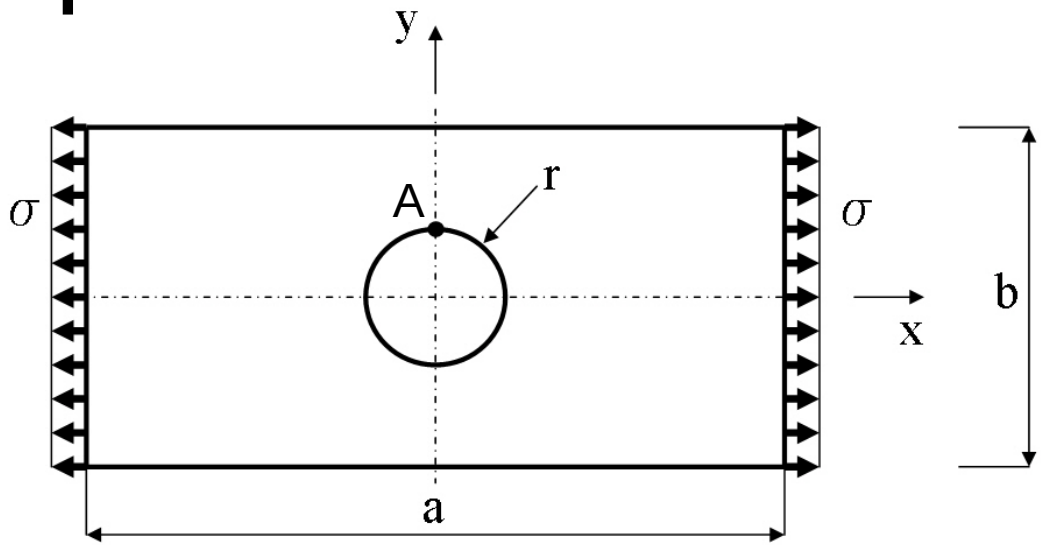
Course in ANSYS

Example0702

AutoDesk Inventor
Computational Mechanics, AAU, Esbjerg

Example – Plate with a hole



Objective:
Determine the maximum stress in the x-direction for point A and display the deformation figure

Tasks:
Create a submodel to increase the accuracy of the FEA without increasing the computational effort significantly?

Topics:
Element type, Real constants, modeling, mapped mesh, plot results, output graphics, path operations, submodeling

$E = 210000 N/mm^2$
$\nu = 0.3$
$a = 200mm$
$b = 100mm$
$t = 10mm$
$r = 10mm$
$\sigma = 100 N/mm^2$

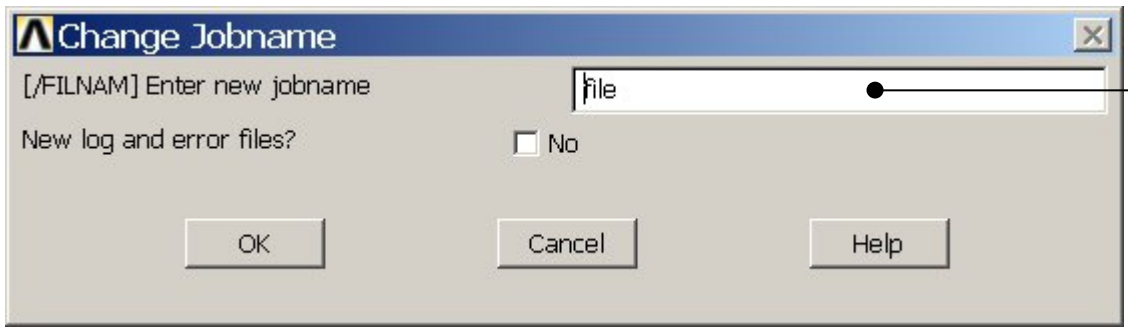
Steps in Submodeling

- The process for using submodeling is as follows:
  - **Create and analyze the coarse model.**
  - Create the submodel.
  - Perform cut boundary interpolation (CBI).
  - Analyze the submodel.
  - Verify that the distance between the cut boundaries and the stress concentration is adequate.

Example - title

Utility Menu > File > Change Jobname — GUI

/jobname, Example0702_coarse — Command line entry

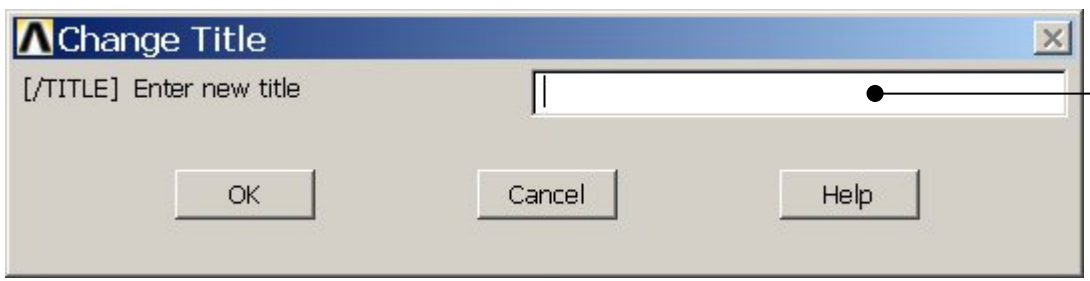


Enter: Example0702_coarse

Utility Menu > File > Change Title

/title, Plate with a hole

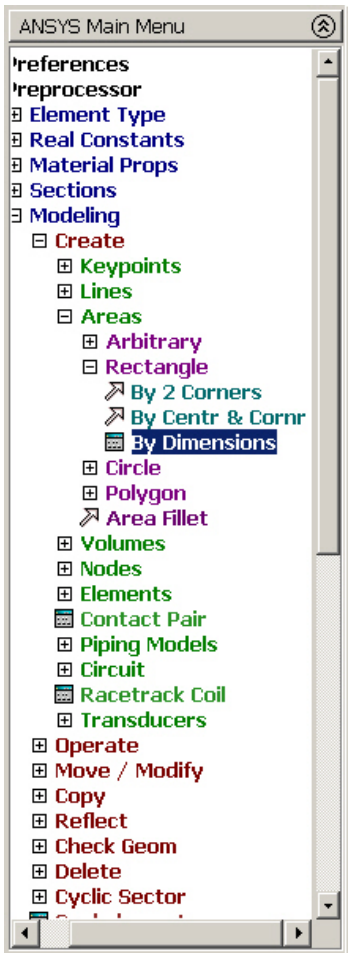
Enter: Plate with a hole

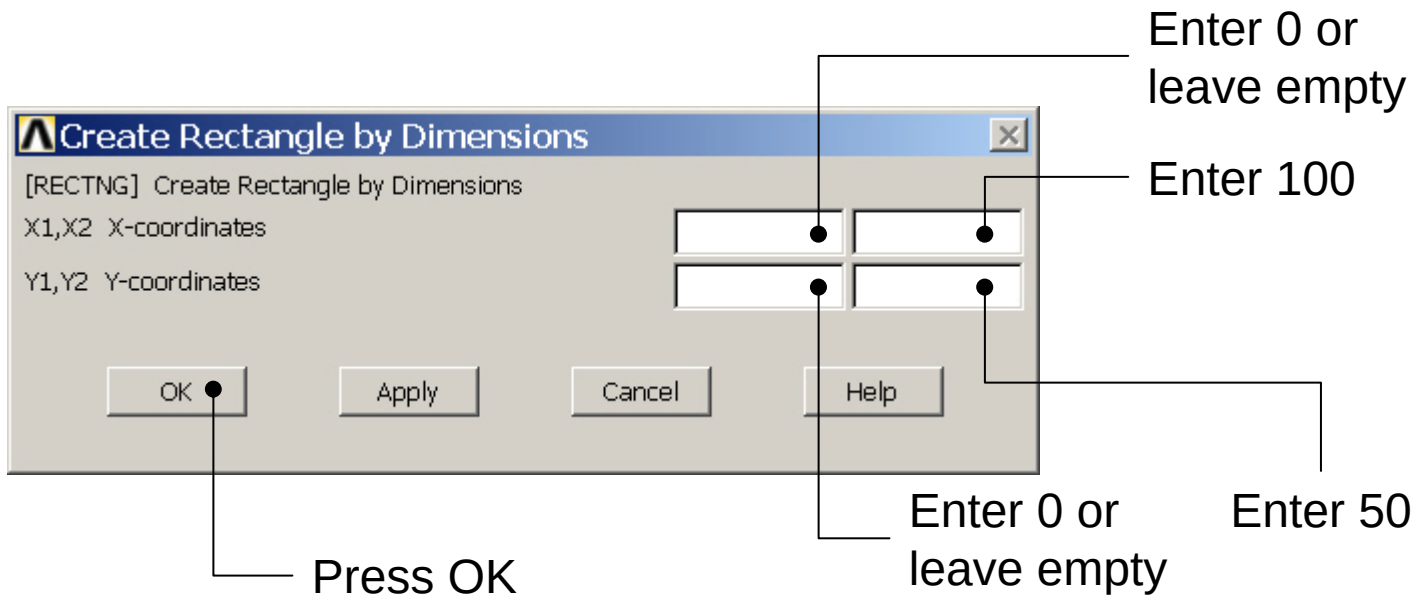


Example – Areas Rectangle

Preprocessor > Modeling > Create > Areas > Rectangle > By Dimensions

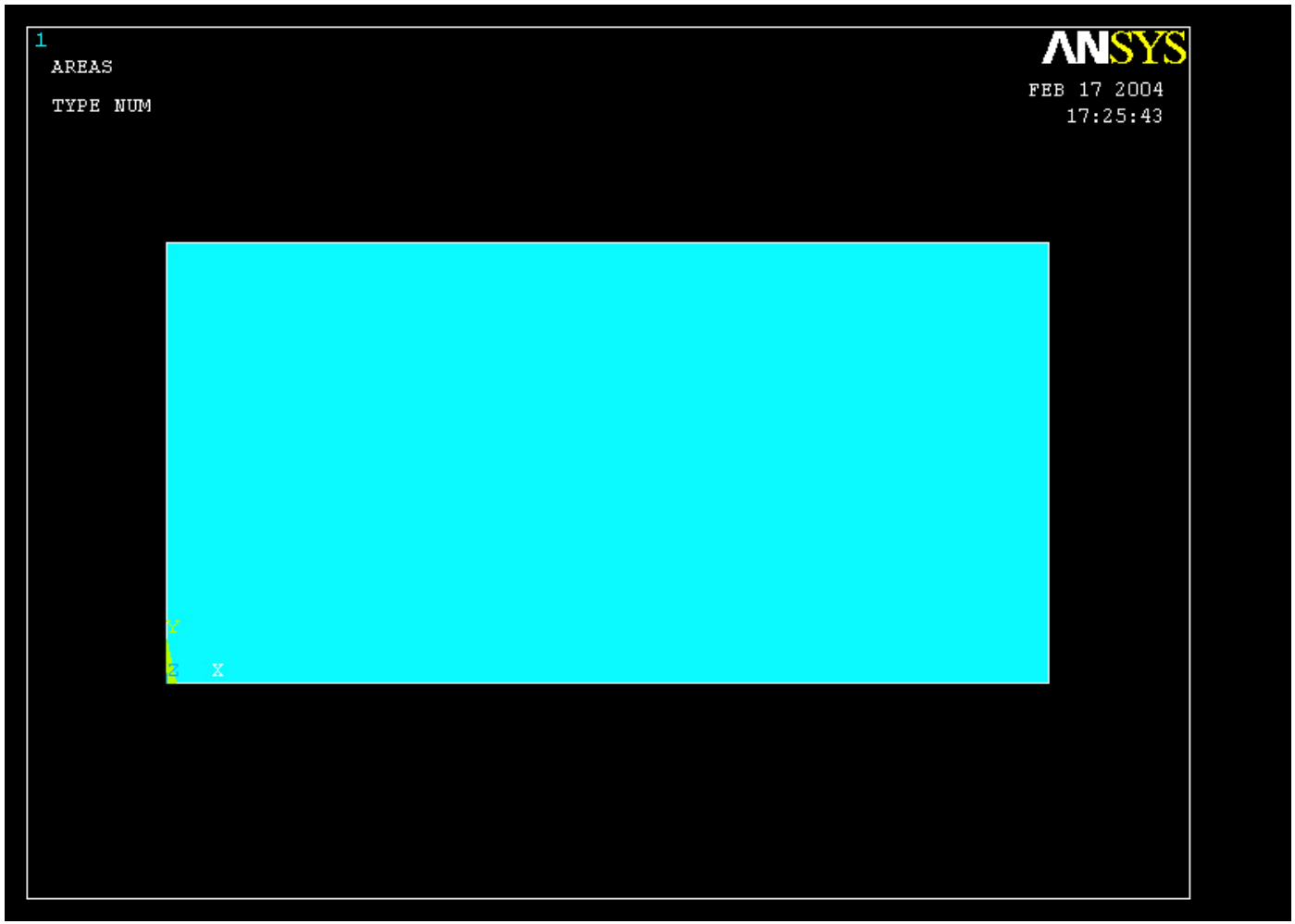
Create an area given by X=(0,100) and Y=(0,50)





Note: Keypoints (4 kp's) and lines (4 lines) are automatically generated (also numbered automatically)

