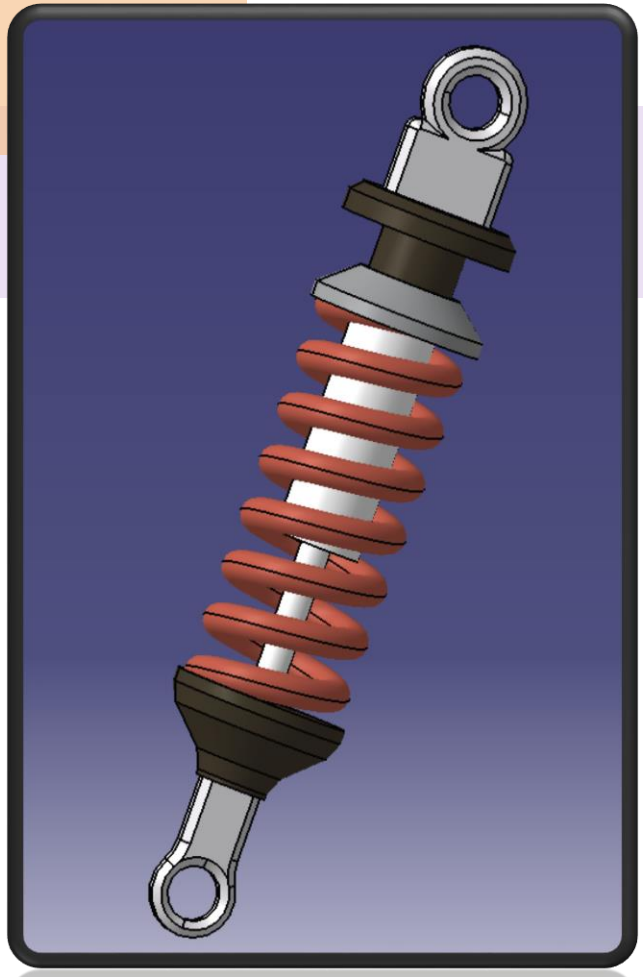
CAE Term Project

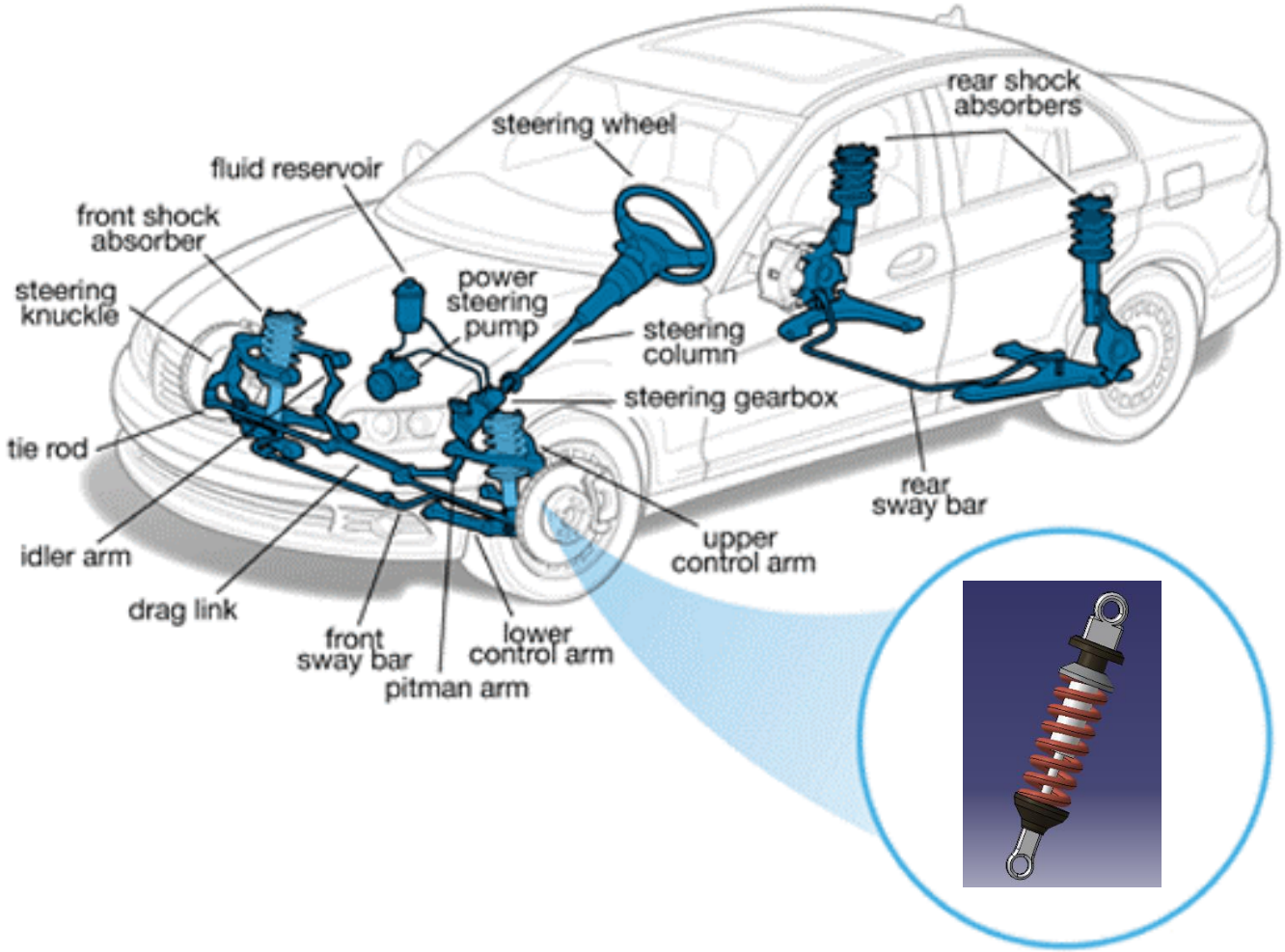
〈Shock Absorber Analysis〉



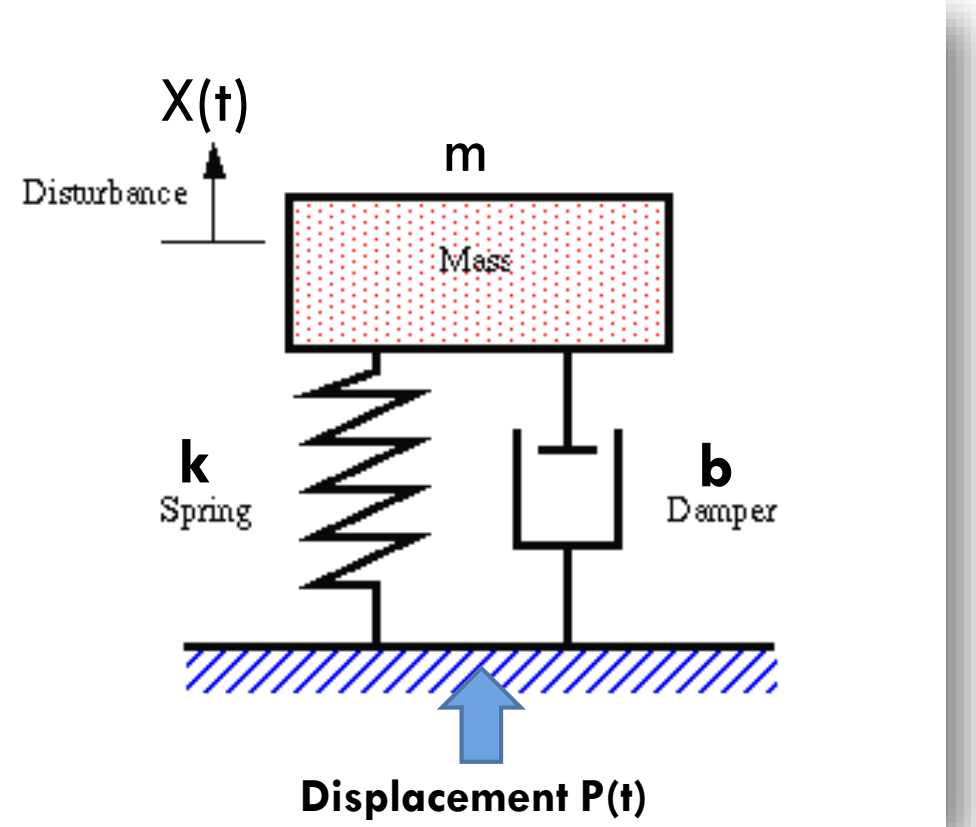
학과 : 미래자동차공학과
학번 : 2011008785
이름 : 김한수

〈Contents〉

1. Shock Absorber



1. Shock Absorber



운동 방정식 : $m\ddot{x} + b\dot{x} + kx = b\dot{p} + kp$

$$ex)\ m = 10kg, b = 50N \cdot \frac{s}{m}, k = \frac{250N}{m}, x(0) = 0,\ \dot{x}(0) = 0$$

