ANSYS Mechanical Connections Tips and Tricks Webinar

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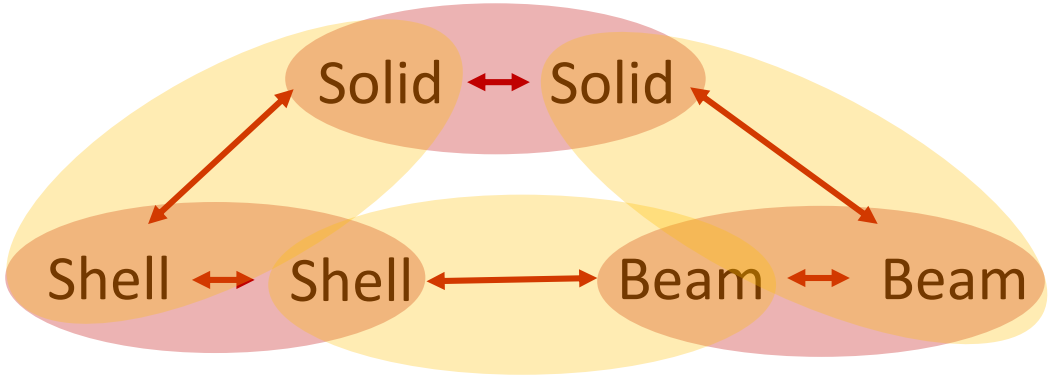
Overview

This presentation will help you to make the best choice to connect your assembly.

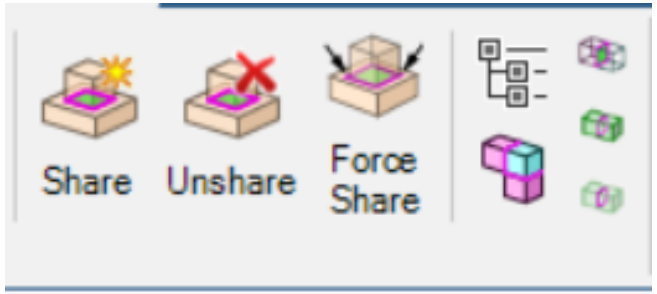
Program

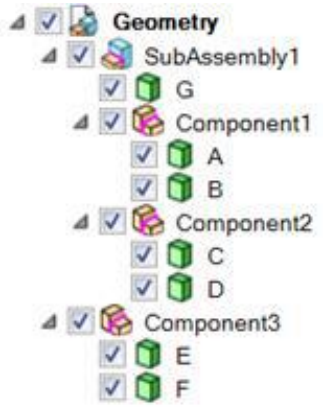
- Tools within Mechanical to connect bodies together
  - Share Topology
  - Contacts (Linear, Non Linear, MPC)
  - Remote Points
  - Beams and Springs
  - Joints
  - Mesh connection / Node merge
- Best connections for each situation
- Model assembly
- Conclusion

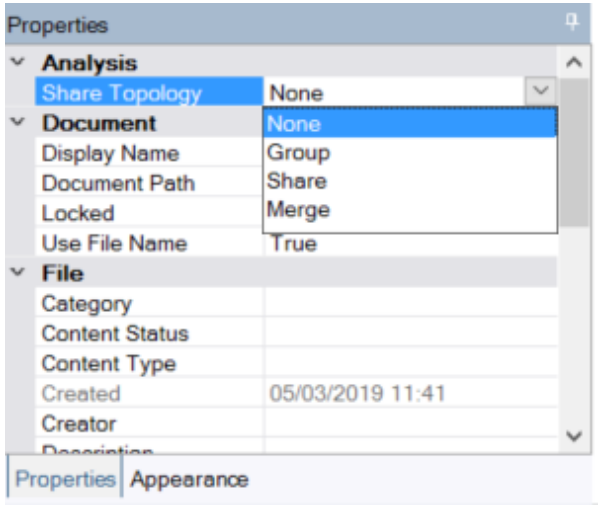


Tools within SpaceClaim/DesignModeler to connect bodies together

- Share Topology
  - First tool to use before going in Mechanical
  - Allow to control mesh connection between bodies
  - Can be setup globally, by component, and modified manually
  - View Assembly Structure help you understand how the assembly will appear when transferred downstream to ANSYS Workbench





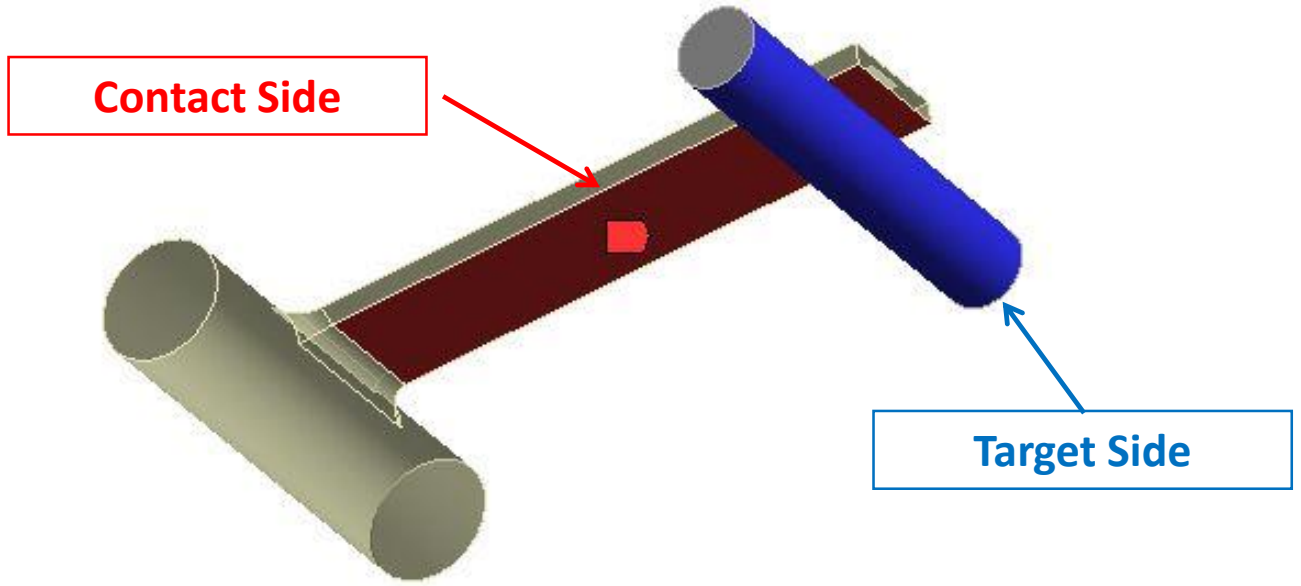


Tools within Mechanical to connect bodies together

- Contact

Surface contact elements can be visualized as a “skin” covering the surfaces of the parts in an assembly.

It is these elements that define the behavior when parts are in contact (e.g. friction, bonding, heat transfer, etc.).



Tools within Mechanical to connect bodies together

- Contact

Five contact behaviors are available:

Contact Type	Iterations	Normal Behavior (Separation)	Tangential Behavior (Sliding)
Bonded	1	No Gaps	No Sliding
No Separation	1	No Gaps	Sliding Allowed
Frictionless	Multiple	Gaps Allowed	Sliding Allowed
Rough	Multiple	Gaps Allowed	No Sliding
Frictional	Multiple	Gaps Allowed	Sliding Allowed

- *Bonded* and *No Separation* contact are **linear** and require only 1 iteration.
- *Frictionless, Rough and Frictional* contact are **nonlinear** and require multiple iterations.

Tools within Mechanical to connect bodies together

- Contact

  - Automatic detection is available after geometry transfer
  - Can be used in most of the cases
  - Don’t connect nodes them self but use internal formulation
  - Behavior and pinball can affect the connection stiffness

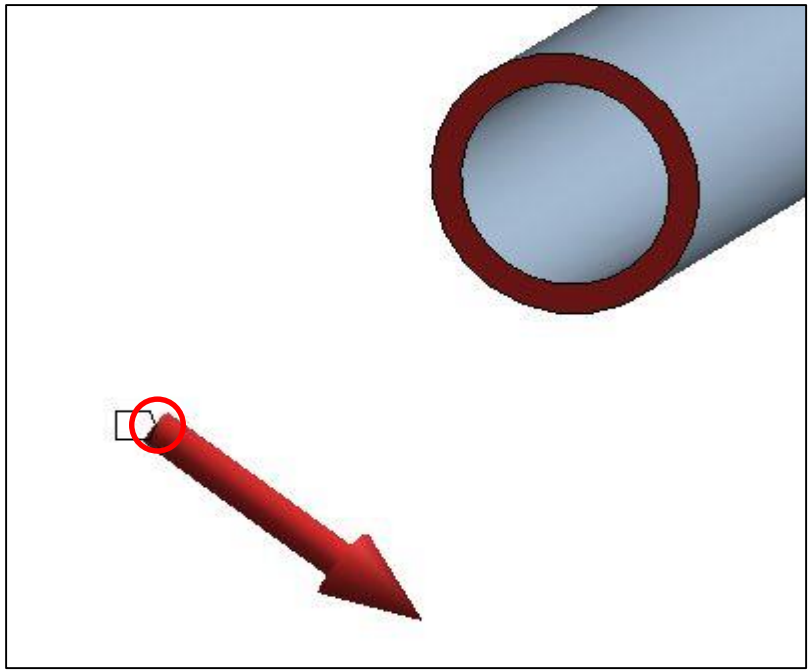
Interested in learning more about **nonlinear contacts**? See the following webinar:

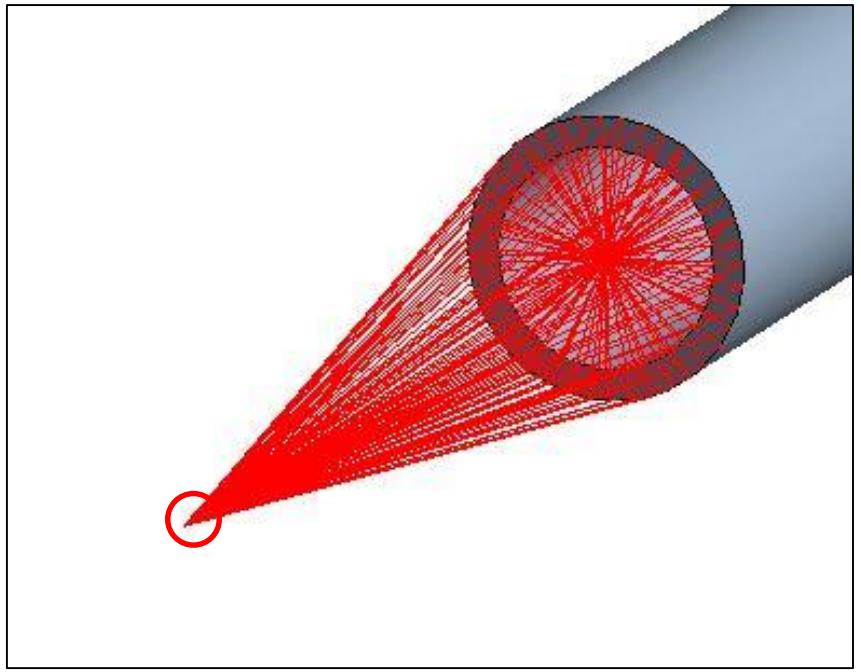
https://support.ansys.com/AnsysCustomerPortal/en_us/Knowledge+Resources/Solutions/Mechanical/2058242

Tools within Mechanical to connect bodies together

- Remote Point

A remote point is defined where the specified “condition” is to be located. These remote points are what are scoped to the geometry via constraint equations.





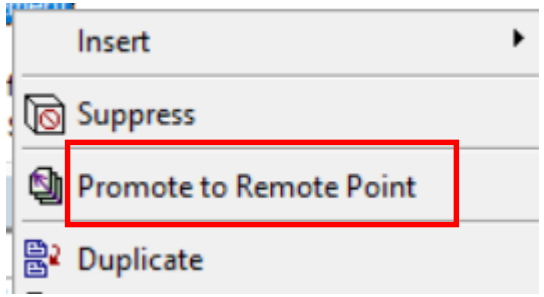
Remote Force Example

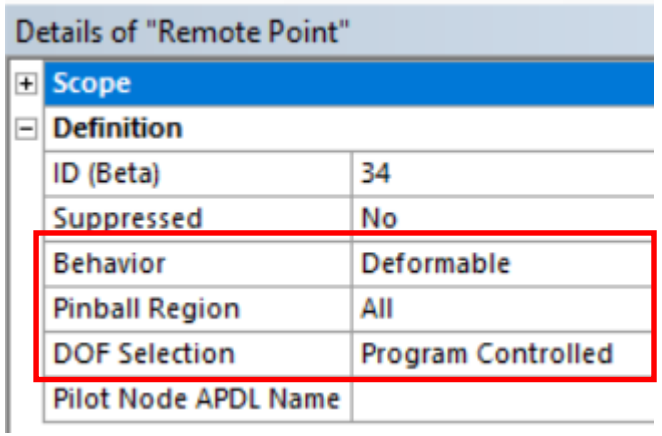
Tools within Mechanical to connect bodies together

- Remote Point

Remote points occur automatically when a remote BC is defined (**Point mass, joint, beam connector, spring, remote force/displacement, moment**)

- A point associated with a remote boundary condition can be “promoted” to an independent remote point via RMB.





Additional Controls:

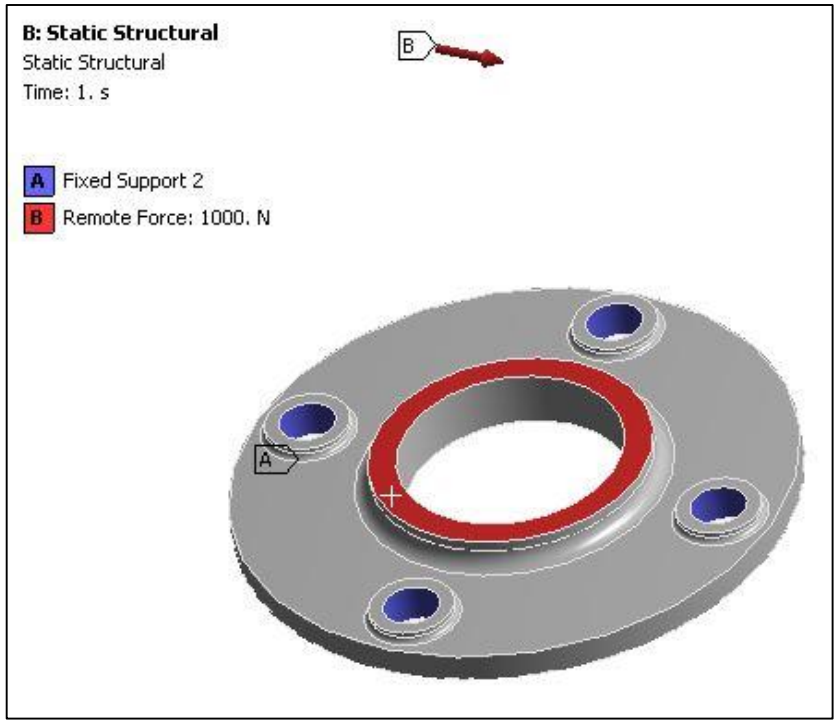
- Remote boundary conditions contain a “behavior” control that allow either rigid, deformable or coupled settings.
- An additional advanced setting allows control over the Pinball Region.
- User can Active or Inactive the DOFs