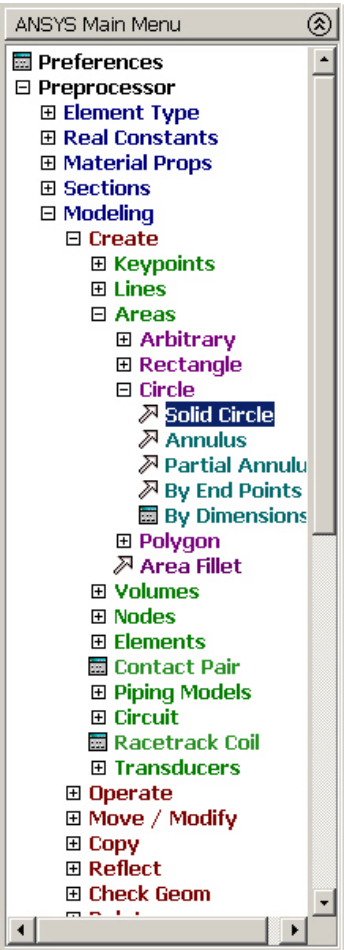
Example – Areas Rectangle

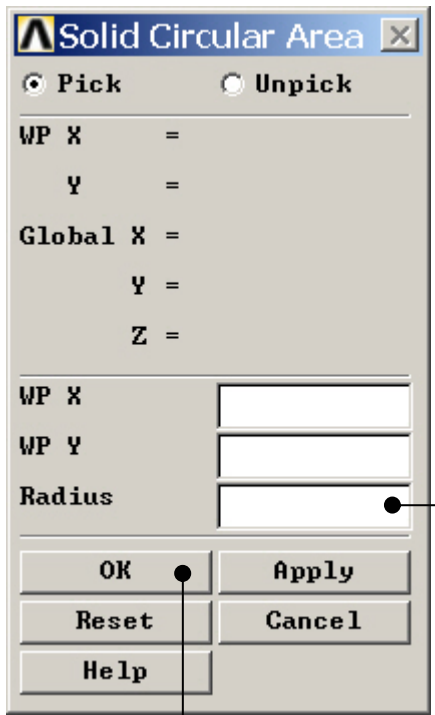


Example – Areas Circle

Preprocessor > Modeling > Create > Areas > Circle > Solid Circle

Create an area given by (X,Y)=(0, 0) and Radius=10



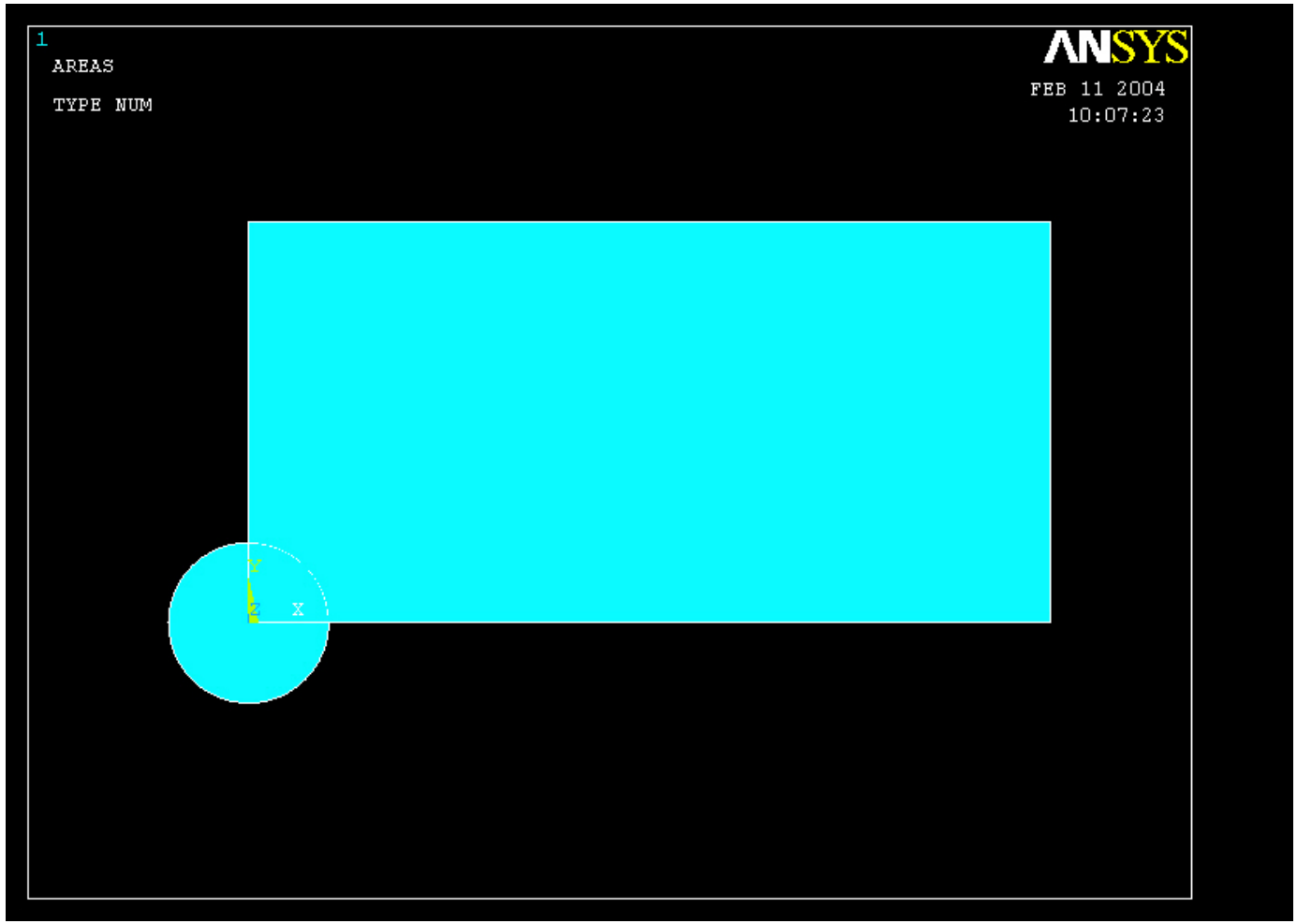


Enter 10

Press OK

Note: Keypoints (4 kp's) and lines (4 lines) are automatically generated (also numbered automatically)