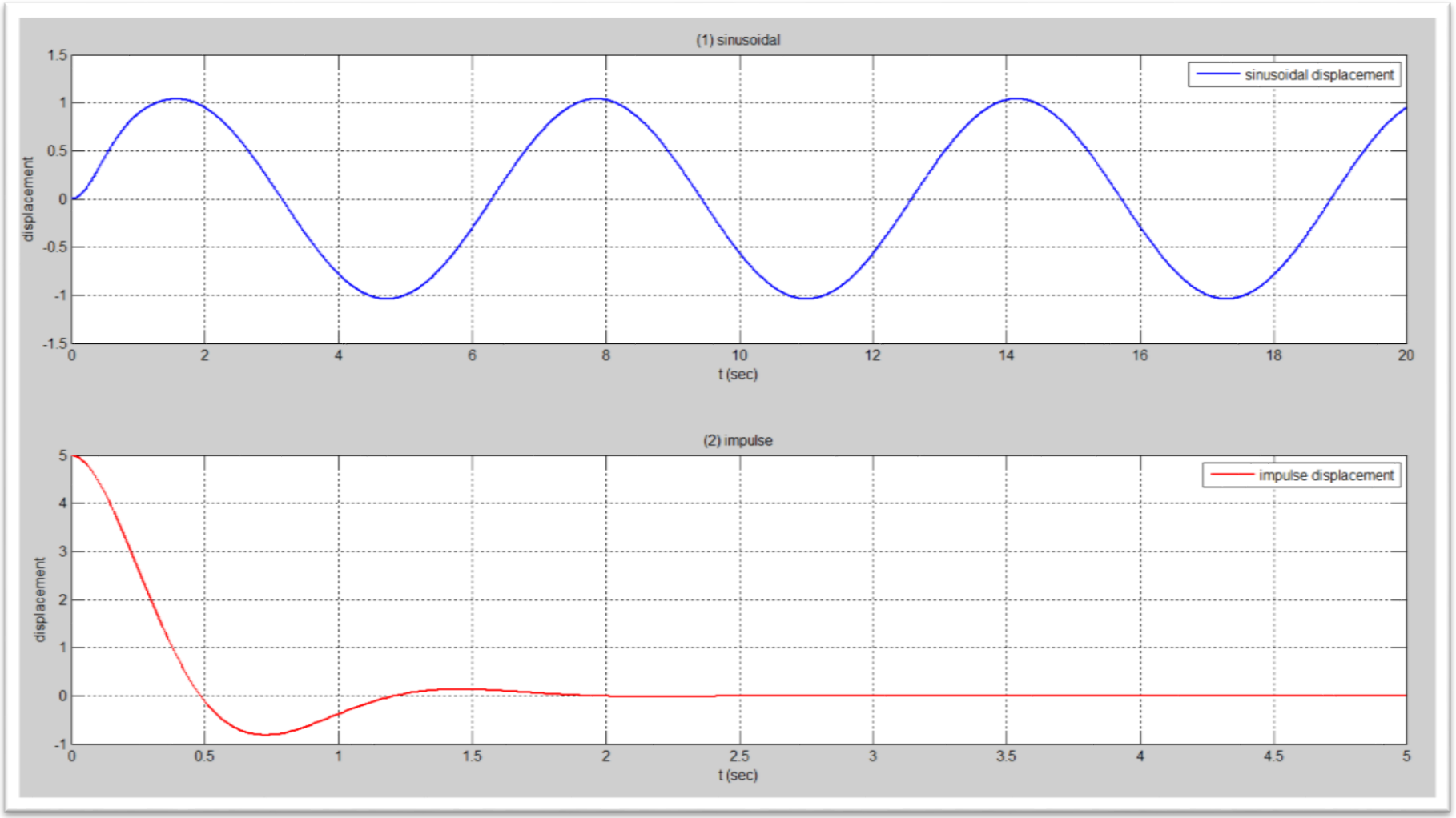
$$TF = \frac{5s + 25}{s^2 + 5s + 25}$$

① p(t)가 sinusoidal function :sin(t) 일 때

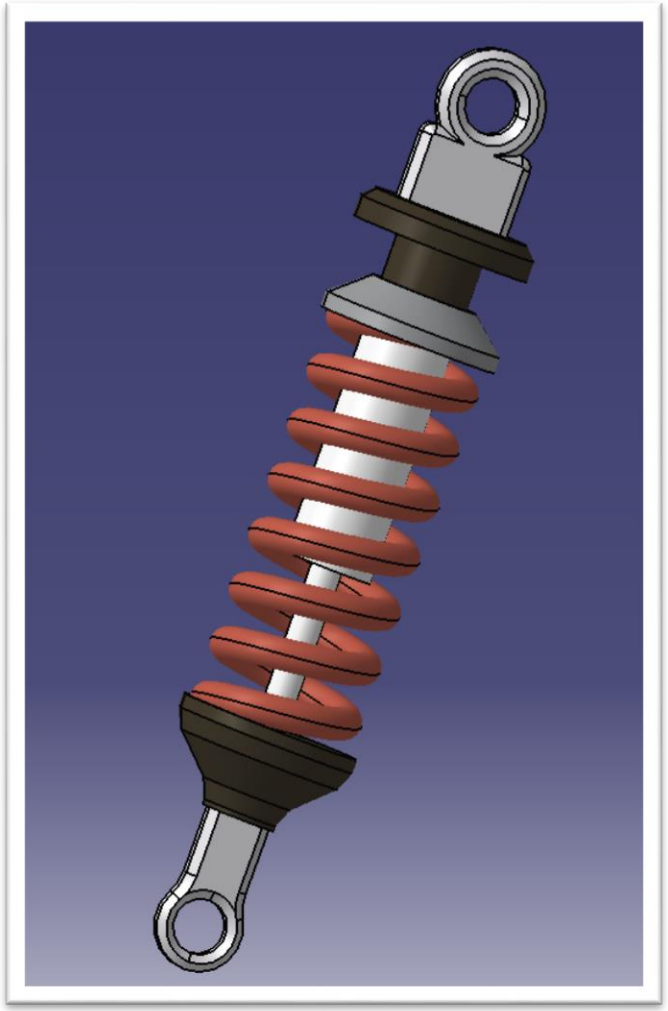
② P(t)가 impulse function : unity 일 때

2011008785 Kim Hansu

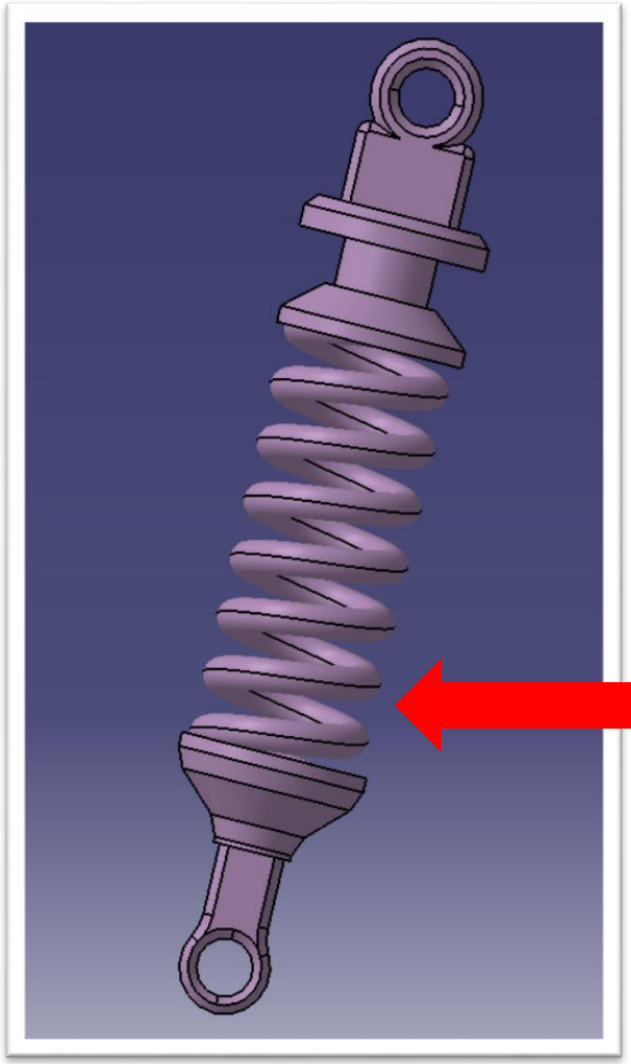
1. Shock Absorber

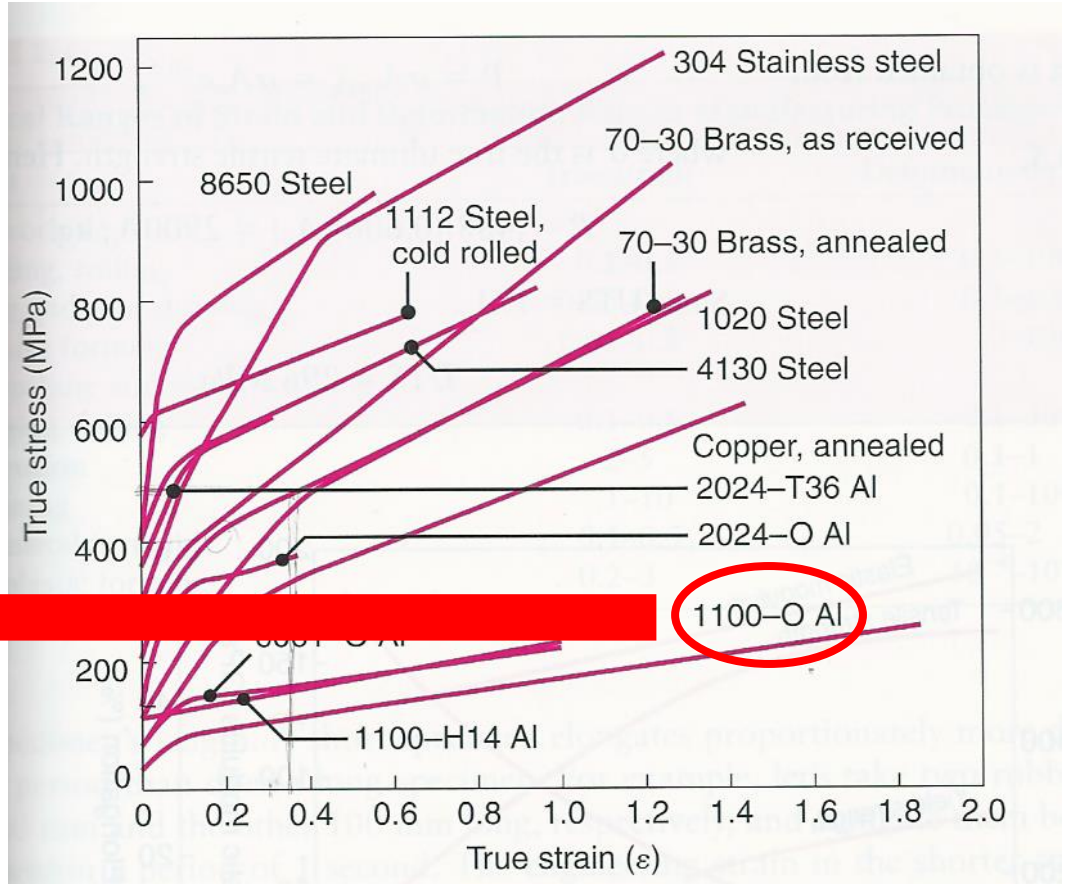


2. Modeling



2. Modeling



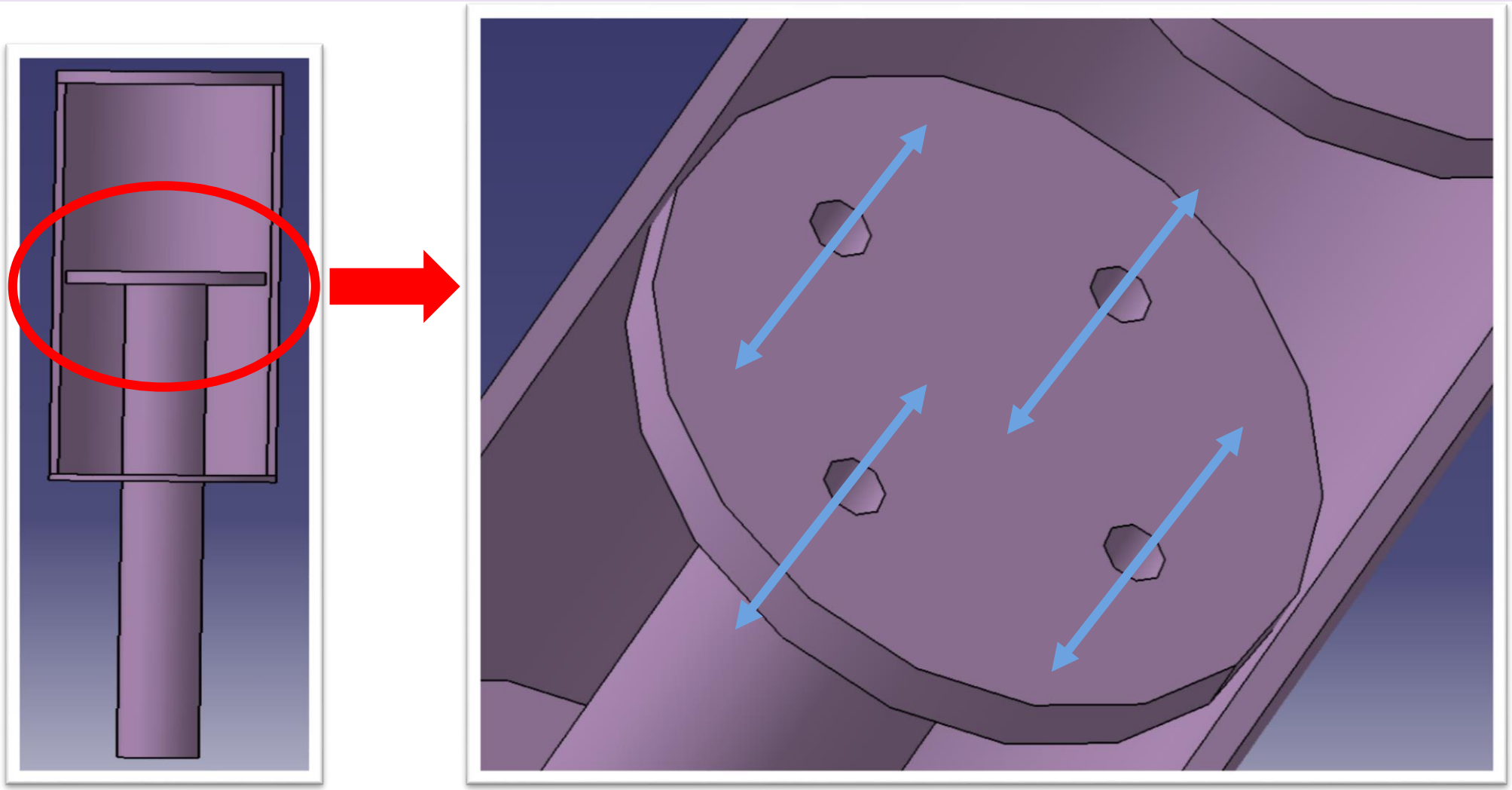

304 Stainless steel
70–30 Brass, as received
8650 Steel
1112 Steel, cold rolled
70–30 Brass, annealed
1020 Steel
4130 Steel
Copper, annealed
2024–T36 Al
2024–O Al
1100–O Al
1100–H14 Al
True stress (MPa)
True strain (ε)
0
200
400
600
800
1000
1200
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0

2. Modeling

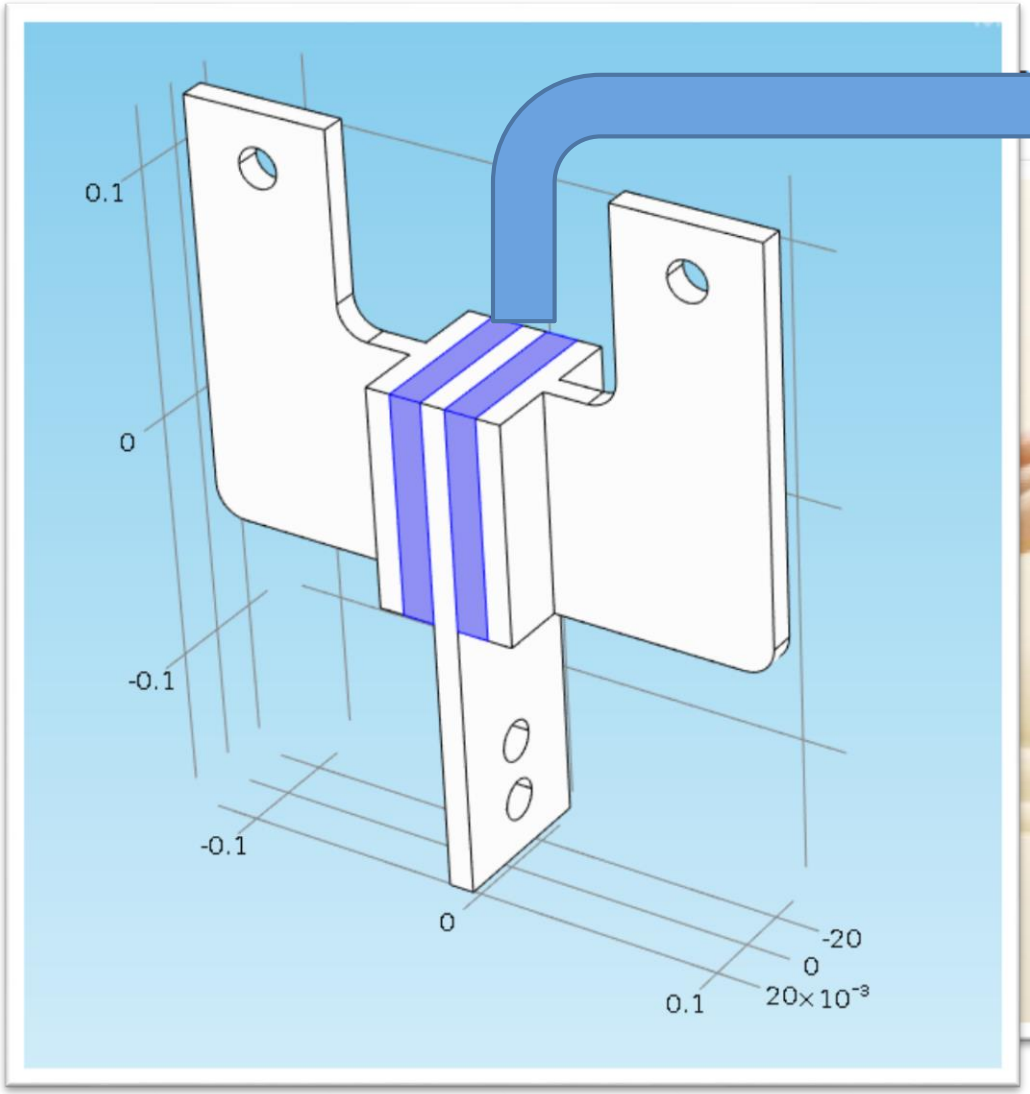
Aluminum 1100-0

Categories:	Metal; Nonferrous Metal; Aluminum Alloy; 1000 Series Aluminum		
Material Notes:	This is a common commercial grade sold when "aluminum" is specified. As with other unalloyed aluminum grades, it is used where the intrinsic formability and corrosion resistance of aluminum is needed while high strength is not. Data points with the AA note have been provided by the Aluminum Association, Inc. and are NOT FOR DESIGN.		
Composition Notes:	The aluminum content for unalloyed aluminum not made by a refining process is the difference between 100.00% and the sum of all other analyzed metallic elements present in amounts of 0.010% of more each, expressed to the second decimal before determining the sum. For alloys and unalloyed aluminum not made by refining process, when the specified maximum limit is 0.XX, an observed value or a calculated value greater than 0.005 but less than 0.010% is rounded off and shown as "less than 0.01%".		
