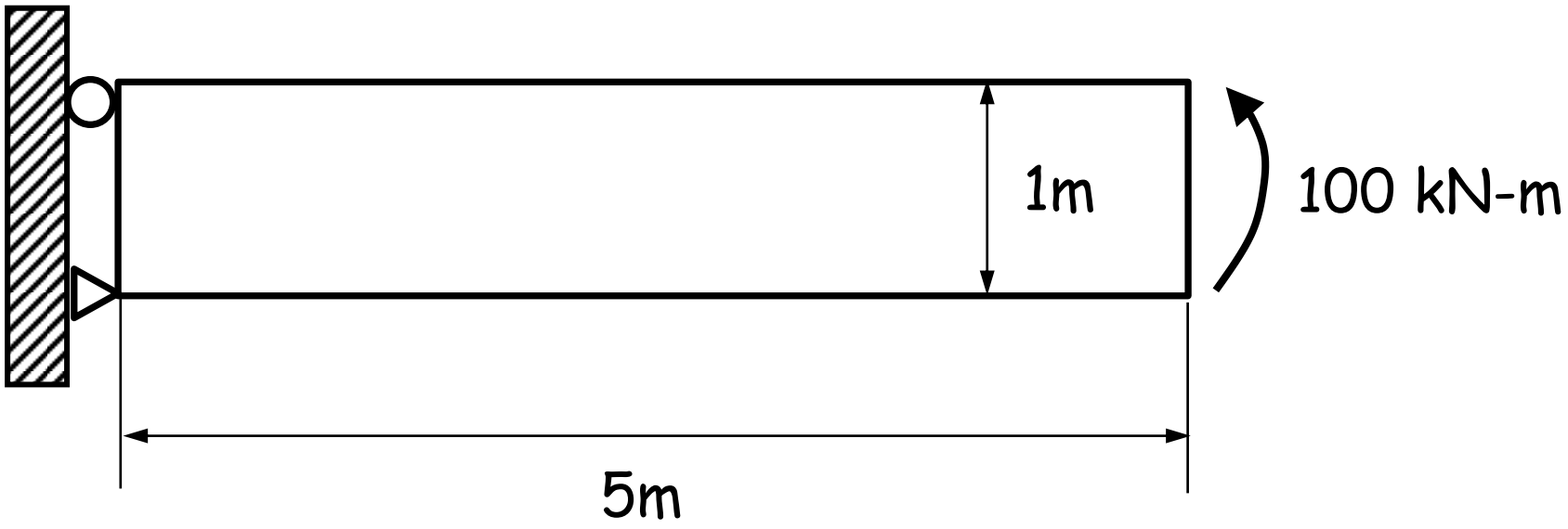
Tutorial 6-1:

3D Modeling

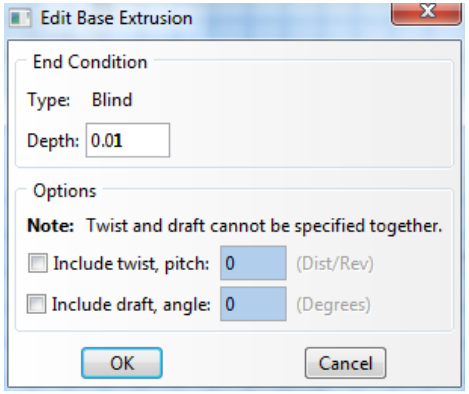
CANTILEVER BEAM

- 3D cantilever beam
  - E=210 Gpa, Poison ratio 0.3
  - Thickness t = 0.5 m



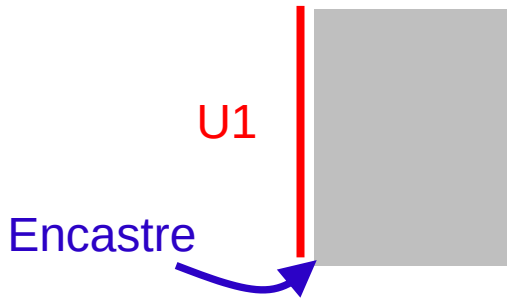
CANTILEVER BEAM

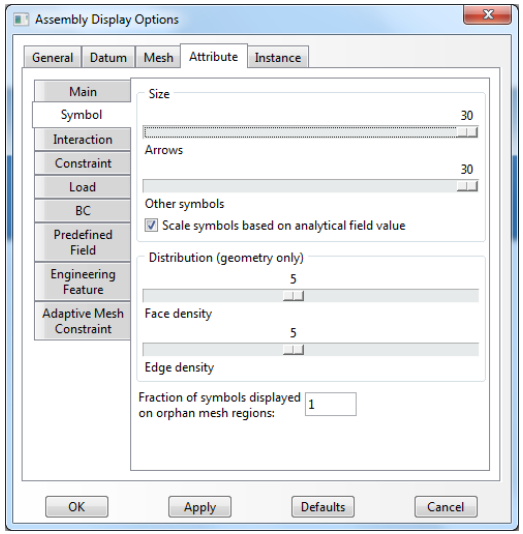
- Parts
  - 3D Planar, Deformable, Solid, Extrusion, App Size = 10
  - Create lines (rectangle): (0, 0), (5, 1)
  - Depth = 0.01
- Materials
  - Mechanical, Elasticity, Elastic
  - Young's modulus = 200E9, Poisson's ratio = 0.3
- Sections
  - Solid, Homogeneous
- Assign the section to the part