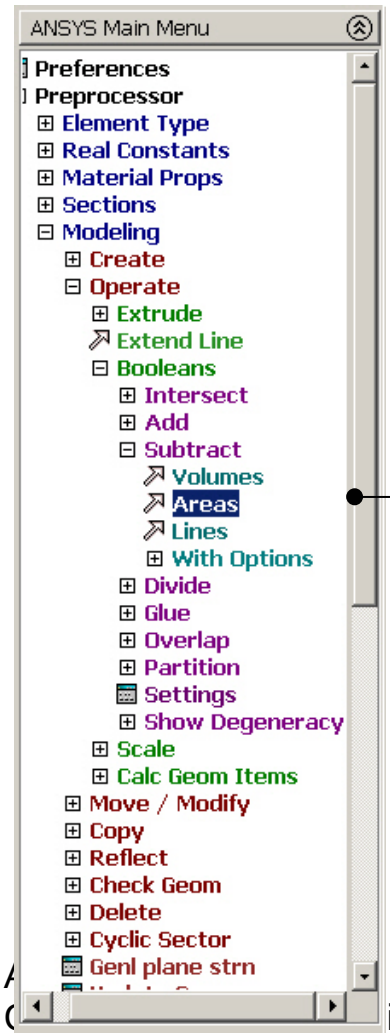
Example - Area

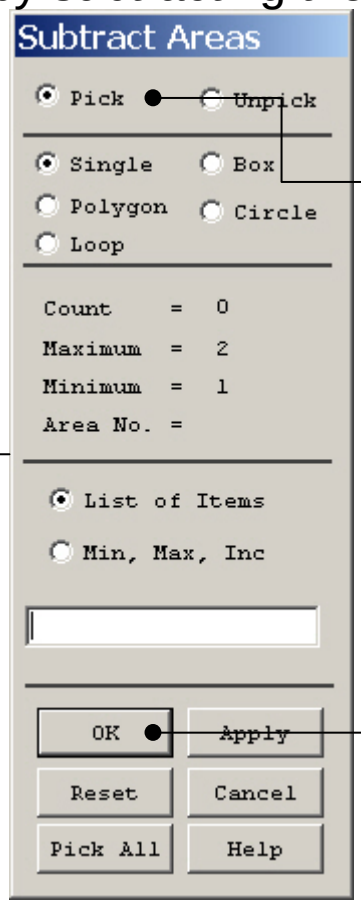


Example - Operate

Preprocessor > Modeling > Operate > Booleans > Subtract > Areas

Create the final area by subtracting the circular area from the rectangular area





Note: Bottom left corner of ANSYS GUI

[ASBA] Pick or enter base areas from which to subtract

Select the rectangular area and press OK

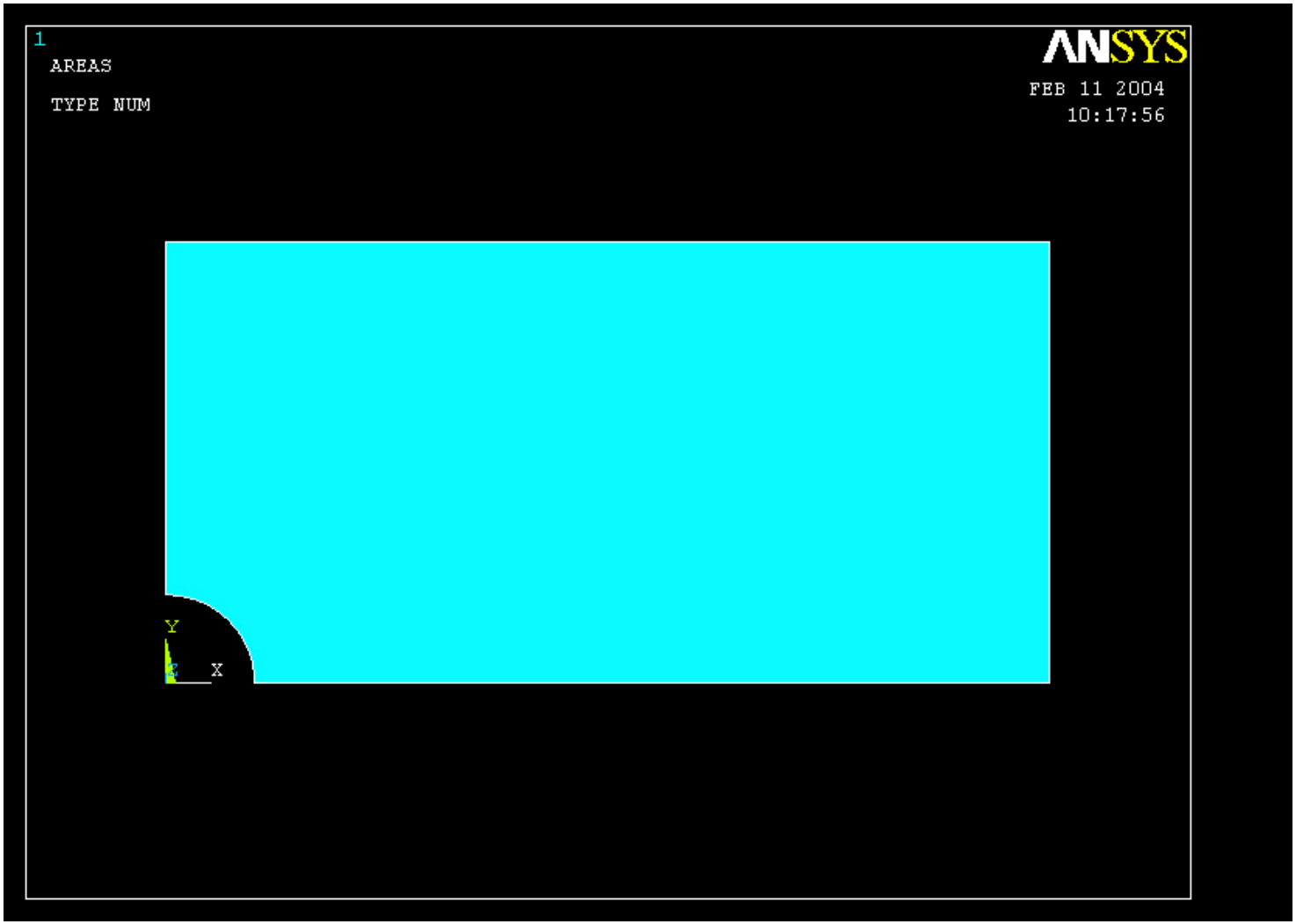
Note: Bottom left corner of ANSYS GUI

Pick or enter areas to be subtracted

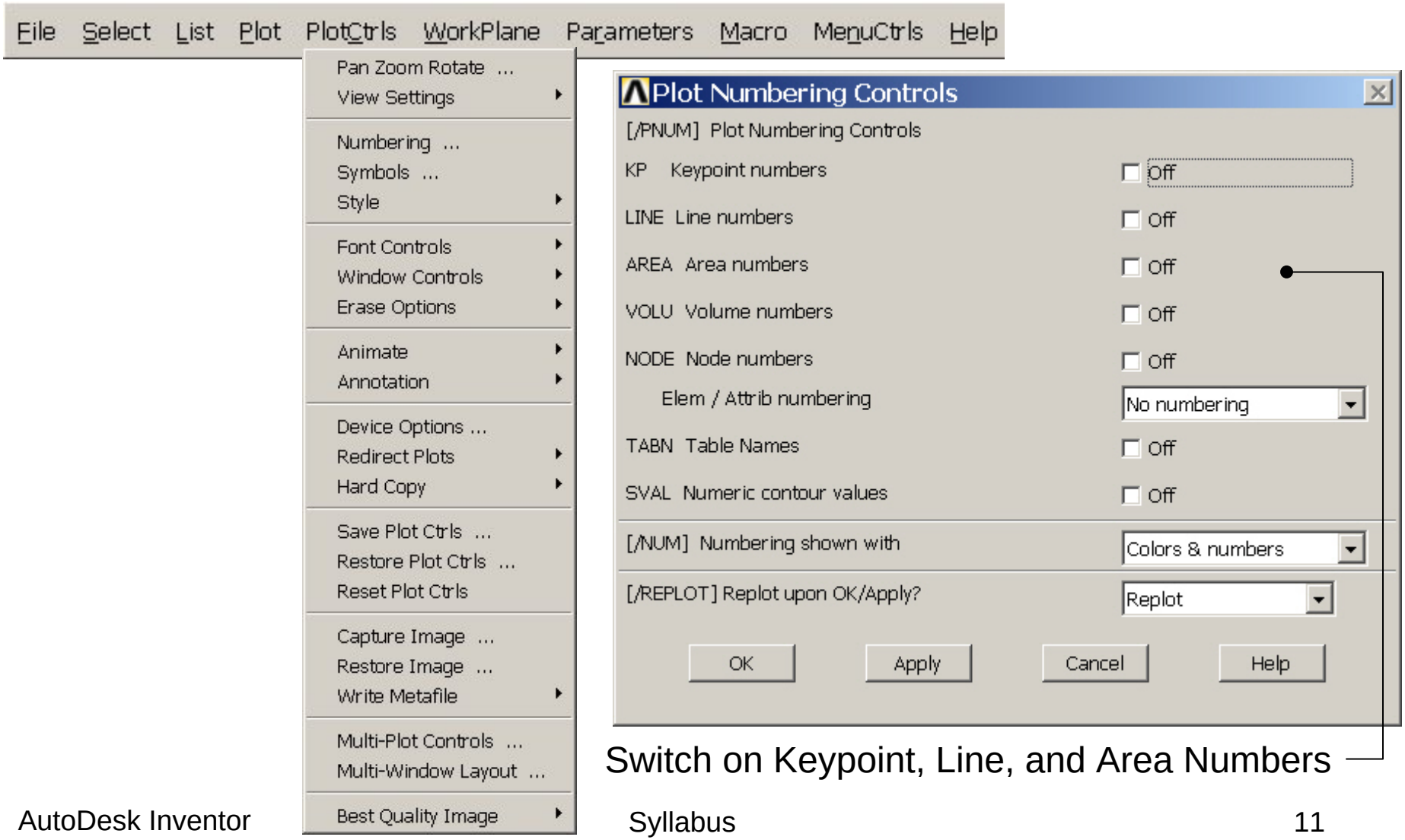
Select the circular area

Press OK

Example – Areas

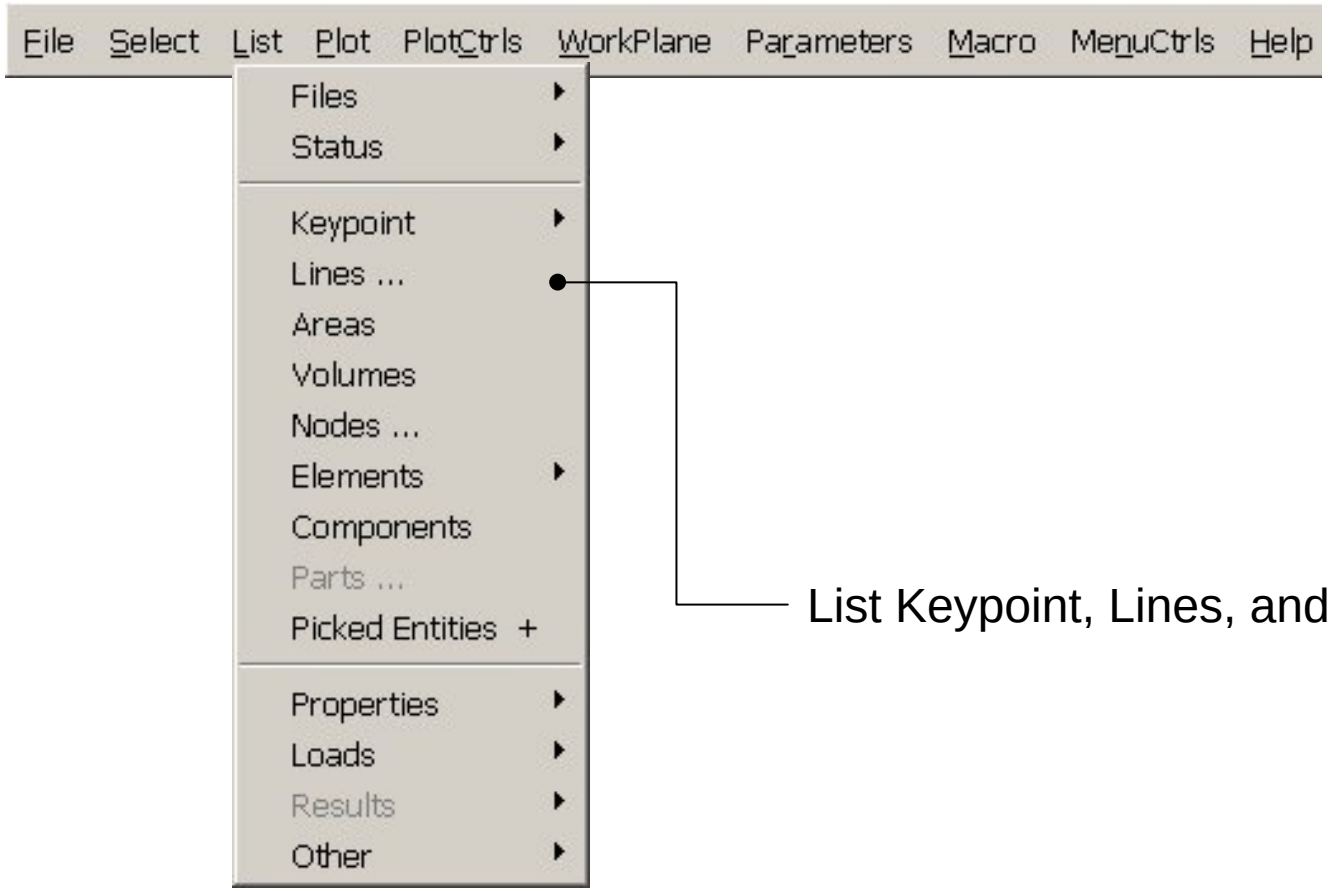


Example - Numbering



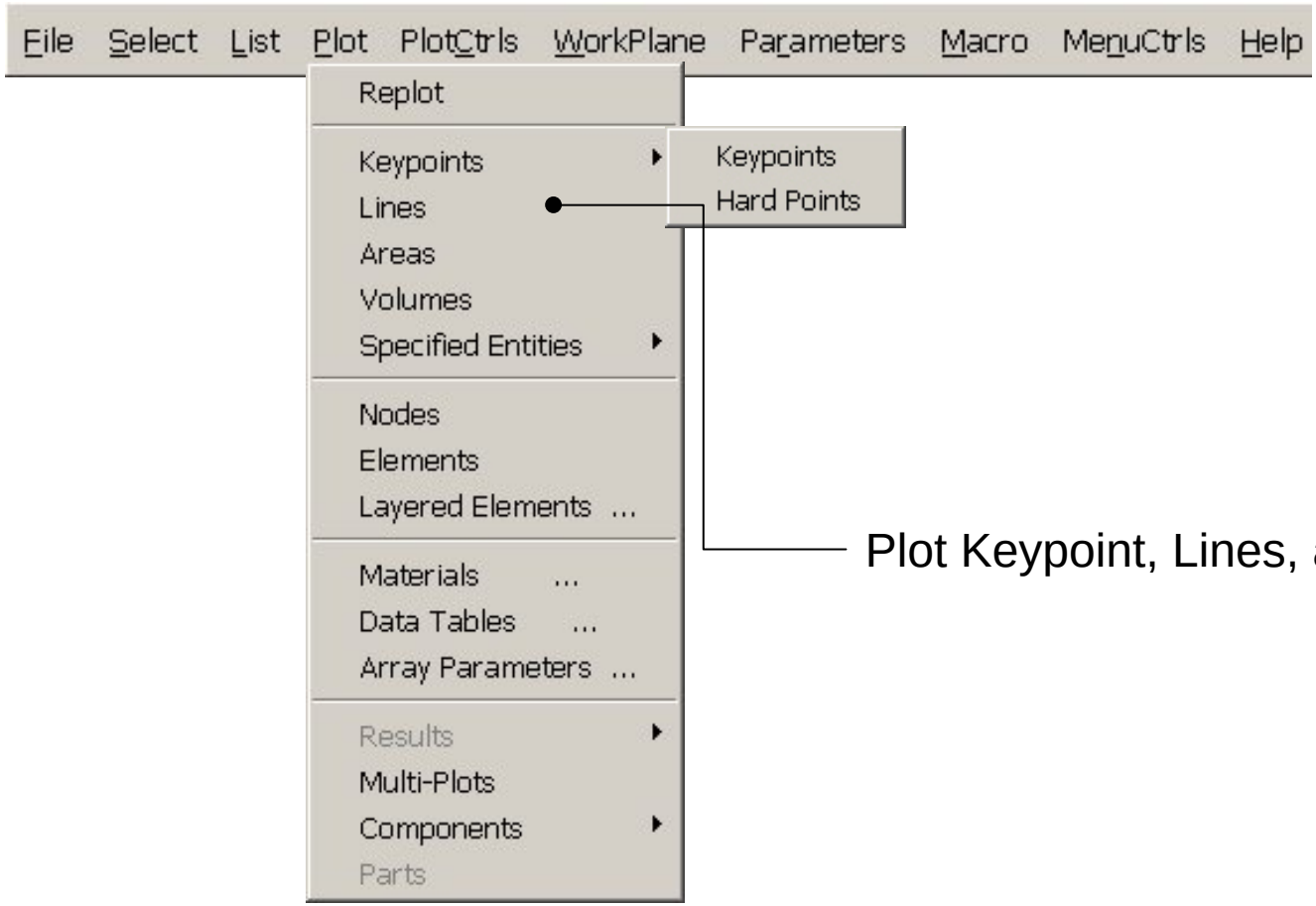
Switch on Keypoint, Line, and Area Numbers