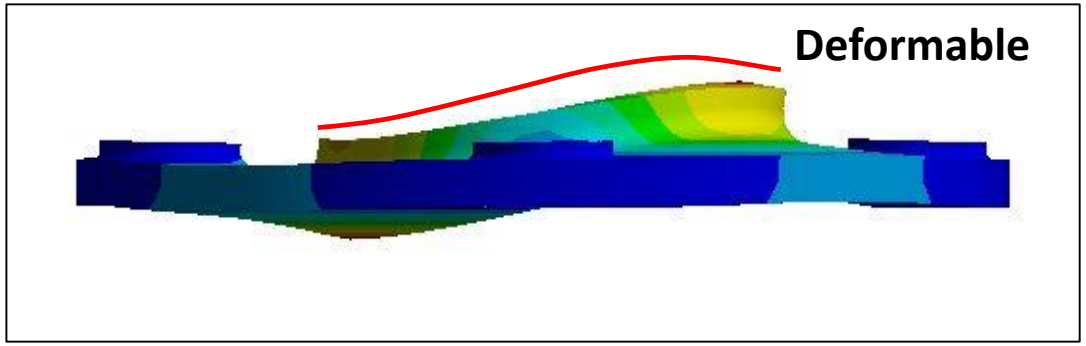
Tools within Mechanical to connect bodies together

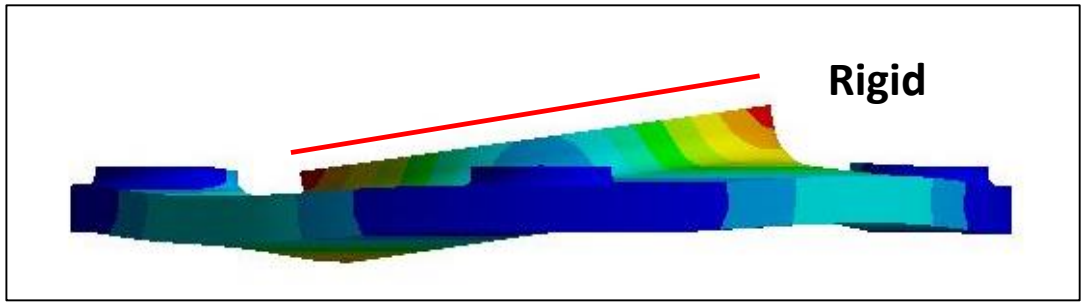
- Remote Point

Example of a remote force scoped to the face shown in red:

Behavior	Rigid
Pinball Region	Rigid
DOF Selection	Deformable
Pilot Node APDL Name	Coupled
	Beam





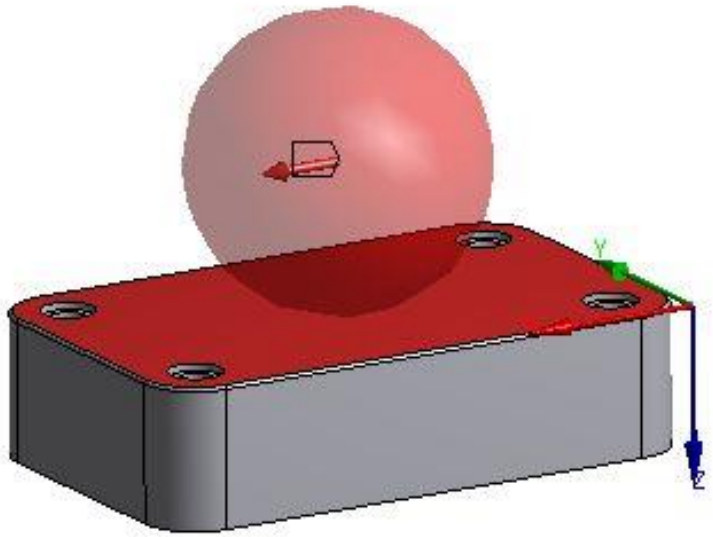


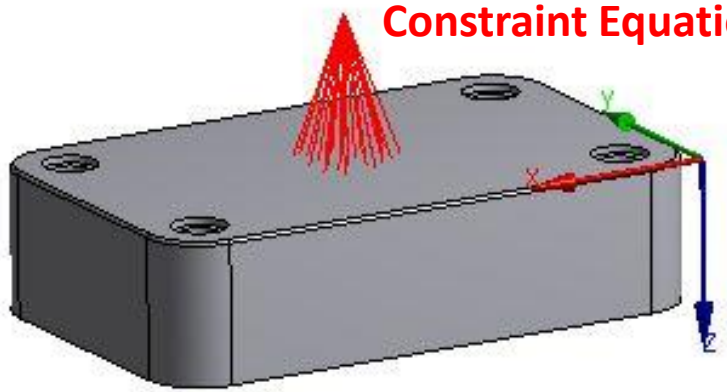
Tools within Mechanical to connect bodies together

- Remote Point

Large numbers of constraint equations can slow down compute times or cause over-constraint. The “Pinball Region” settings allows the number of constraint equations:

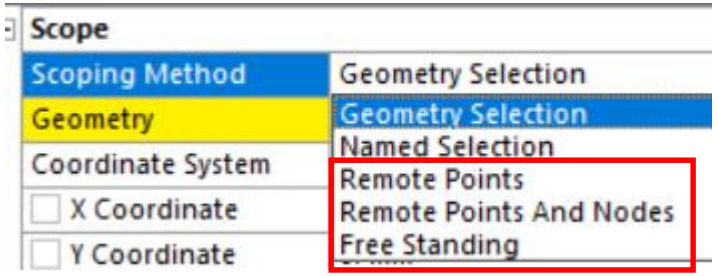
Definition	
ID (Beta)	34
Suppressed	No
Behavior	Deformable
Pinball Region	21. mm

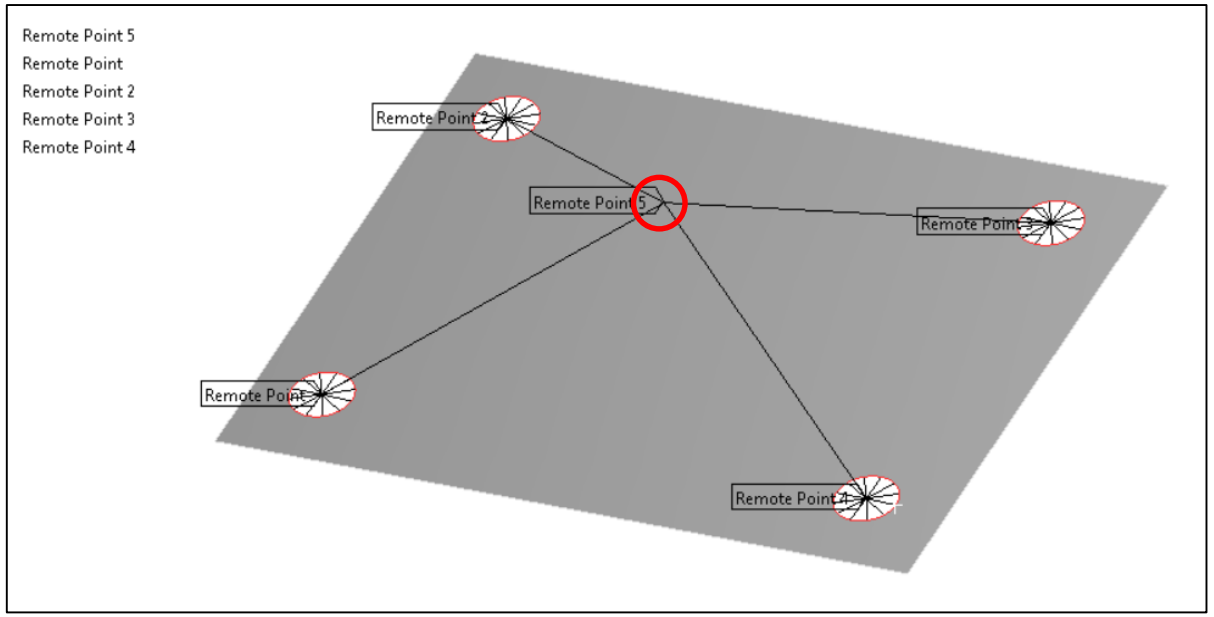




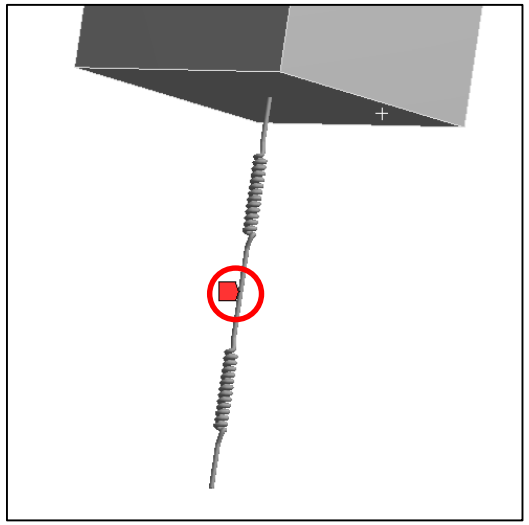
Tools within Mechanical to connect bodies together

- Remote Point





Remote Point attached to other Remote Points



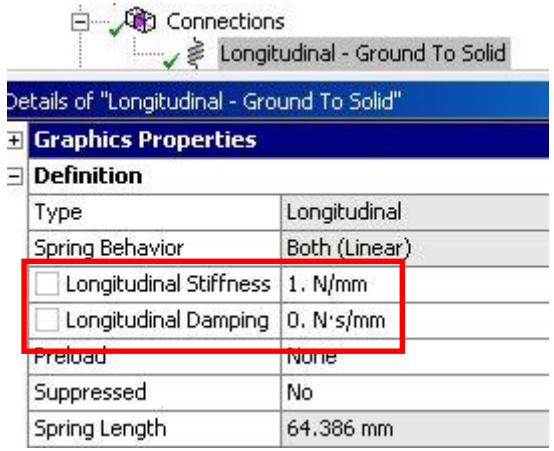
Free standing Remote Point

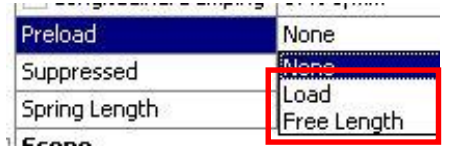
Tools within Mechanical to connect bodies together

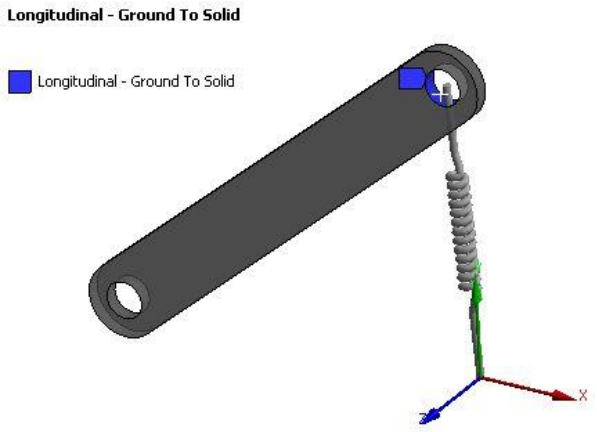
- Beams and **Springs**

A longitudinal or torsional spring can be defined as any another form of connection.

- Body to Body or Body to Ground
- Direct or Remote attachment (same Remote Point can be used for several springs)
- Preload may be added using either a free length or load value.
- Damping may be added to the spring's definition.







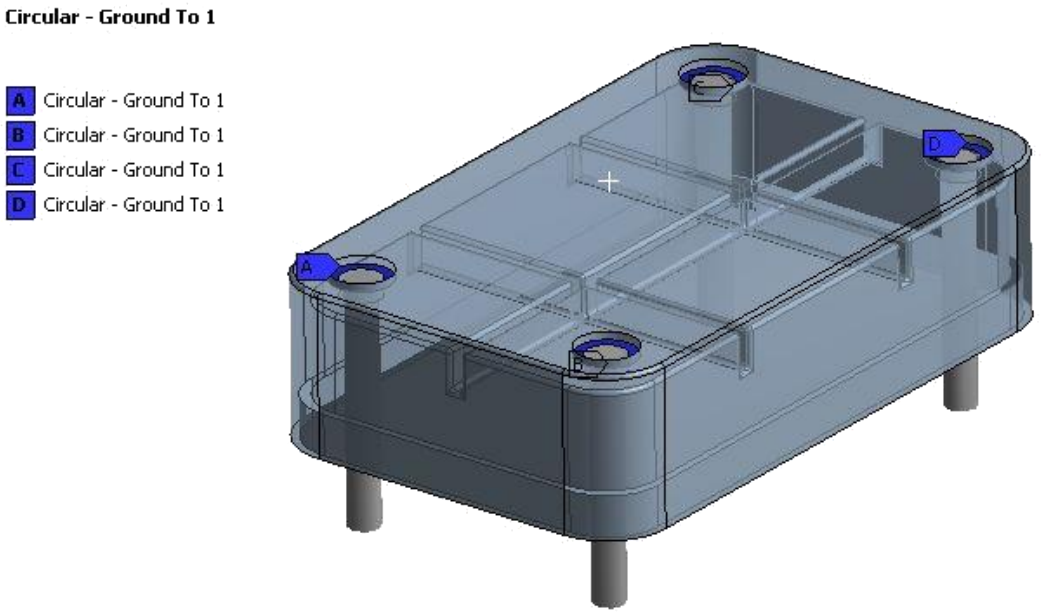
Tools within Mechanical to connect bodies together

- **Beams** and Springs

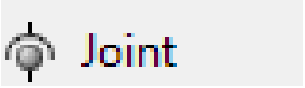
The Beam feature is often useful in simulating various fasteners (e.g. bolts).

Beams are defined in terms of reference and mobile sides.