CANTILEVER BEAM

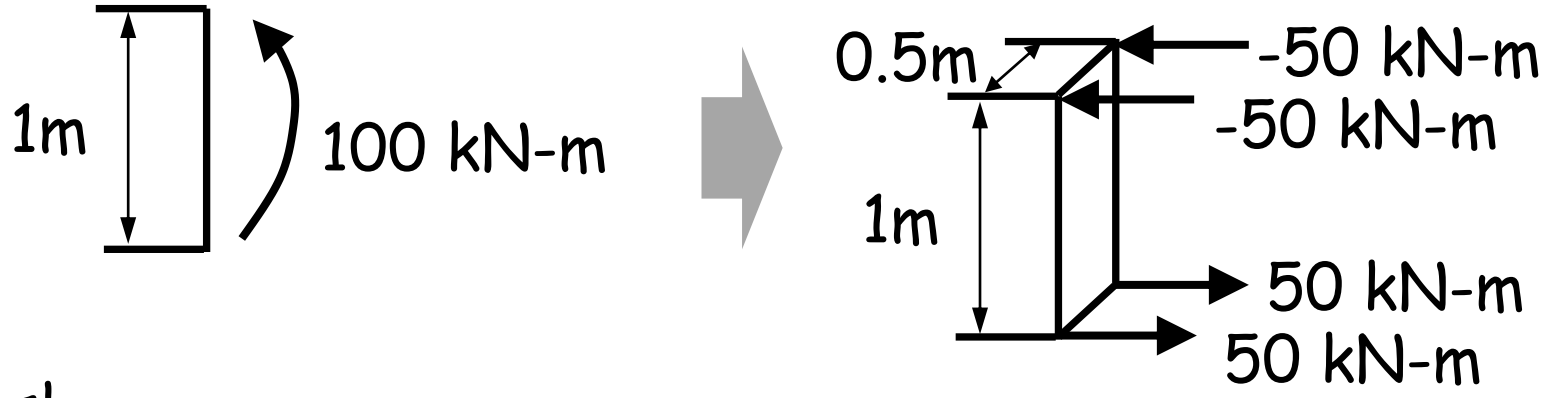
- Assembly, Instance
- Steps
  - Linear perturbation, Static
- BCs
  - Initial, Encastre + Displacement/Rotation, U2





CANTILEVER BEAM

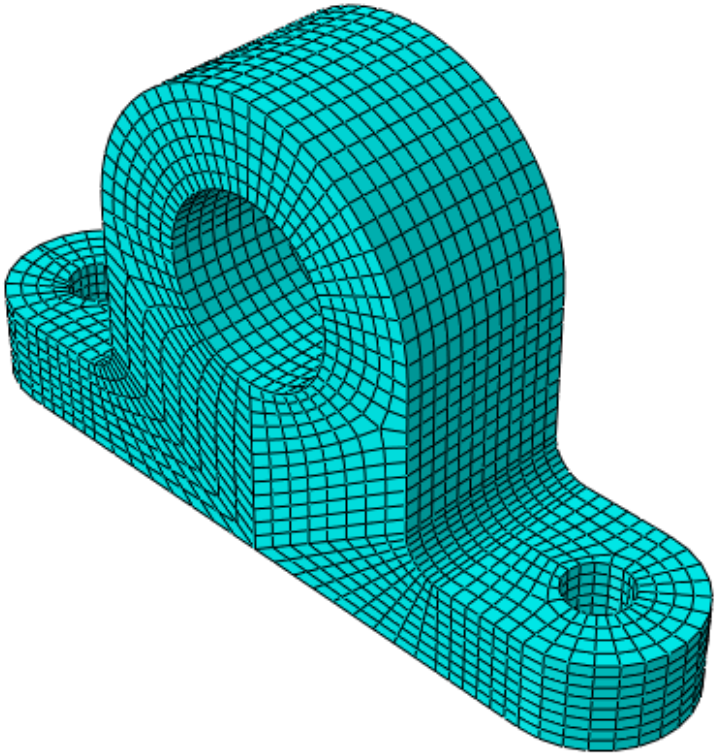
- Loads
  - Mechanical, Pressure, select upward, Uniform, 30