Example - List Menu



List Keypoint, Lines, and Areas

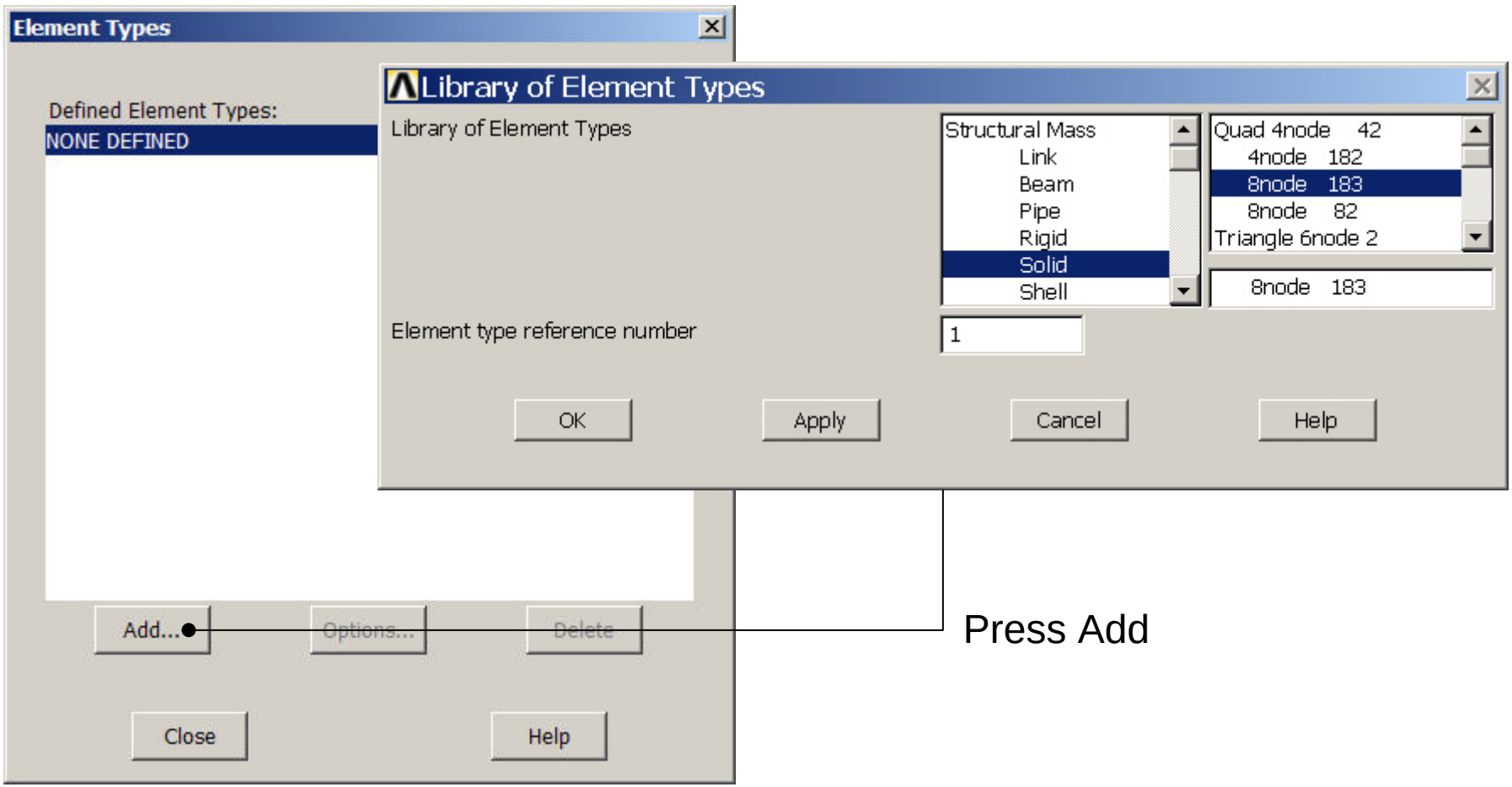
Example - Plot Menu



Plot Keypoint, Lines, and Areas

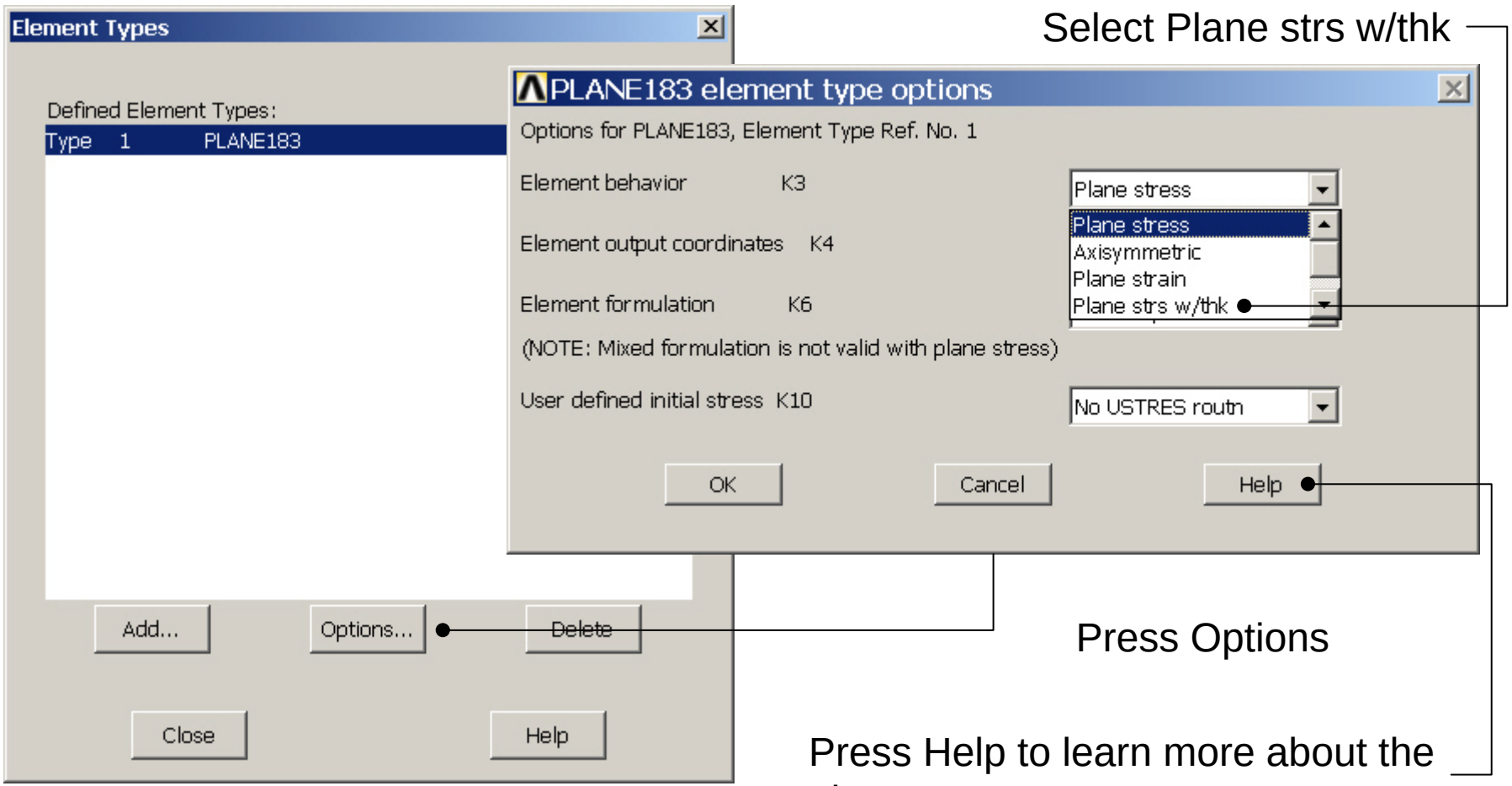
Example – Element Type

Preprocessor > Element Type > Add/Edit/Delete



Example - Element Type

Preprocessor > Element Type > Add/Edit/Delete



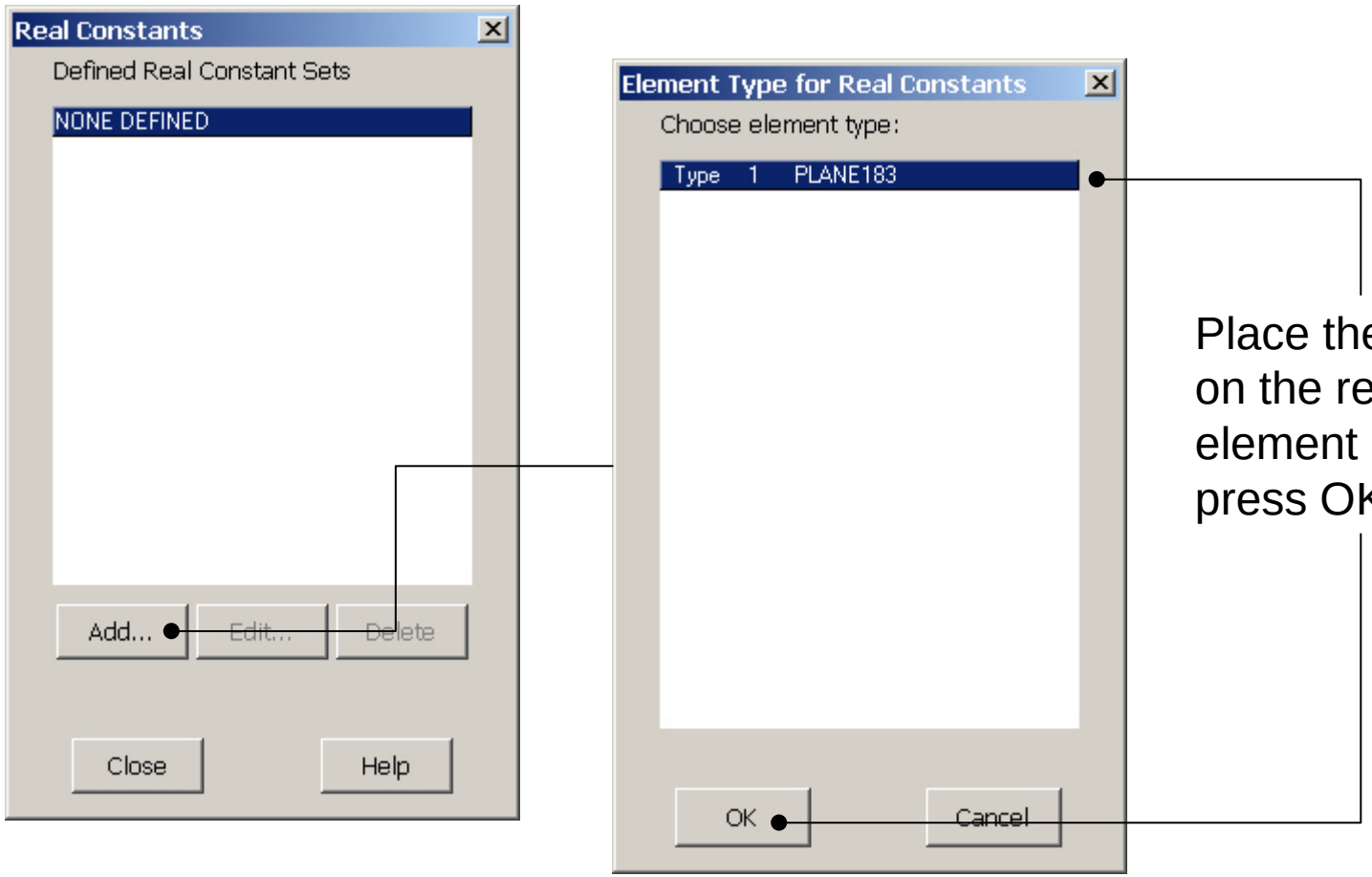
Select Plane strs w/thk

Press Options

Press Help to learn more about the element.

