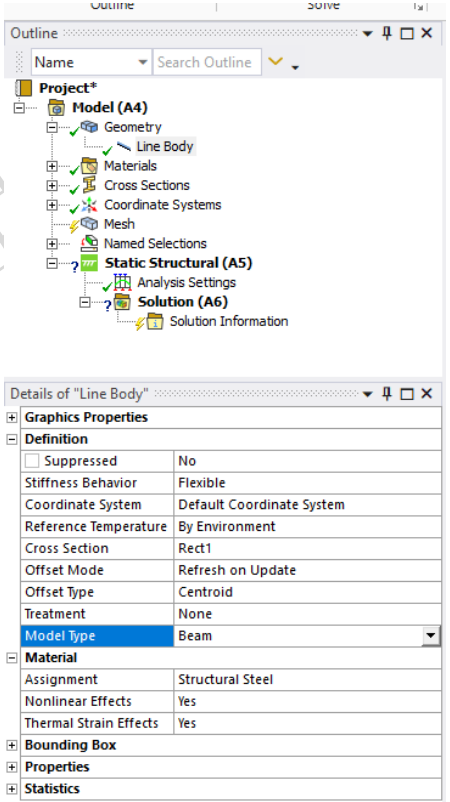
ANSYS 2020R1结构新功能

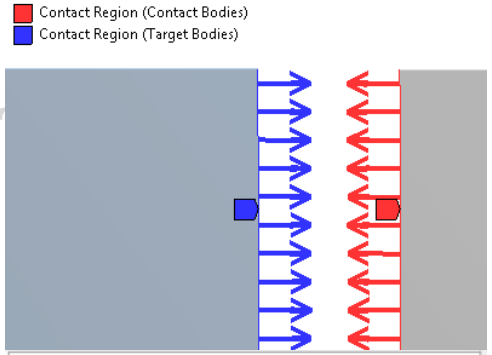
线体处理

- 线体可以在UI中访问处理属性



2D接触法向显示及反向

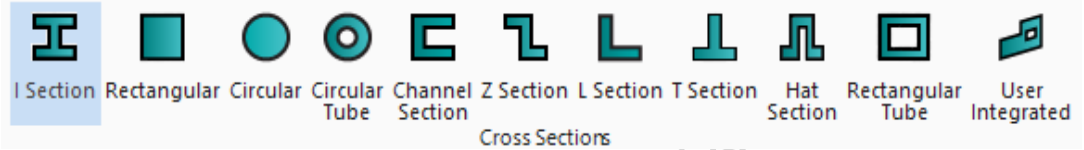
- 对于2D面体的边接触，增加接触单元法向显示。此属性显示接触中的每条边的单元法线方向
- 该显示功能与“**Geometric Modifications**”类别的两个附加属性相结合:反转接触法向和反转目标法向。这些属性使您能够反转接触单元的法线方向。

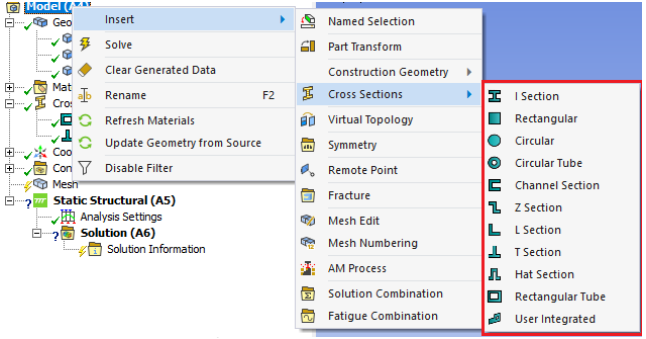


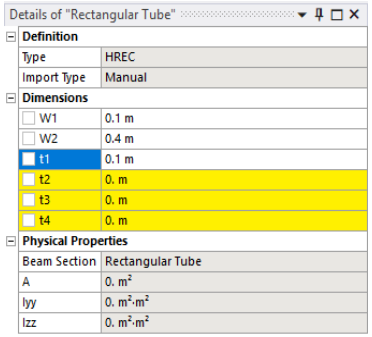
Scope	
Scoping Method	Geometry Selection
Contact	1 Edge
Target	1 Edge
Contact Bodies	cont
Target Bodies	targ
Shell Thickness Effect	No
Protected	No
Definition	
Display	
Element Normals	Yes
Advanced	
Geometric Modification	
Contact Geometry Correction	None
Target Geometry Correction	None
Flip Contact Normals	No
Flip Target Normals	No