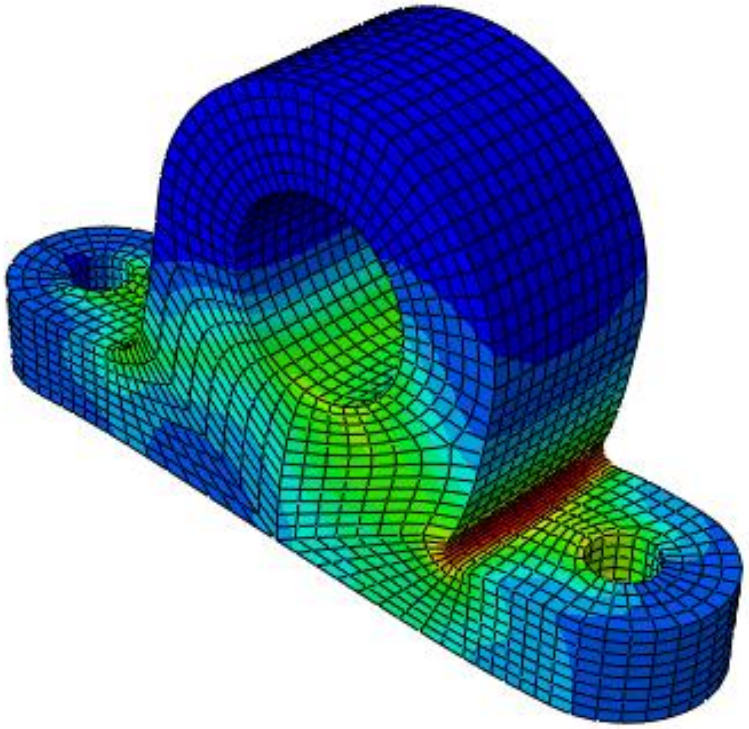


- Mesh
  - Hexa - structured mesh is default setting as it is possible
  - Global element size = 1
- Cantilever beam with 8-node solid
  - Max v = 1.872×10^{-4} (Exact 1.5×10^{-4})

BRACKET ANALYSIS

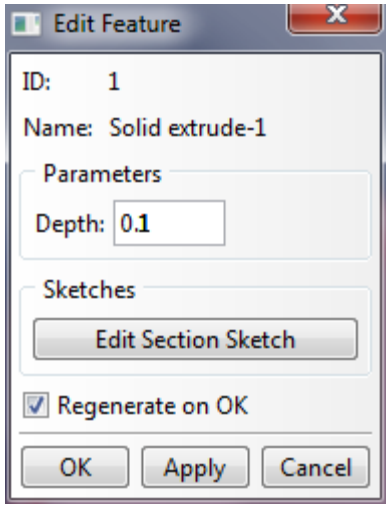
- A bracket with a shaft hole
  - E=210 Gpa, Poison ratio 0.3
  - 3D geometry modeling
  - 8-node hexa element with structure mesh