Example – Real Constants

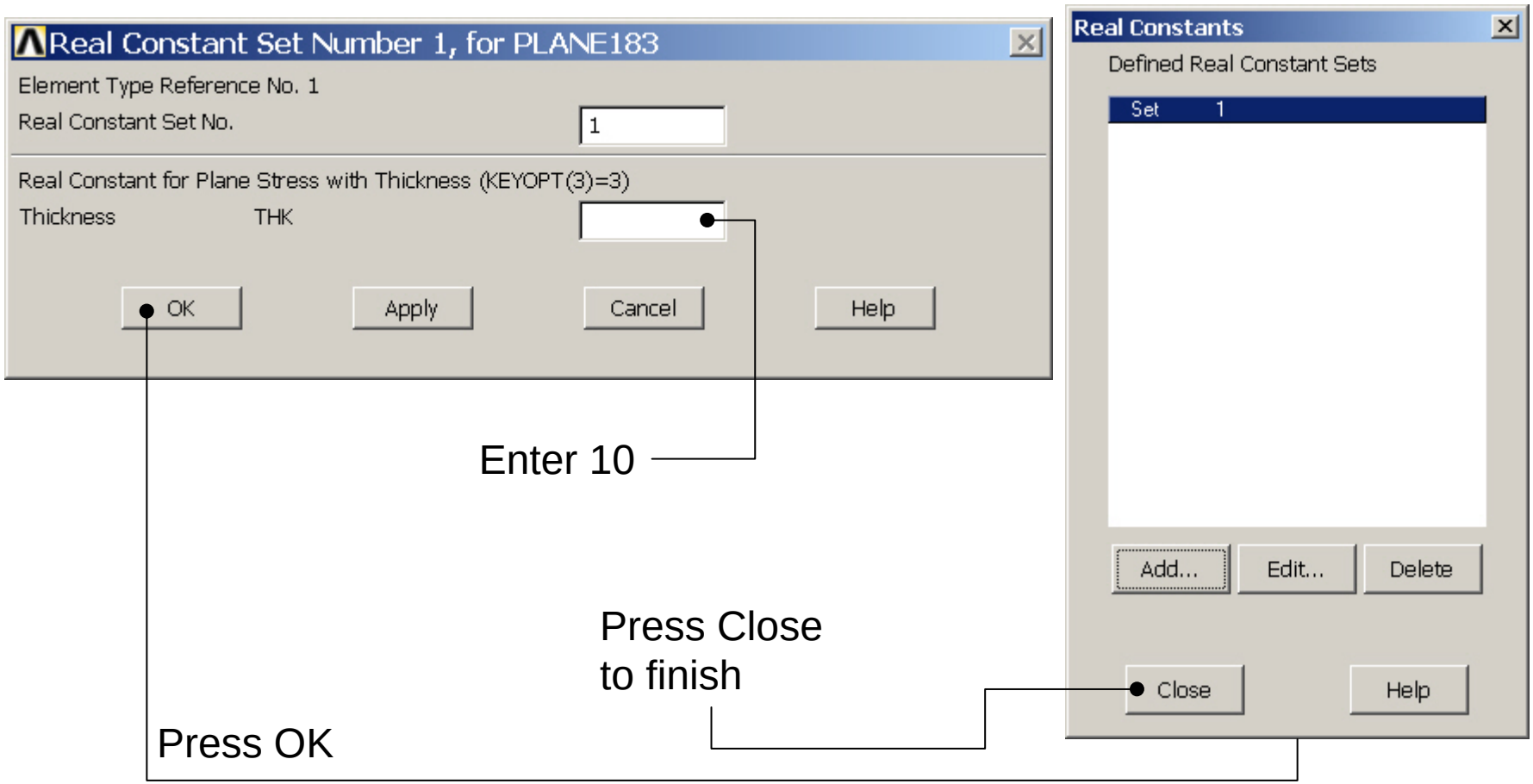
Preprocessor > Real Constants > Add



Place the cursor on the relevant element and press OK

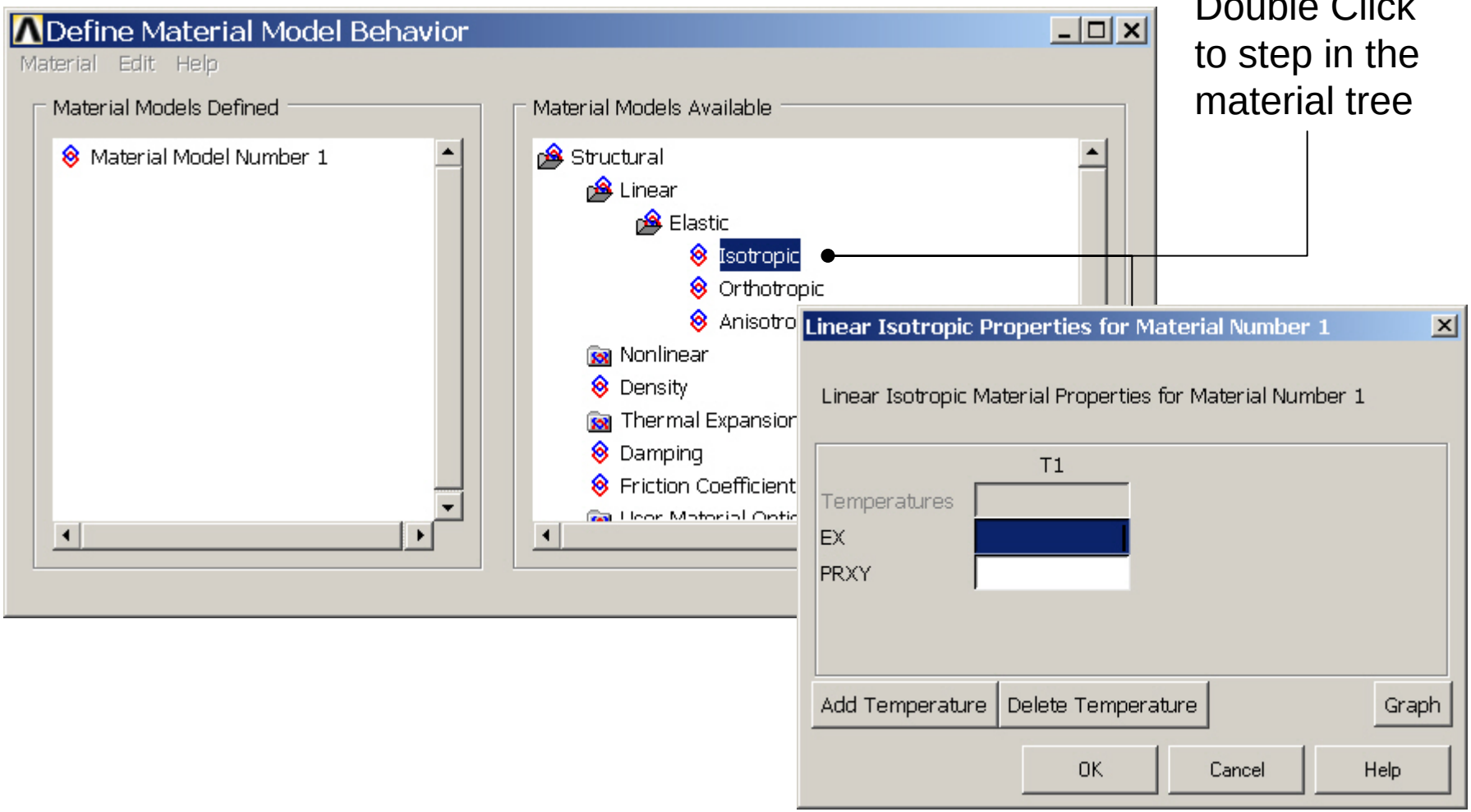
Example - Real Constants

Preprocessor > Real Constants > Add



Example - Material Properties

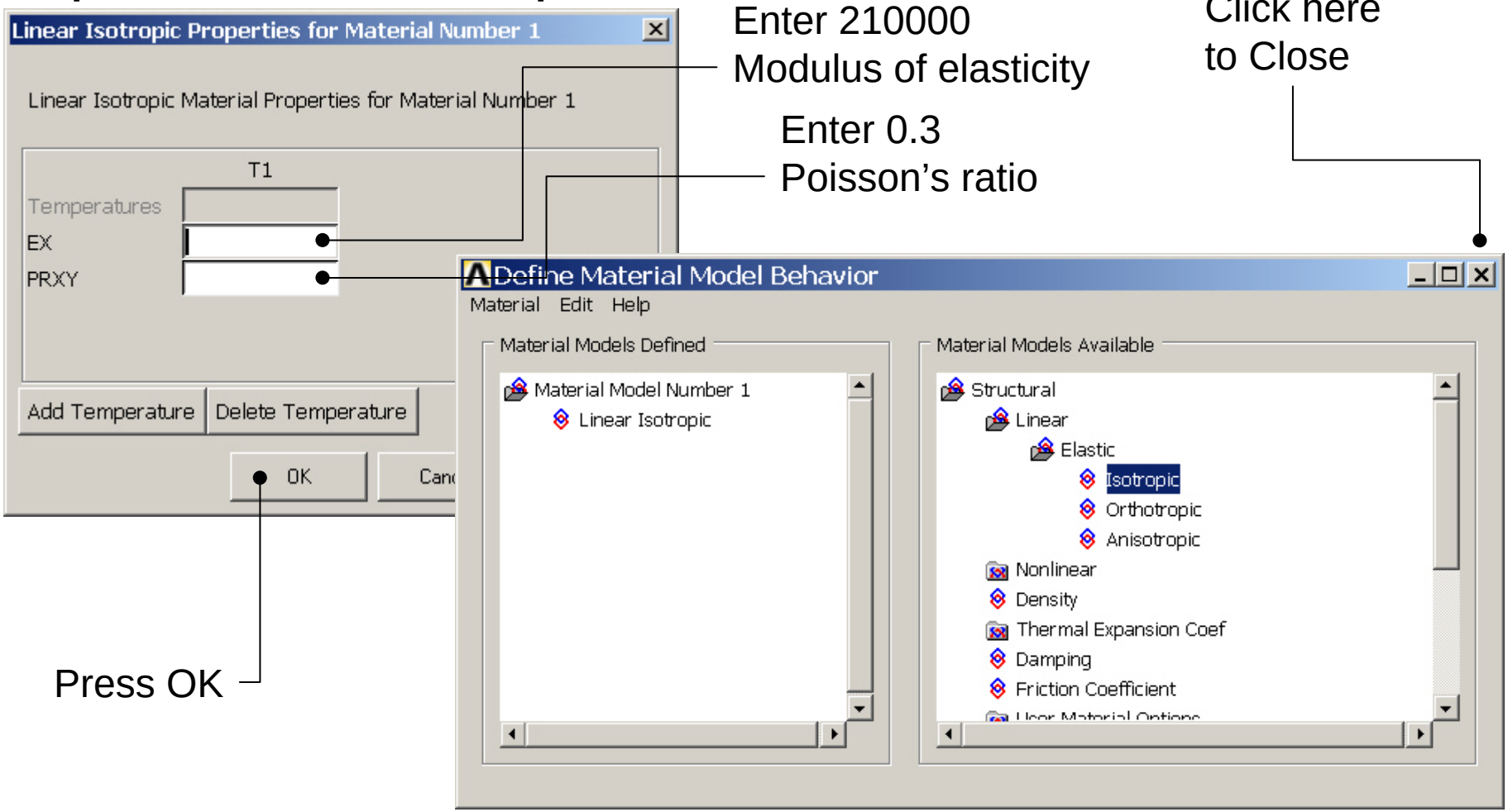
Preprocessor > Material Props > Material Models



Double Click to step in the material tree

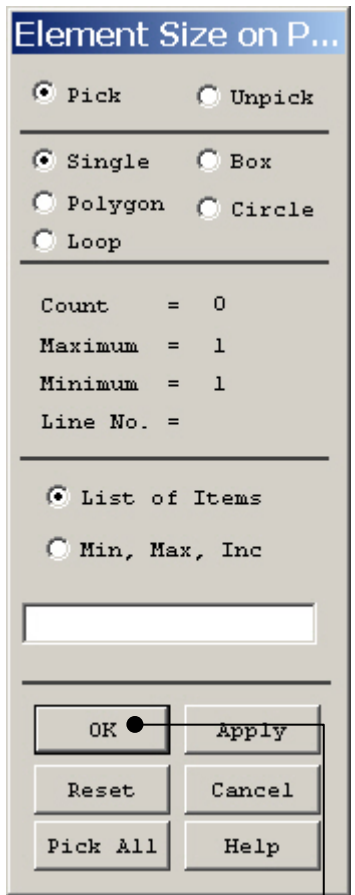
Example - Material Properties

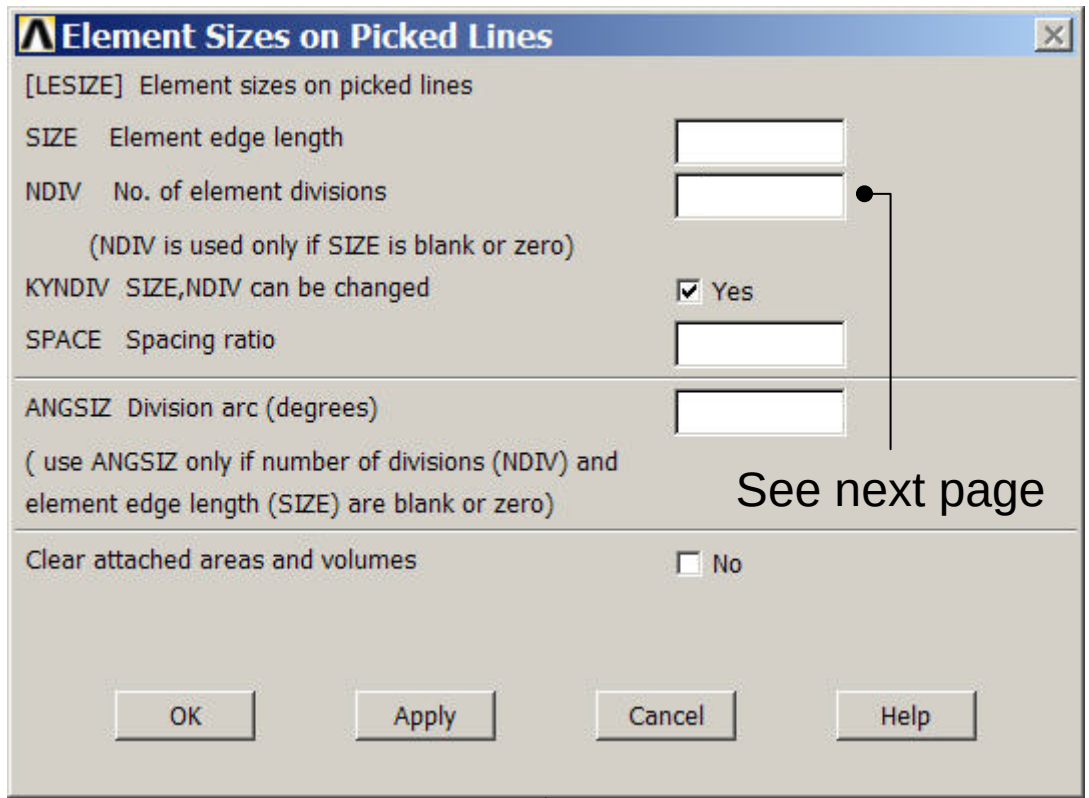
Preprocessor > Material Props > Material Models



Example - Meshing

Preprocessor > Meshing > Size Cntrls > ManualSize > Lines > Picked Lines





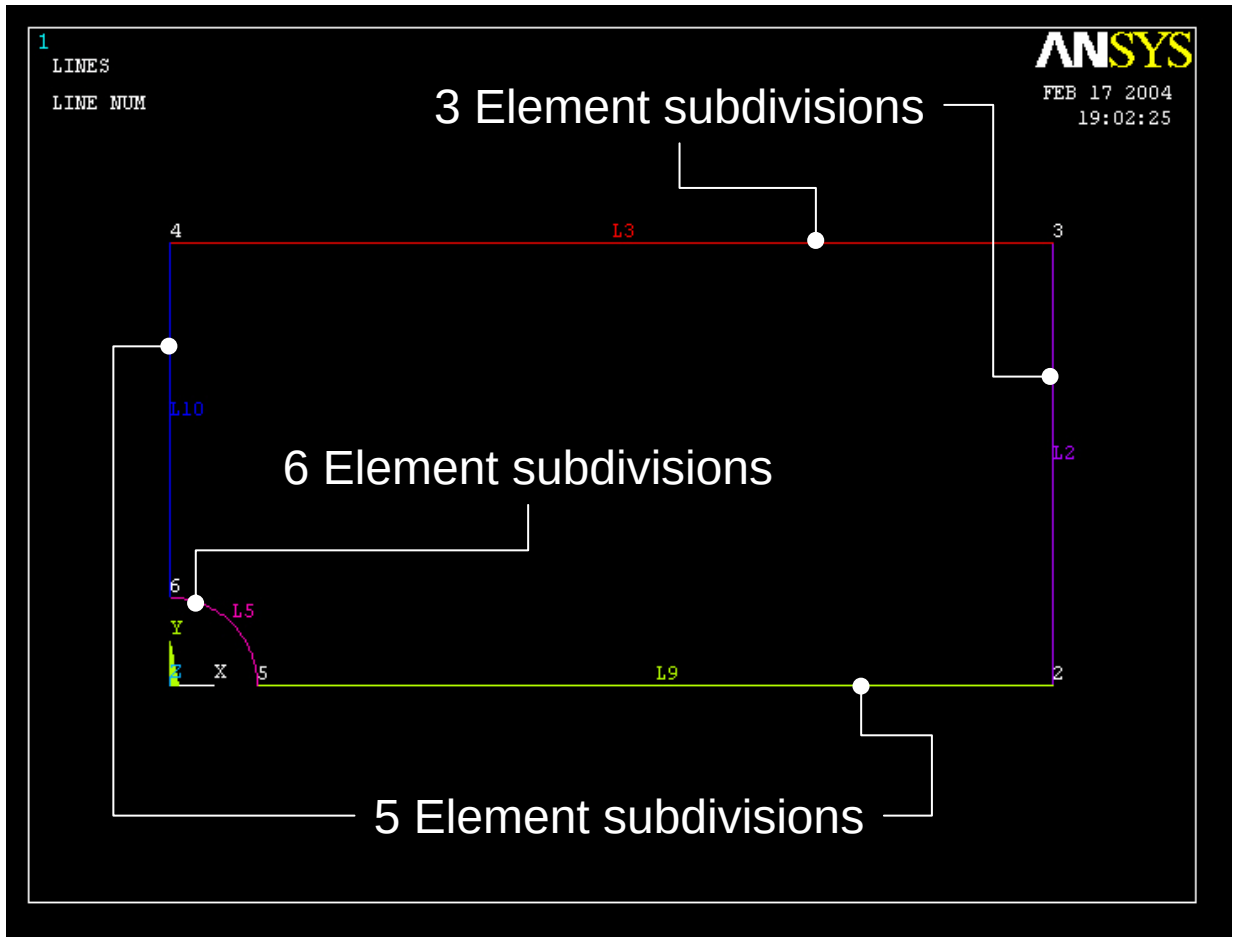
Select/Pick Lines to specify mesh size for