Key Words:	Composition information provided by the Aluminum Association and is not for design. Aluminum 1100-O; UNS A91100; ISO Al99.0Cu; NF A45 (France); CSA 990C (Canada); AA1100-O		
Physical Properties	**Metric**	**English**	**Comments**
Density	2.71 g/cc	0.0979 lb. / in³	AA; Typical
Mechanical Properties	**Metric**	**English**	**Comments**
Hardness, Brinell	23	23	AA: Typical; 500 g. load; 10 mm ball.
[illegible]	[illegible]	13000 psi	AA; Typical
Tensile Yield Strength	34.5 MPa	5000 psi	AA; Typical
Elongation at Break	[illegible] @ Thickness 1.59 mm	35.00% @ Thickness .0625 mm	AA; Typical
	45.00% @ Diameter 12.7 mm	45.00% @ Diameter 0.500 mm	AA; Typical
Modulus of Elasticity	68.9GPa	10000 ksi	AA; Typical: Average of tension and compression. Compression modulus is about 2% greater than tensile modulus.
Notched Tensile Strength	90.0 MPa	131000 psi	2.5 cm width x 0.16 cm thick side-notched specimen, Kt = 17
Ultimate Bearing Strength	159 MPa	23100 psi	Edge distance/pin diameter = 2.0
Bearing Yield Strngth	55.0 Mpa	7980 psi	Edge distance/pin diameter = 2.0
Poissons Ratio	0.33	0.33	
Fatigue Strength	34.5 MPa @# of cycles 5.00e+8	5000 psi @# of cycles 5.00e+8	Completely reversed stress; RR Moore machine/specimen
Machinability	10.00%	10.00%	0 - 100 Scale of Aluminum Alloys
Shear Modulus	26.0 GPa	3770 ksi	Calculated
Shear Strength	62.1 MPa	9000 psi	AA: Typical