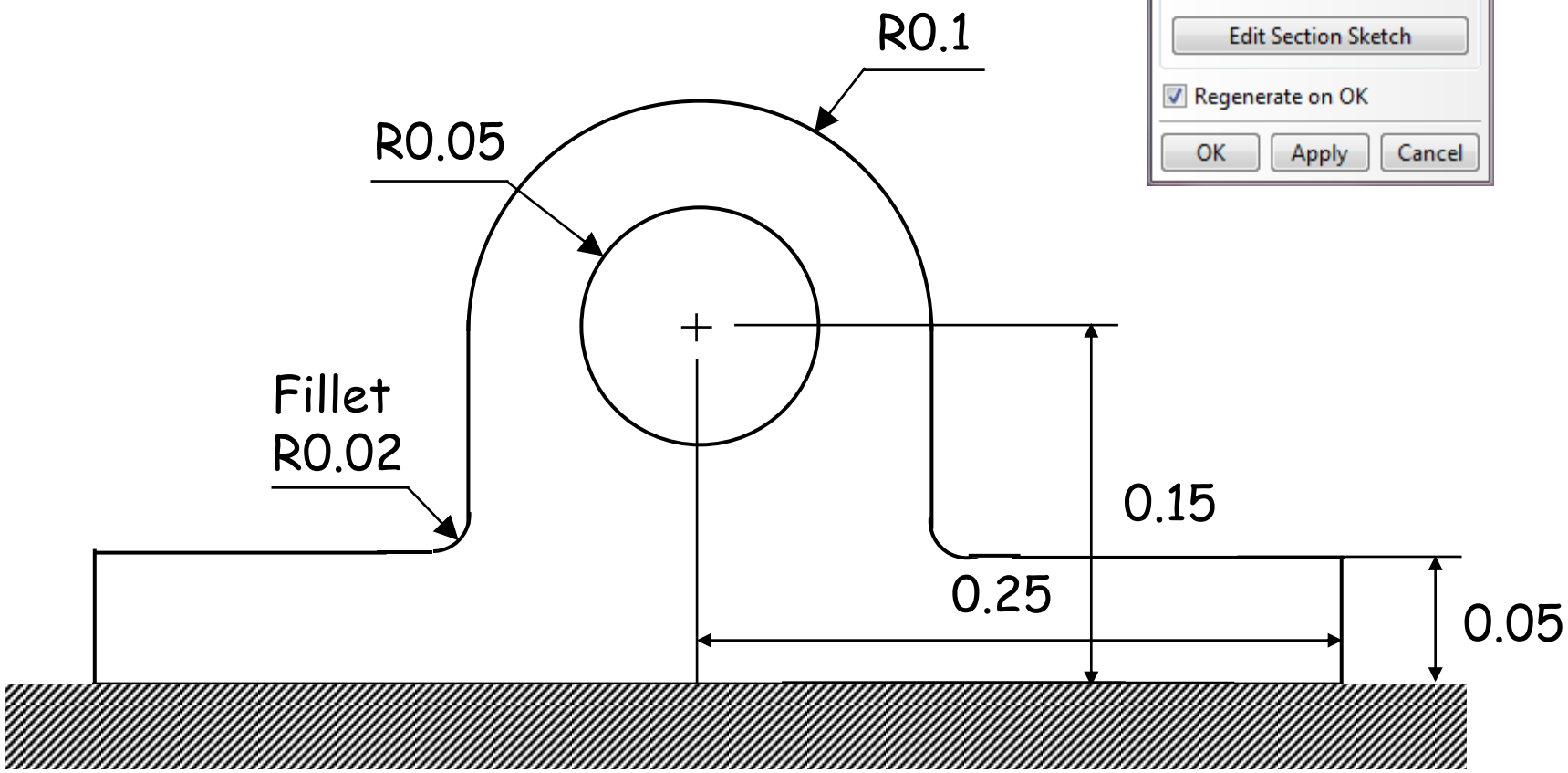




PART MODULE

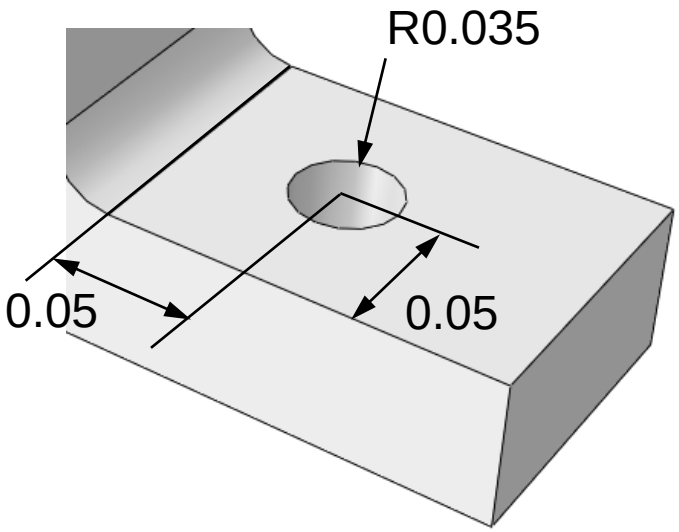
- Parts
  - Create Part-1
  - 3D, Extrude, Depth 0.1

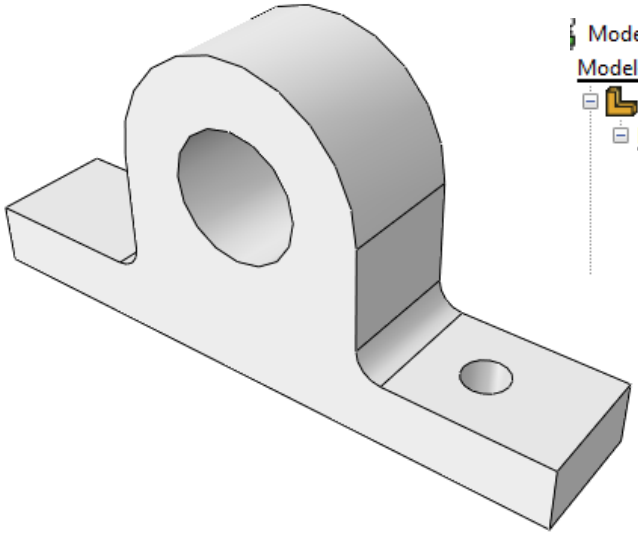


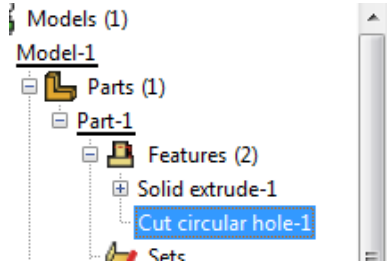


PART MODULE

- Parts
  - Create Cut / Circular Hole 
  - Dist. from Edge1 = 0.05 , Dist. from Edge2 = 0.05, Diameter 0.035
  - Do it again for the opposite side