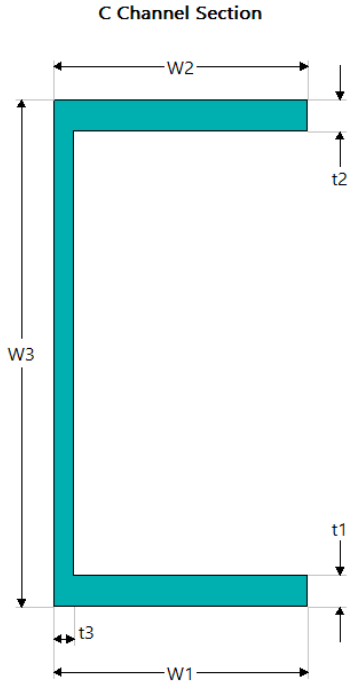
可编辑和用户定义的截面

- Mechanical现在支持创建、编辑和复制横截面

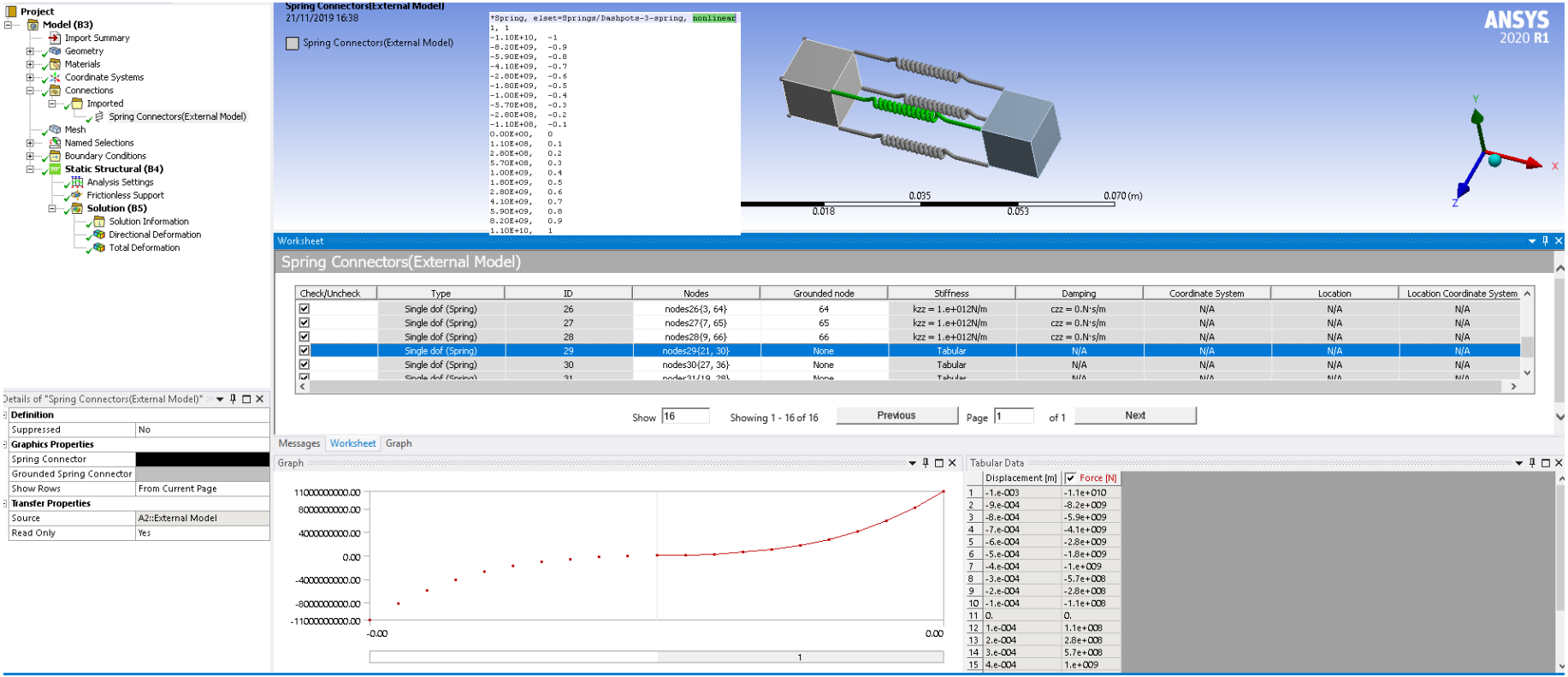




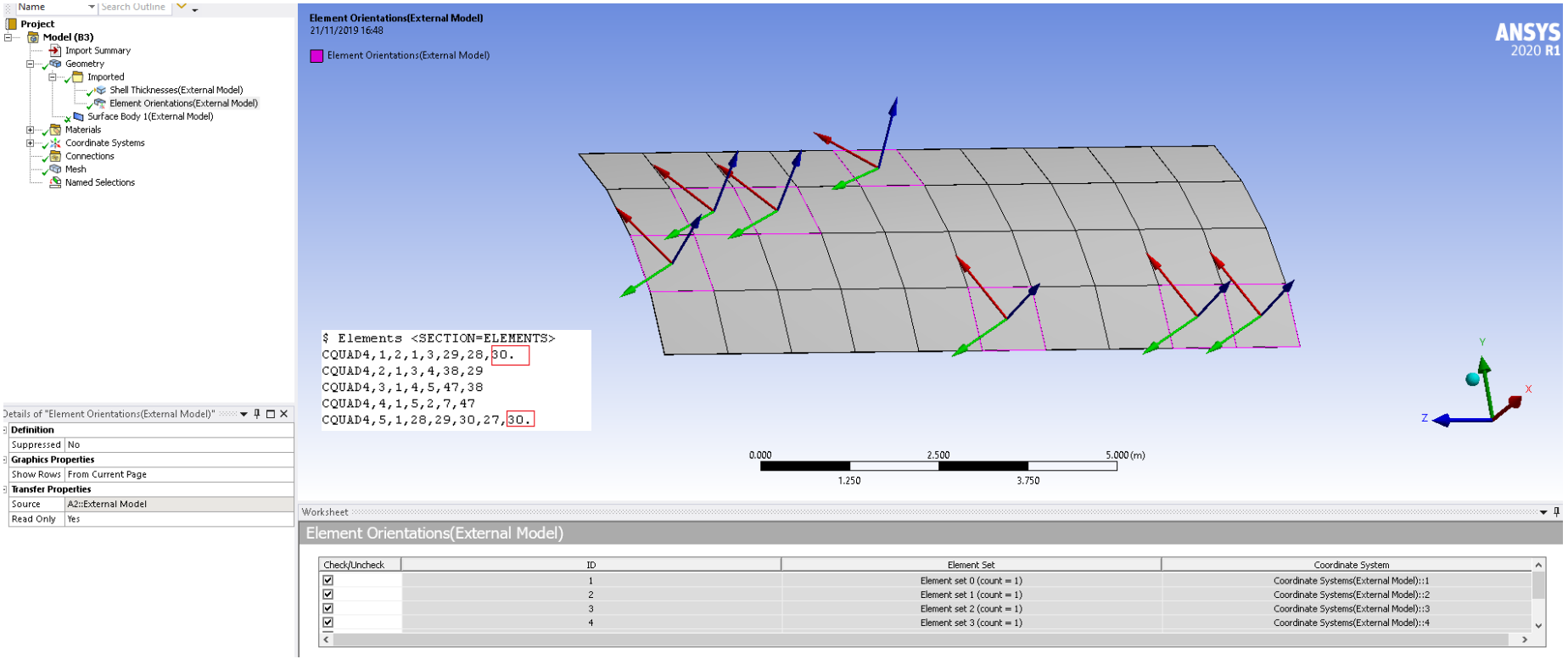




支持ABAQUS的非线性弹簧导入（表格输入）

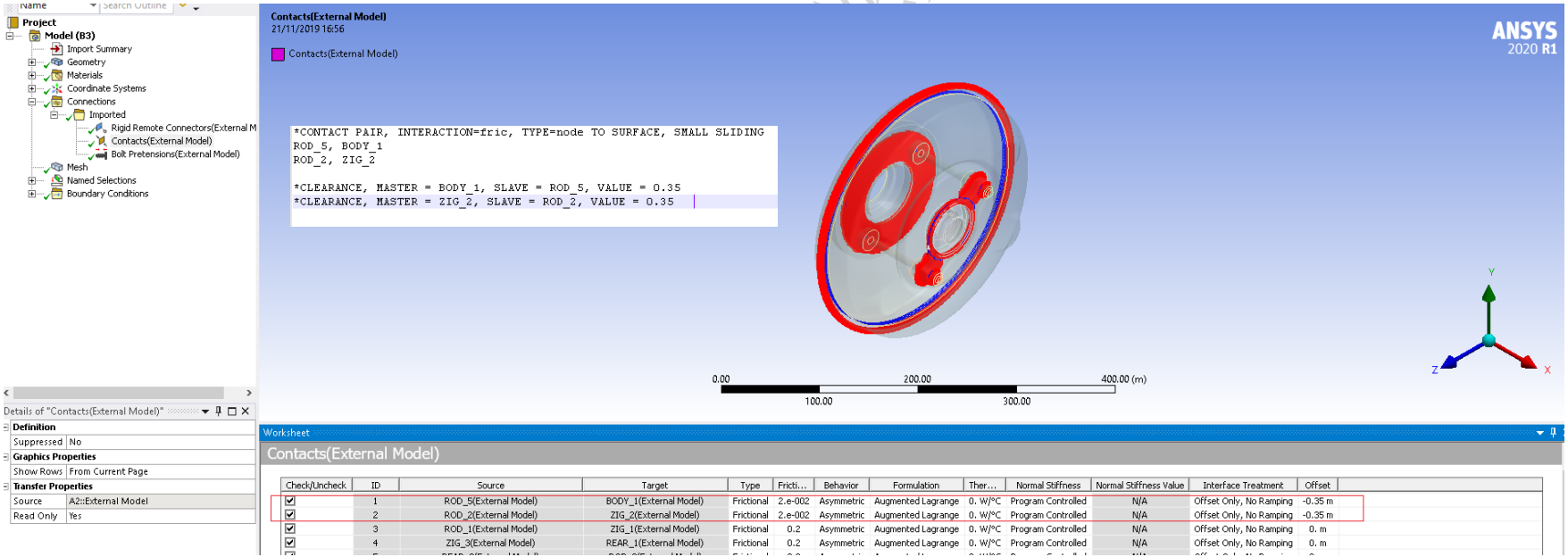


支持 NASTRAN CQUAD*/CTRA*/CTRI* 卡片导入



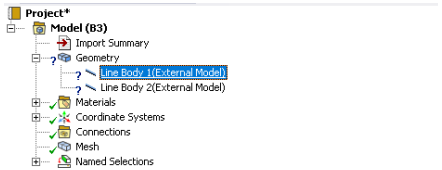
支持ABAQUS 接触干涉和间隙

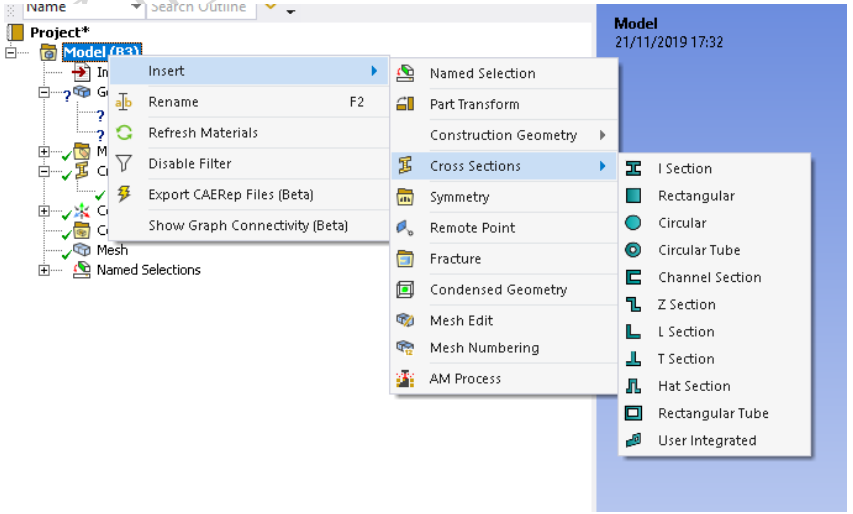
- 在Interface Treatment中显示

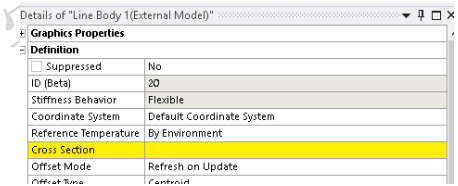


允许导入梁单元而不需要分配横截面

- 没有指定横截面的梁单元现在可以导入
- 可在Model中新建横截面属性赋予线体

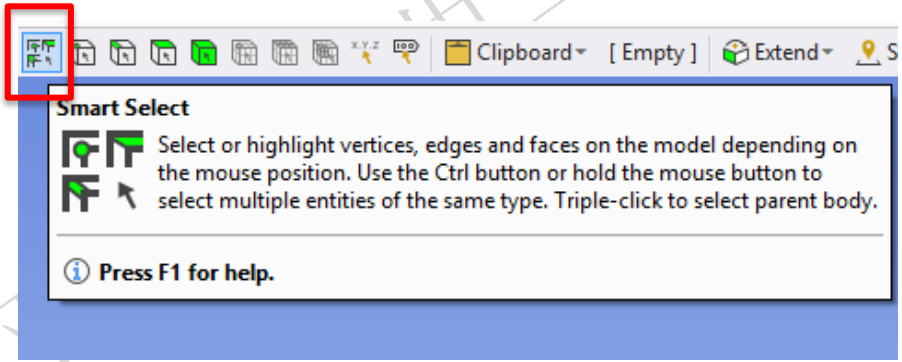






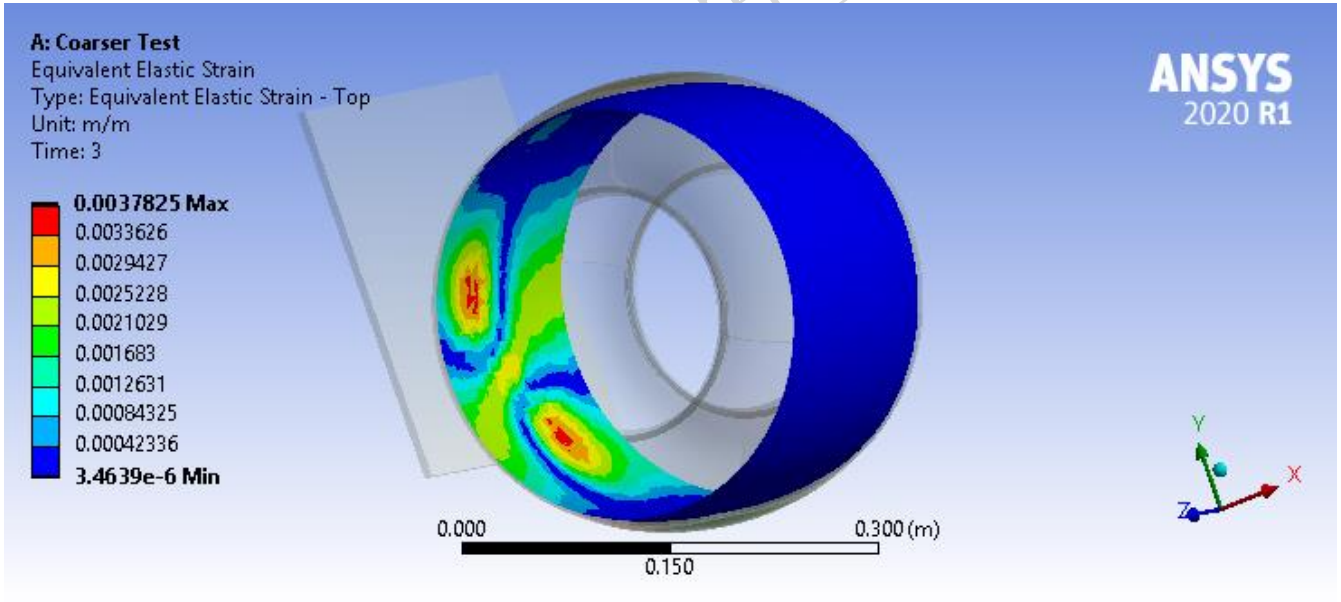
智能选择

- 图形工具栏选项“智能选择”是默认的几何图形选择选项



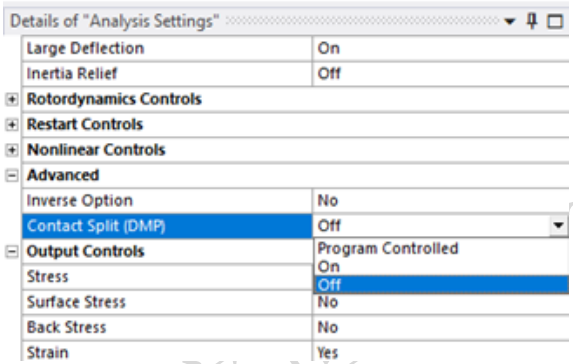
Reinforcement 单元结果

- 当模型中有加强元素(REINF263、REINF264和REINF265)时，现在可以使用“**Result File Item**”选项查看单元的结果



接触加强

- **“Advanced Analysis Settings”** 支持新的设置 *Contact Split (DMP)*，**在分布式模式下具有更好的求解性能。当启动时，对于存在大量接触对的模型，可以加快求解速度。**Contact Split (DMP)默认设为OFF



Cantilever Beam Model with number of contacts = 228

Solution time with 12 cores, without contact splitting

```
CP Time      (sec) =         15.766
Elapsed Time (sec) =         24.000
```

Solution time with 12 cores, with contact splitting, Number of maximum splits per contact = 12
25 % less Elapsed Time

```
CP Time      (sec) =         14.062
Elapsed Time (sec) =         18.000
```

接触加强

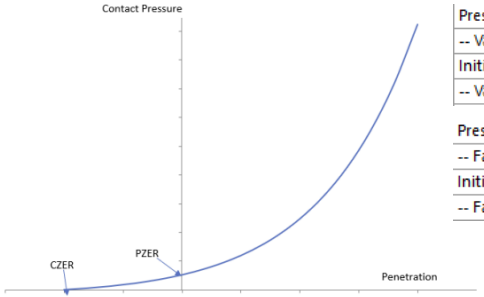
- **“Update Stiffness” 中增加** (Each Iteration, Exponential)选项；
- **此选项仅适用于罚函数法的摩擦/无摩擦接触**
- **该选项将根据指数压力-穿透关系更新接触刚度**

Details of "Contact Region"

Definition	
Type	Frictional
Friction Coefficient	0.2
Scope Mode	Automatic
Behavior	Program Controlled
Trim Contact	Program Controlled
Trim Tolerance	1.1979e-003 m
Suppressed	No
Advanced	
Formulation	Pure Penalty
Small Sliding	Program Controlled
Detection Method	Program Controlled
Penetration Tolerance	Program Controlled
Elastic Slip Tolerance	Program Controlled
Normal Stiffness	Program Controlled
Update Stiffness	Program Controlled
Stabilization Damping Factor	Program Controlled / Never / Each Iteration / Each Iteration, Aggressive / Each Iteration, Exponential
Pinball Region	
Time Step Controls	
Geometric Modification	
Interface Treatment	Add Offset, No Ramping