2. Modeling



2. Modeling

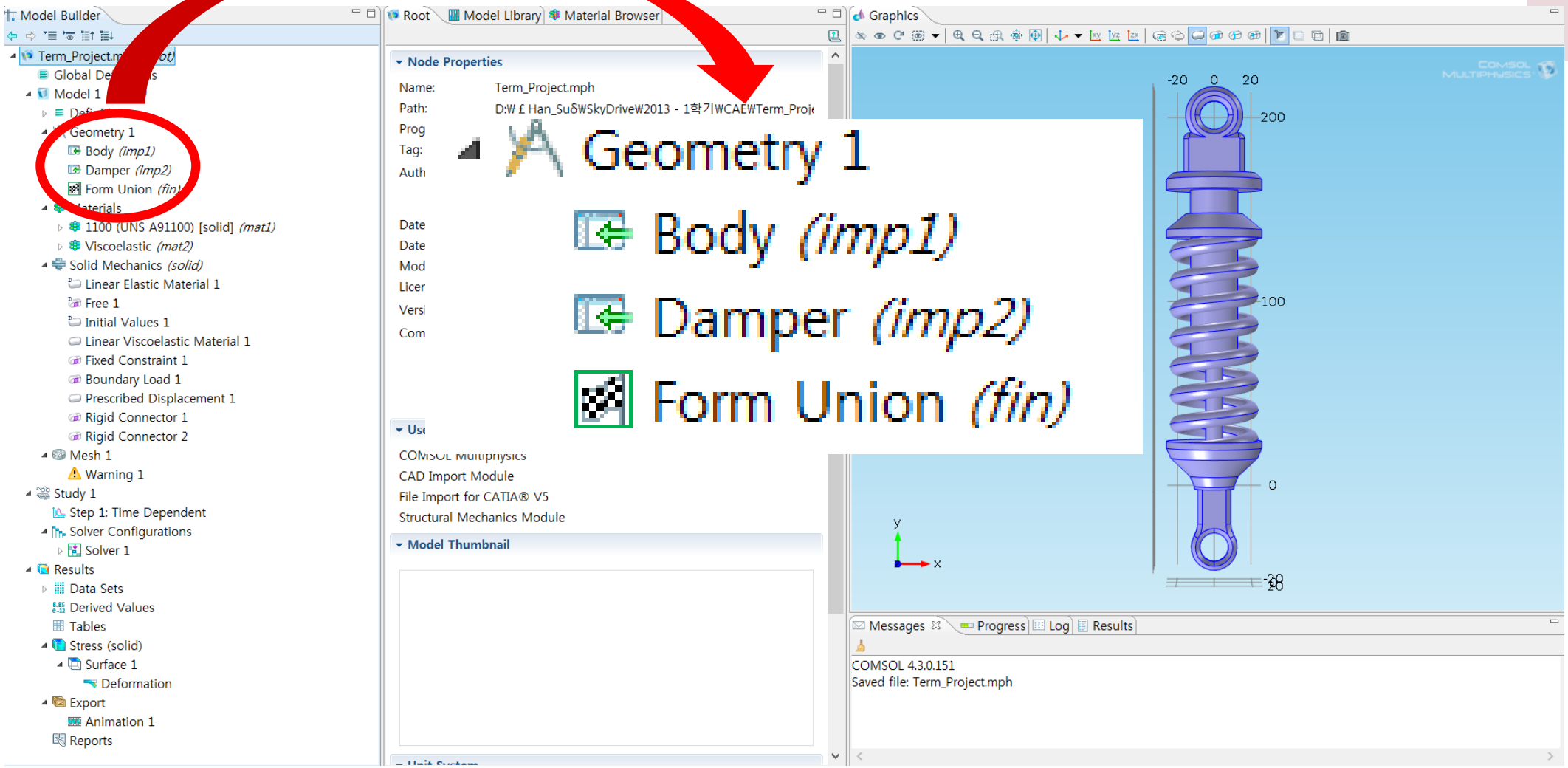


Material Contents

	Property	Name	Value	Unit	Property group
✓	Density	rho	1060	kg/m^3	Basic
✓	Bulk modulus	K	4e8	N/m^2	Bulk modulus and shear modulus
✓	Shear modulus	G	5.86e4	N/m^2	Bulk modulus and shear modulus

3. Analysis

①


Model Builder
Term_Project.m
Global De
Model 1
Geometry 1
Body (imp1)
Damper (imp2)
Form Union (fin)
Materials
1100 (UNS A91100) [solid] (mat1)
Viscoelastic (mat2)
Solid Mechanics (solid)
Linear Elastic Material 1
Free 1
Initial Values 1
Linear Viscoelastic Material 1
Fixed Constraint 1
Boundary Load 1
Prescribed Displacement 1
Rigid Connector 1
Rigid Connector 2
Mesh 1
Warning 1
Study 1
Step 1: Time Dependent
Solver Configurations
Solver 1
Results
Data Sets
Derived Values
Tables
Stress (solid)
Surface 1
Deformation
Export
Animation 1
Reports
Root
Model Library
Material Browser
Node Properties
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COMSOL Multiphysics
CAD Import Module
File Import for CATIA® V5
Structural Mechanics Module
Model Thumbnail
Geometry 1
Body (imp1)
Damper (imp2)
Form Union (fin)
Graphics
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Messages
Progress
Log
Results
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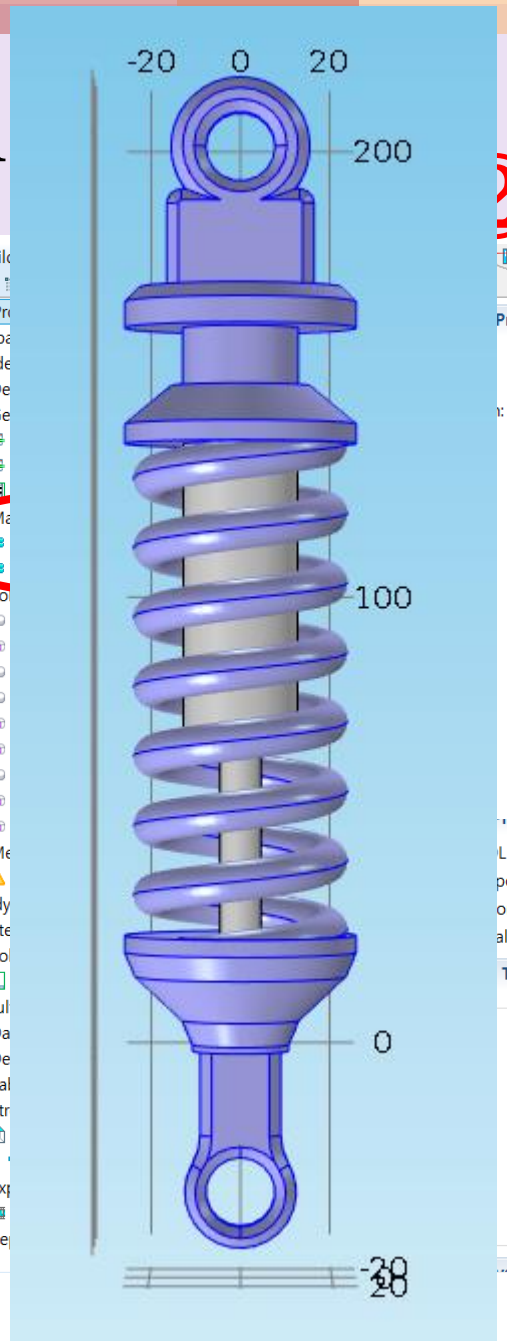
Saved file: Term_Project.mph

3. An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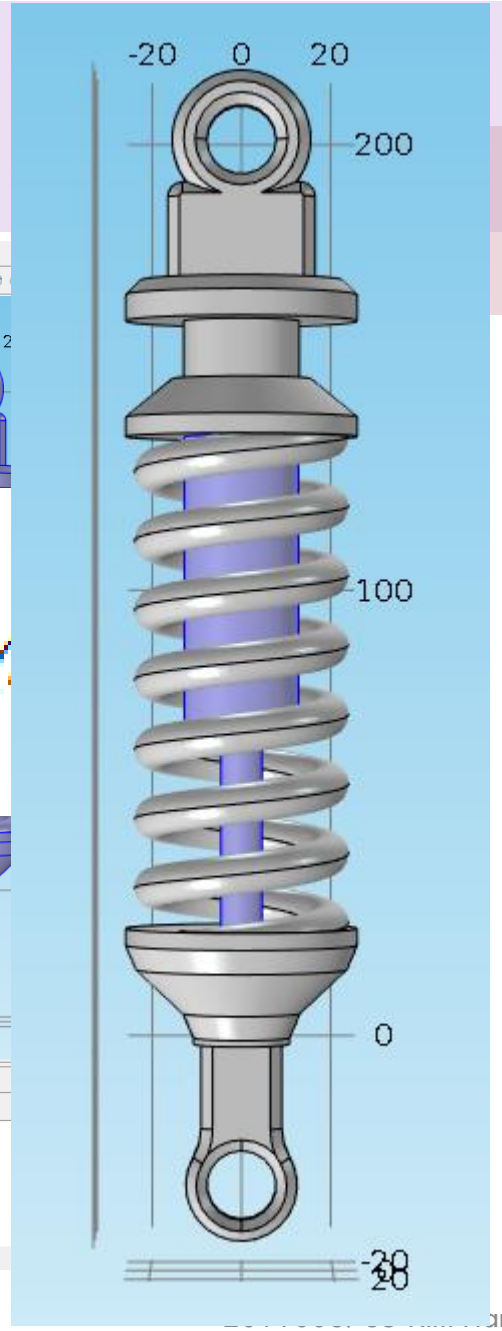
Model Builder
Model Library
Material Browser
Graphics
Properties
Term_Project.mph
COMSOL 4.3 (Build: 151)
Model2
Materials
1100 (UNS A91100) [solid]
Viscoelastic (mat2)
Thumbnail
Messages
Progress
Log
Results
COMSOL 4.3.0.151
Saved file: Term_Project.mph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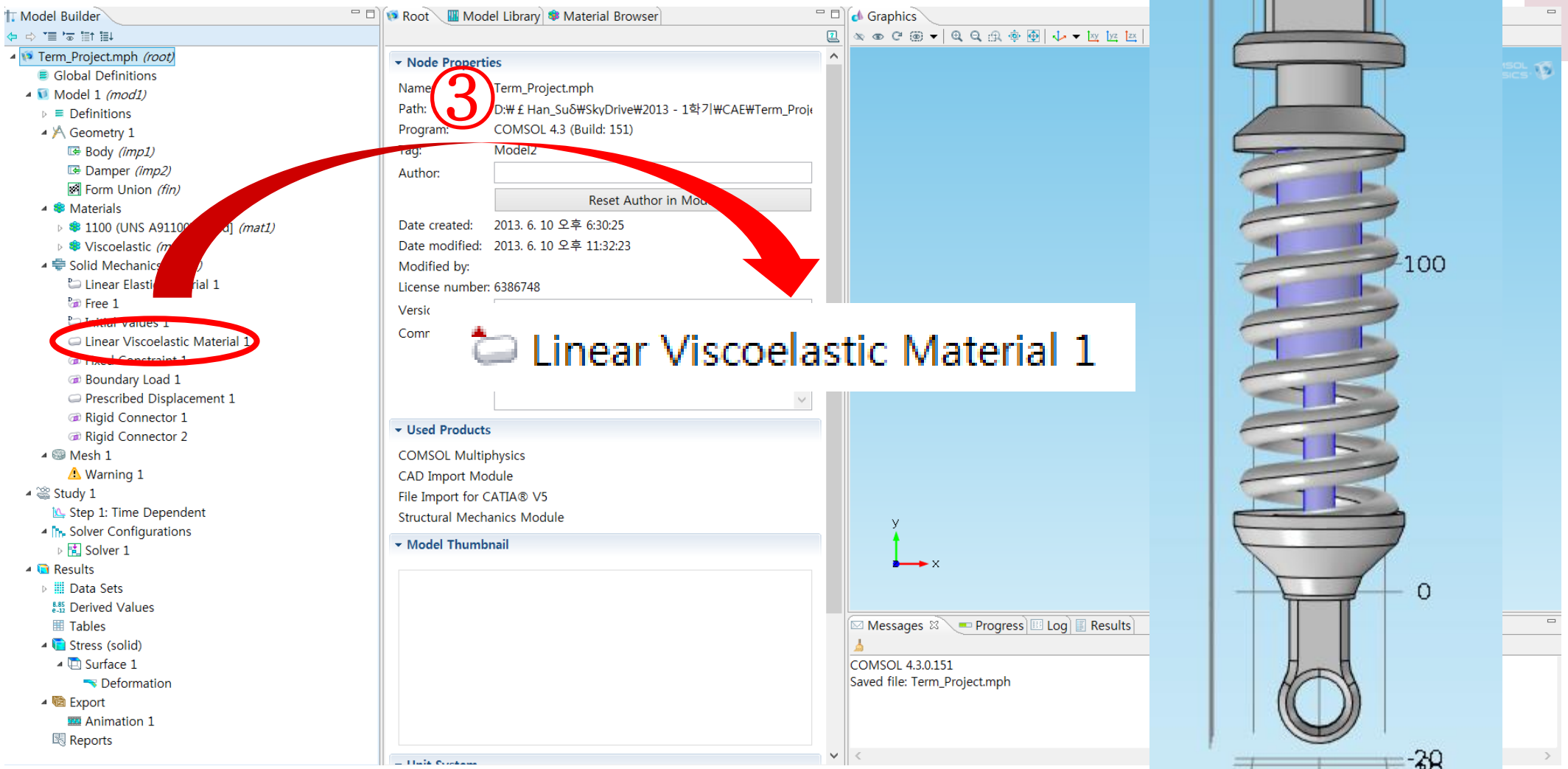
3. Analysis