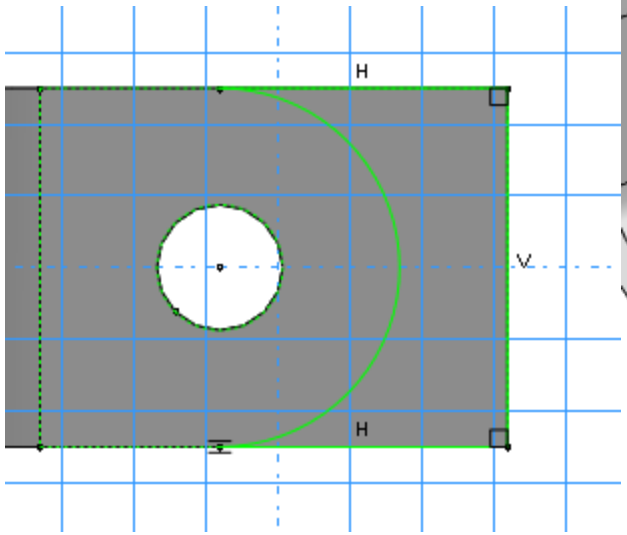


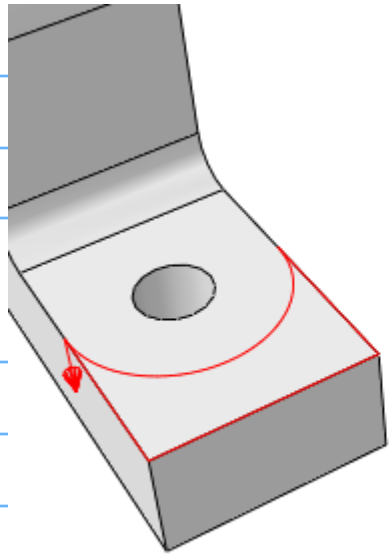


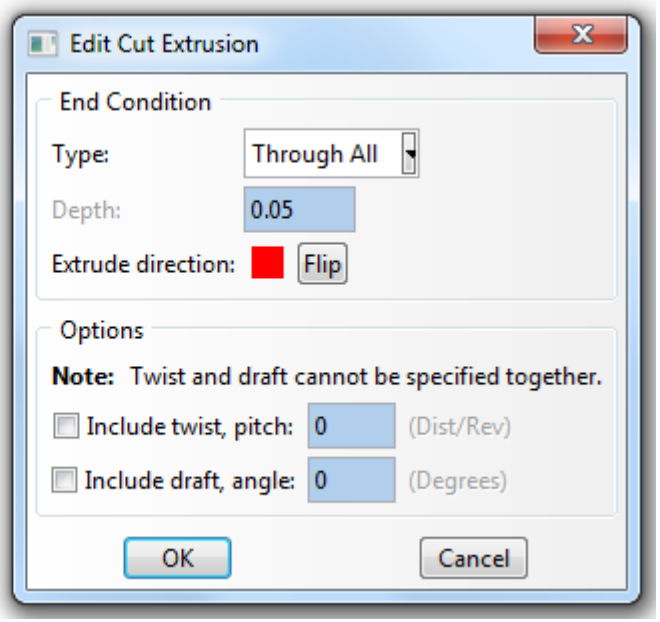
- Tip
  - Create a hole then edit those parameters (the cut circular hole is categorized as a feature of a part)

PART MODULE

- Parts
  - Create Cut / Extrude 
  - Select a planar, select an edge
  - Make a circle and three edges, click "done" button
  - Do it again for the opposite side





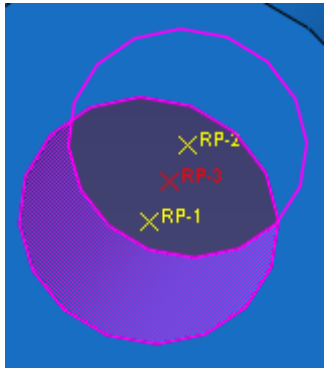


PROPERTY / ASSEMBLY / STEPS MODULES

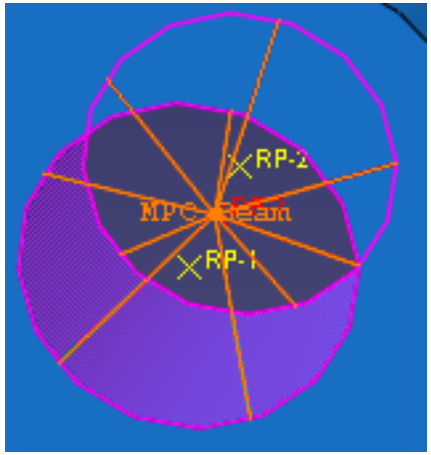
- Materials
  - Mechanical, Elasticity, Elastic
  - Young's modulus = 210E9, Poisson's ratio = 0.3
- Sections
  - Solid, Homogeneous
- Assign the section to the part
- Assembly, Instance
- Steps
  - Linear perturbation, Static

INTERACTION MODULE (MPC)