- 一旦选择了这个选项，就会出现另外两个属性:
  - Pressure At Zero Penetration → PZER in MAPDL
  - Initial Clearance → CZER in MAPDL

Figure 3.13: Pressure-Penetration Relationship



Pressure At Zero Penetration	Value
-- Value	2. MPa
Initial Clearance	Value
-- Value	0.1 mm

Pressure At Zero Penetration	Factor
-- Factor	1.6
Initial Clearance	Factor
-- Factor	2.e-002

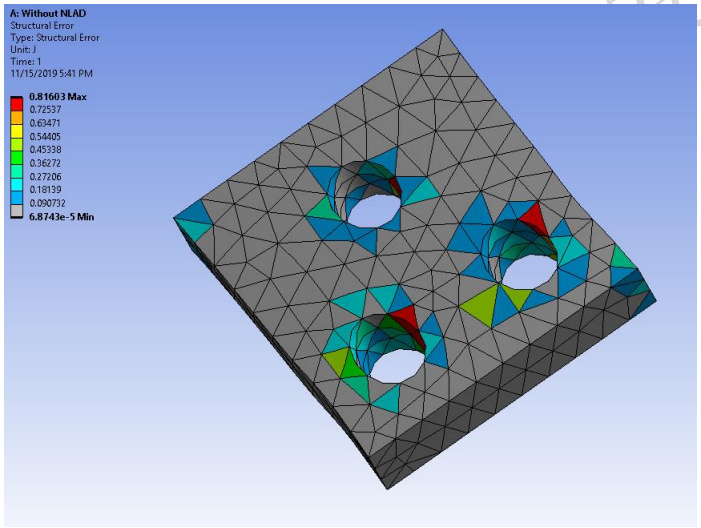
- 两个属性都有三个下拉菜单选项:
  1. Program Controlled (default):
  2. 计算默认值Value: 用户可以定义任何正值
  3. Factor: 用户可以定义求解器计算因子

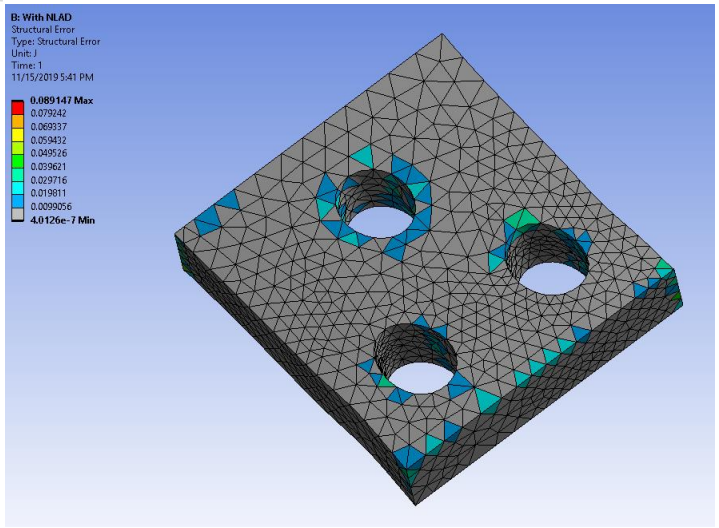
Update Stiffness	Each Iteration, Exponential
Pressure At Zero Penetration	Program Controlled
Initial Clearance	Program Controlled

Program Controlled
Program Controlled
Value
Factor

NLAD加强

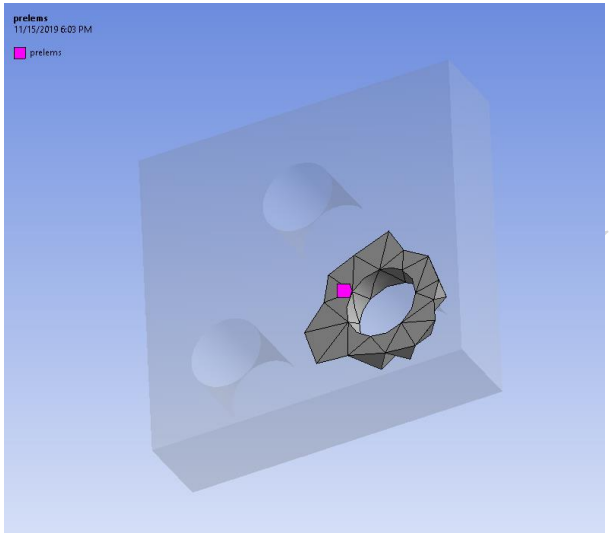
- 支持大变形关闭时的非线性自适应网格功能
- 当结构变形不大但Structural Error大的情况下，可以通过自适应细化网格来修正

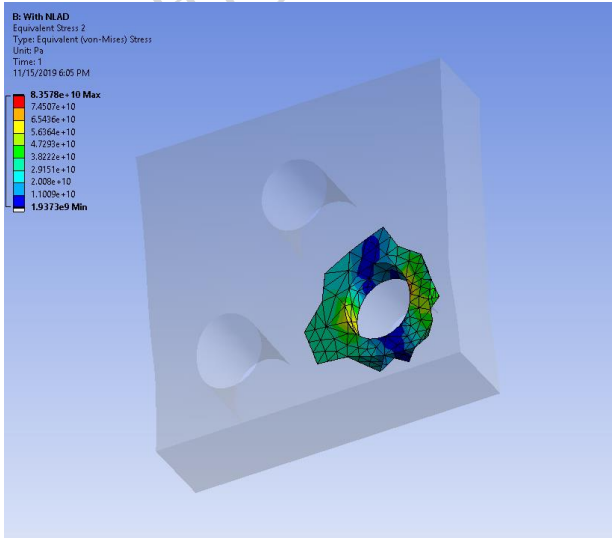


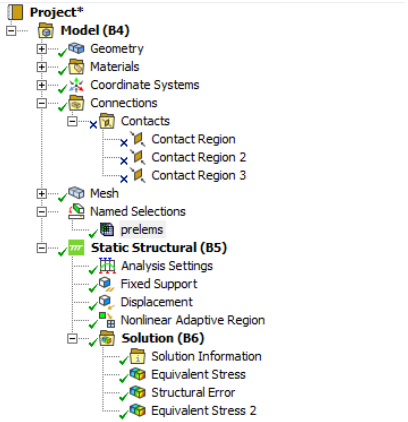


NLAD加强

- 求解过程中数据保存（测试功能）
  - 支持在NLAD求解中保存，可以帮助用户评估name selection 单元组的结果







Details of "prelems"

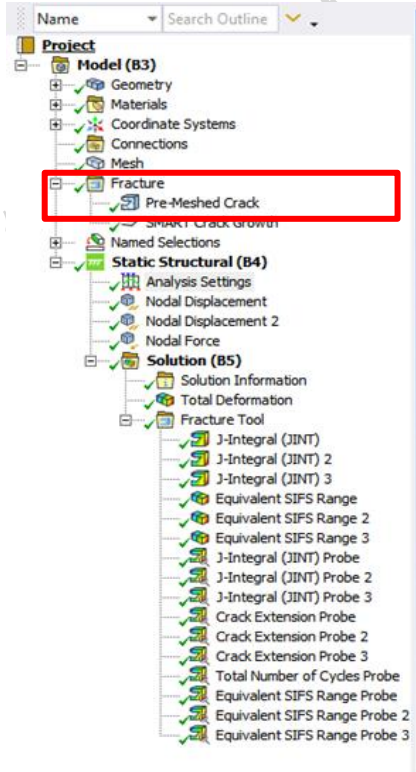
Scope	
Scoping Method	Geometry Selection
Geometry	30 Elements
Definition	
Send to Solver	Yes
Visible	Yes
Program Controlled Inflation	Exclude
Preserve During Solve (Beta)	Yes
Statistics	
Type	Manual
Total Selection	30 Elements
Suppressed	0
Used by Mesh Worksheet	No

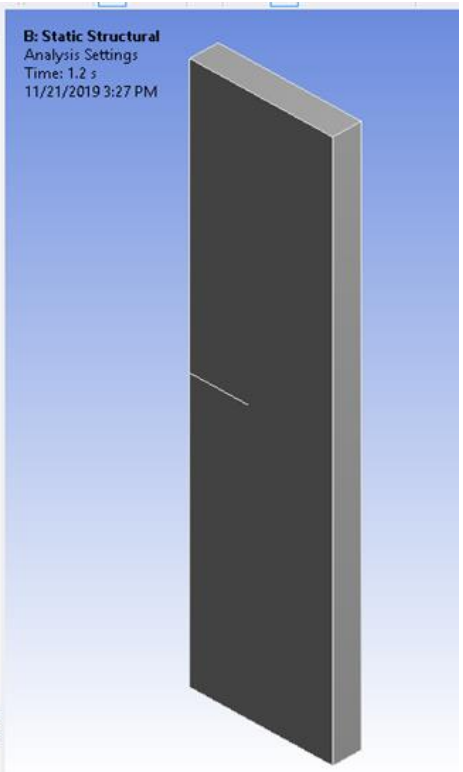
断裂

- SMART裂纹扩展现在支持多加载步加载

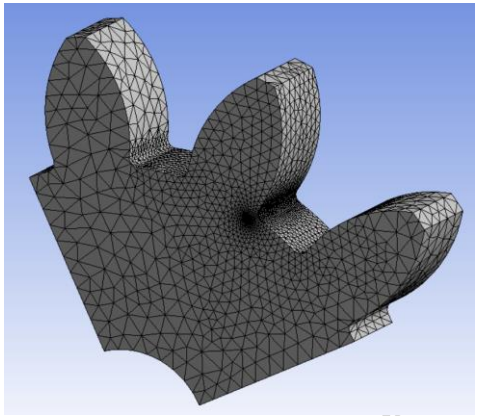
Details of "Analysis Settings"

Step Controls	
Number Of Steps	2.
Current Step Number	2.
Step End Time	1.2 s
Auto Time Stepping	Off
Define By	Substeps
Number Of Substeps	3.
Solver Controls	
Solver Type	Program Controlled
Weak Springs	Off
Solver Pivot Checking	Program Controlled
Large Deflection	Off
Inertia Relief	Off
Rotordynamics Controls	
Restart Controls	
Fracture Controls	
Fracture	On
SIFS	No
J-Integral	Yes
Material Force	No
T-Stress	No
Nonlinear Controls	