- Body to Body or Body to Ground
- The behavior can be rigid or deformable.
- Direct or Remote attachment
- Beam Probe is available for Axial and Shear Force, Torque and Moment
- **<u>Pretension Load can be defined</u>**

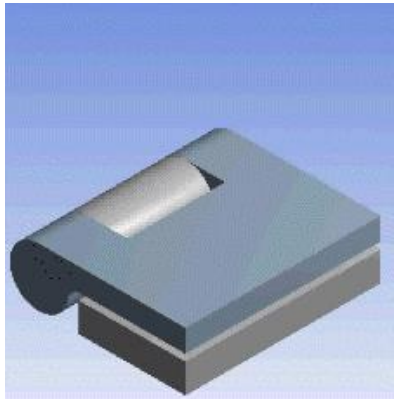


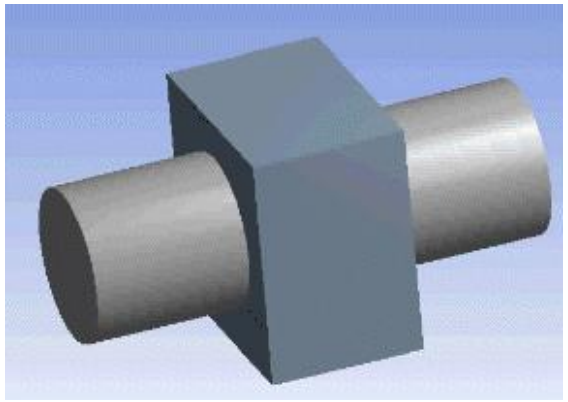
Tools within Mechanical to connect bodies together

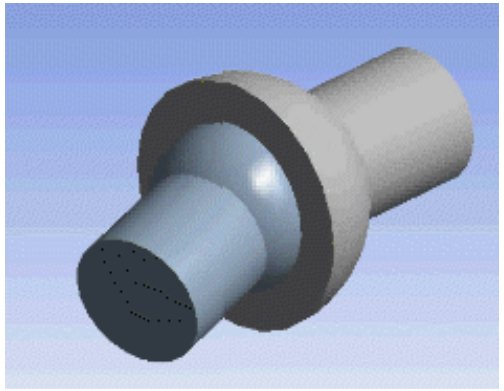


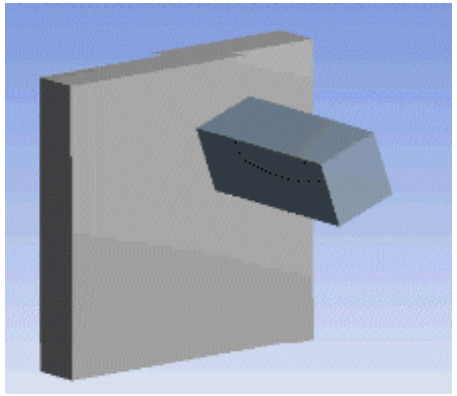
- Joint

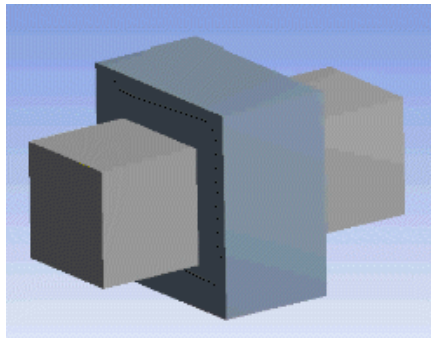
Joints give a description of relative motion between two bodies

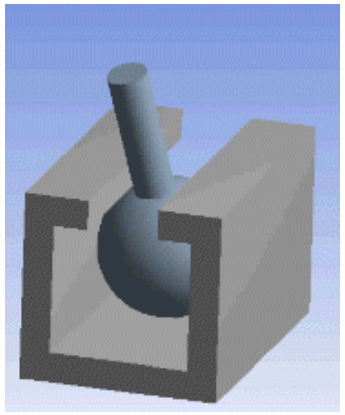

Revolute

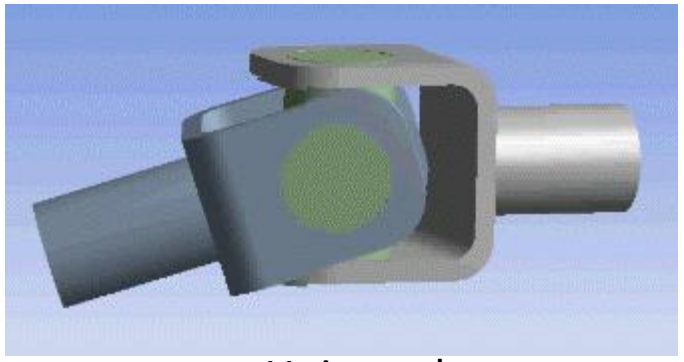

Cylindrical


Spherical


Planar


Translational


Slot


Universal

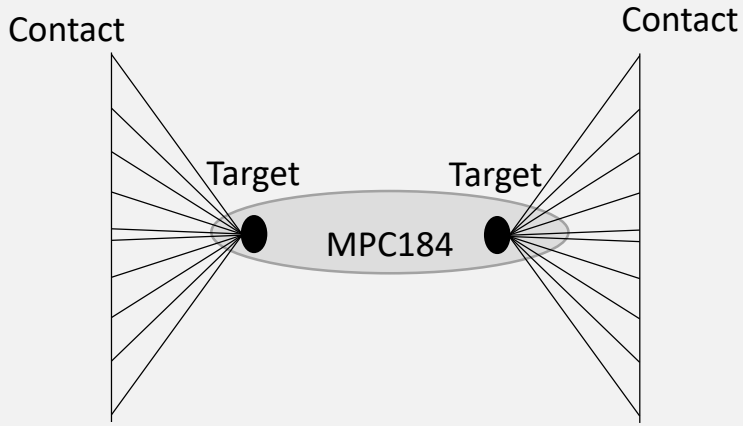
Tools within Mechanical to connect bodies together

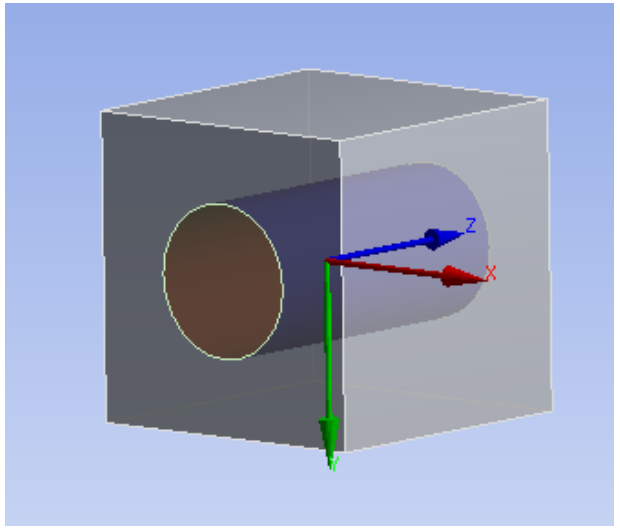
Joint

- Joint

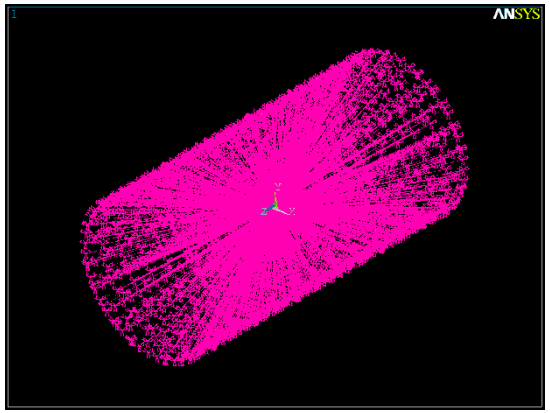
Setup of a kinematic joint:

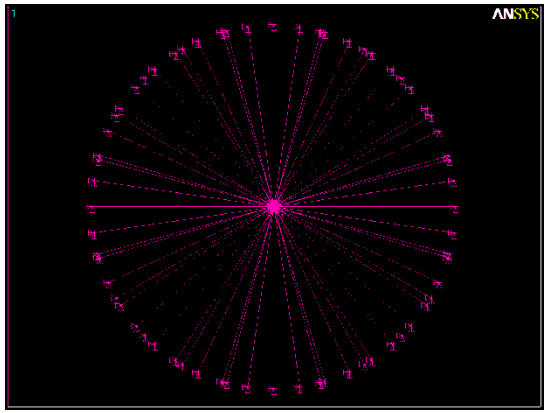
- Creation of two pilot nodes
- Constraint equation between pilot node and Interfaces
- Creation of element MPC 184





Definition of a joint in Mechanical





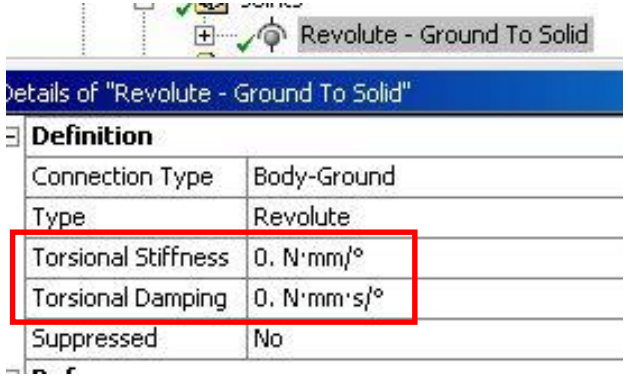
What the solver sees

Tools within Mechanical to connect bodies together

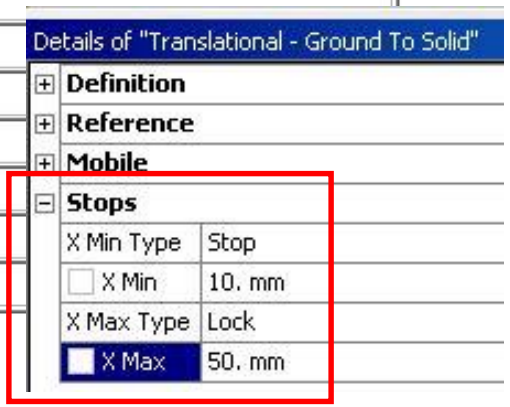
- Joint Stops and Locks

For the Revolute and Cylindrical joint types a torsional stiffness and/or damping can be defined in the joint's details.

Most joints can also employ stops and/or locks to limit the range of joint motion



Joint Type	Stop/Lock
Revolute	Yes
Cylindrical	Yes
Translational	Yes
Slot	Translational
Universal	Yes
Spherical	No
Planar	Yes
General	Translational



Tools within Mechanical to connect bodies together

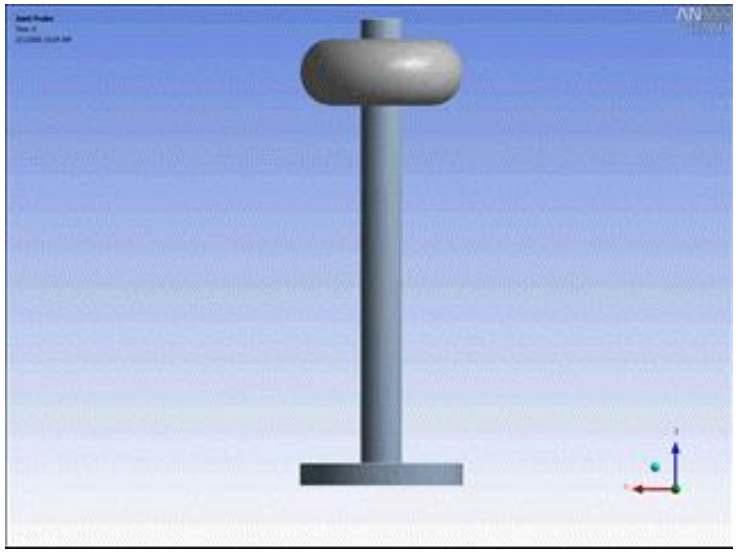
- General / Bushing Joint

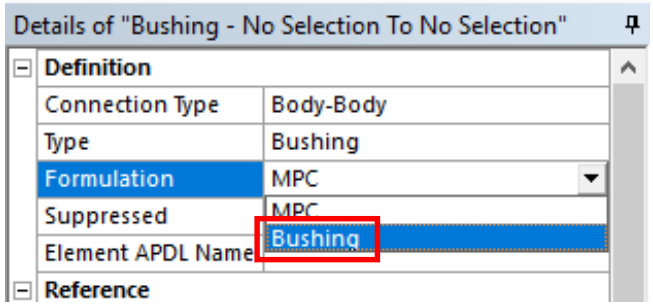
Has six degrees of freedom, three translations and three rotations

Inputs:

- Stiffness Coefficients (can be non linear)
- Dampening Coefficients

Equivalent to having 6 independent springs for six DOF





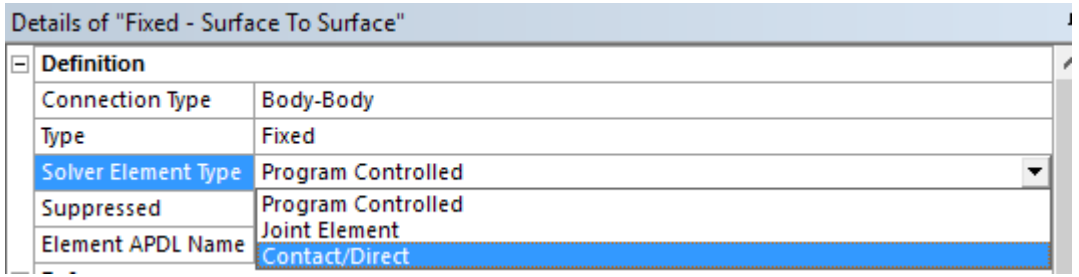
COMBIN250 (Nastran CBUSH element) available for modal and harmonic analysis from ANSYS 2019R1

=> Doesn't use Lagrangien coefficients and doesn't create constraint equations. Can be used with CMS

Tools within Mechanical to connect bodies together

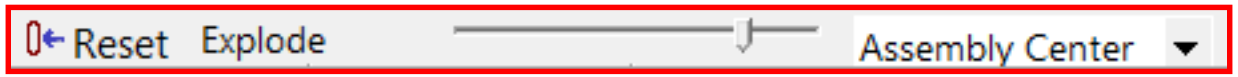
- Joint

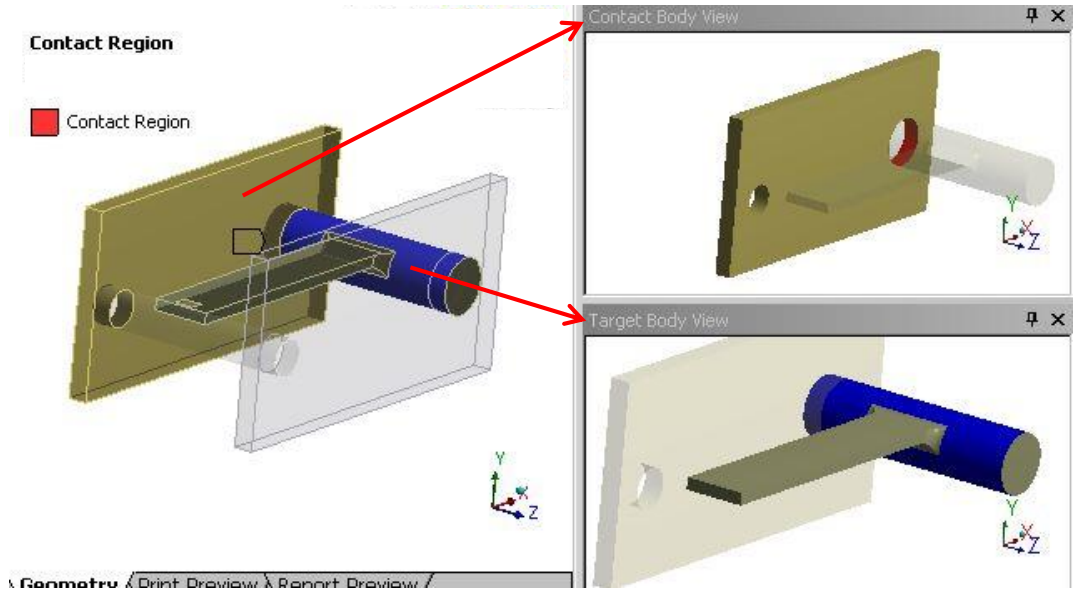
Benefits of joints:

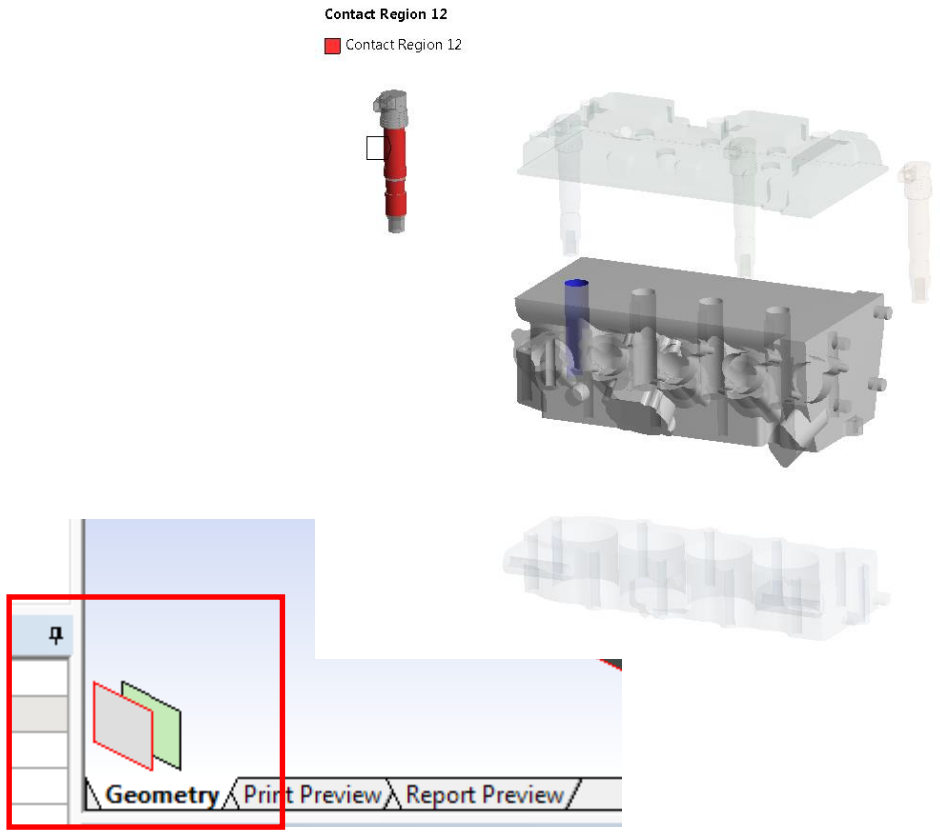


- Easy to set up
- Large deformations are supported
- Advanced Stiffness and Damping definition
- Easy modification of bodies positions through configure tool
- Faster in most cases than penalty equivalents
- Fixed joint can now be used with Iterative solver (or sparse without pivoting) by using Contact/direct solver element type option
- Advanced post processing including relative motion, force and torque