Pick the two longest lines

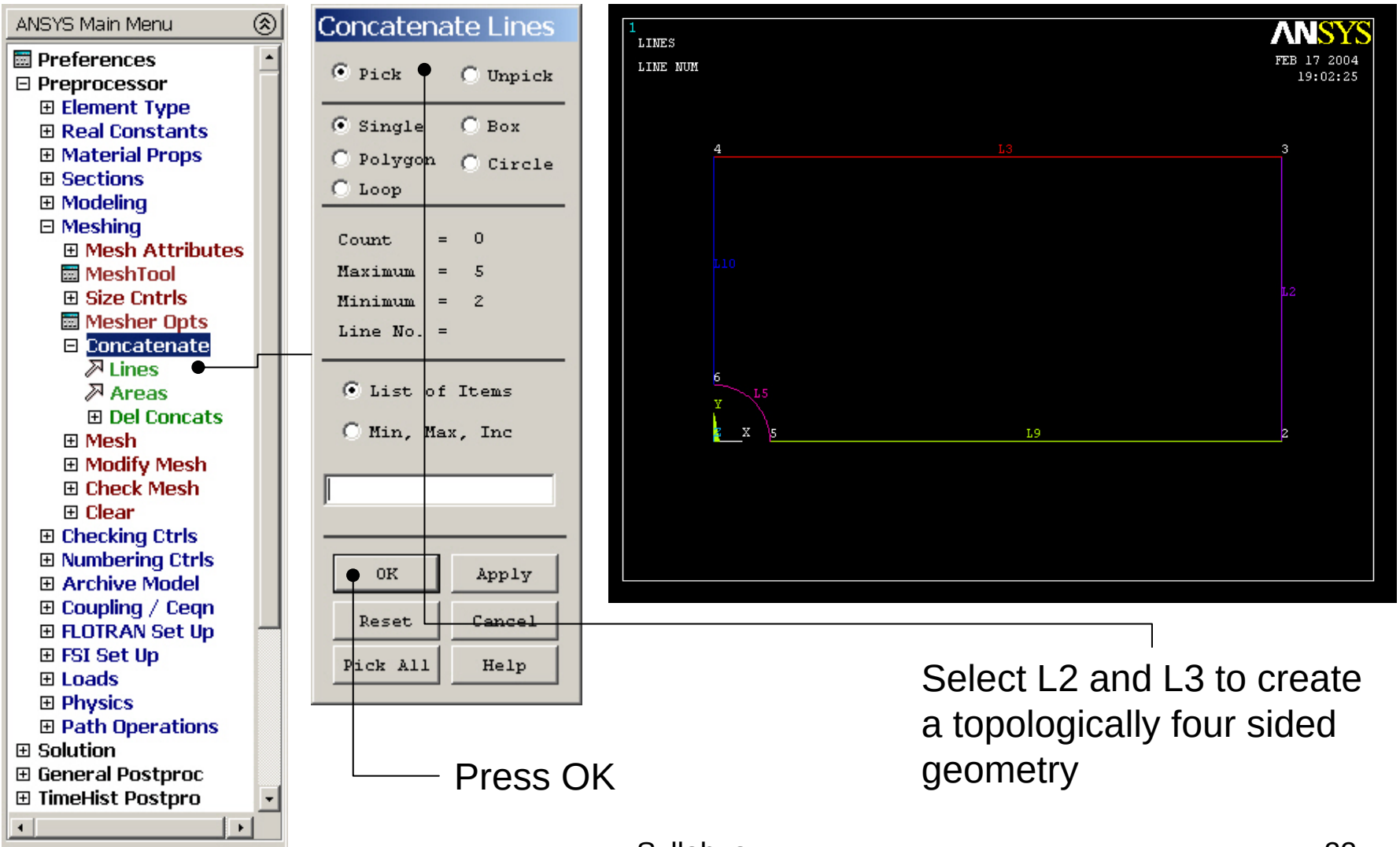
See next page

Press OK when finish with selection

Example – Mesh Size

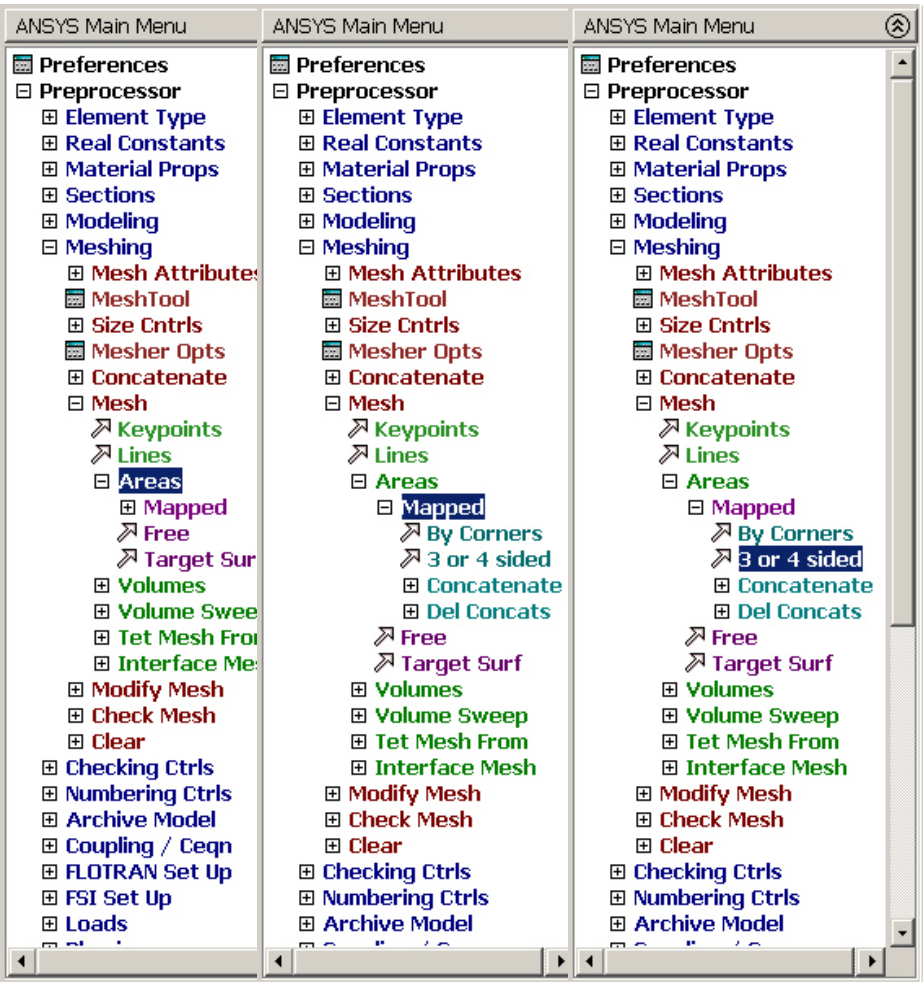


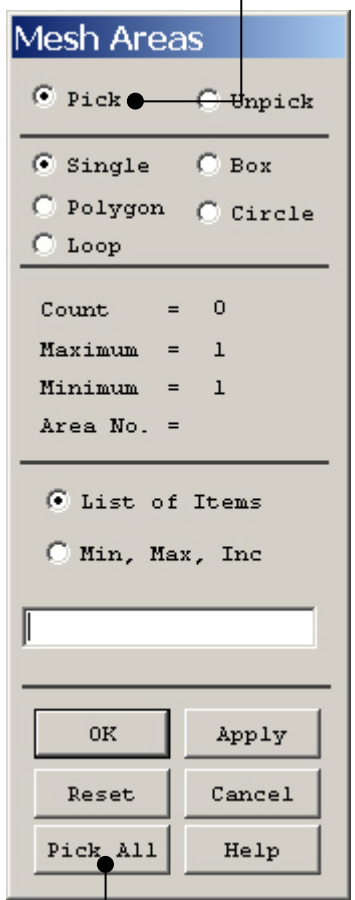
Example – Concatenate Lines



Example - Meshing

Preprocessor > Meshing > Mesh > Areas > Mapped > 3 or 4 sided



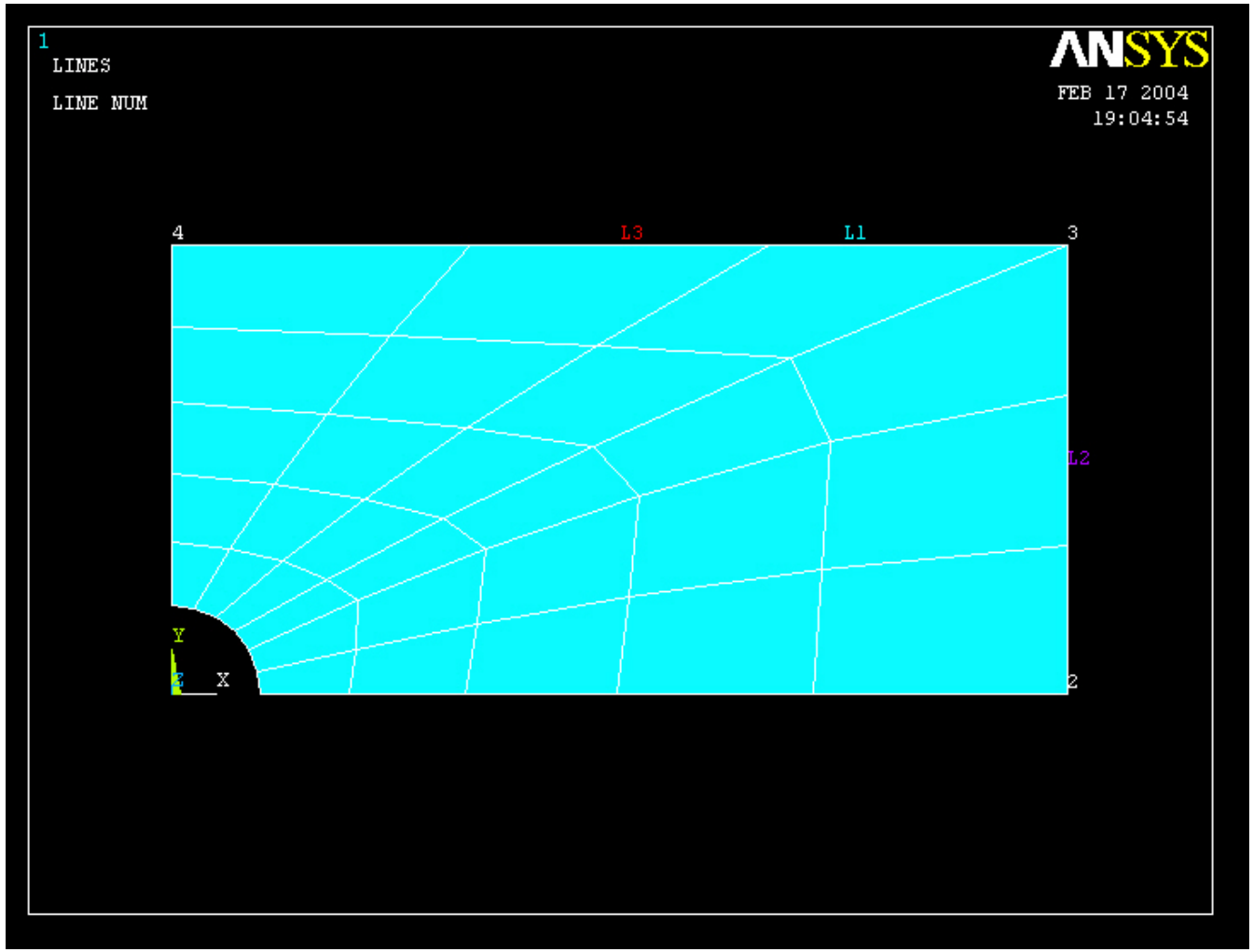


Select individual areas to be meshed

NB: It is often necessary to “Clear” the model for example if Element Type or model geometry is to be changed

Select all areas defined to be meshed

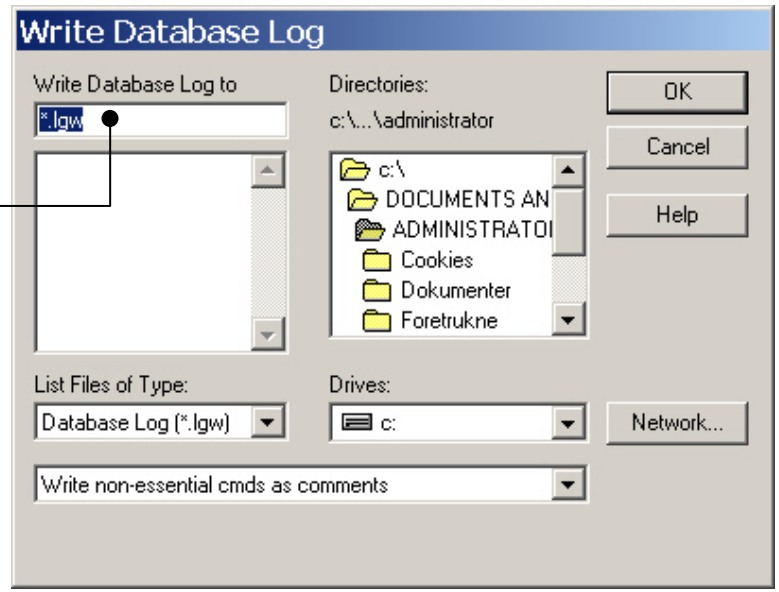
Example – Mapped Mesh



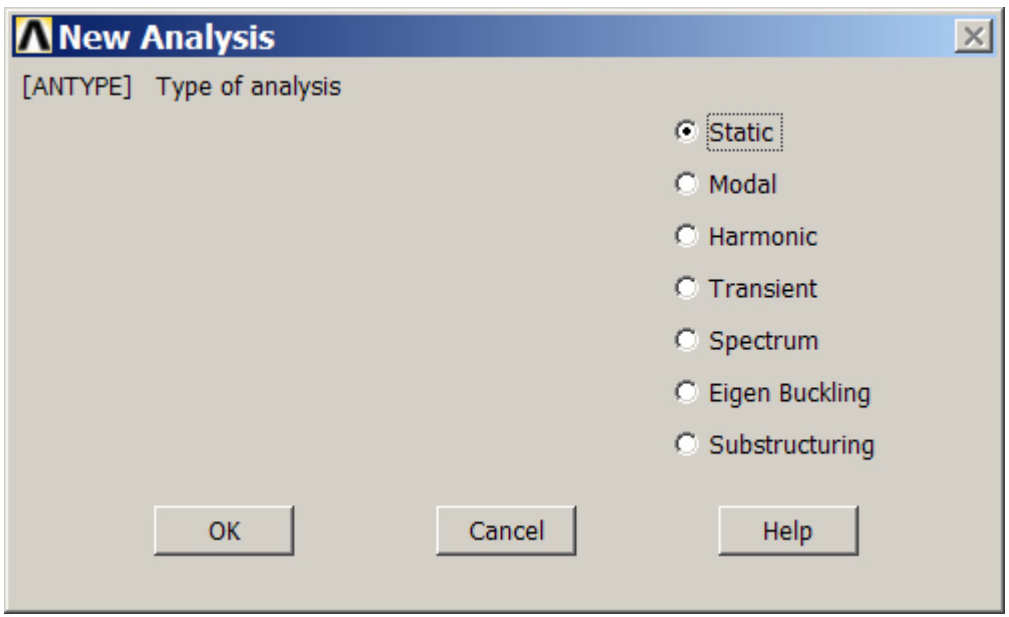
Example – Analysis Type

File > Write DB log file

Enter “example0702_coarse.lgw”