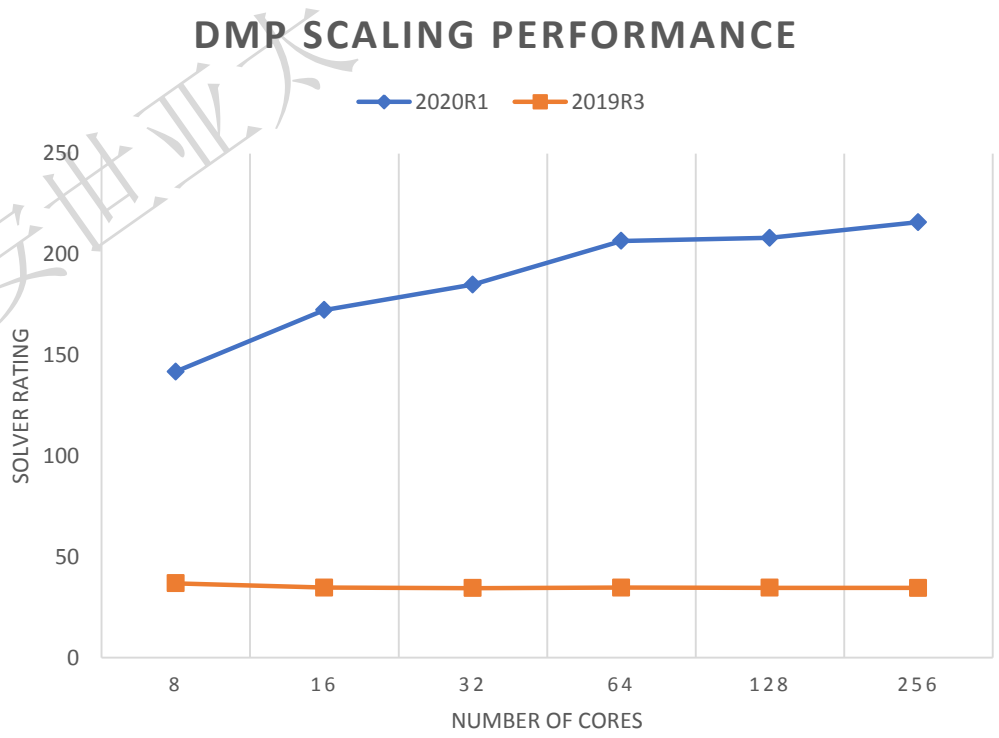




分布式裂纹计算

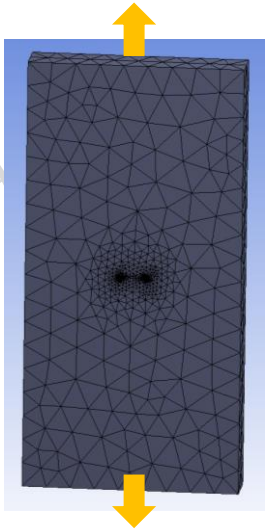


- 支持2.2 million DOF; PCG solver
- 支持静力裂纹计算
- 求解速度加快



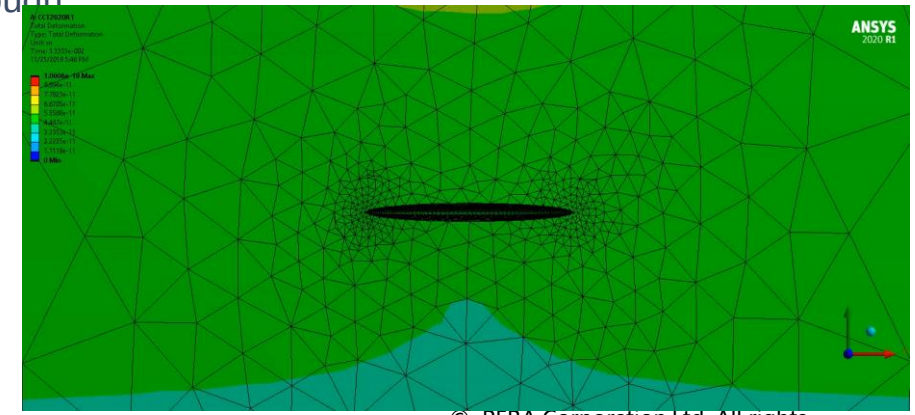
SMART 裂纹扩展加强

- 鲁棒性提升
  - 持续求解和网格改进
    - 大幅减少网格重构单元数量
    - 提升网格重构成功率
    - Improved remeshing with crack growing into corner
    - Improved remeshing with crack growing cut through part
    - Improved remeshing with crack growing cut through edge
  - 持续改进
    - 裂缝参数计算
    - 裂缝方向预测
    - 裂纹扩展预测



Problem Description:

- Center cracked tension panel subjected to remote tension pressure load
- Elliptic surface crack
- Fatigue crack growth with Paris Law

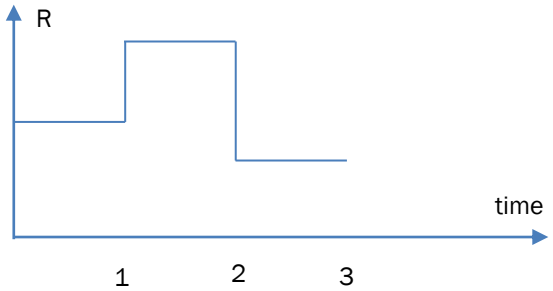


SMART 裂纹扩展加强

- 表格输入裂纹扩展疲劳应力比
  - 定义应力比随时间变化的表格

```
*dim,rtable,table,6,1,,TIME     ! R ratio table
rtable(1,0) = 0
rtable(1,1) = 0.3
rtable(2,0) = 1.0
rtable(2,1) = 0.3
rtable(3,0) = 1.0001
rtable(3,1) = 0.5
rtable(4,0) = 2
rtable(4,1) = 0.5
...
```

  - 利用表格输入载荷和应力比来模拟复杂的加载形式



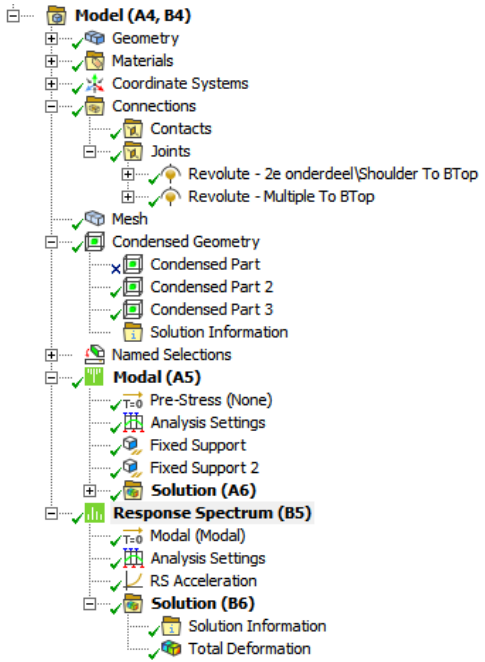
线性动力学增强

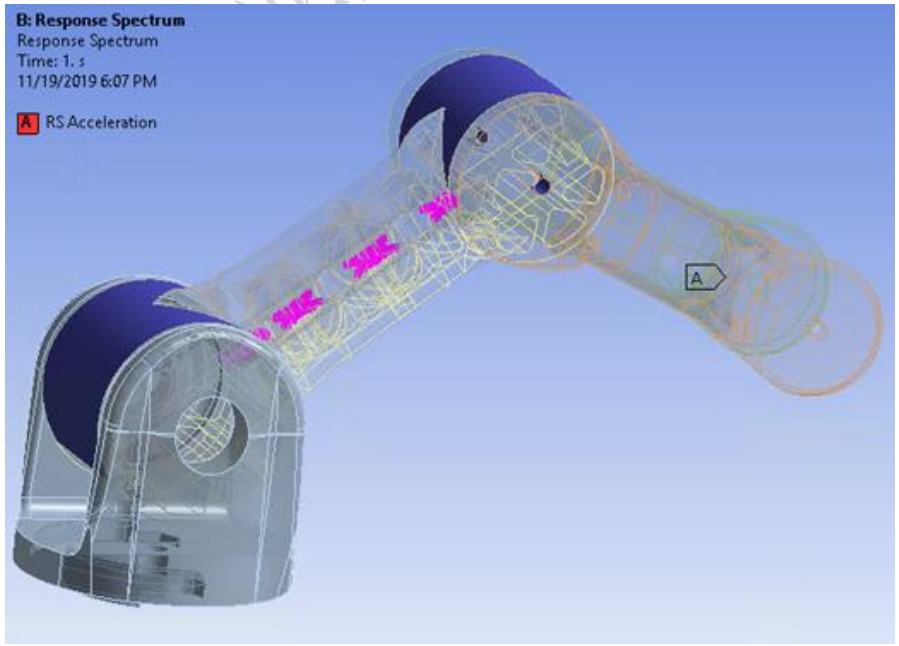
2020R1 线性动力学增强：

- 针对响应谱分析的CMS缩减方法
- Maxwell的体积力密度传递

CMS 增强

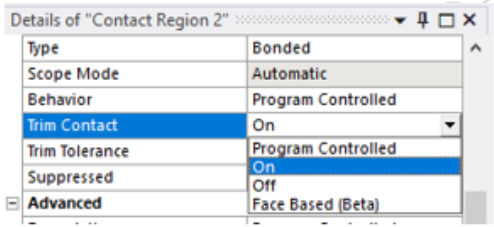
- 在响应谱分析中支持基于CMS的超单元方法

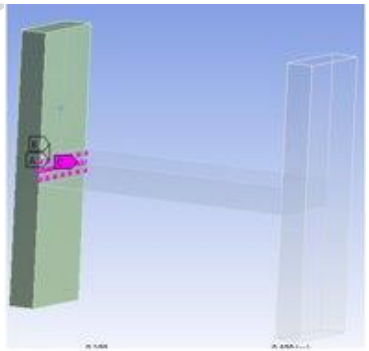




CMS 增强

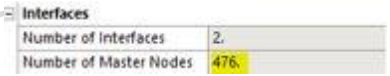
- 当选择“Trim Contact”选项为On时，这将控制自由度数量的减少，提高运算速度。

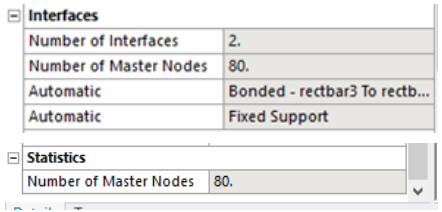




Before Trim

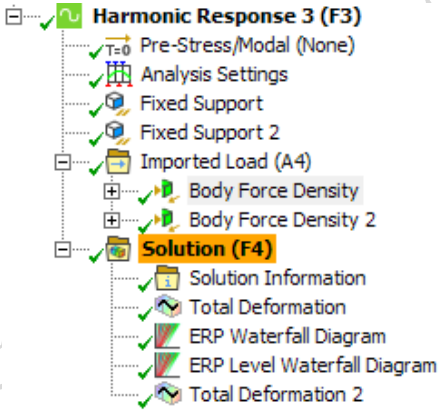
After Trim

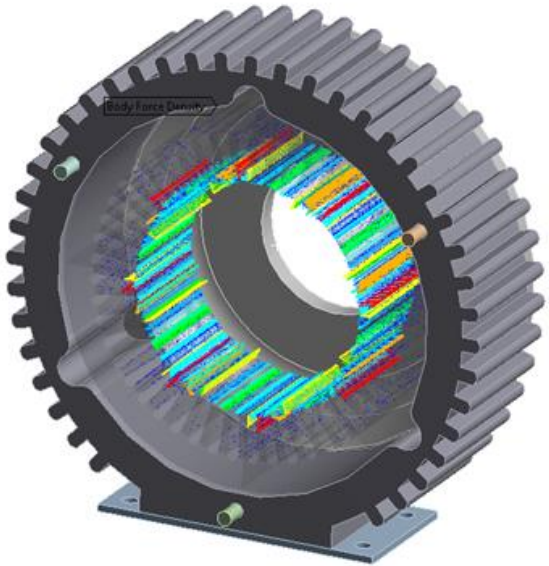




Maxwell的体积力密度传递

- 在完全谐响应中支持随频率的体积力密度
- 应用：变压器、电机





耦合分析

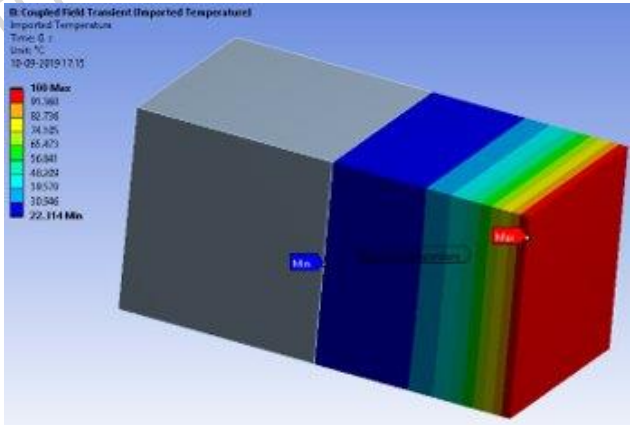
- Mechanical支持以下附加特性，用于耦合静态和耦合瞬态分析
  - 输入温度场作为初始条件
  - 支持外部导入用于耦合分析
  - 焊点
  - 约束方程和耦合条件
  - 温度跟踪