Model Builder
Term_Project.mph (root)
Global Definitions
Model 1 (mod1)
Definitions
Geometry 1
Body (imp1)
Damper (imp2)
Form Union (fin)
Materials
Solid Mechanics
Free 1
Linear Viscoelastic Material 1
Boundary Load 1
Prescribed Displacement 1
Rigid Connector 1
Rigid Connector 2
Mesh 1
Warning 1
Study 1
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Solver Configurations
Solver 1
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Data Sets
Derived Values
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Stress (solid)
Surface 1
Deformation
Export
Animation 1
Reports
Root
Model Library
Material Browser
Node Properties
Name:
Path:
Program:
Tag:
Author:
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Date created:
Date modified:
Modified by:
License number:
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COMSOL 4.3 (Build: 151)
Model2
2013. 6. 10 오후 6:30:25
2013. 6. 10 오후 11:32:23
6386748
Linear Viscoelastic Material 1
Used Products
COMSOL Multiphysics
CAD Import Module
File Import for CATIA® V5
Structural Mechanics Module
Model Thumbnail
Graphics
Messages
Progress
Log
Results
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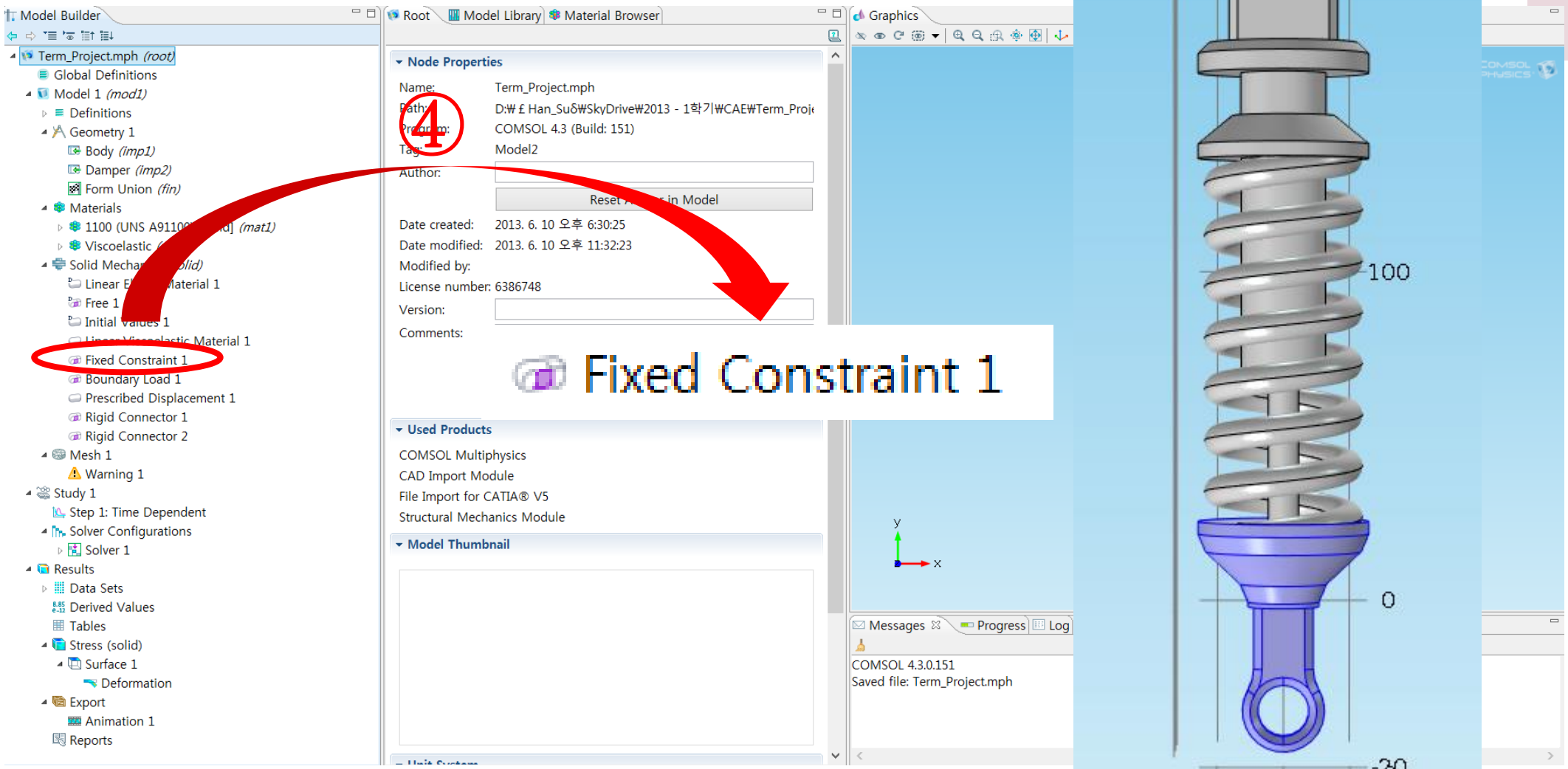
3. Analysis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Form Union (fin)
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Solid
Free 1
Fixed Constraint 1
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Rigid Connector 1
Rigid Connector 2
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COMSOL 4.3 (Build: 151)
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Date modified: 2013. 6. 10 오후 11:32:23
Modified by:
License number: 6386748
Version:
Comments:
④
Fixed Constraint 1
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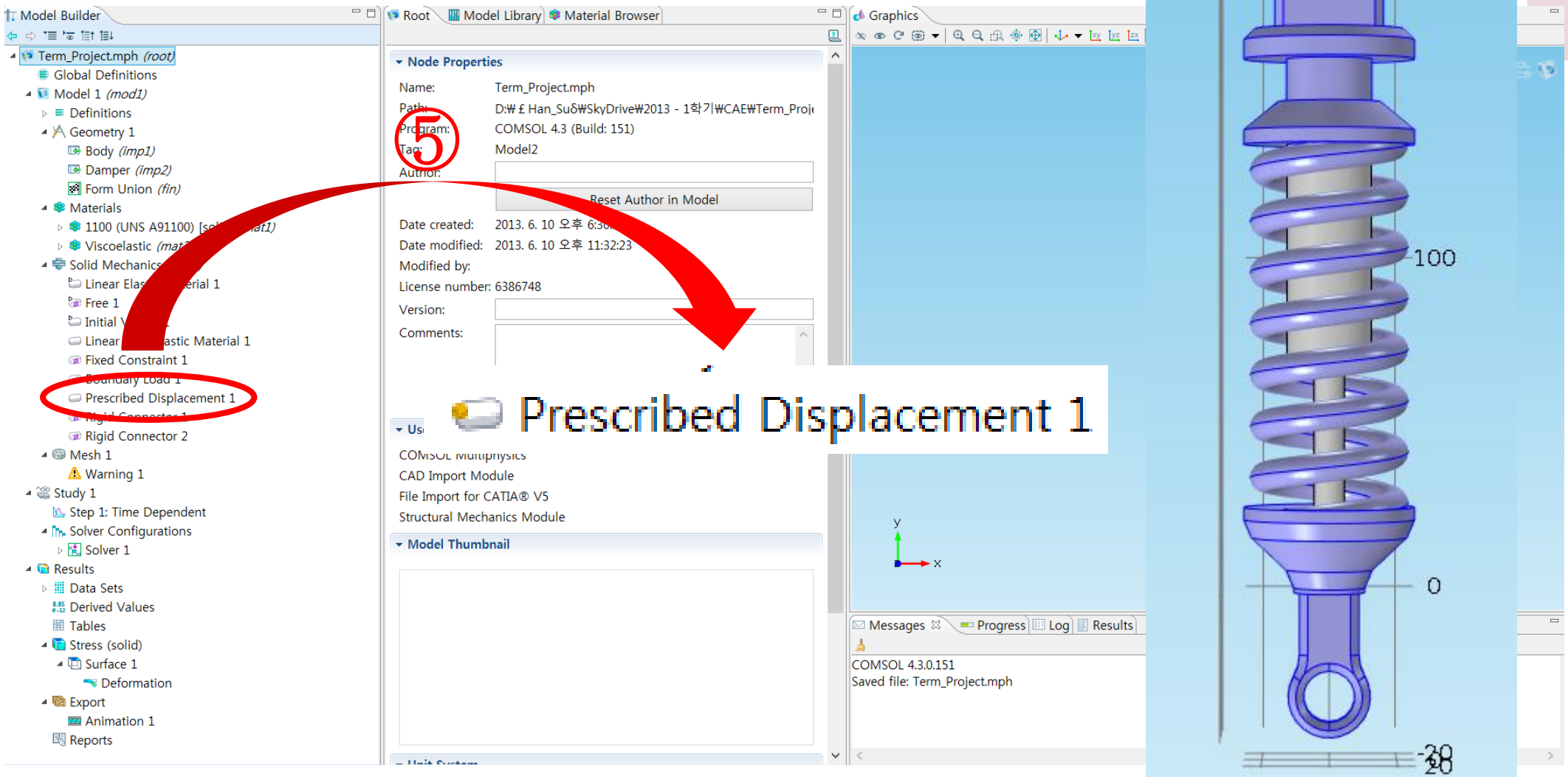
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Animation 1
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Material Browser
Node Properties
Name: Term_Project.mph
Program: COMSOL 4.3 (Build: 151)
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Date modified: 2013. 6. 10 오후 11:32:23
Modified by:
License number: 6386748
Version:
Comments:
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Prescribed Displacement 1
COMSOL Multiphysics
CAD Import Module
File Import for CATIA® V5
Structural Mechanics Module
Model Thumbnail
Graphics
Messages
Progress
Log
Results
COMSOL 4.3.0.151
Saved file: Term_Project.mph
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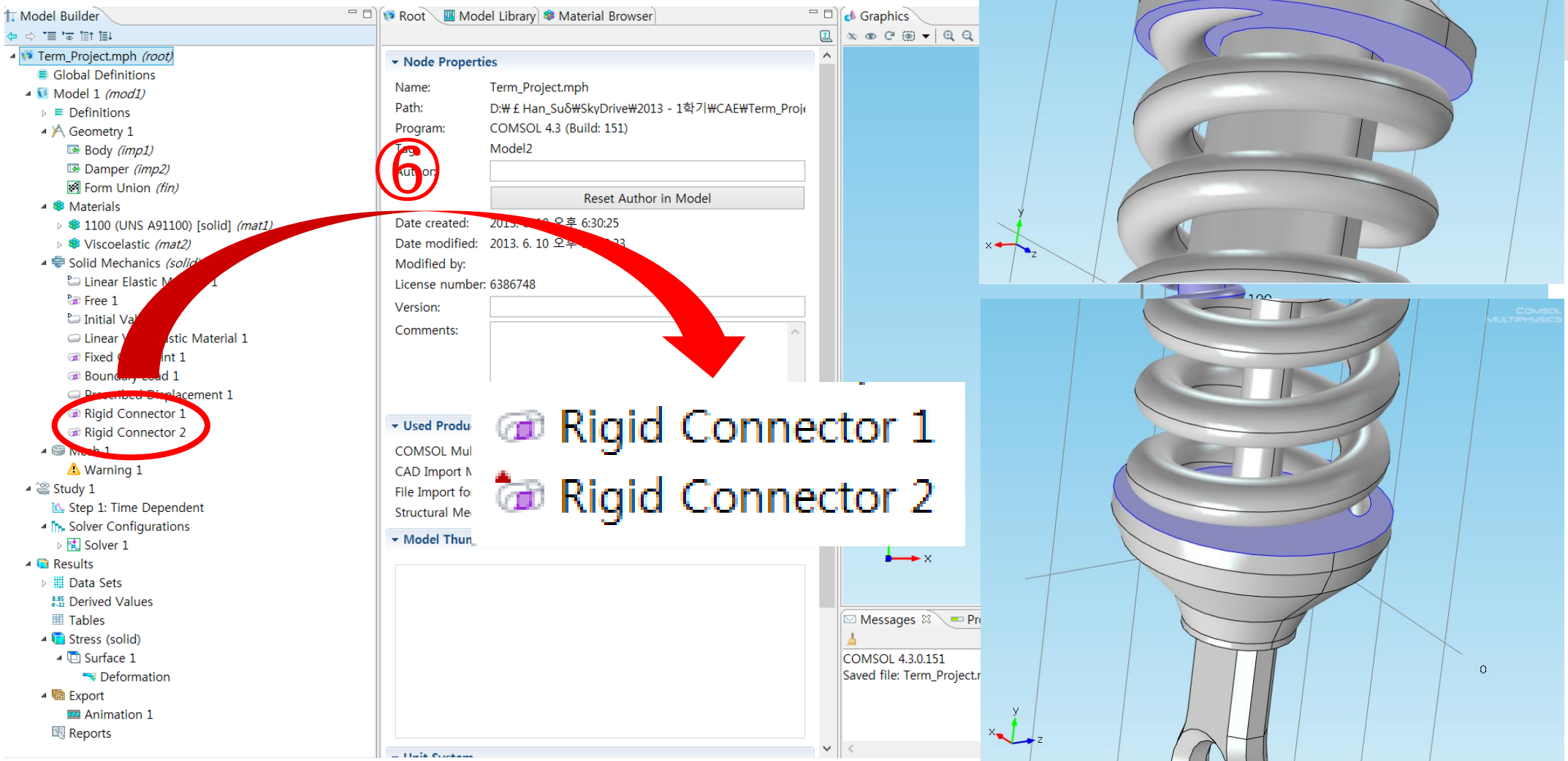
3. Analysis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Form Union (fin)
Materials
1100 (UNS A91100) [solid] (mat1)
Viscoelastic (mat2)
Solid Mechanics (solid)
Free 1
Rigid Connector 1
Rigid Connector 2
Warning 1
Study 1
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Solver Configurations
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Node Properties
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Path:
Program: COMSOL 4.3 (Build: 151)
Model2
Reset Author in Model
Date created:
Date modified: 2013. 6. 10
Modified by:
License number: 6386748
Version:
Comments:
⑥
Rigid Connector 1
Rigid Connector 2
Graphics
Messages
COMSOL 4.3.0.151
Saved file: Term_Project.m