- How to apply loads at the center of shaft hole?
  - Side tool bar/Create a reference point (RP-3) at the center of the shaft hole (RP-1 and RP-2 are the center of circles)
    Note: We need only one reference point RP-1 and RP-2 were made to show where they are
  - Menu/Constraint/Create/MPC Constraint MPC (Multiple point constraints)
  - Select the RP-3 as the MPC control point (master node)
  - Select the surface (magenta area) of the hole shaft as the slave nodes
  - MPC type select as of Beam



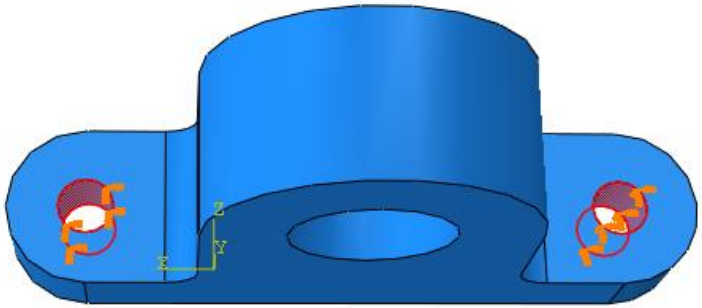
Reference Points



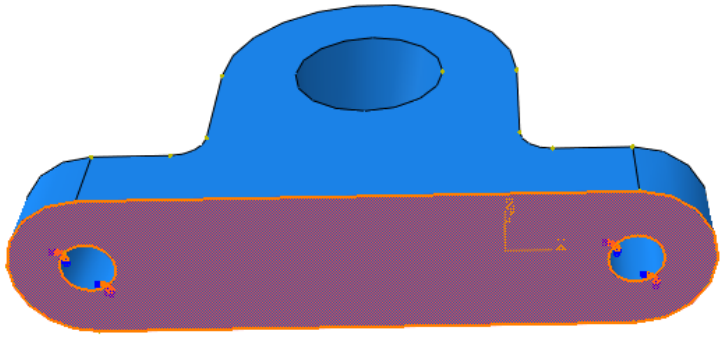
Applied Beam type MPCs

LOADS MODULE

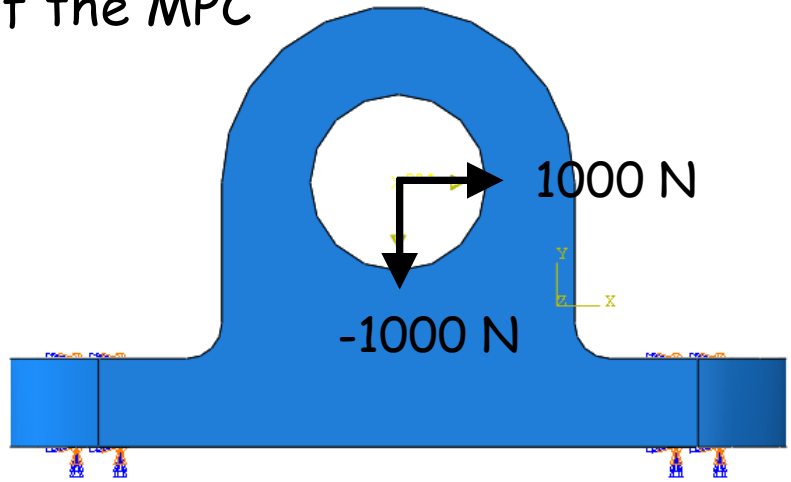
- BCs
  - Step1, ENCASTRE



  - Step1, Displacement/Rotation, y-dir

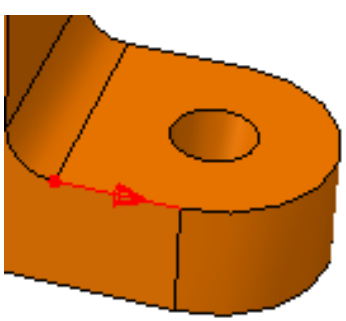


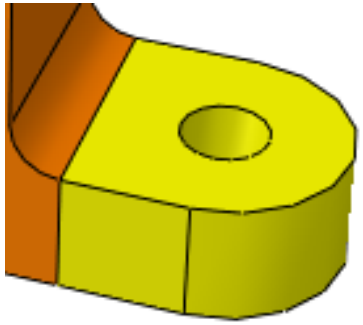
- Loads
  - Step1,
    CF1 = 1000 N, CF2 = -1000 N on
    the master node of the MPC