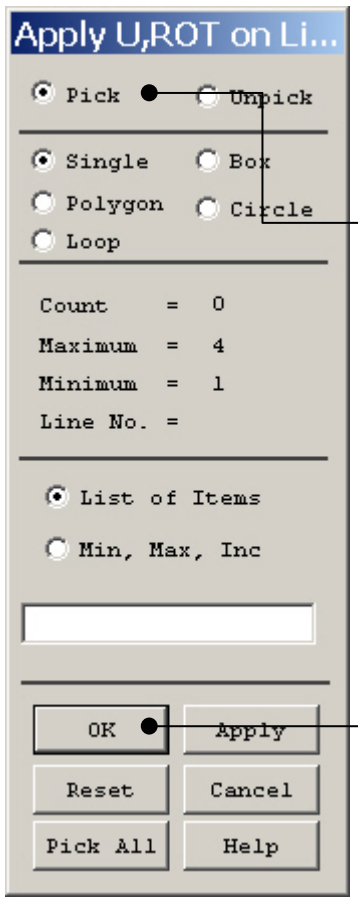


Solution > Analysis Type > New Analysis



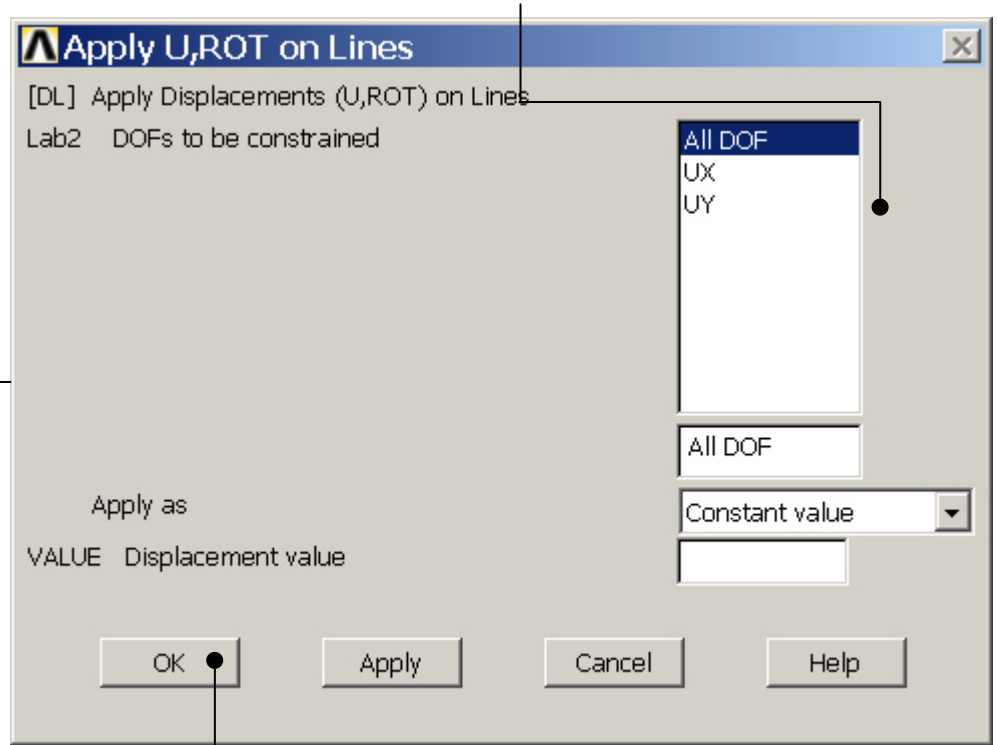
Example – Define Loads

Solution > Define Loads > Apply > Structural > Displacement > On Lines



Select the bottom straight line

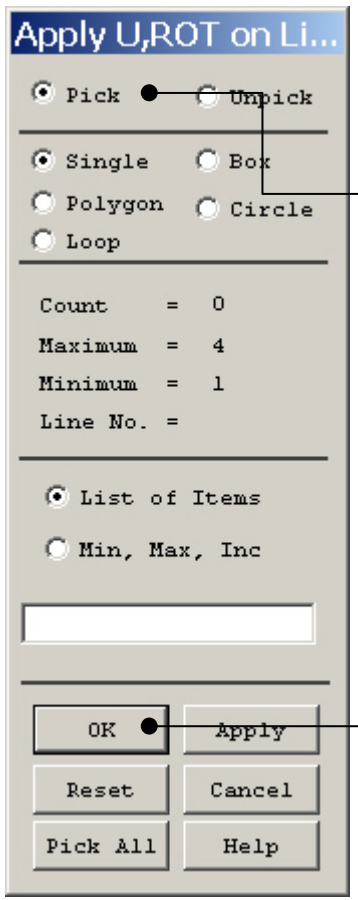
Select UY to fix the plate in the y-direction



Press OK

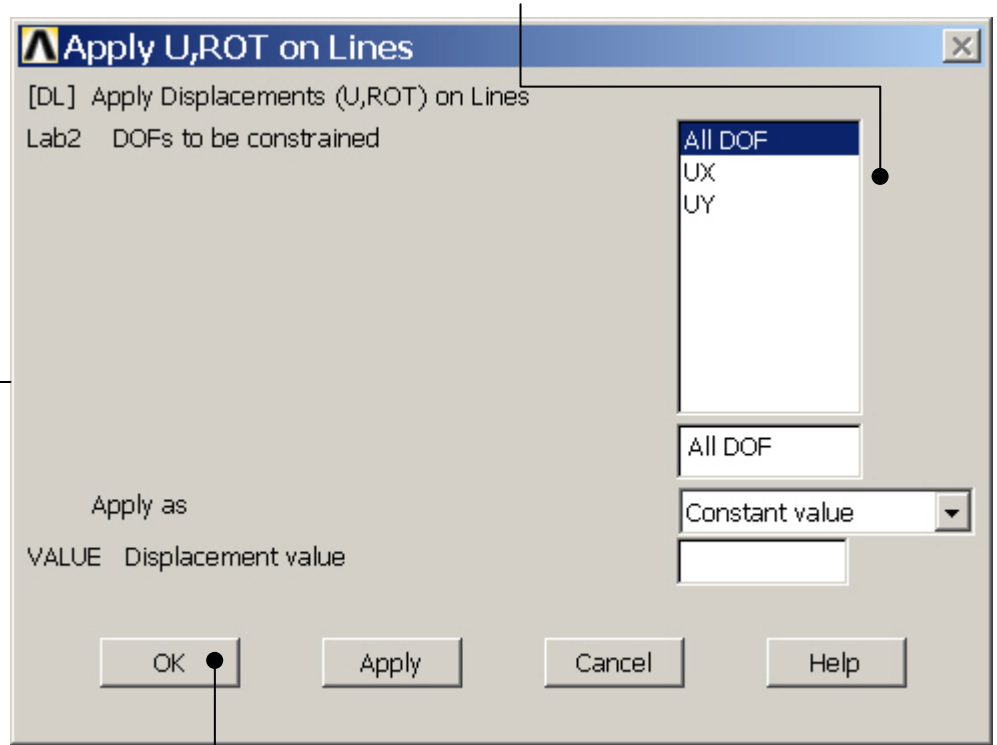
Example – Define Loads

Solution > Define Loads > Apply > Structural > Displacement > On Lines



Select the left straight line

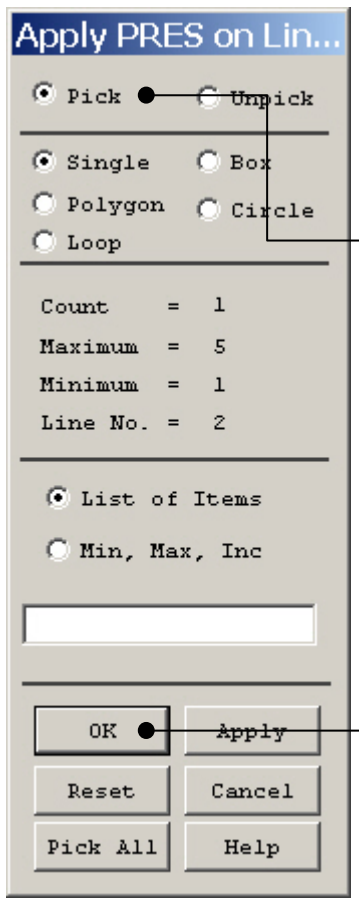
Select UX to fix the plate in the x-direction



Press OK

Example – Define Loads

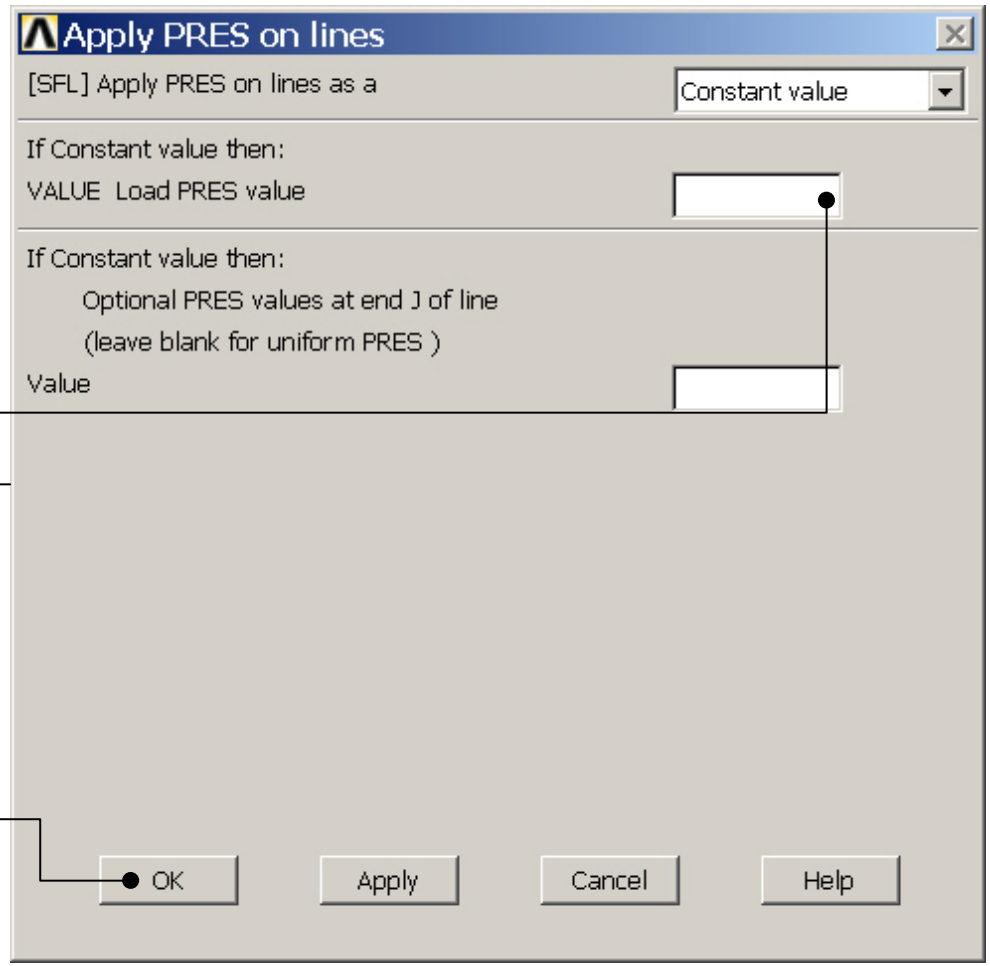
Solution > Define Loads > Apply > Structural > Pressure > On lines