Selection options Multi body view, explode view or plans





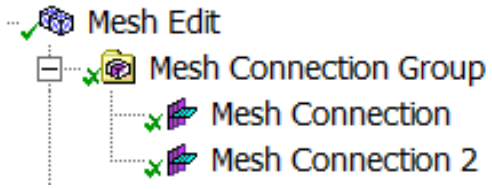


Tools within Mechanical to connect bodies together

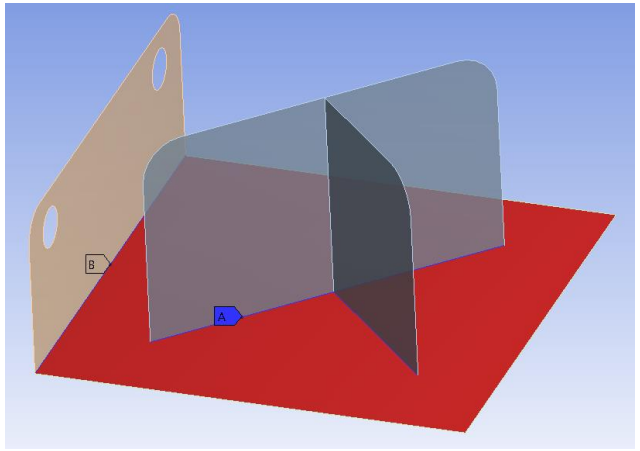
- Mesh connection

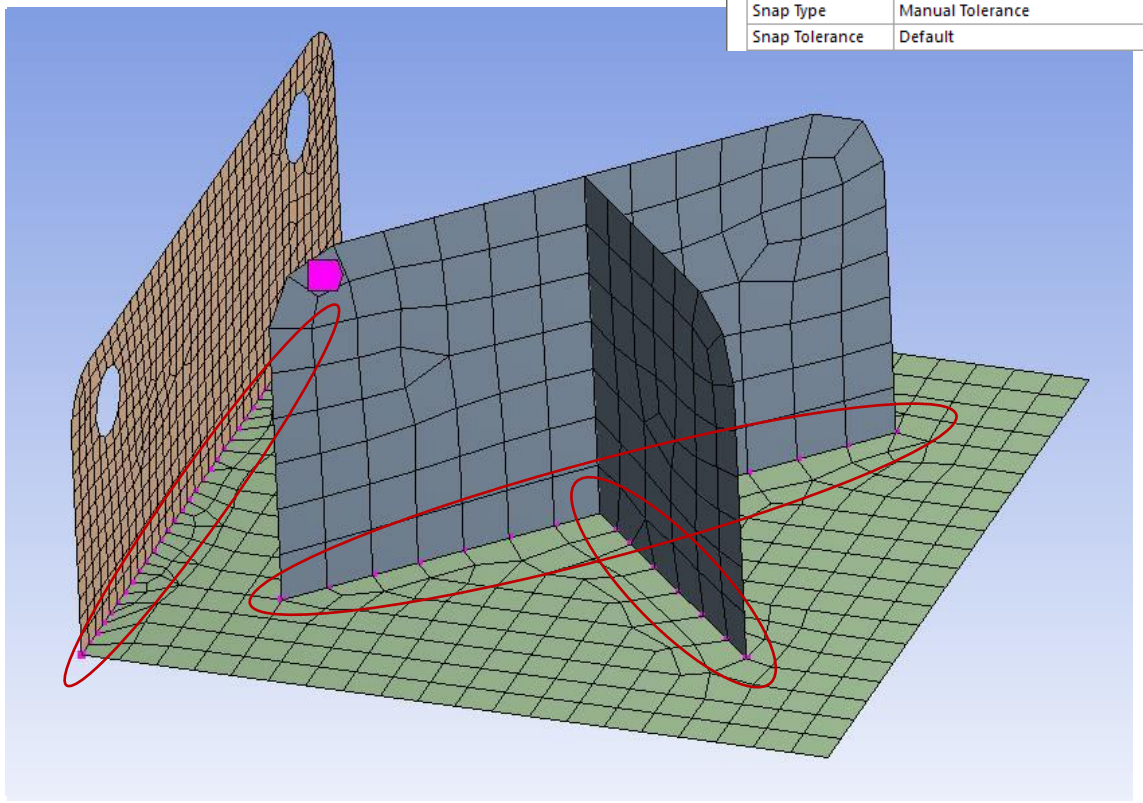
  The mesh connection is only available for shells and beams

  It remesh the area in order to connect the mesh:



Scope	
Scoping Method	Geometry Selection
Master Geometry	1 Face
Slave Geometry	1 Edge
Master Bodies	Component2\Surface
Slave Bodies	Component2\Surface
Definition	
Scope Mode	Manual
Tolerance Type	Slider
Tolerance Slider	0.
Tolerance Value	8.6603e-002 mm
Suppressed	No
Snap to Boundary	Yes
Snap Type	Manual Tolerance
Snap Tolerance	Default



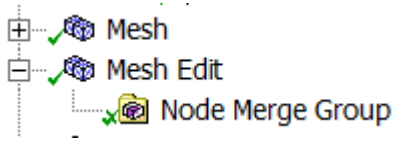


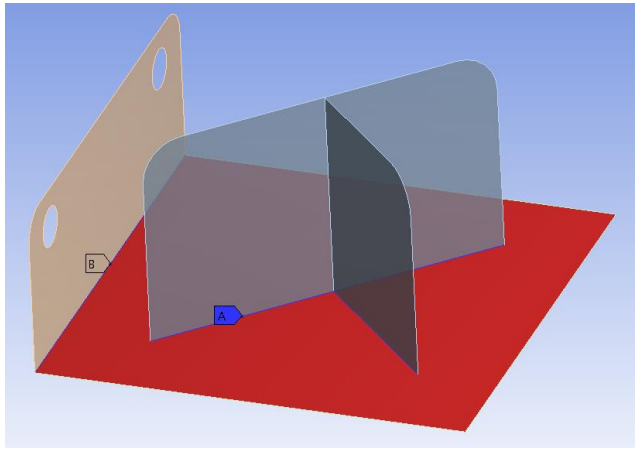
Tools within Mechanical to connect bodies together

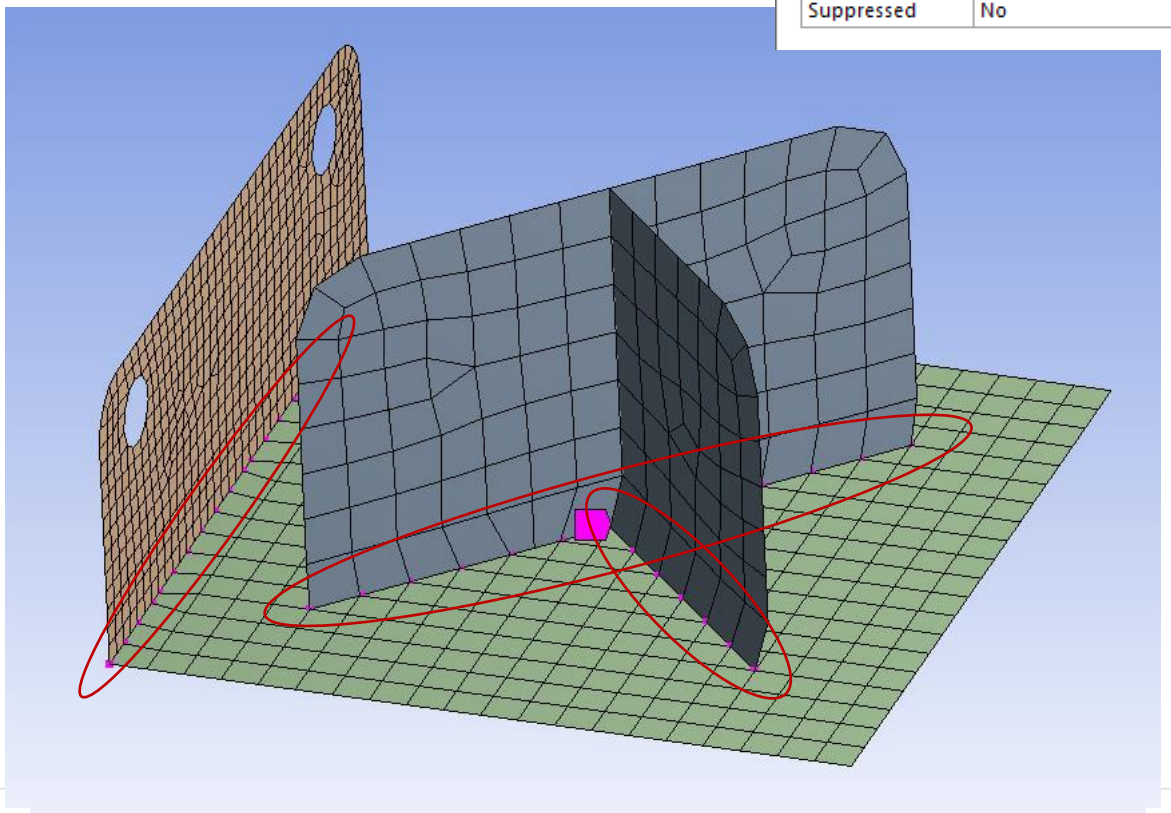
- Node merge

  The node merge moves nodes to connect meshes (same NUMMRG in APDL)

Scope	
Scoping Method	Geometry Selection
Master Geometry	1 Edge
Slave Geometry	1 Edge
Master Bodies	Component2\Surface
Slave Bodies	Component2\Surface
Definition	
Scope Mode	Manual
Tolerance Type	Value
Tolerance Value	0.1 mm
Suppressed	No





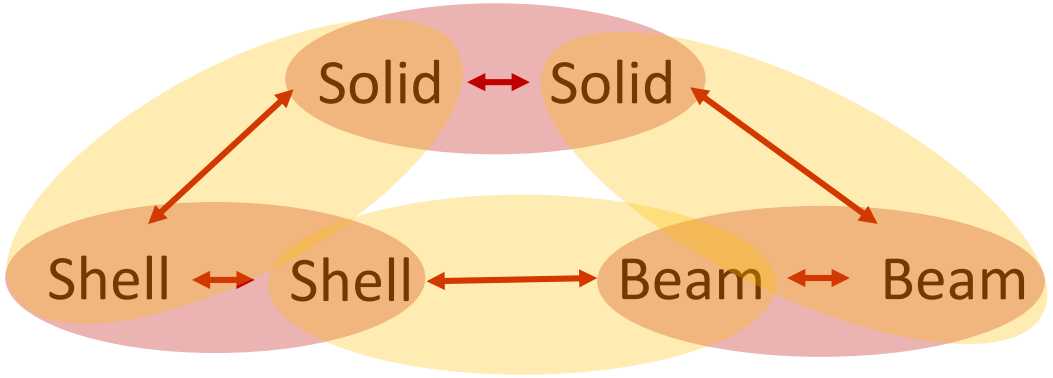


Overview

This presentation will help you to make the best choice to connect your assembly.

Program

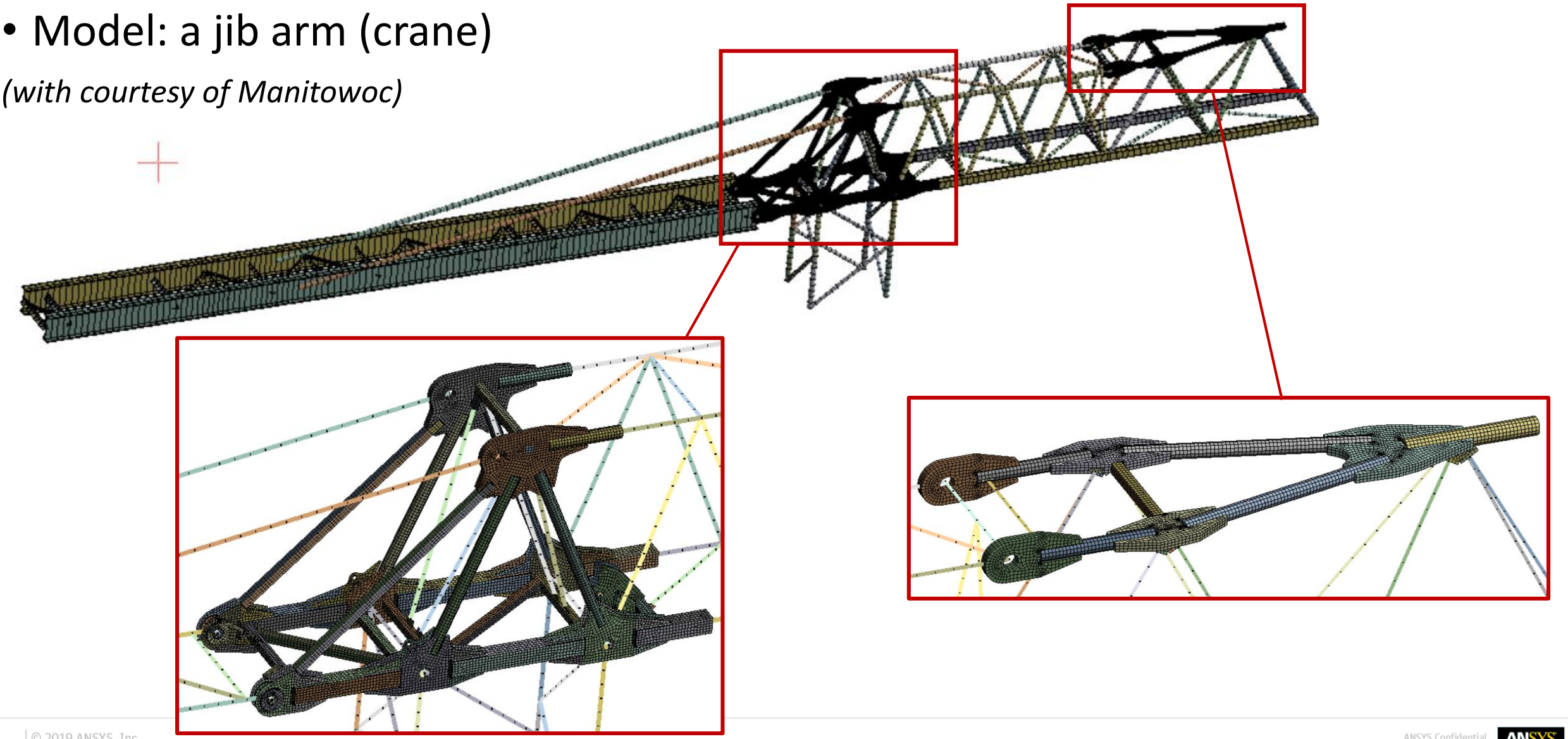
- Tools within Mechanical to connect bodies together
  - Share Topology
  - Contacts (Linear, Non Linear, MPC)
  - Remote Points
  - Beams and Springs
  - Joints
  - Mesh connection / Node merge
- Best connections for each situation
- Model assembly
- Conclusion