3. Analysis ⑦'

Function Name

Function name: impulse

Parameters

Argument: t

Extrapolation: None

Smoothing: No smoothing

Intervals

Start	End	Function
0	1	0
1	1.1	-2000*(t-1)*(t-1.1)
1.1	2	0

Start:

End:

Function:

Units

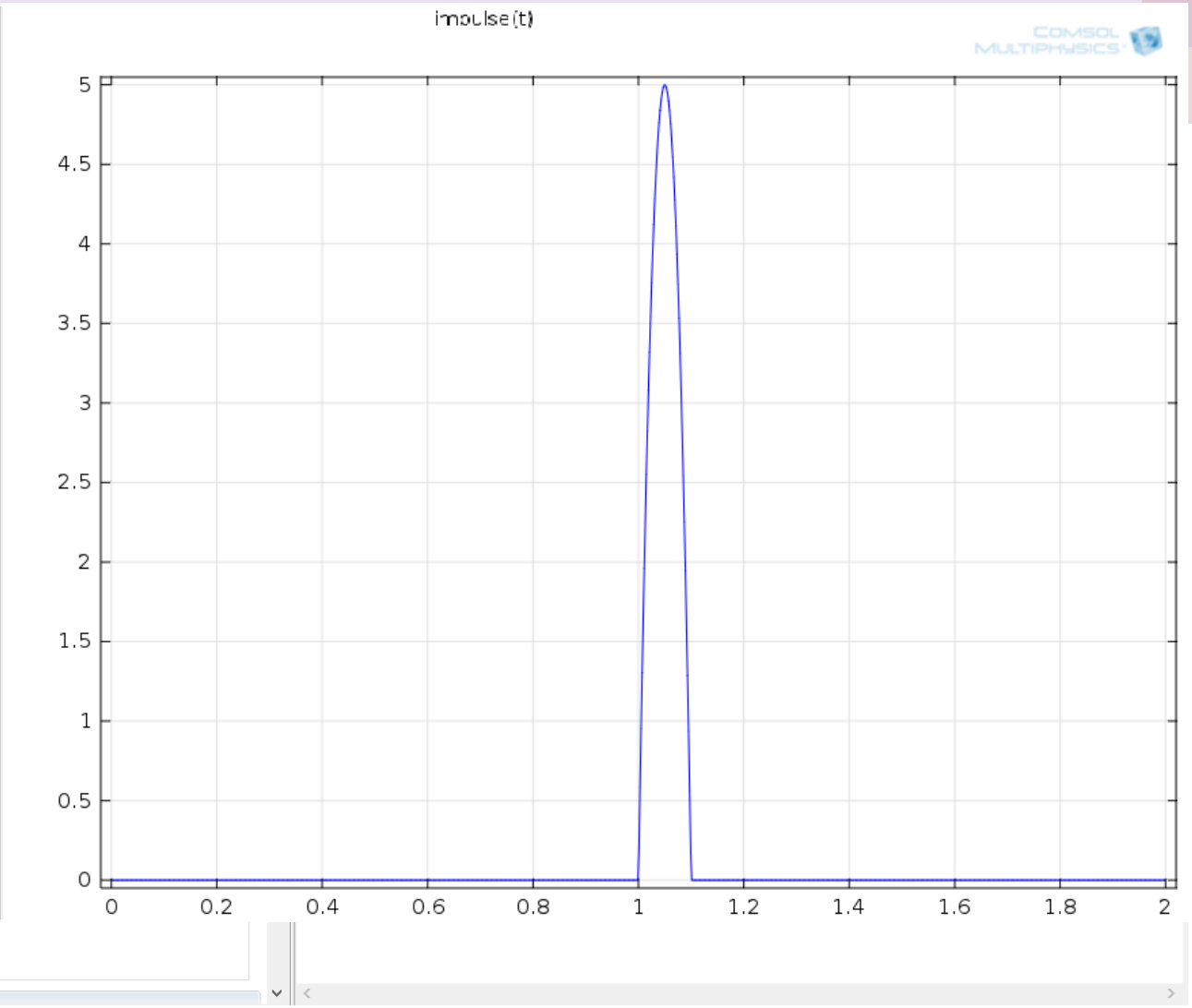
Arguments:

Function:

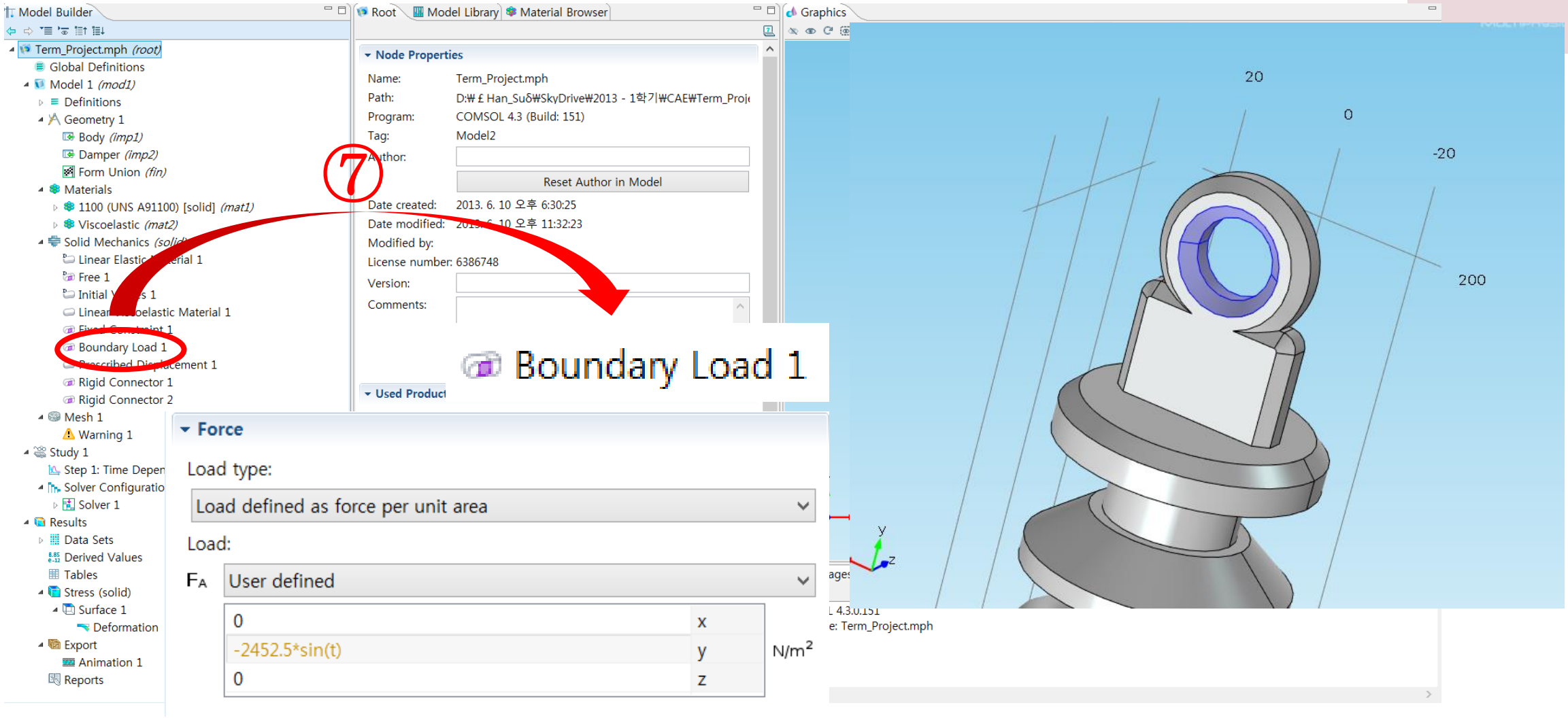
Export

Animation 1

Reports



3. Analysis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Model 1 (mod1)
Definitions
Geometry 1
Body (imp1)
Damper (imp2)
Form Union (fin)
Materials
1100 (UNS A91100) [solid] (mat1)
Viscoelastic (mat2)
Solid Mechanics (solid)
Free 1
Boundary Load 1
Rigid Connector 1
Rigid Connector 2
Mesh 1
Warning 1
Study 1
Step 1: Time Depen
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Solver 1
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Model Library
Material Browser
Node Properties
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Program: COMSOL 4.3 (Build: 151)
Tag: Model2
Author:
Reset Author in Model
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Date modified: 2013. 6. 10 오후 11:32:23
Modified by:
License number: 6386748
Version:
Comments:
Used Product
⑦
Boundary Load 1
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Load type:
Load defined as force per unit area
Load:
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User defined
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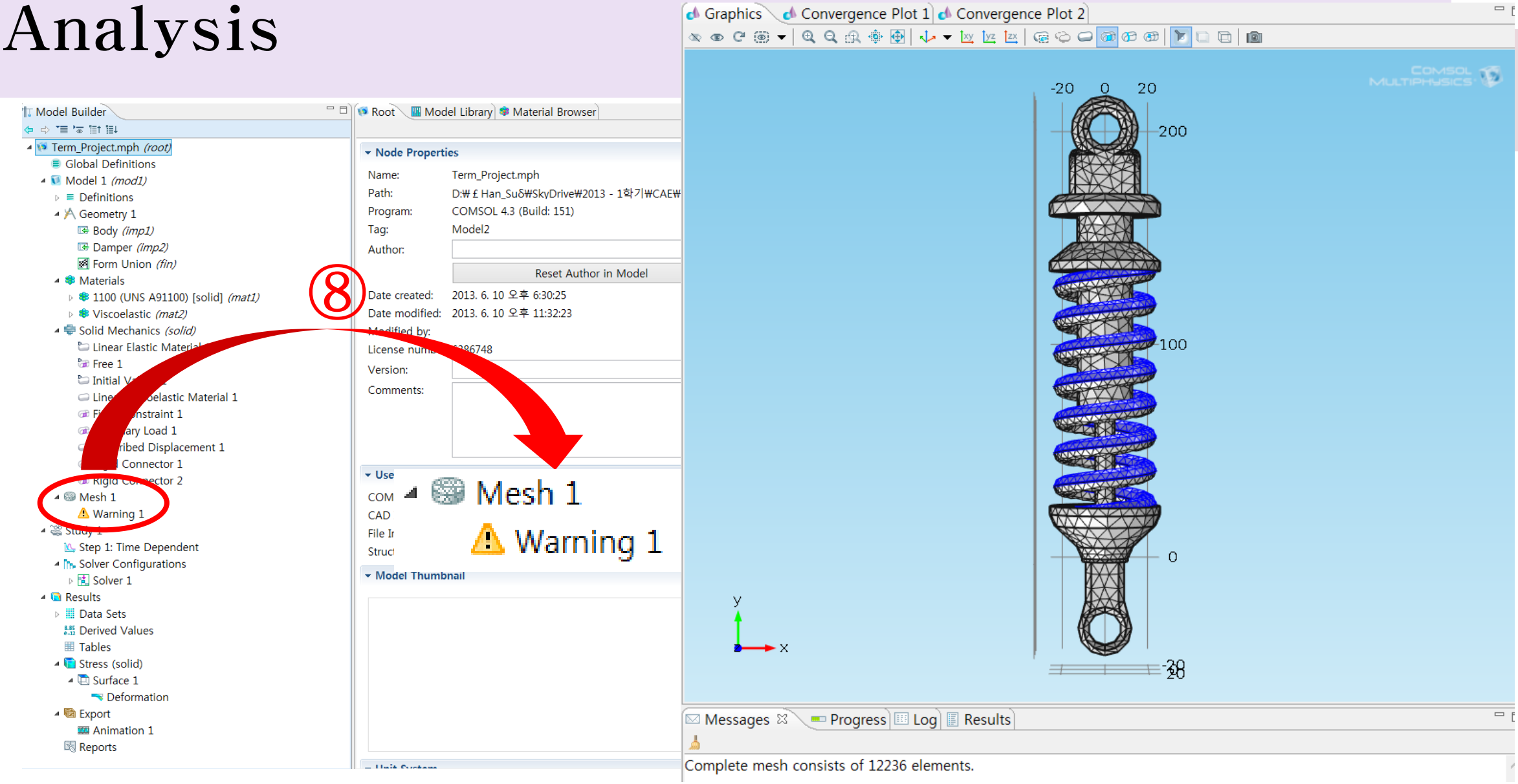
3. Analysis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Solid Mechanics (solid)
Free 1
Mesh 1
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Node Properties
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Program: COMSOL 4.3 (Build: 151)
Tag: Model2
Author:
Reset Author in Model
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Date modified: 2013. 6. 10 오후 11:32:23
Comments:
Model Thumbnail
8
Mesh 1
Warning 1
Graphics
Convergence Plot 1
Convergence Plot 2
COMSOL MULTIPHYSICS
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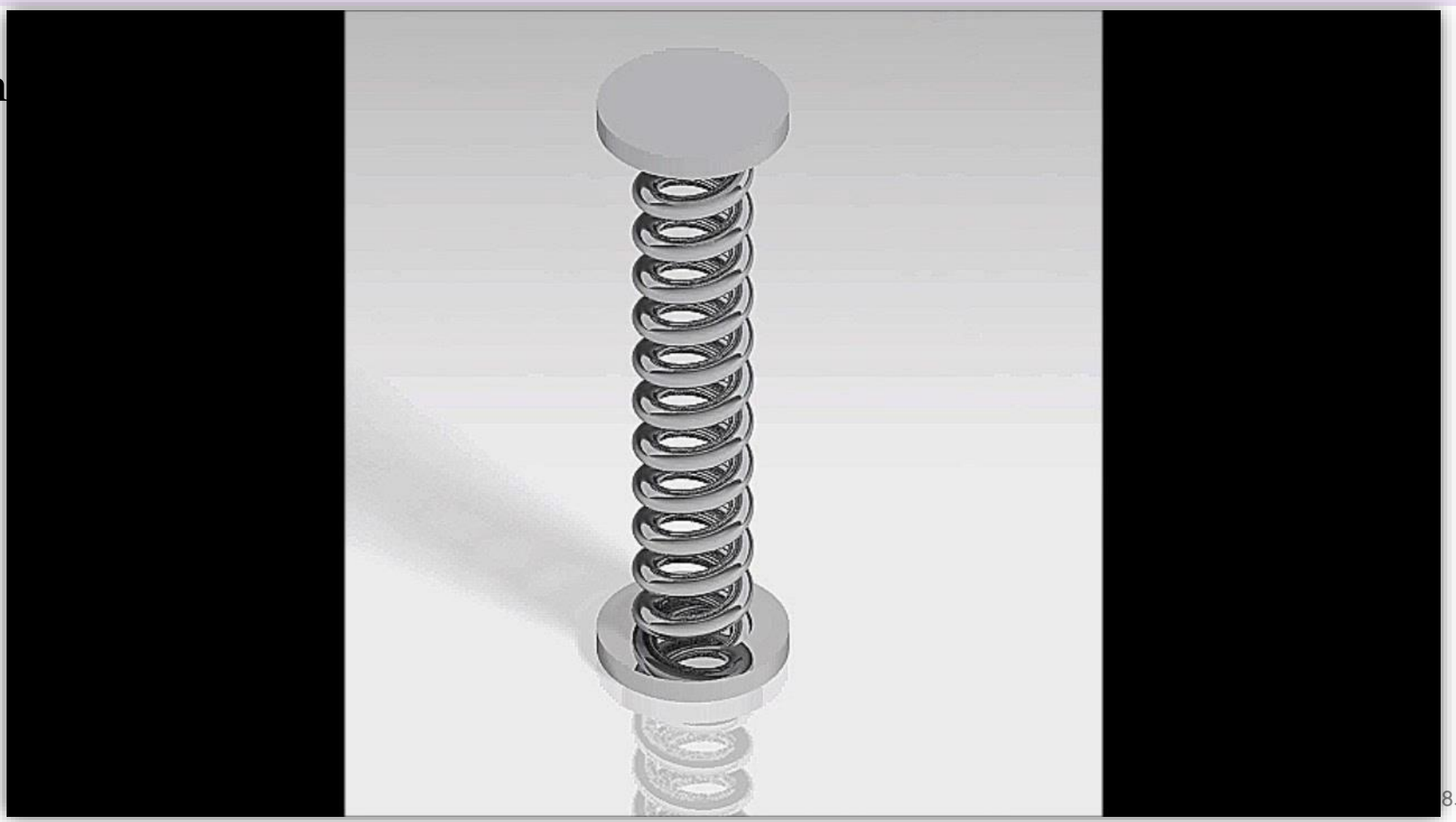
Results
Complete mesh consists of 12236 elements.