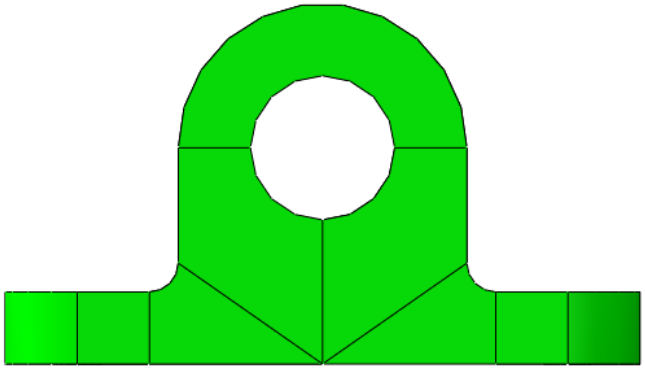
MESH MODULE

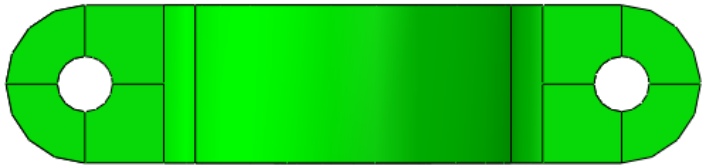
- Mesh (Partitioning)
  - Partition Cell 
  - Select Point & Normal, Click "Done"





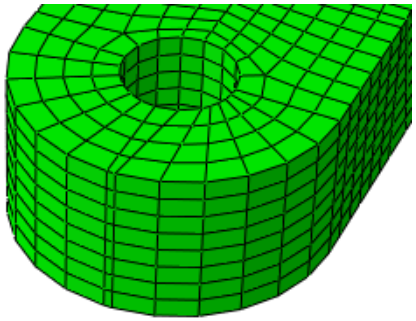
- Tip
  - A color of a volume indicates the best meshing method
  - If a color of a volume is dark orange, the volume can not be meshed that partitioning is needed
  - If the structured mesh is applicable for a volume, the color will be green

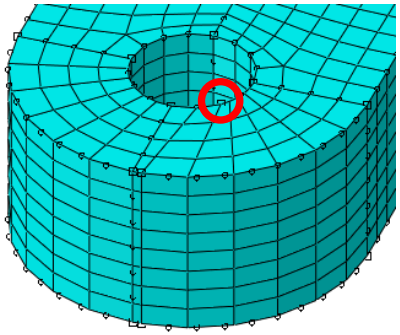




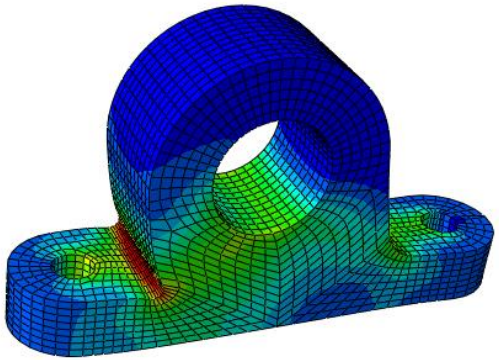
MESH MODULE

- Mesh
  - Hexa - structured mesh is default setting as it is possible
  - Global element size = 0.08
- Tip
  - Mesh shape can be distorted by geometric modeling: The rectangle represents start/end point of the circle