Best connections for each situation

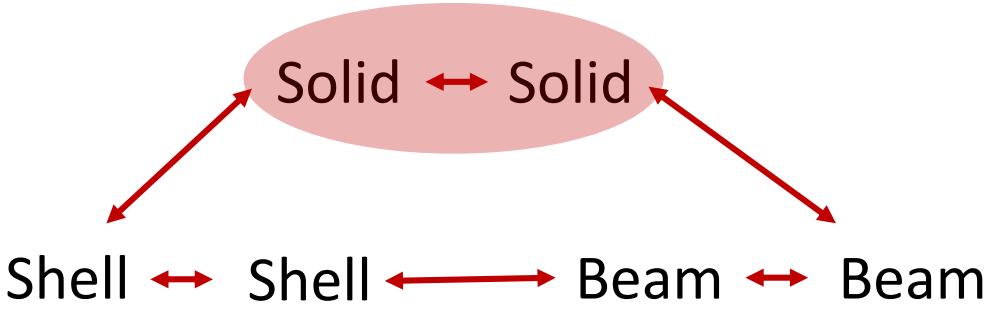
- Model: a jib arm (crane)

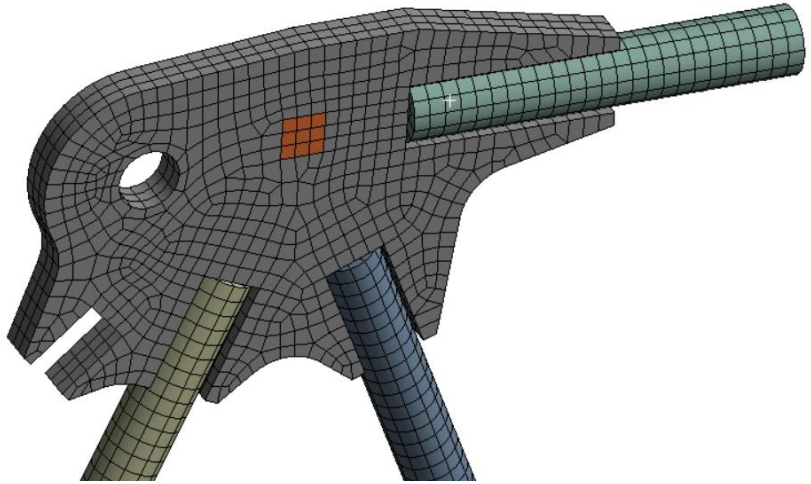
(with courtesy of Manitowoc)

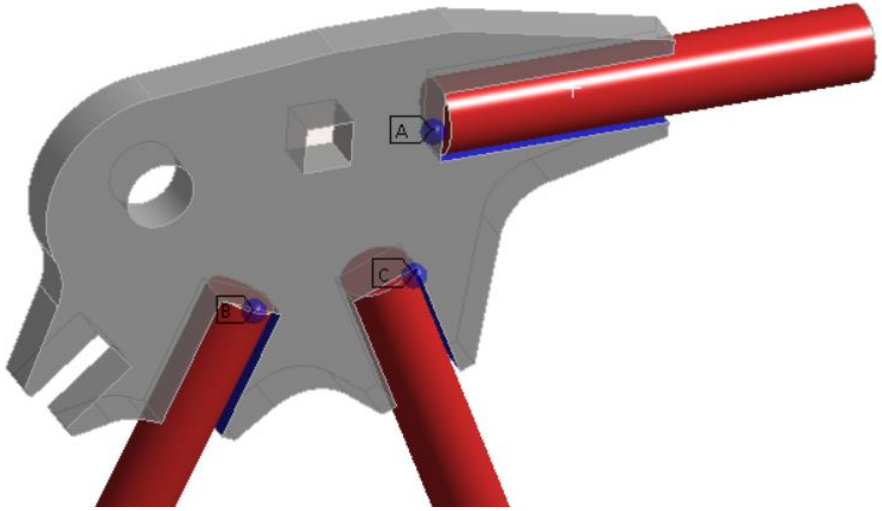


Best connections for each situation

- Solid to Solid connection







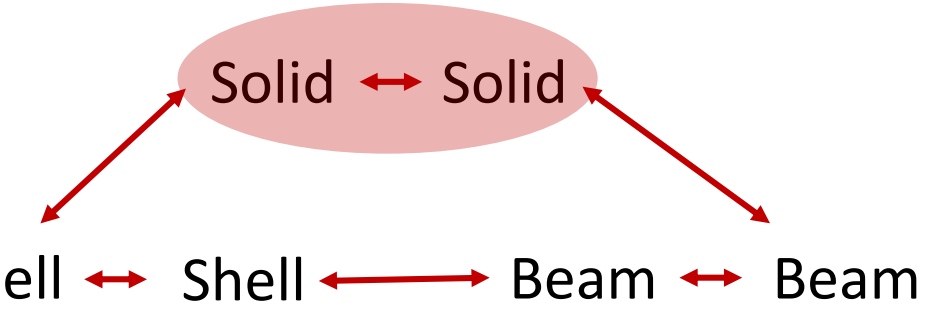
Contacts MPC

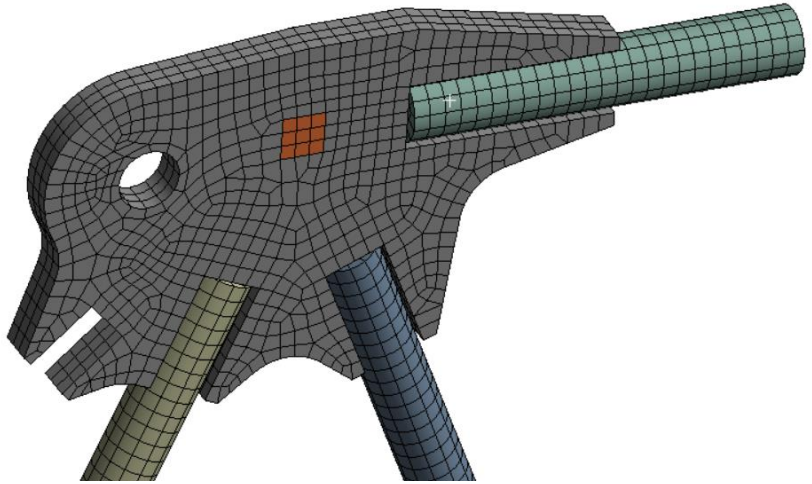
Scope	
Scoping Method	Geometry Selection
Protected	No
Definition	
Type	Bonded
Scope Mode	Automatic
Behavior	Asymmetric
Trim Contact	Program Controlled
Trim Tolerance	76.629 mm
Suppressed	No
Advanced	
Formulation	MPC
Detection Method	Program Controlled
Constraint Type	Program Controlled
Pinball Region	Radius
Pinball Radius	20. mm
Geometric Modification	
Contact Geometry Correction	None
Target Geometry Correction	None

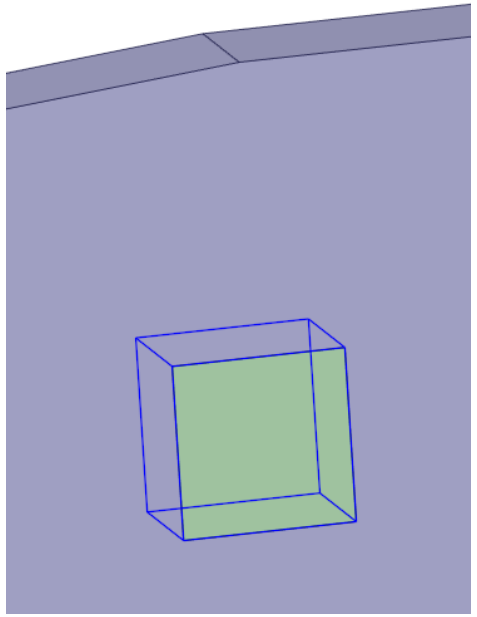
Example of settings

Best connections for each situation

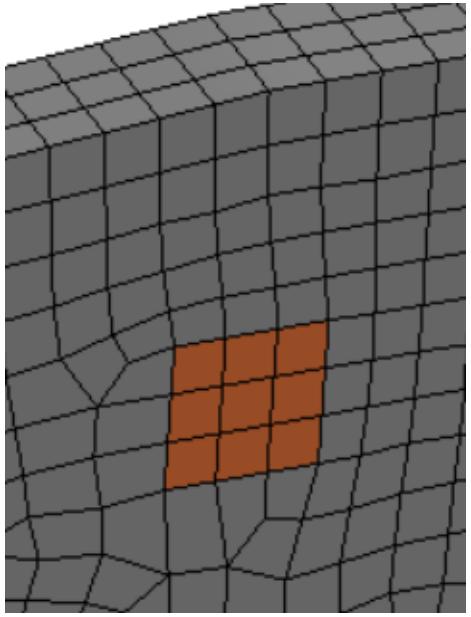
- Solid to Solid connection







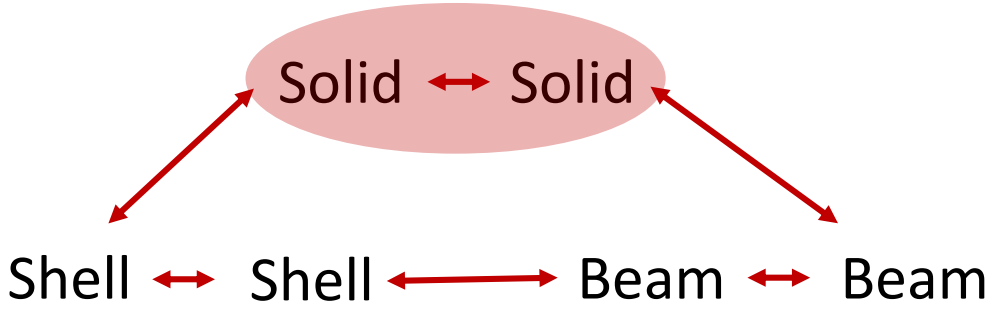
Share Topology
in Spaceclaim



Mesh merged at
the interface

Best connections for each situation

- Solid to Solid connection

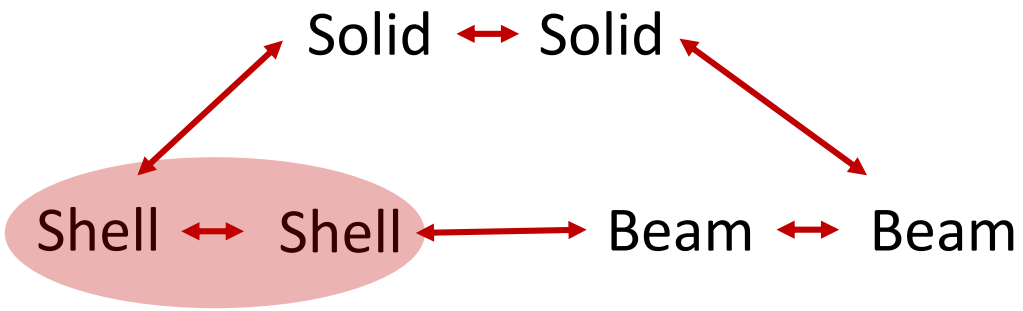


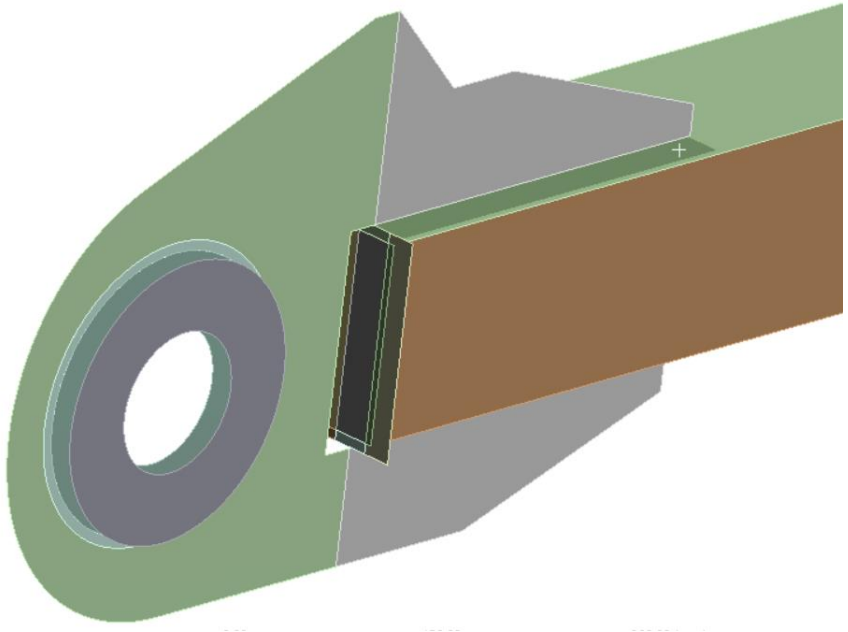
	Solid to Solid
Contact	+++
Joint	++
Share Topology	+++*
Mesh connection	x

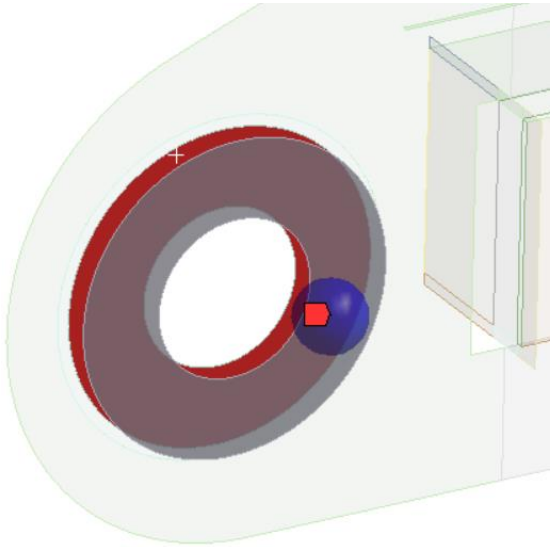
*can add difficulty for the mesh due to the imprints