耦合分析

- Mechanical支持“输入温度”选项，将其作为初始条件或边界条件。默认是将其作为边界条件应用。“输入温度”在之前的软件版本中一直作为边界条件应用。

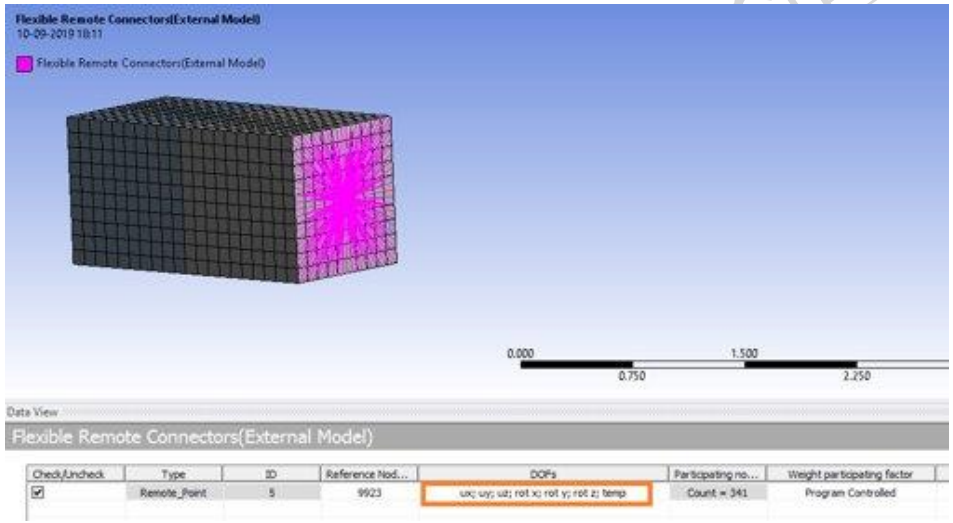
Details of "Imported Temperature"

Scope	
Scoping Method	Named Selection
Named Selection	elbow
Definition	
Type	Imported Temperature
Apply As	Initial Condition
Tabular Loading	Boundary Condition
Suppressed	Initial Condition
Beta Options (Beta)	
Show Body Wireframe (Beta)	No
Settings	
Mapping Control	Program Controlled
Mapping	Profile Preserving
Weighting	Triangulation
Transfer Type	Volumetric
Graphics Controls	
Display Source Points	Off
Display Source Point Ids	Off

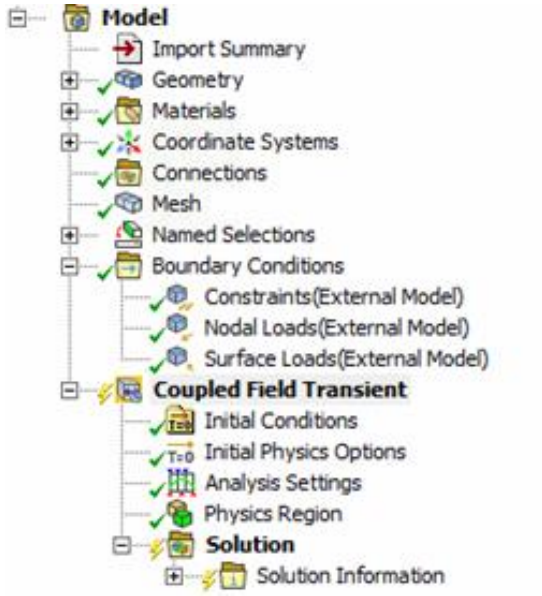


耦合分析

- 支持将CDB、Nastran和Abaqus文件导入到耦合分析中。在传输中，丢失的属性会自动失效，以引起用户的注意(例如接触热导)

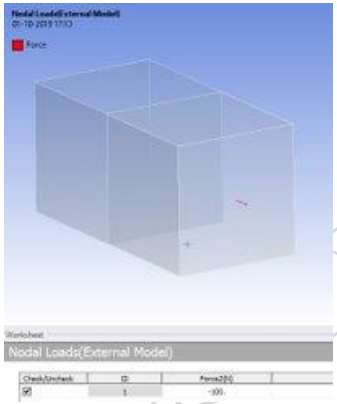


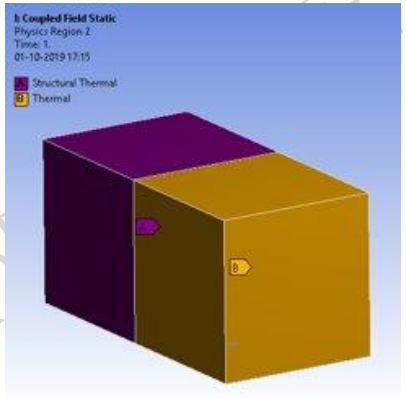
Remote Point degrees of freedom

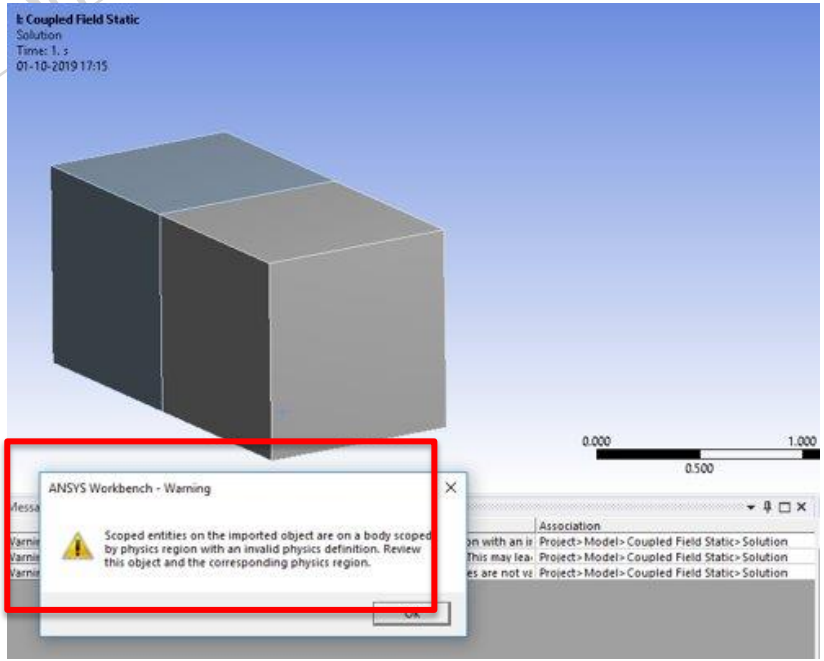


耦合分析

- 当导入的对象不被支持时，将通过显示适当的警告来指导用户。

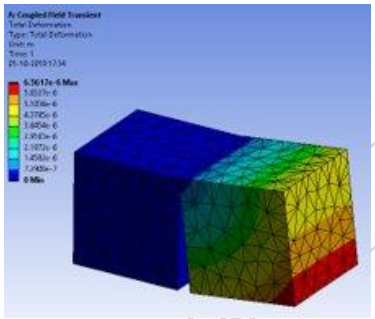


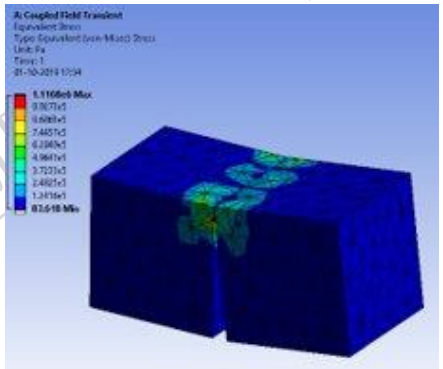


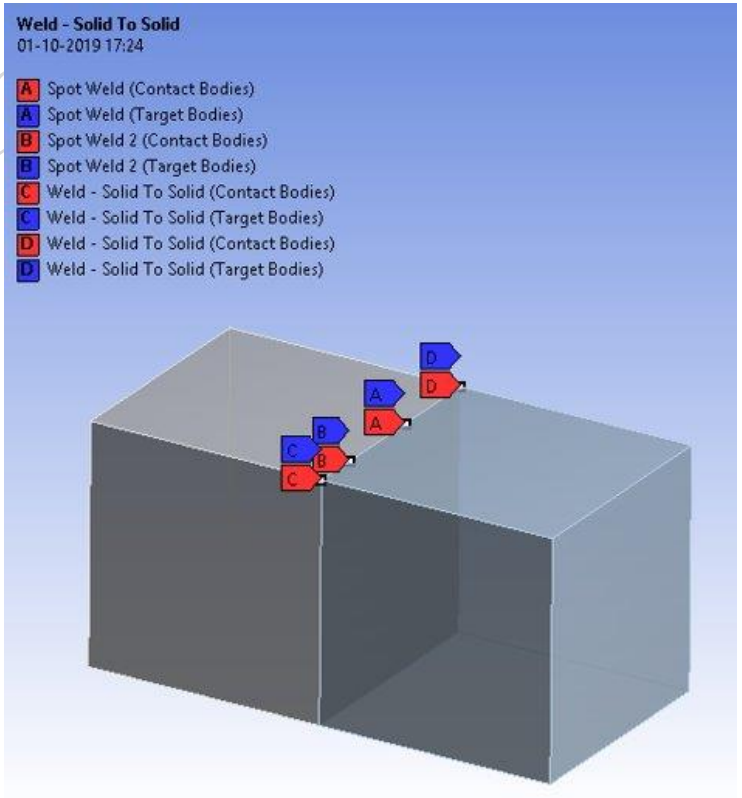


耦合分析

- 在耦合分析中支持点焊，仅用于结构分析和热接触。

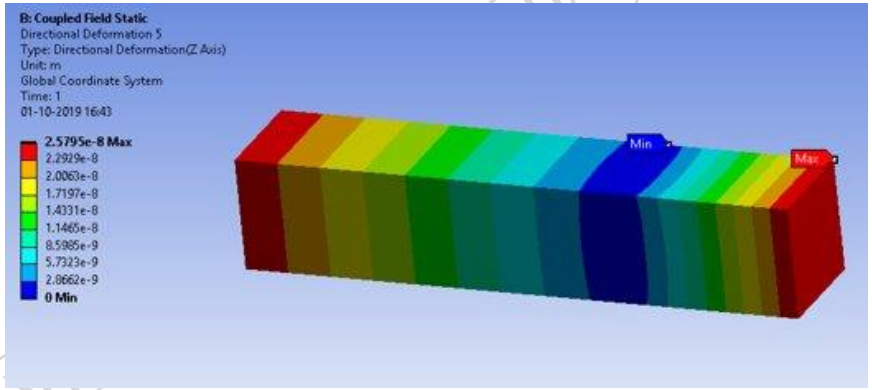






耦合分析

- 约束方程可用于耦合远程点之间的自由度



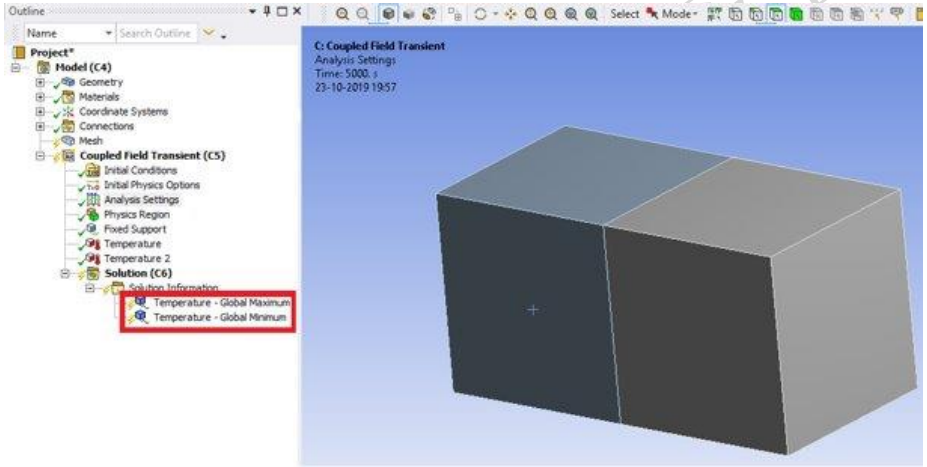
Constraint Equation

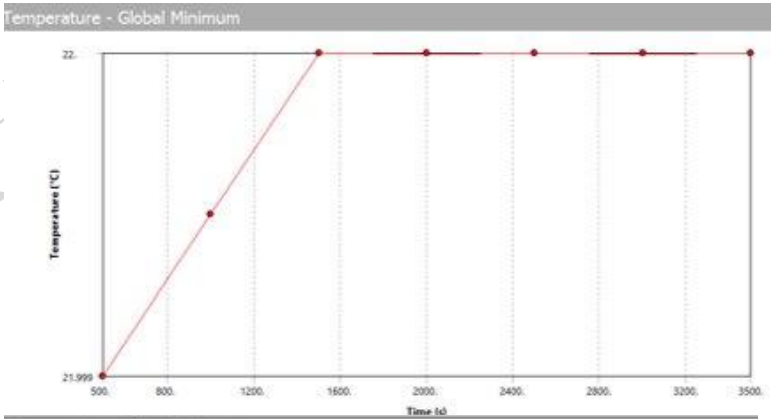
0 = -1000000 (1/m) * Remote Point(X Displacement) + 1000000 (1/m) * Remote Point 2(X Displacement)