- Analysis, Create Job, Data Check, Submit
- Results

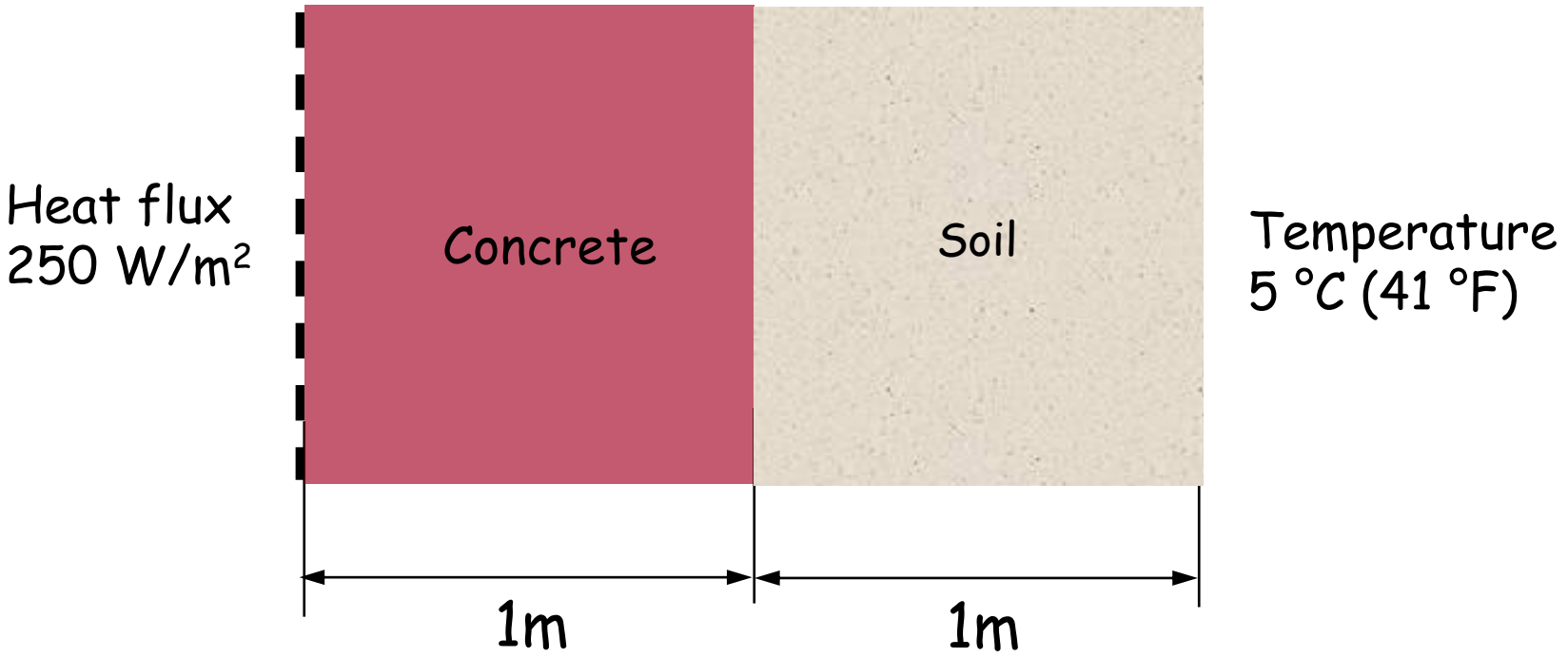


Tutorial 6-2:

Heat Transfer

HEAT CONDUCTION

- Fire in the subway tunnel (Heat Deterioration)
  - Aluminum alloy
  - Thermal conductivity
    Concrete: k=1.7 W/(m·K)
    Soil: k=1.5 W/(m·K)

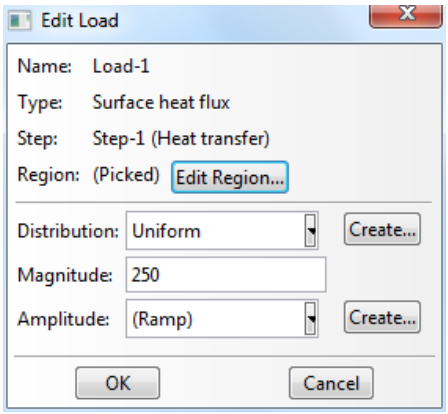


HEAT CONDUCTION

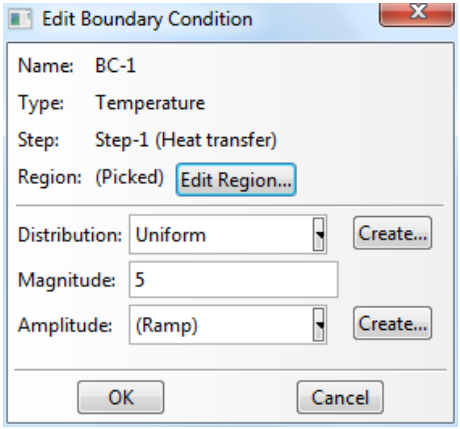
- Parts
  - Create Part-1
  - 3D, Extrude, Depth 1 m
- Materials
  - Thermal, Conductivity
  - Concrete: 1.7 W/(m·K), Soil: 1.5 W/(m·K)
- Sections
  - Solid, Homogeneous
  - Concrete section, Soil section
- Assign the section to the part
- Assembly, Instance

HEAT CONDUCTION

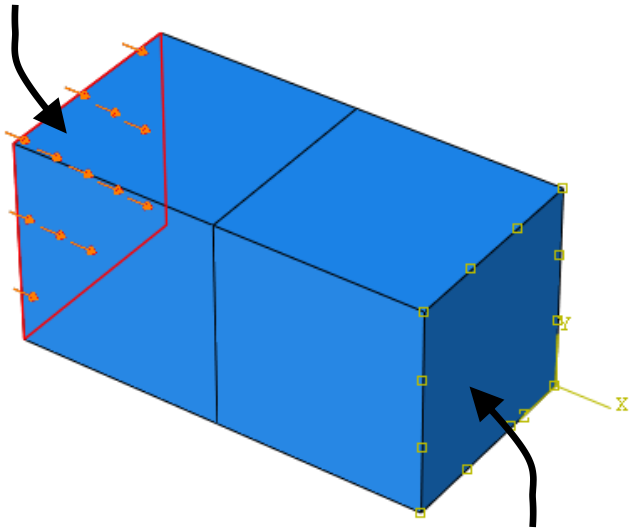
- Steps
  - General, Heat transfer
- Loads
  - Surface heat flux



- BCs
  - Temperature



Heat flux
250 W/m^2



Temperature:
5 °C (41 °F)

HEAT CONDUCTION

- Mesh
  - Assign Element Type, Heat Transfer
  - Global seed, 1 m
- Analysis, Create Job, Data Check, Submit
- Results
  - HFL: Heat flux
  - NT: Nodal temperature
  - RFL: Residual flux