Best connections for each situation

- Shell to Shell connection





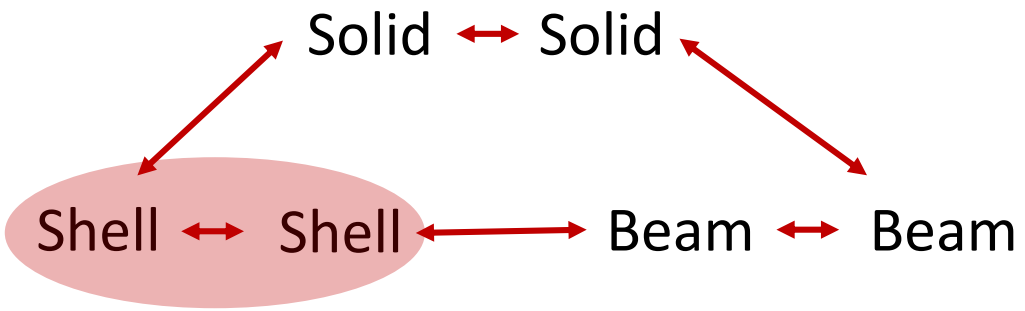


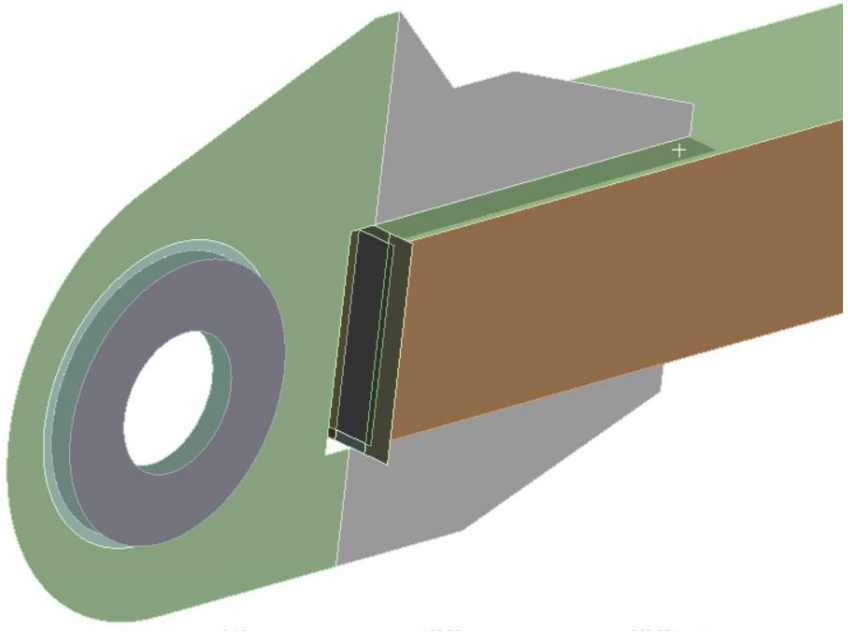
Contact

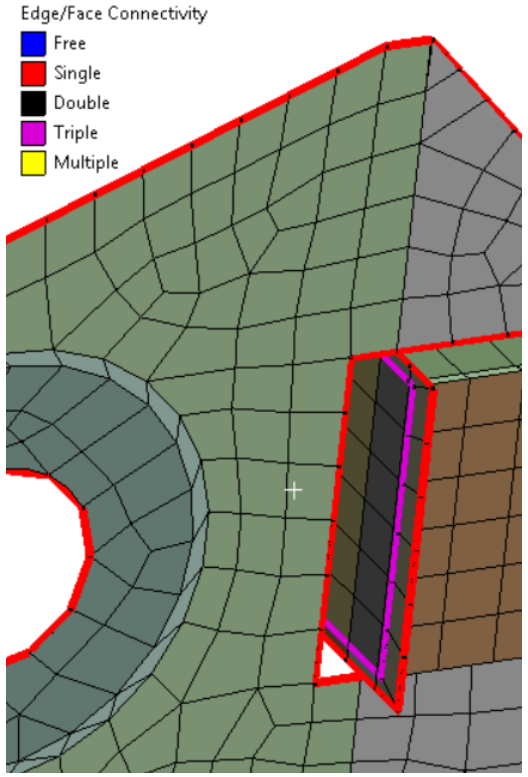
Scope	
Scoping Method	Geometry Selection
Contact	1 Face
Target	1 Face
Contact Bodies	Shells\Pied - Liaison ext arriere dte
Target Bodies	Shells\Pied - rondelle ext arriere dte
Contact Shell Face	Top
Target Shell Face	Bottom
Shell Thickness Effect	Yes
Protected	No
Definition	
Type	Bonded
Scope Mode	Automatic
Behavior	Asymmetric
Trim Contact	Program Controlled
Trim Tolerance	76.629 mm
Suppressed	No
Advanced	

Best connections for each situation

- Shell to Shell connection



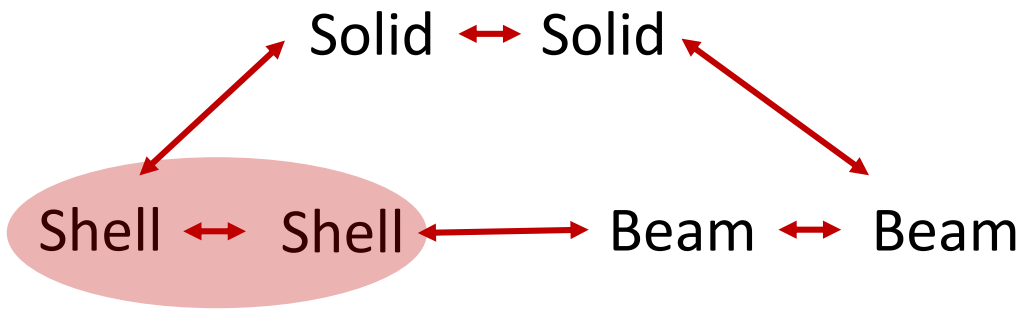




Share Topology or Mesh Connection

Best connections for each situation

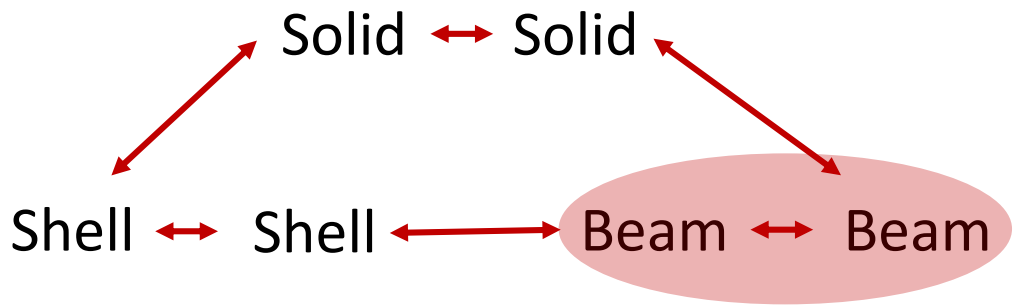
- Shell to Shell connection

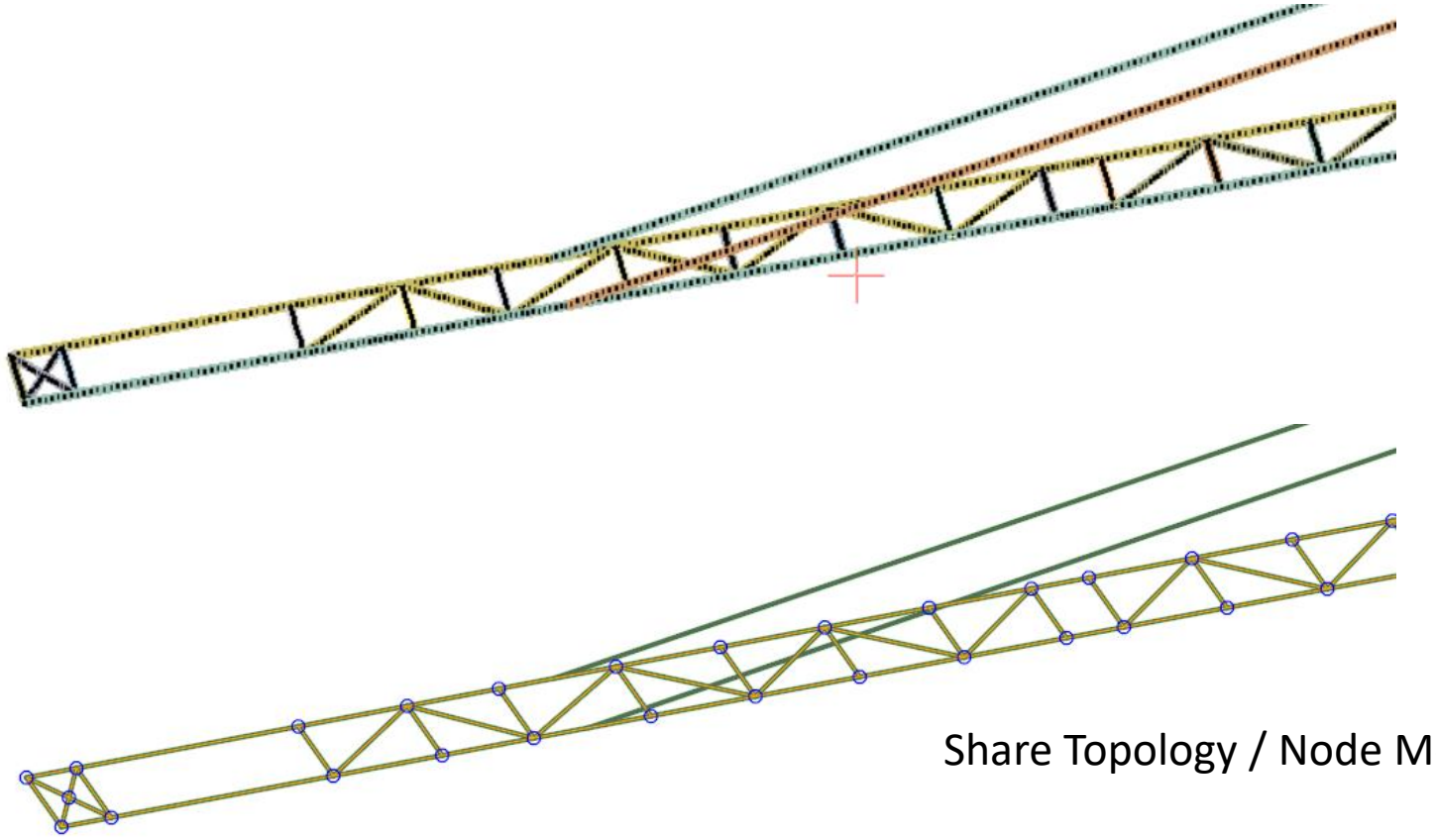


	Solid to Solid	Shell to Shell
Contact	+++	++
Joint	++	-
Share Topology	+++	+++
Mesh connection	x	+++

Best connections for each situation

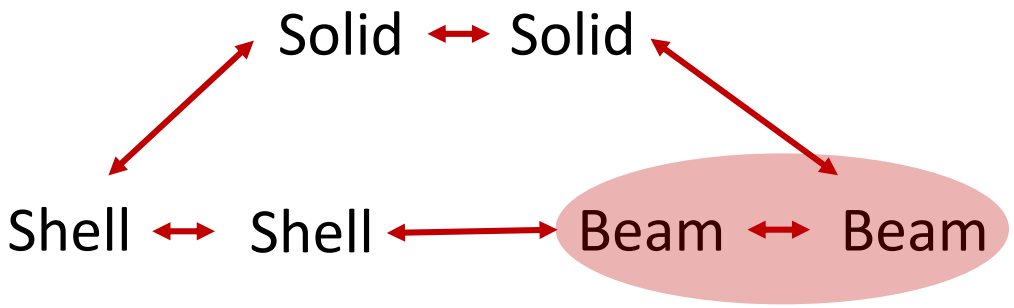
- Beam to Beam connection





Share Topology / Node Merge

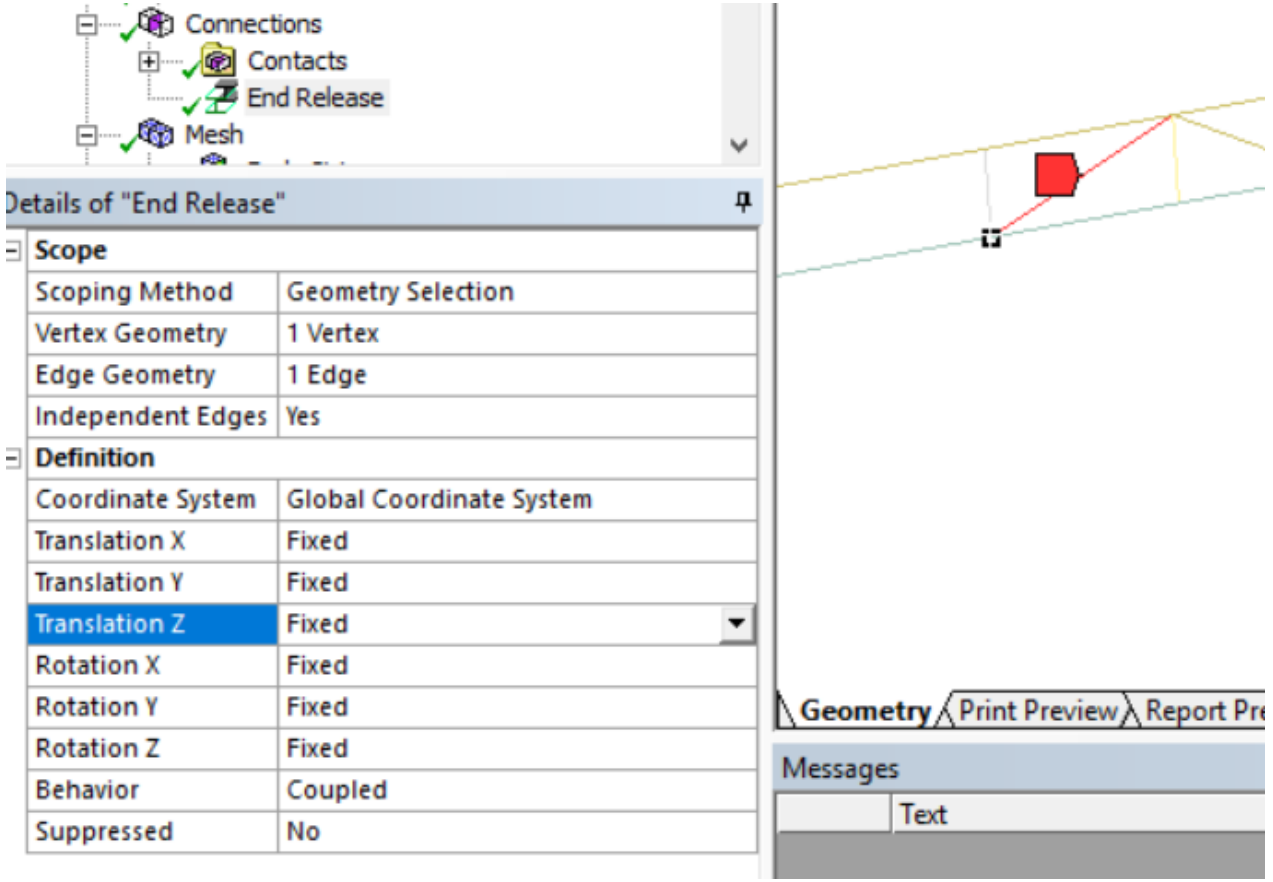
Best connections for each situation



- End Release

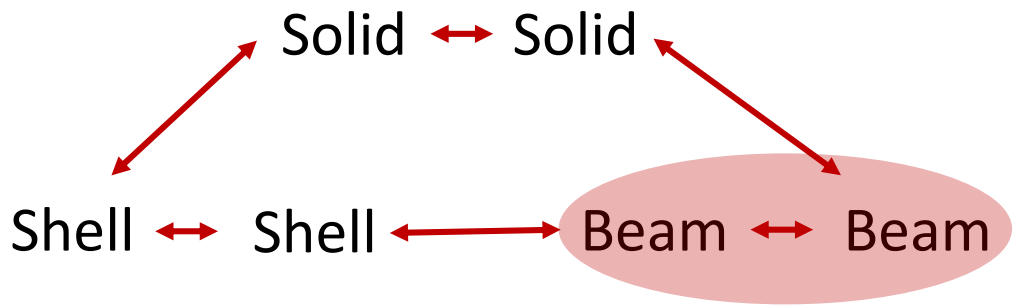
For line body models, the End Release feature enables you to free the degrees of freedom (translation and rotation) at a vertex that is shared by two or more edges.

You can free the constraint of multiple edges at the vertex's location, however, you must always keep at least one edge from being released.