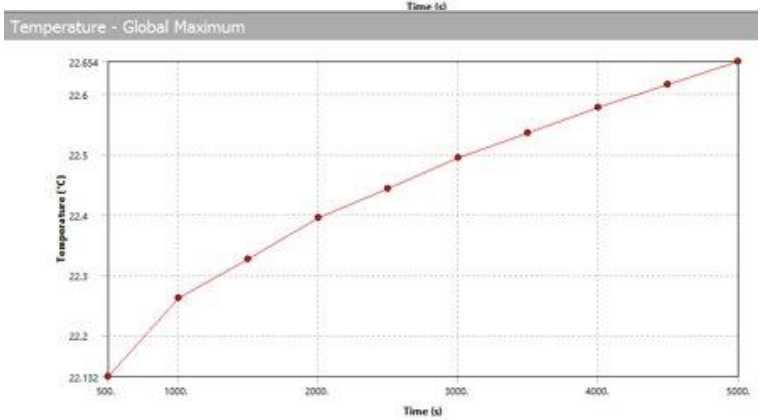
Coefficient	Units	Remote Point	DOF Selection
-1000000	1/m	Remote Point	X Displacement
1000000	1/m	Remote Point 2	X Displacement

耦合分析

- 在耦合瞬态分析中自动加入全局温度最小和最大跟踪





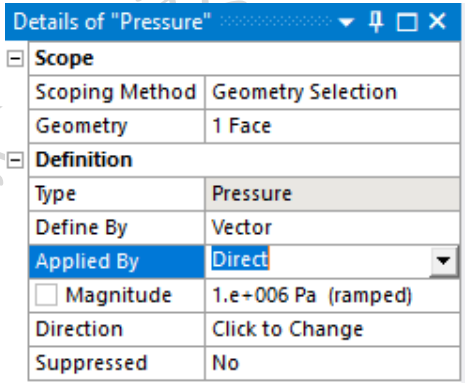


高级功能

- 在2020 R1版本中支持的高级功能:
  - 直接加载，不产生表面效果单元
  - 在瞬态动力学分析中基于应用程序的瞬态设置
  - 输出欧拉角、体积和能量

直接加载

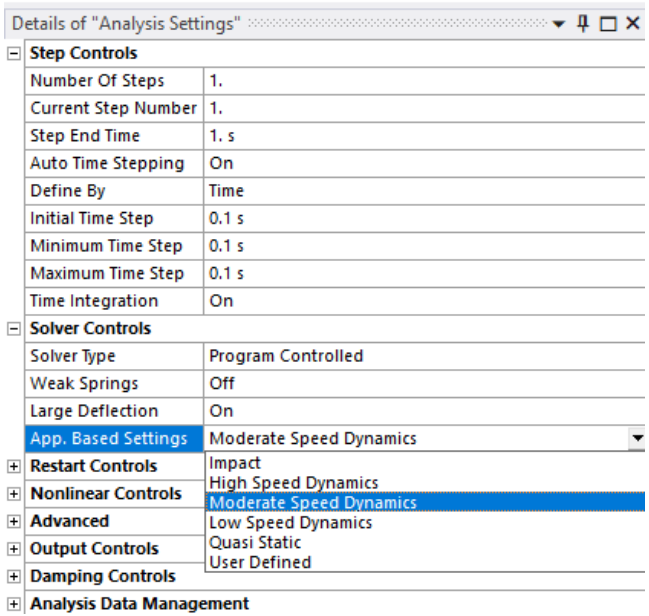
- 对3D实体可直接压力加载，不会产生新的表面效应单元来施加压力载荷。相反，可直接将载荷应用到实体单元表面。此方法适用于压力(法向/矢量/分量)、力和静水压力的载荷。
- 直接压力加载选项是在 **“Applied By”** 中设置，默认为*Surface Effect* 。



基于应用程序的瞬态设置

- 在完全法瞬态分析下的“求解控制”现在更方便为用户指导选择最佳的解决方案设置，包括数值积分、积分常数等。

- 支持的应用选项包括冲击，高速动力学，中速动力学，低速动力学，准静态和用户定义。当用户自定义时，需指定振幅衰减因子，该值在之前的版本的“阻尼设置”中被认为是数值阻尼

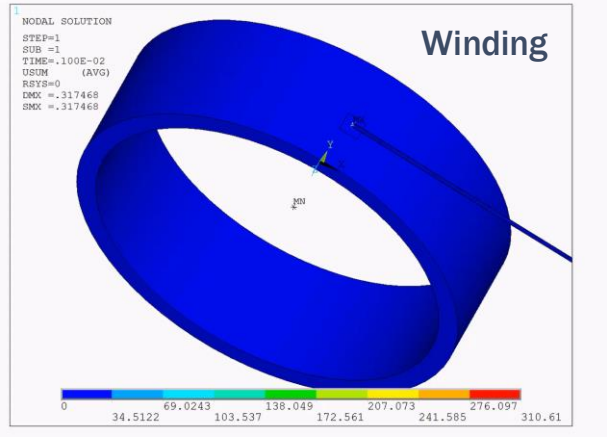


MAPDL 单元

- 3D 3节点电缆元件：CABLE 280
- 基于Pure displacement的SOLID285
- 适用于固体和壳体的分布载荷
- 2D温度单元 PLANE292/293
- 22x耦合分析中用户定义的材料模型

电缆单元CABLE280

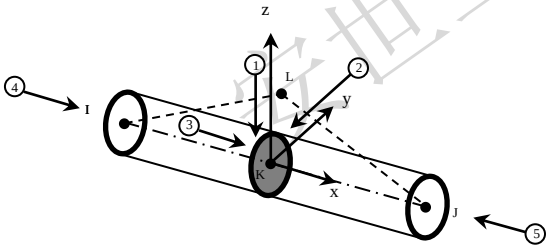
- 适用于中等至极细的电缆结构
- 计算只有平移自由度
- 混合位移/力函数，具有极高的求解精度和鲁棒性
- 广泛的应用:海上，民用和机械



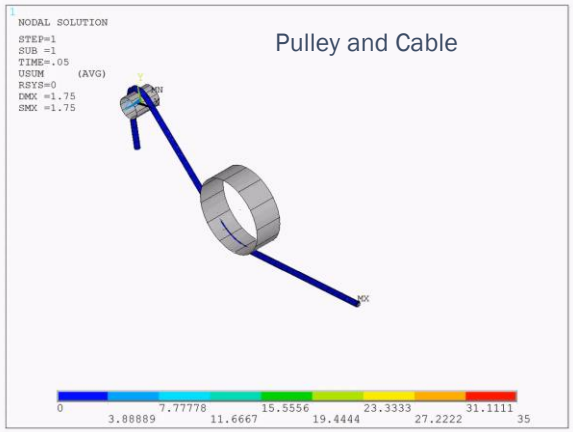
Stranding

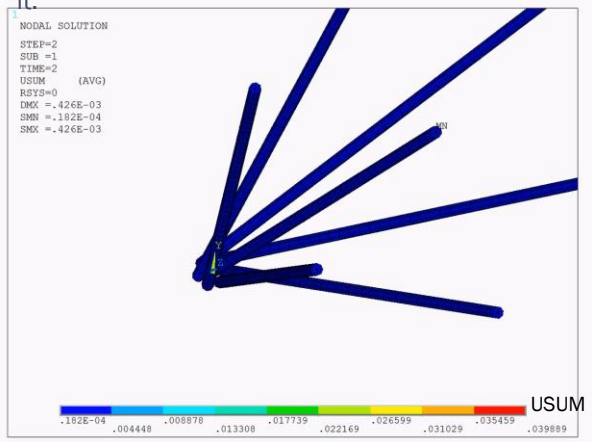
queins.com/en/solutions/stranding/

One cable is placed in the center, a second layer containing six cables is stranded around it.



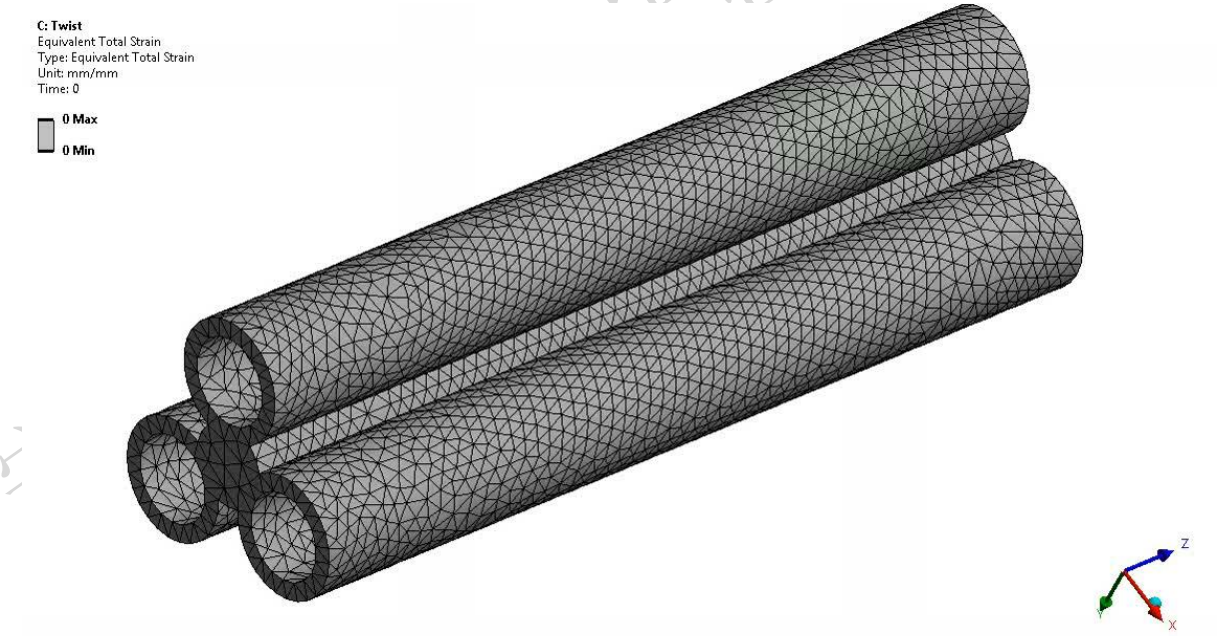
CABLE280 Geometry



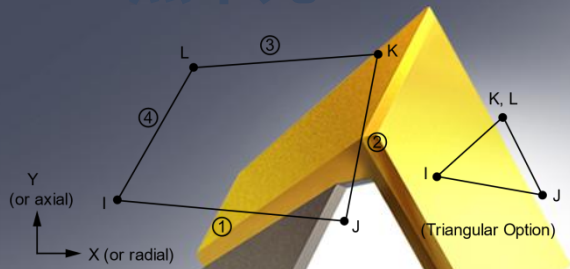


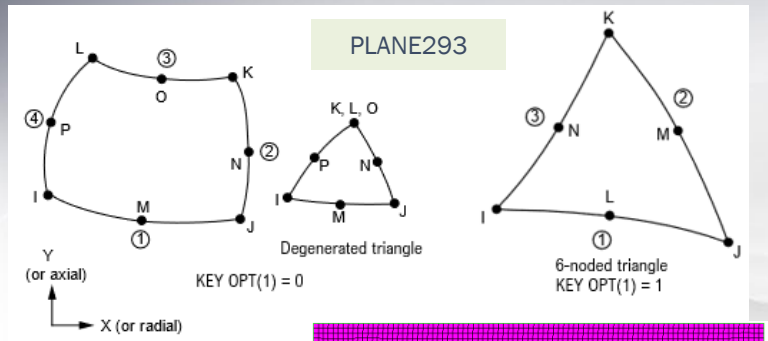
线性四面体单元SOLID285

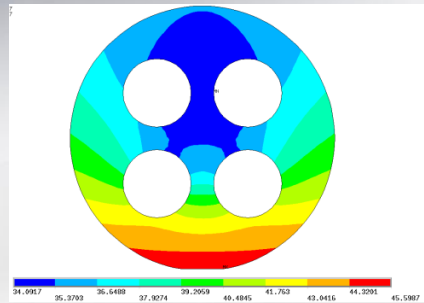
- 只有位移自由度的线性四面体元件:SOLID285 (KEYOPT(1)=1)
  - 可有效稳健处理没有明显的弯曲和不可压缩性的问题