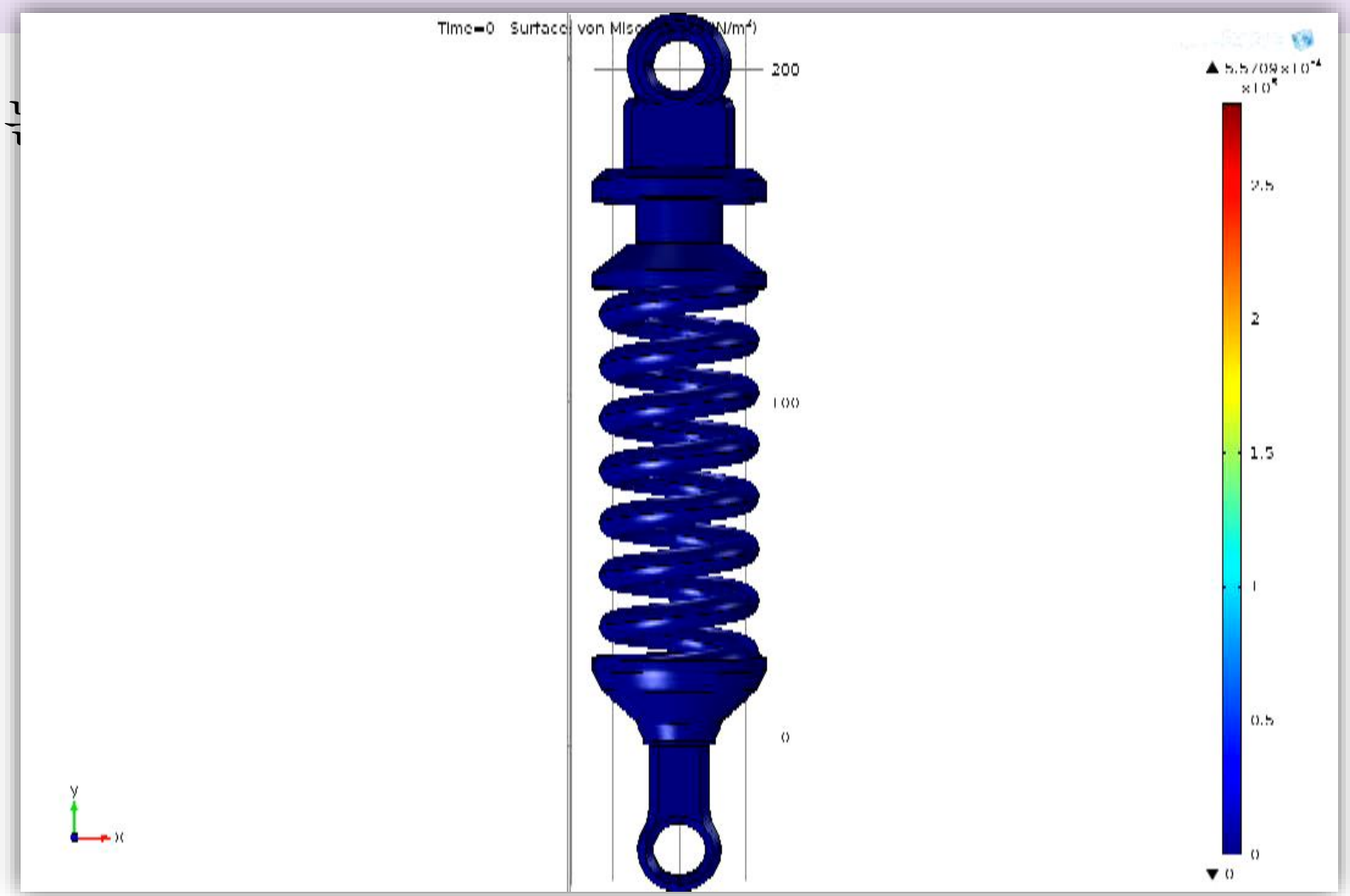
4. Result

(i) Sprin



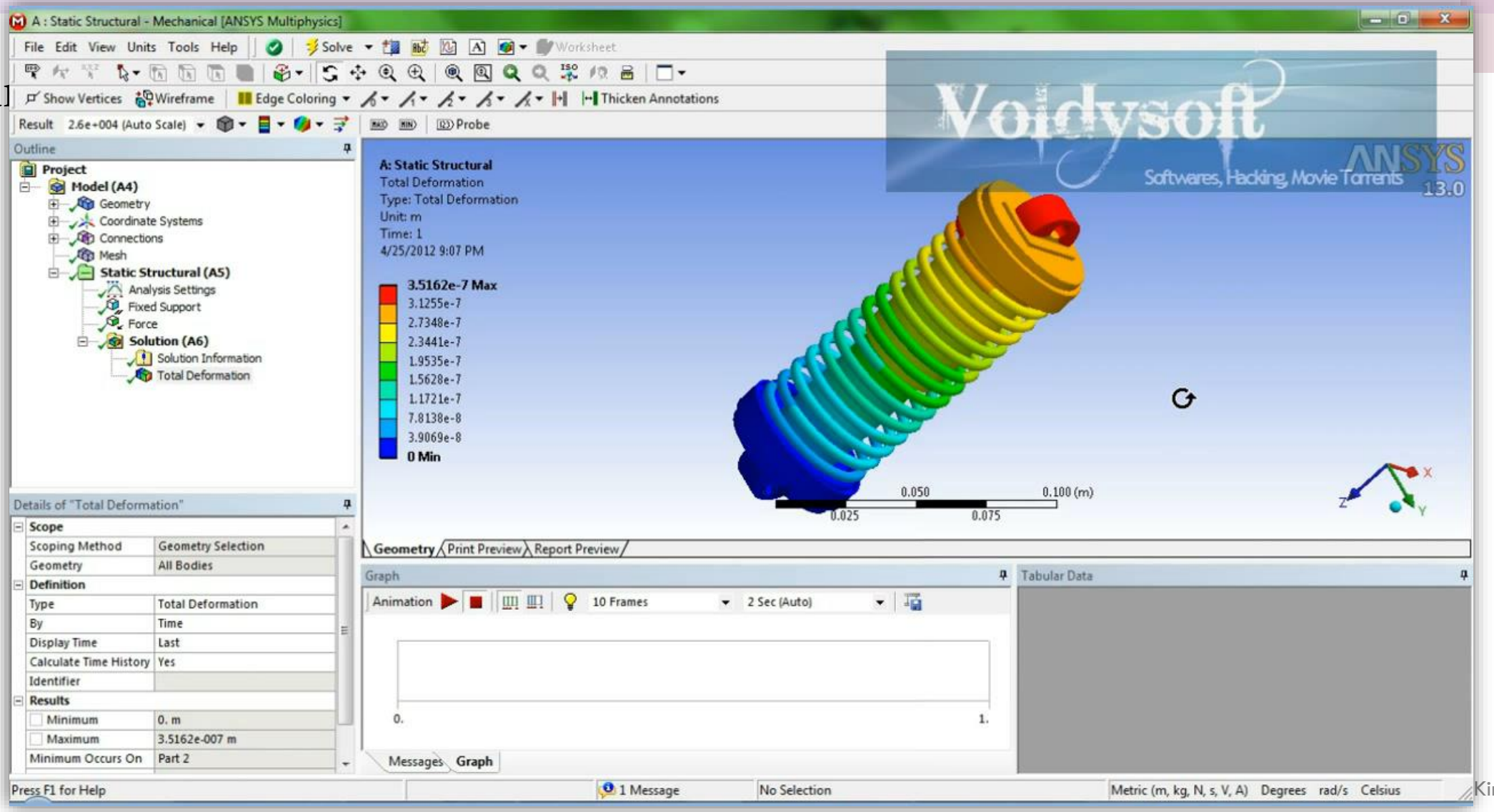
4. Result

(i) Spring만 있



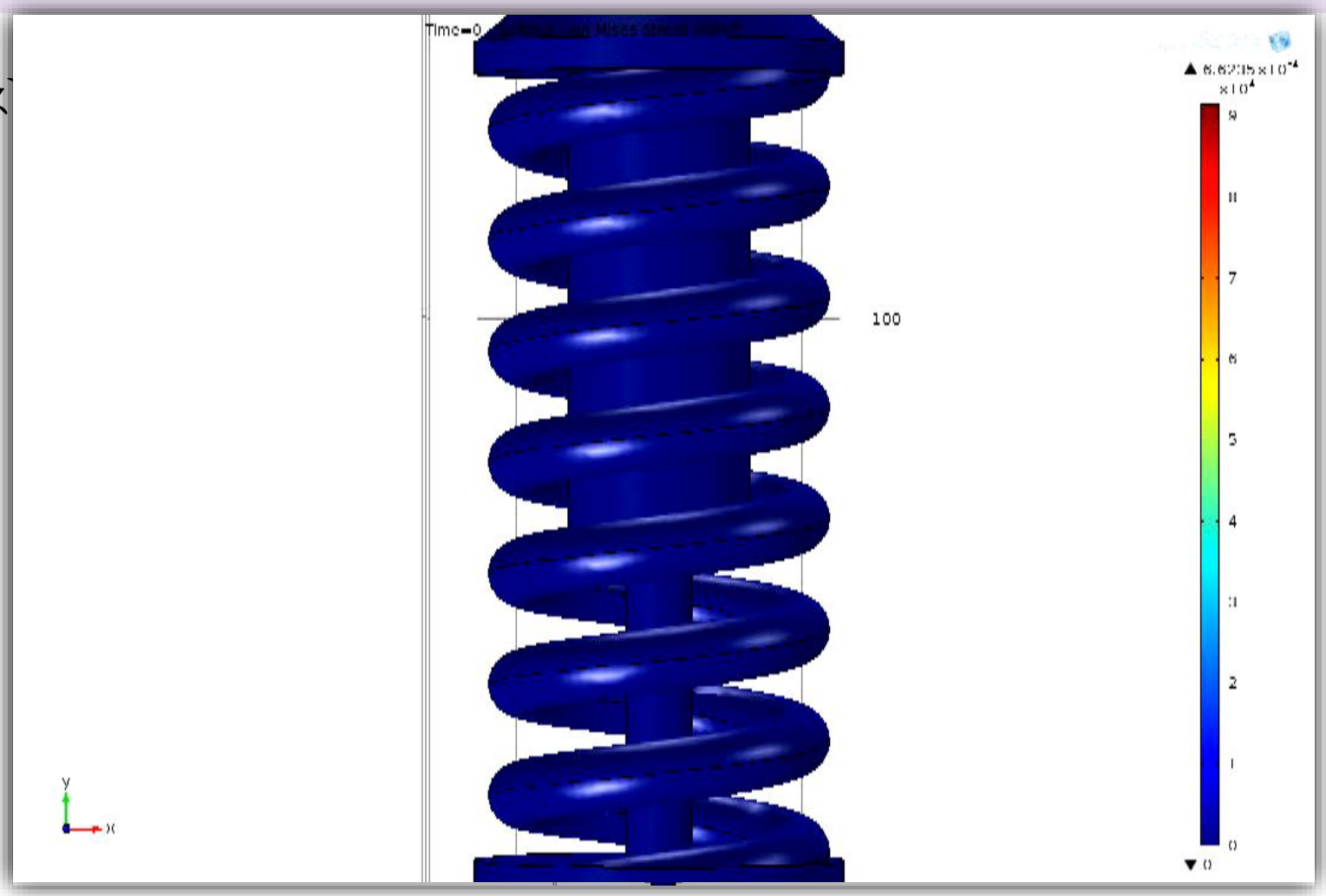
4. Result

(ii) Dar



4. Result

(ii) Damper 까지



5. Conclusion

⊙ 아쉬운 점

① Damper를 유체로 구성해 multiphysics를 못한 것

② Load의 불안정성

③ 시간의 여유

Q & A

감사합니다.