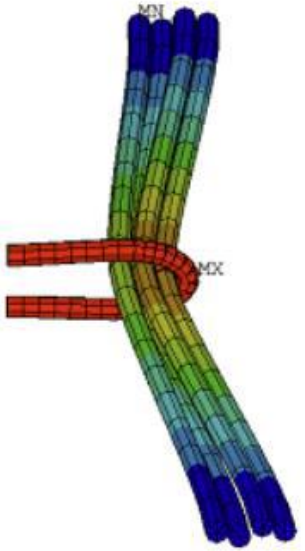
Best connections for each situation

- Beam to Beam connection



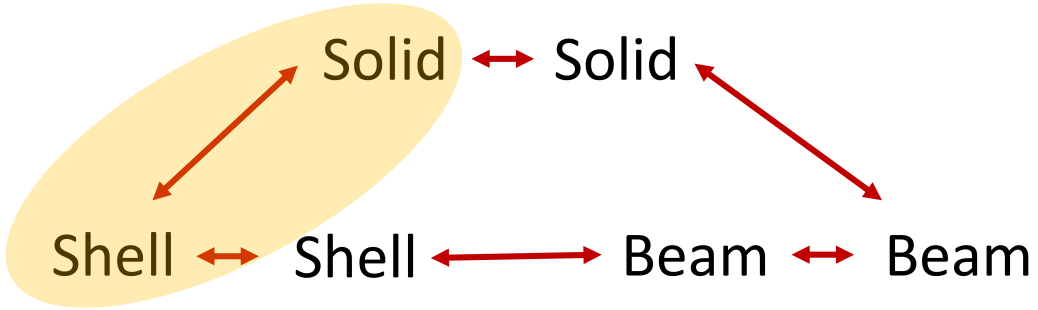
	Solid to Solid	Shell to Shell	Beam to Beam
Contact	+++	++	-*
Joint	++	-	+
Share Topology	+++	+++	+++
Mesh connection	x	+++	+**

*except for this type of modelization

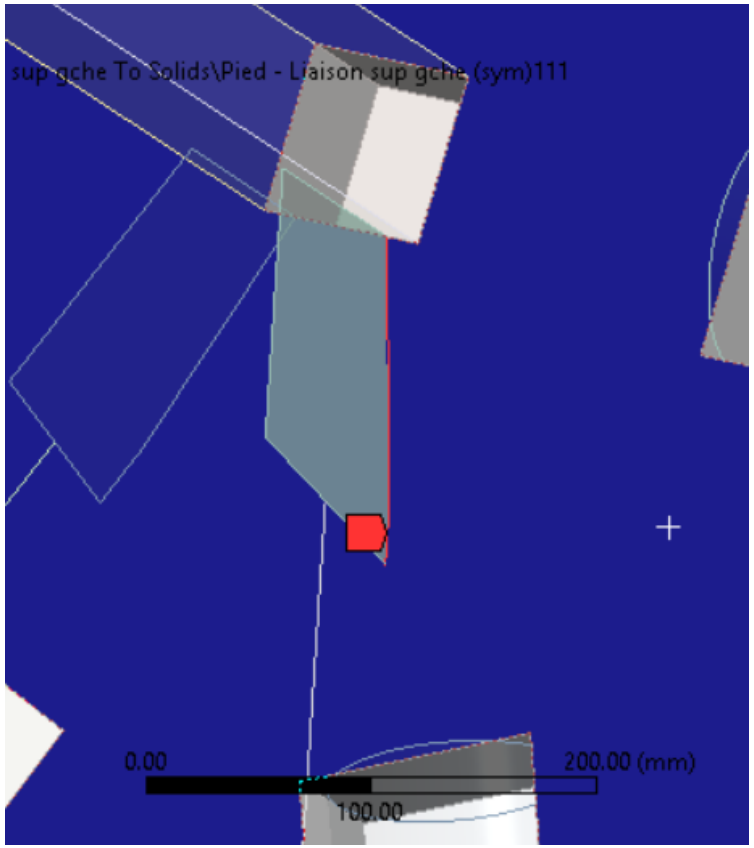


**Node Merge

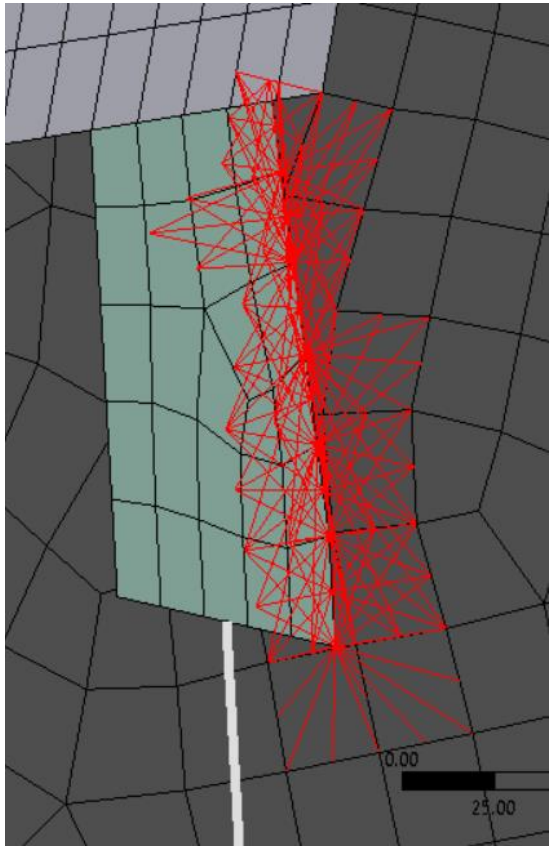
Best connections for each situation



- Solid to Shell connection



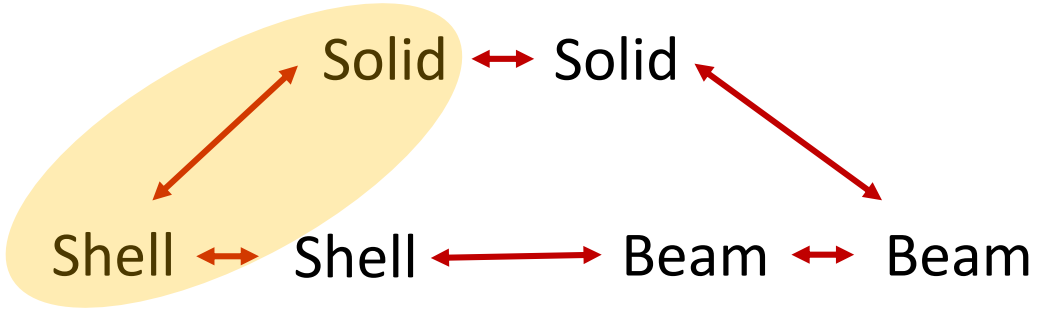
Contact MPC



Display Constraint Equations

The rotational DOF of the shell is coupled with the displacement DOF of the neighbor nodes belong to the face of the solid body.

Best connections for each situation

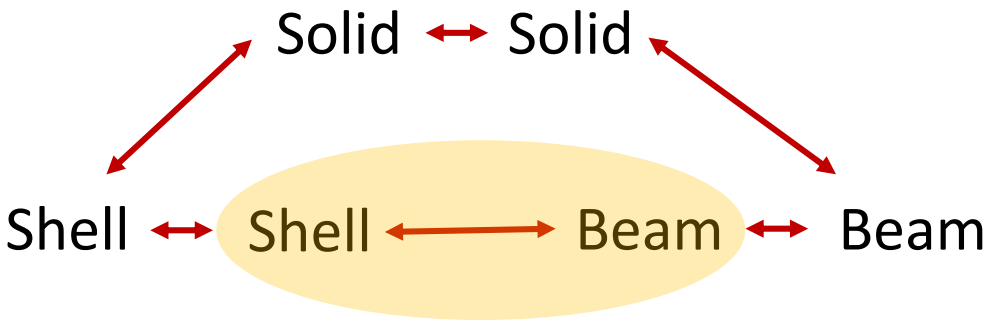


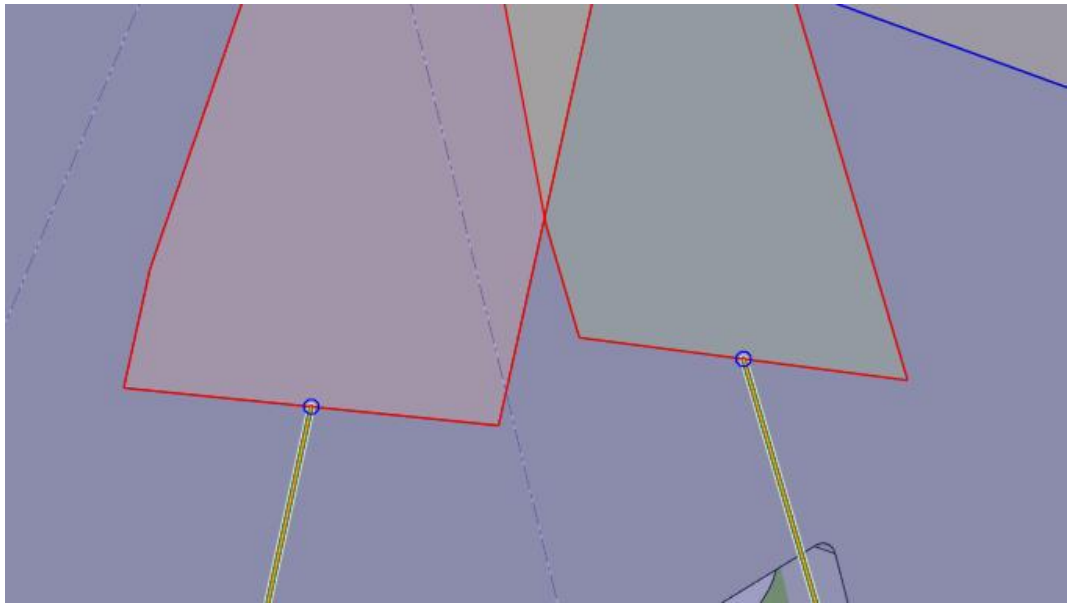
- Solid to Shell connection

	Solid to Solid	Shell to Shell	Beam to Beam	Solid to Shell
Contact	+++	++	-	+++ **(MPC)**
Joint	++	-	+	-
Share Topology	+++	+++	+++	---
Mesh connection	**X**	+++	+	**X**

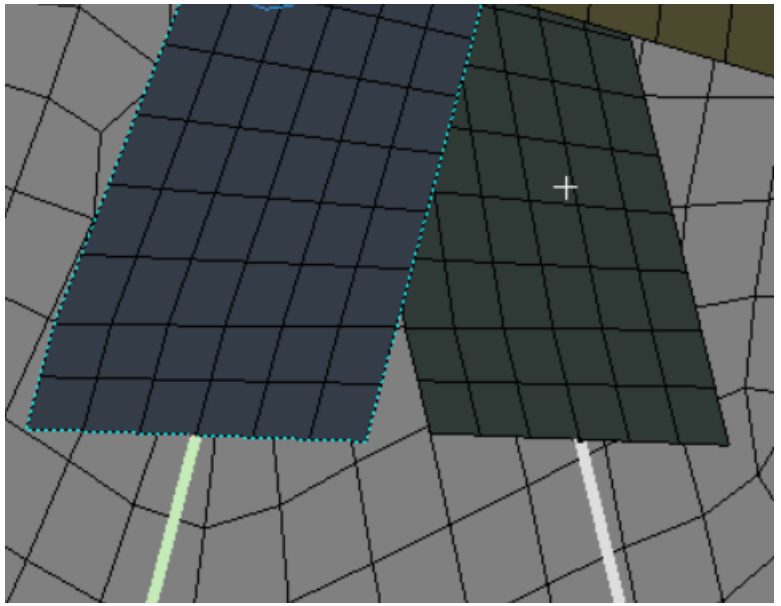
Best connections for each situation

- Shell to Beam connection





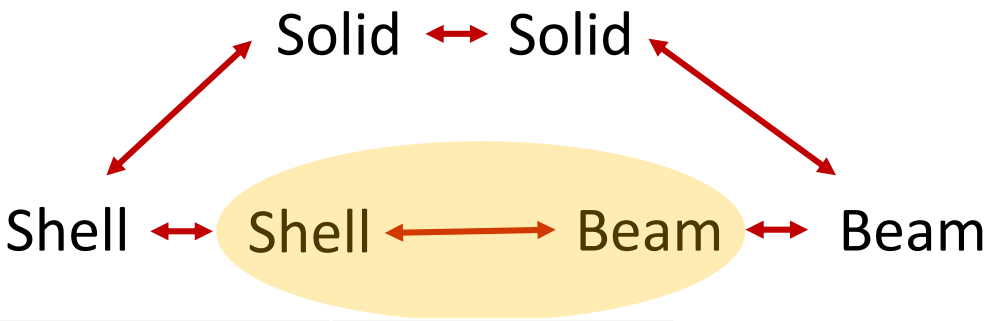
Share Topology



Coincident mesh

Best connections for each situation

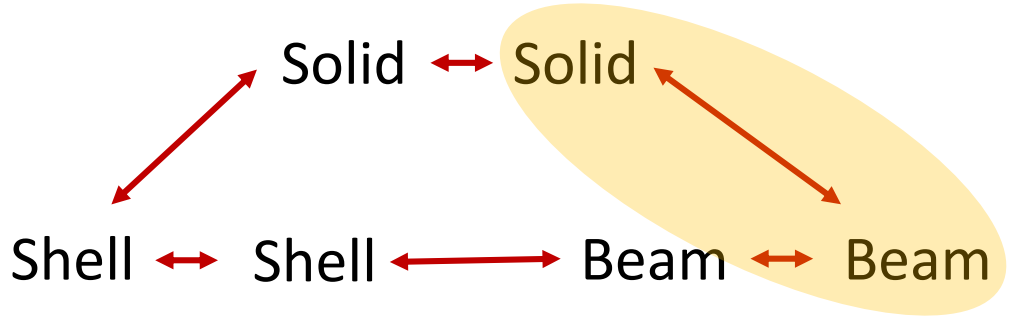
- Shell to Beam connection

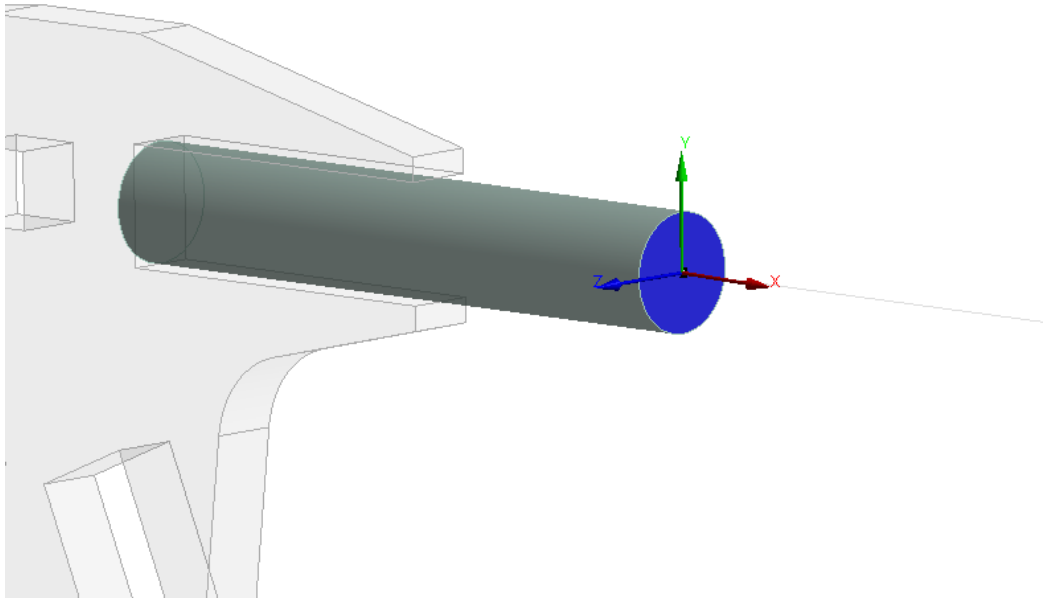


	Solid to Solid	Shell to Shell	Beam to Beam	Solid to Shell	Beam to Shell
Contact	+++	++	-	+++ (MPC)	-
Joint	++	-	+	-	-
Share Topology	+++	+++	+++	---	+++
Mesh connection	X	+++	+	X	++