2D 热单元 PLANE292/293

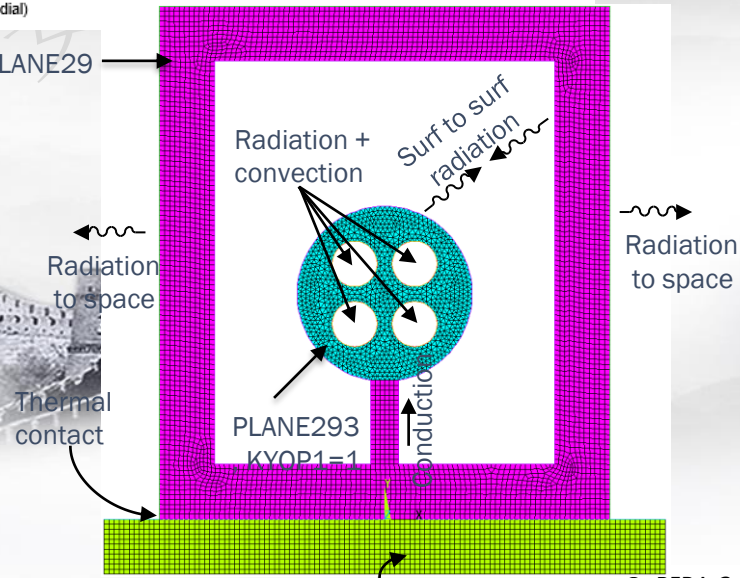






Temperature distribution

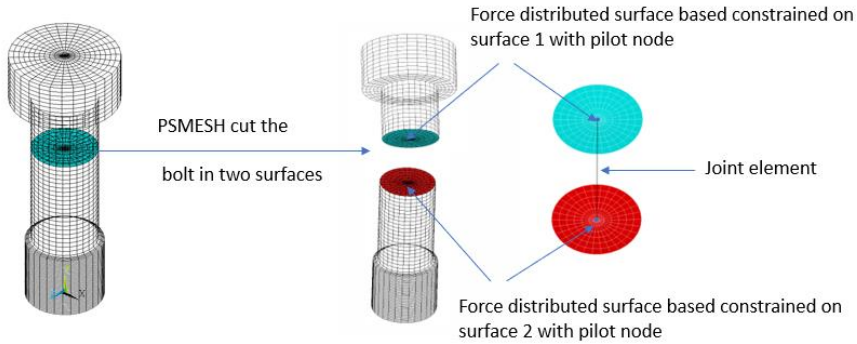
- Capable of simulating complex thermal problems
- 能够模拟复杂的热问题
- 处理非线性热载荷
- UPF 支持



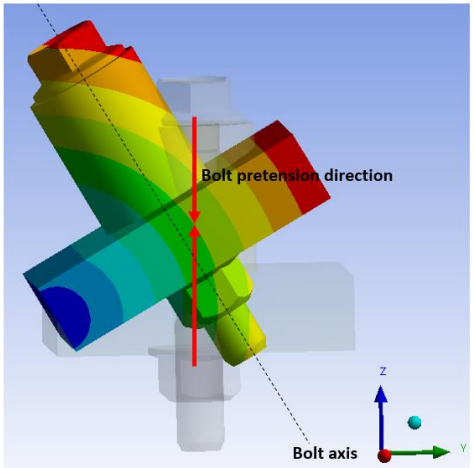
Stove with heat generation, PLANE292

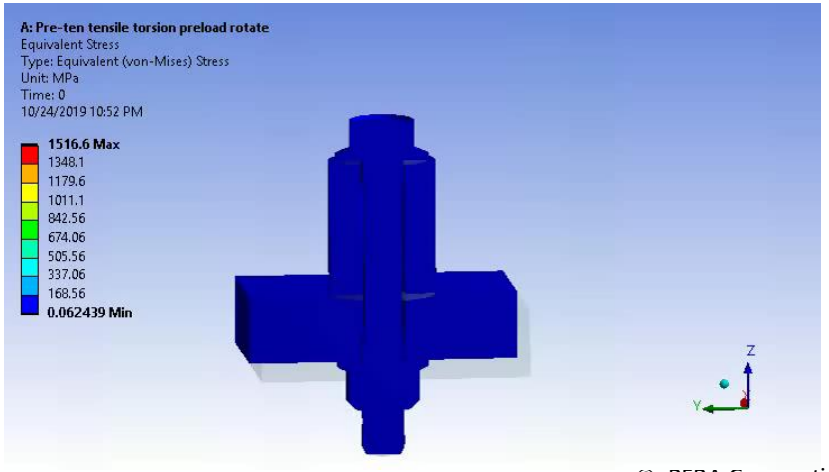
定义大旋转紧固件预紧力

- “PSMESH”现在可以定义“MPC184”连接单元，用于对大旋转或大变形的螺栓施加预紧力
- 连接单元支持大变形，螺栓轴遵循连接节点定义的局部坐标系
- 可以围绕螺栓轴施加转矩和旋转(分别为FJ和DJ)



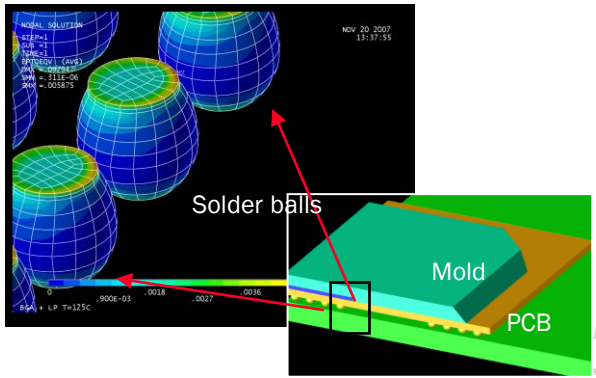
大旋转螺栓模型:

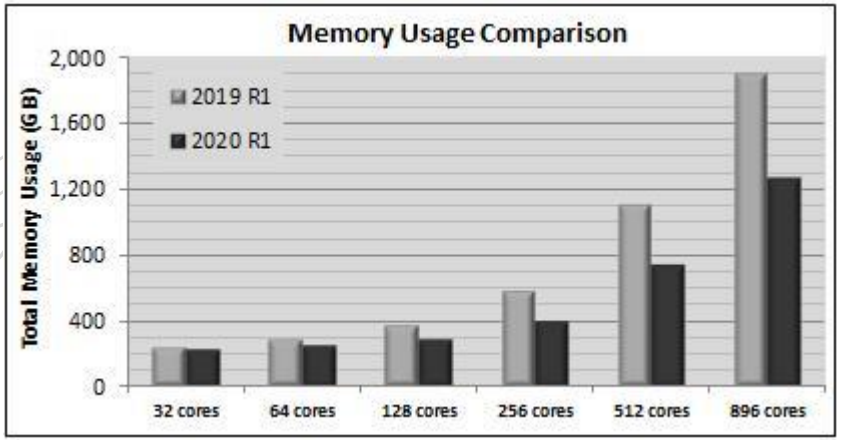




分布式计算增强

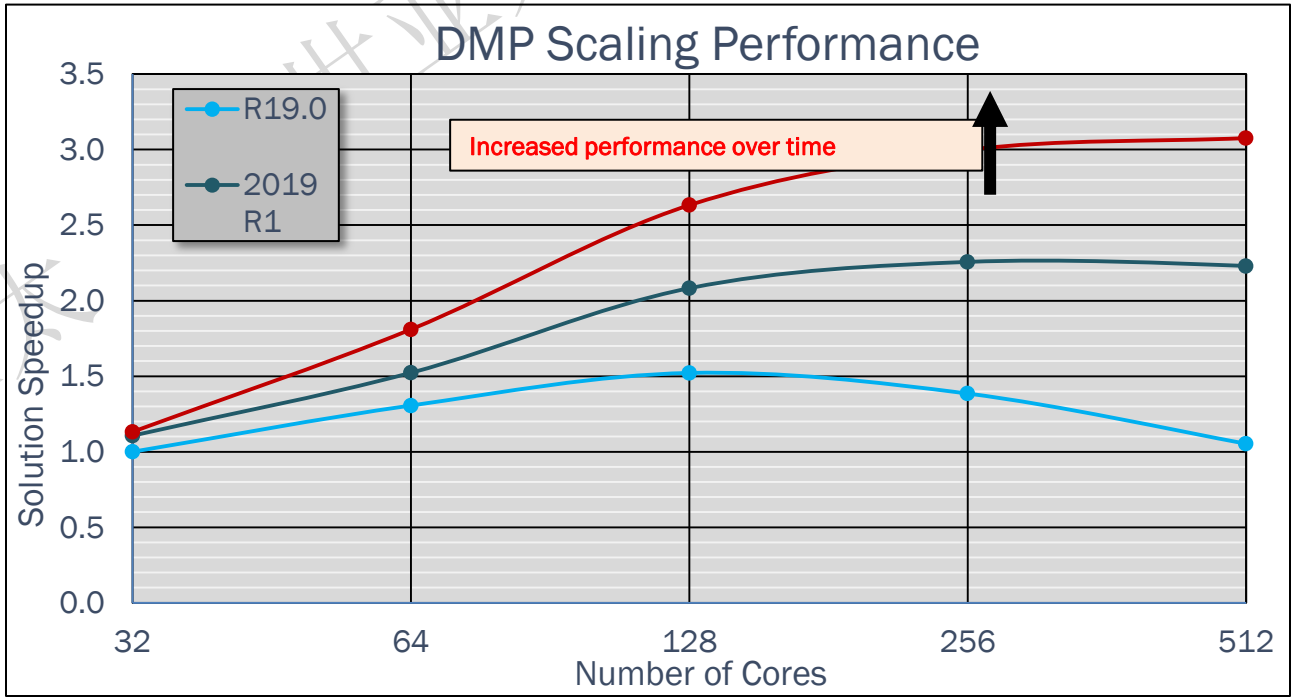
- 显著减少内存使用(BGA模型)





分布式计算增强

- 提升DMP scaling性能 (ECU 模型)