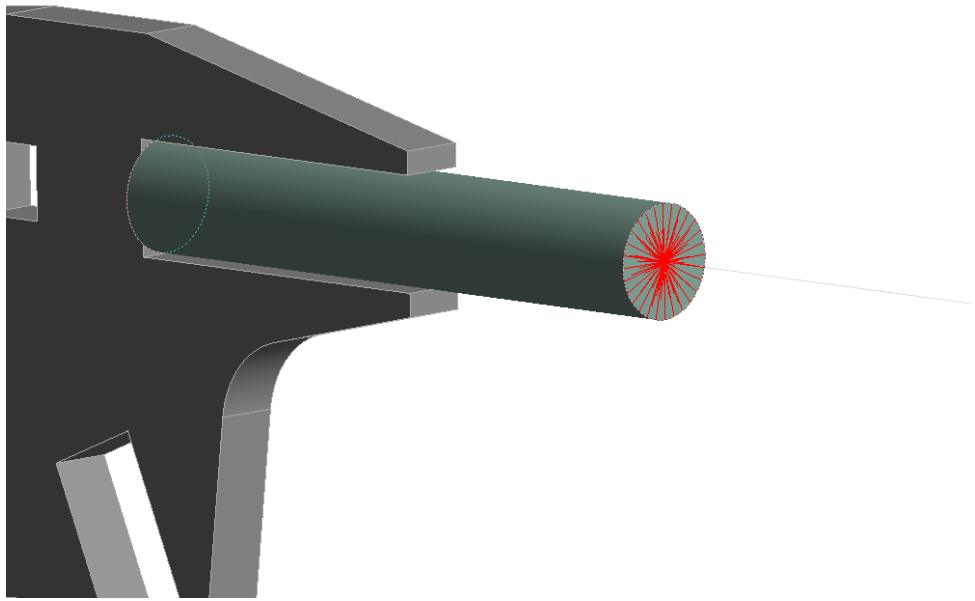
Best connections for each situation

- Solid to Beam connection





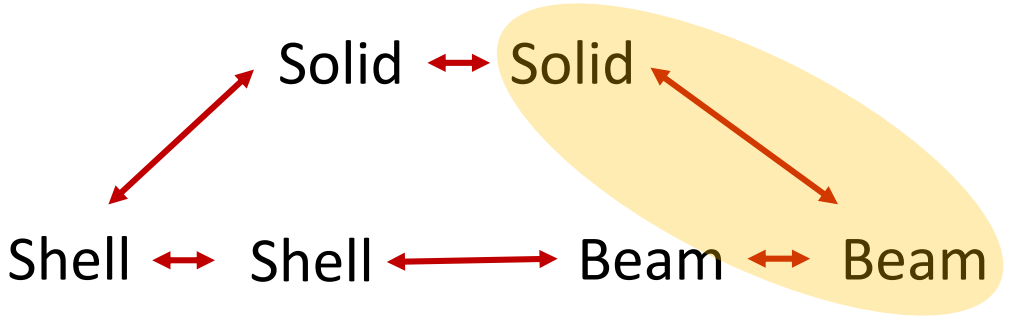
Fixed joint
(direct attachment on the beam)
(remote attachment on the face of the solid)



Constraint Equations

Best connections for each situation

- Solid to Beam connection



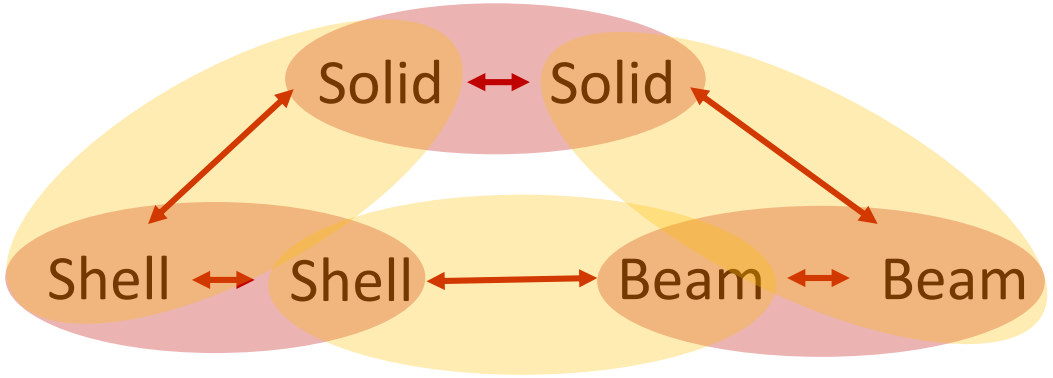
	Solid to Solid	Shell to Shell	Beam to Beam	Solid to Shell	Shell to Beam	Solid to Beam
Contact	+++	++	-	+++ (MPC)	-	++ (MPC)
Joint	++	-	+	-	-	+++
Share Topology	+++	+++	+++	---	+++	---
Mesh connection	X	+++	+	X	++	X

Overview

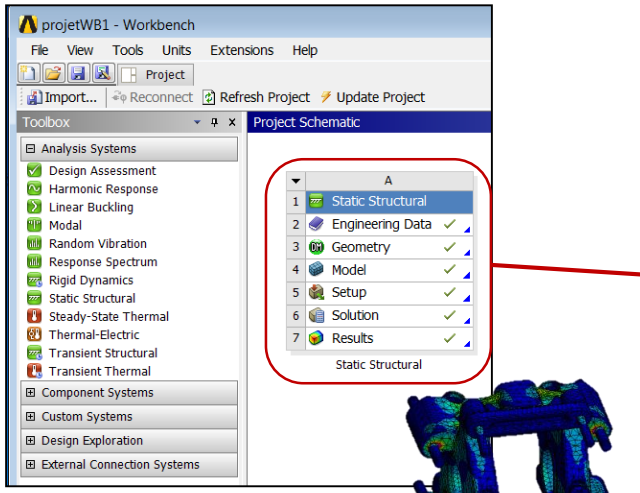
This presentation will help you to make the best choice to connect your assembly.

Program

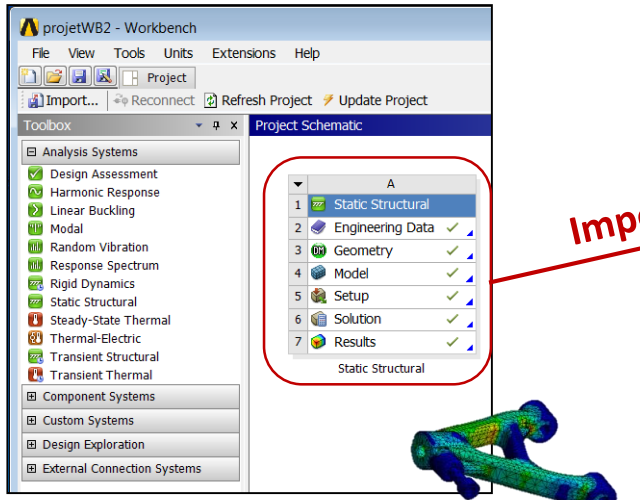
- Tools within Mechanical to connect bodies together
  - Share Topology
  - Contacts (Linear, Non Linear, MPC)
  - Remote Points
  - Beams and Springs
  - Joints
  - Mesh connection / Node merge
- Best connections for each situation
- Model assembly
- Conclusion



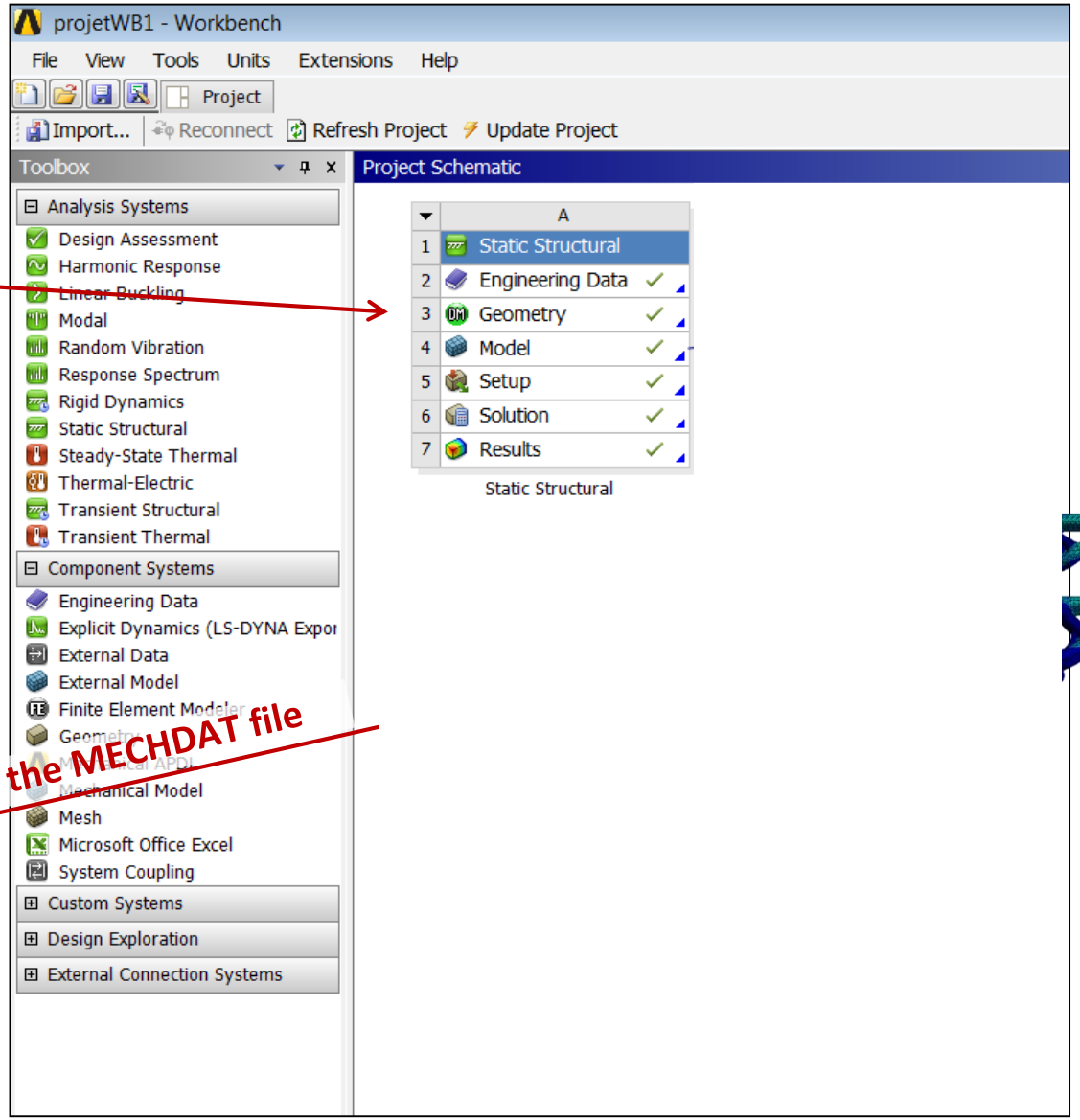
Model assembly



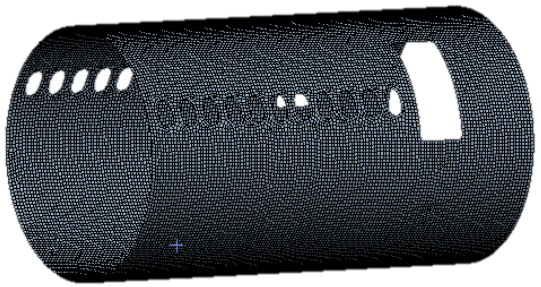
WB Project 1



WB Project 2

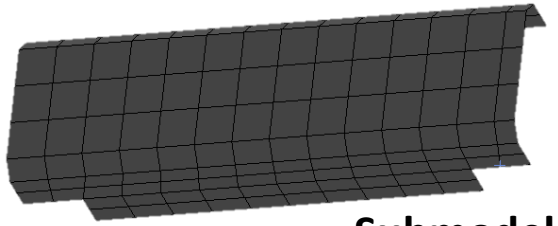


Model assembly



Submodel 1

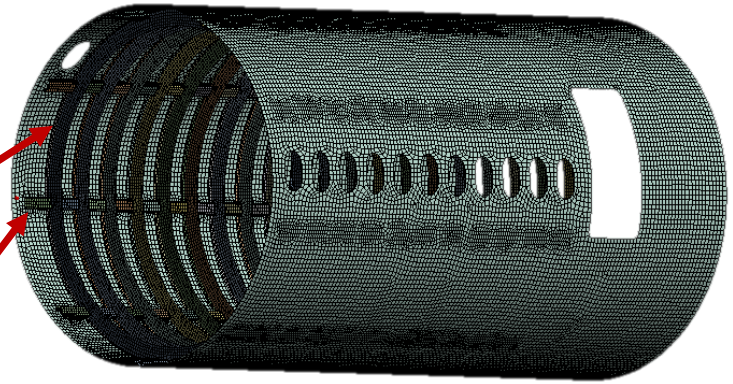
Submodel 2



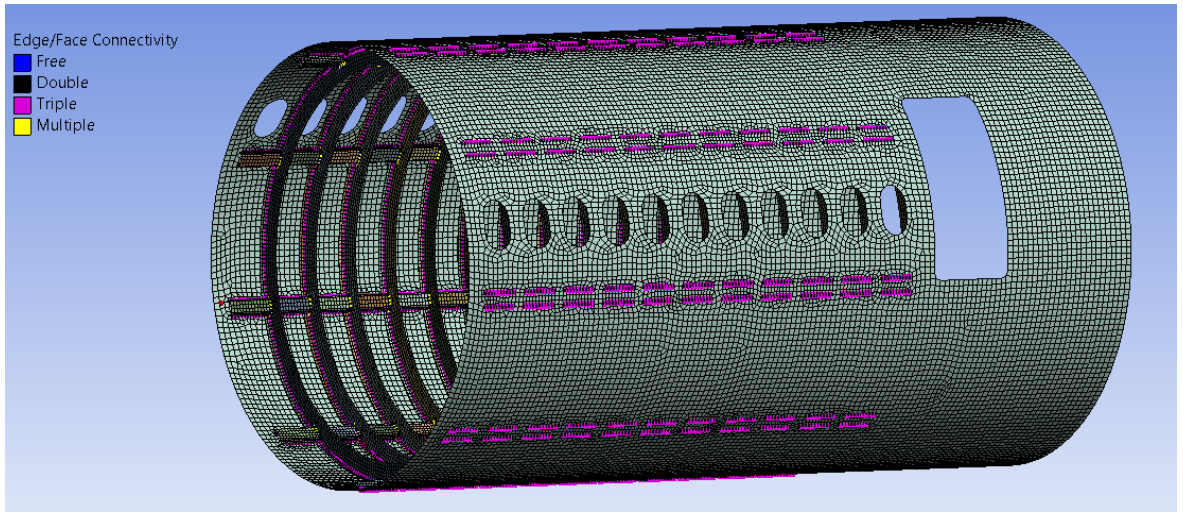
Submodel 3

X 10

X 80



+ mesh connection



Conclusion

- Many tools are available to connect bodies together.
  To make the best choice, consider all the following points:

  - Type of bodies
  - Behavior (linear or non linear) / Relevance to reality
  - Time preparation (CAD vs Mechanical)
  - Time computing
  - Post processing