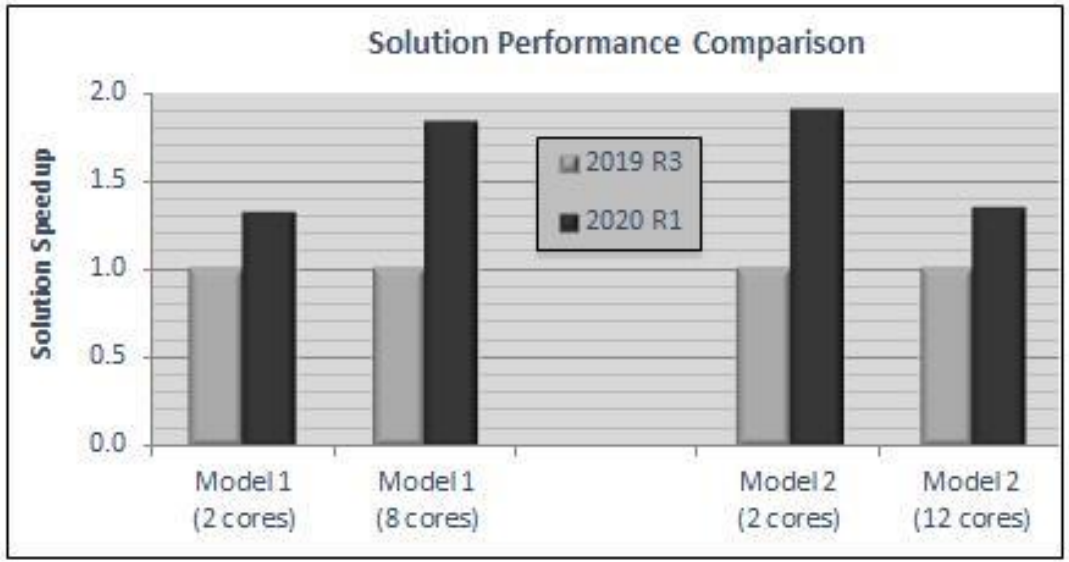


分布式计算增强

- 改进了稀疏求解器的性能

Model 1
- 4.4 MDOF; sparse solver, out-of-core memory mode
- Nonlinear static analysis
- Windows workstation containing an Intel Xeon E5-2687W processors (12 cores), 64 GB RAM, 10k RPM hard drive, Windows 10

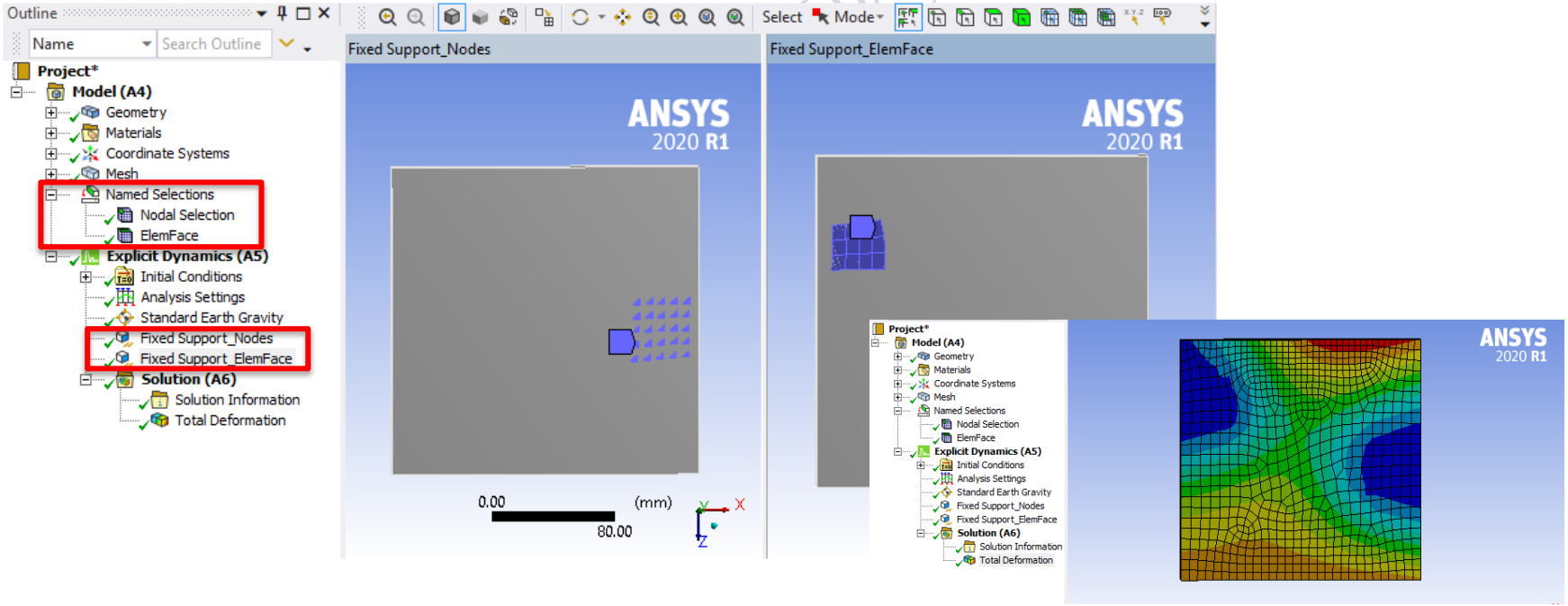
Model 2
- 9 MDOF; sparse solver, out-of-core memory mode
- Nonlinear static analysis
- Windows workstation containing an Intel Xeon E5-2687W processors (12 cores), 64 GB RAM, 10k RPM hard drive, Windows 10



Explicit Dynamics

基于网格编组

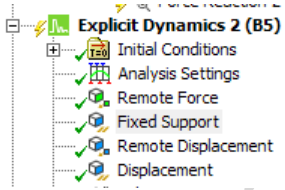
- 基于节点和单元面网格的Name Selections可以用于“**Fixed Support**”边界条件

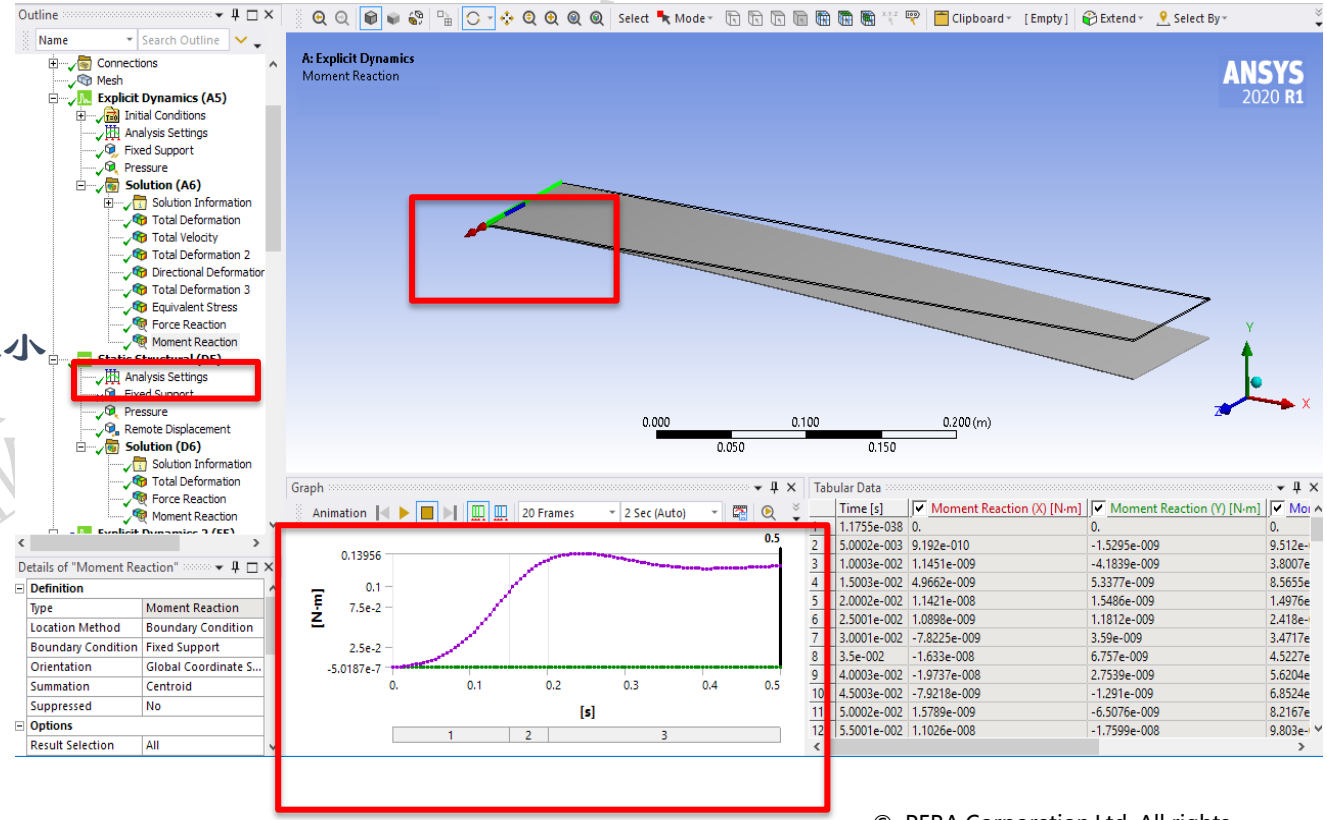


Reaction Probes

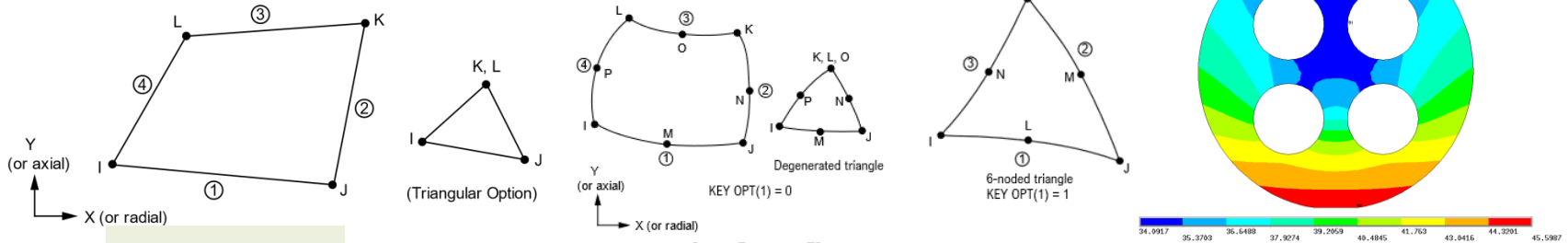
- 支反力和支反力矩现在支持以下边界条件：
  - 固定约束
  - 位移约束
  - 远程位移约束

- 力和力矩的方向和大小





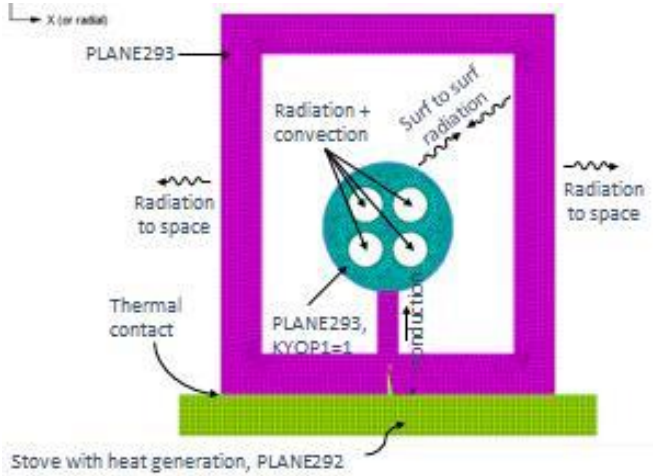
2D 热单元 PLANE292/293



PLANE292

Temperature distribution

- Capable of simulating complex thermal problems
- 能够模拟复杂的热问题
- 处理非线性热载荷
- UPF 支持



Explicit Dynamics