Select the right straight line

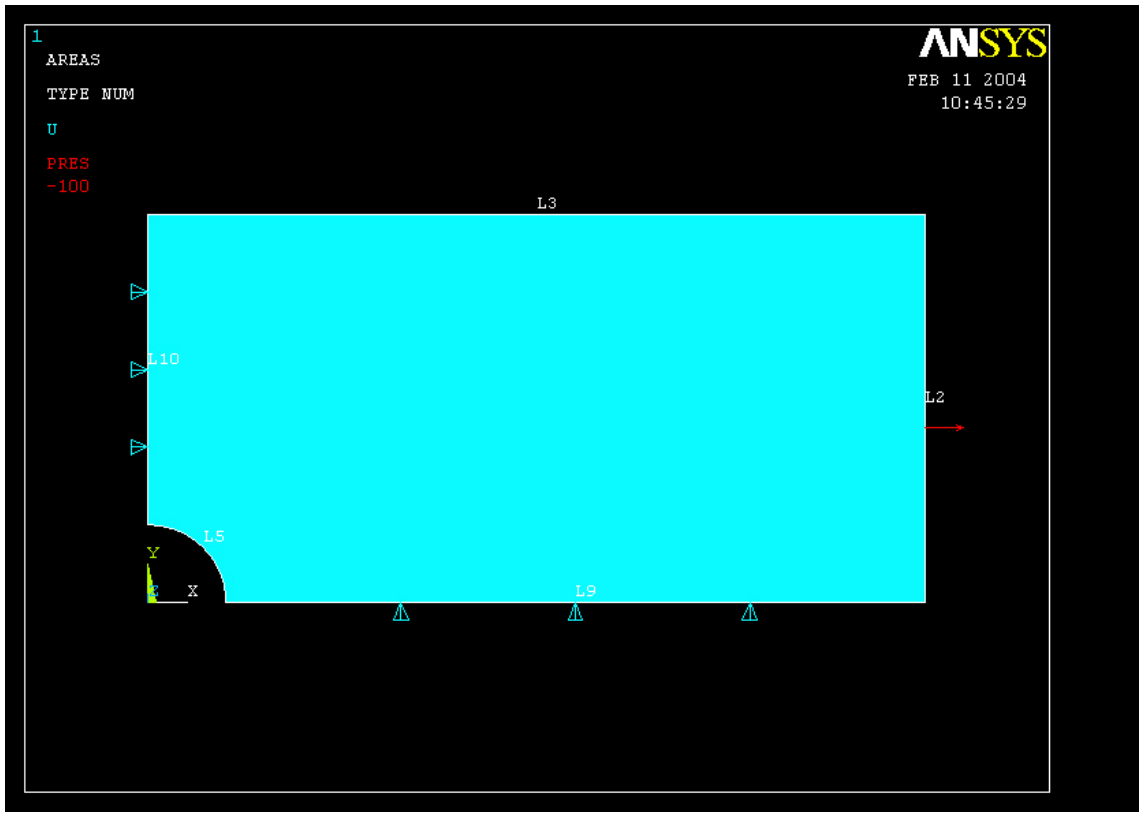
Enter -100

Press OK to finish

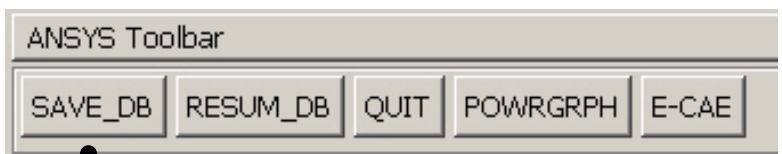


Note: Pressure acts normal and inward to a surface

Example - Save



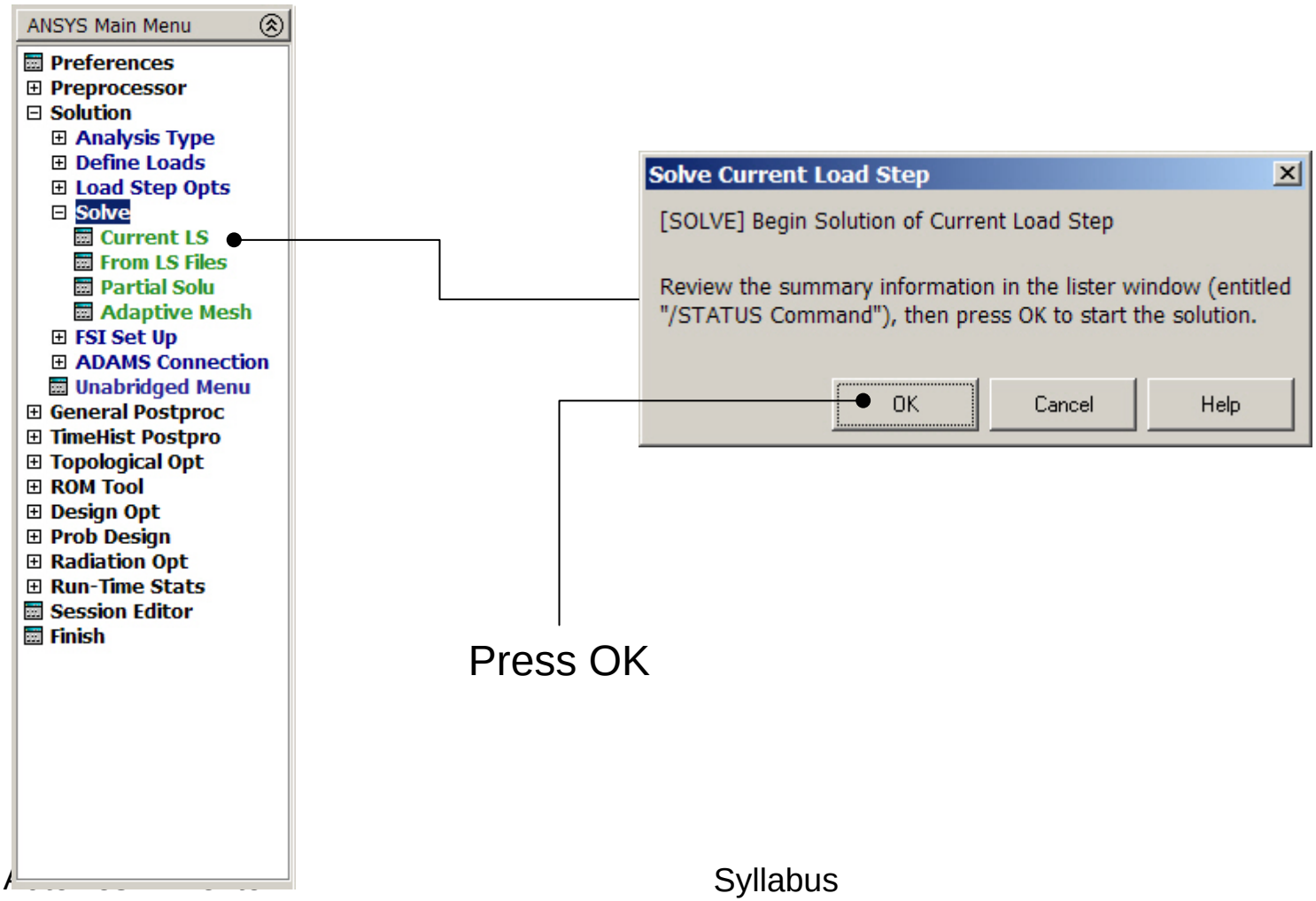
Display of Analysis model



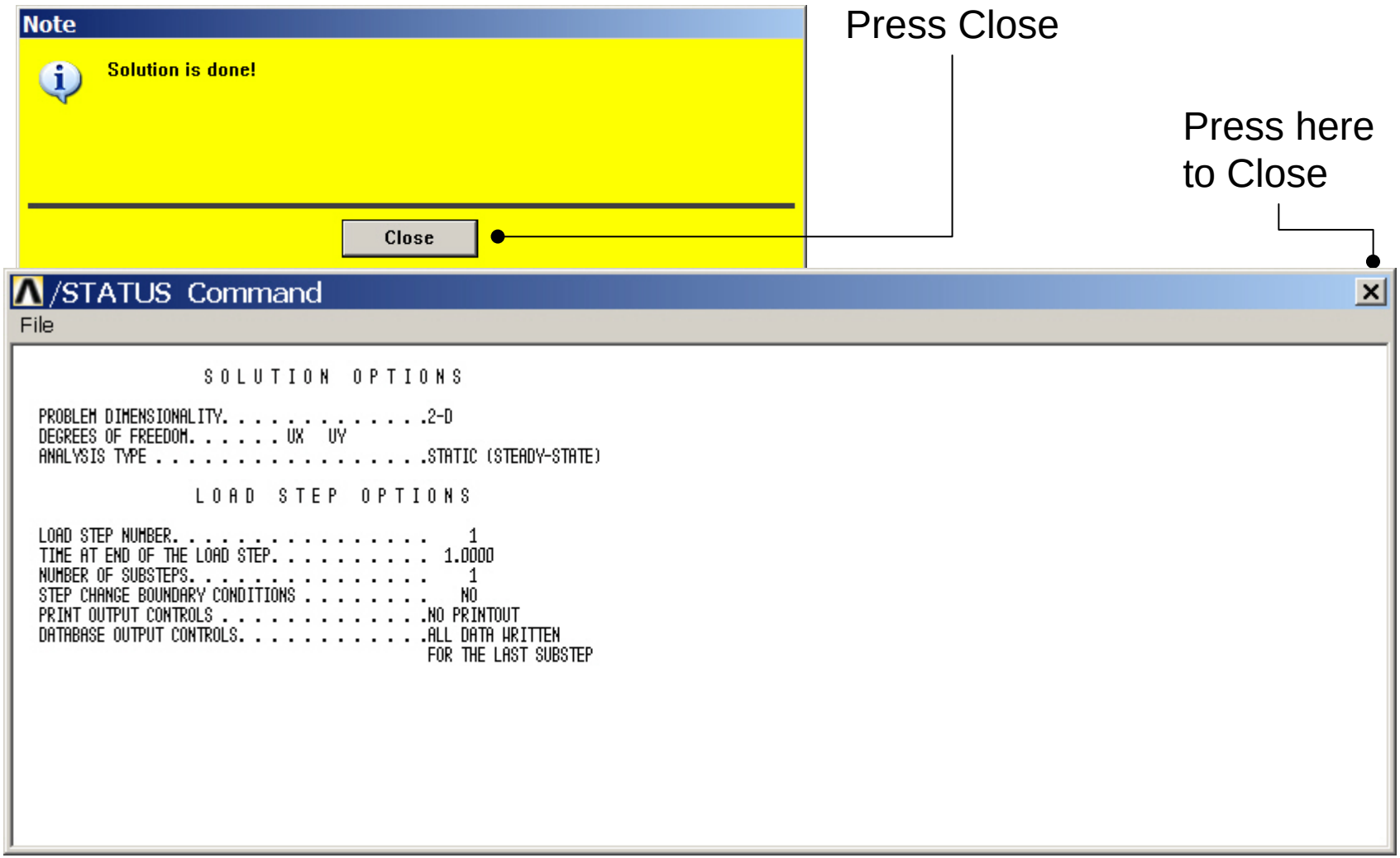
Save the model

Example - Solve

Solution > Solve > Current LS

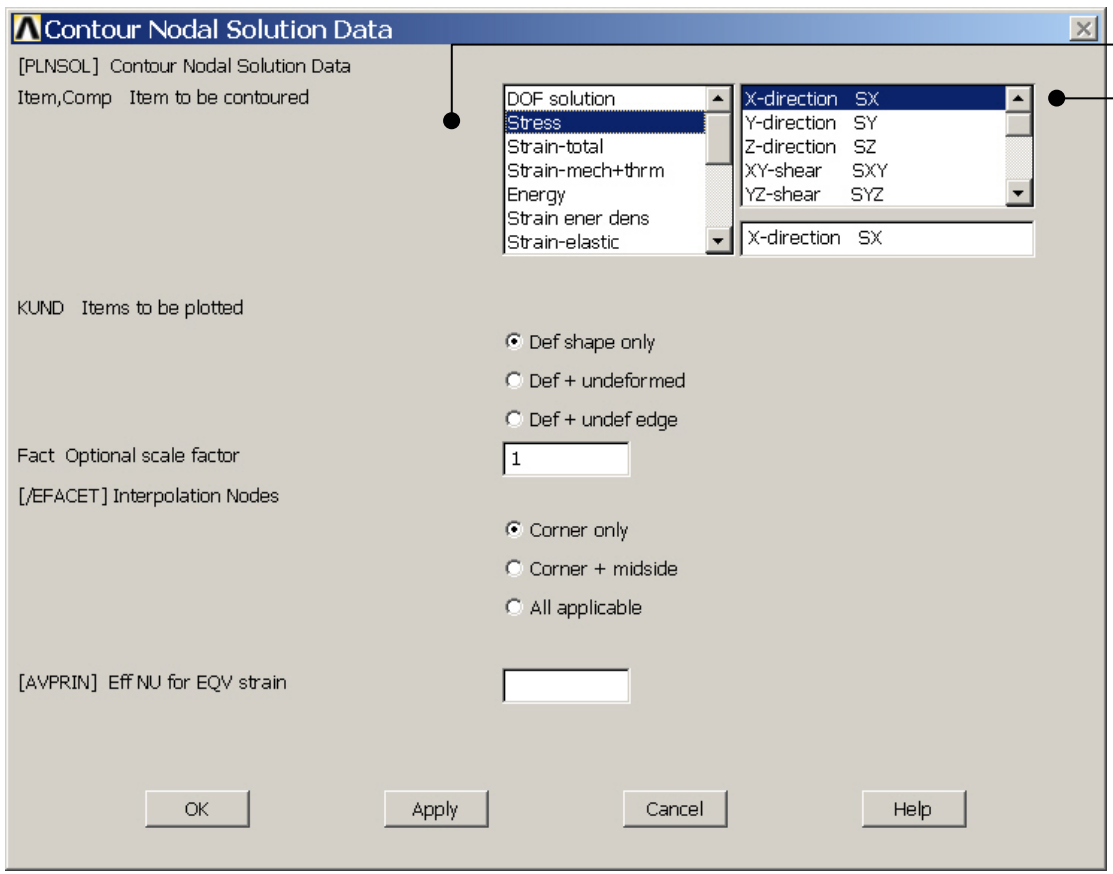


Example - Solve



Example – Contour Plot

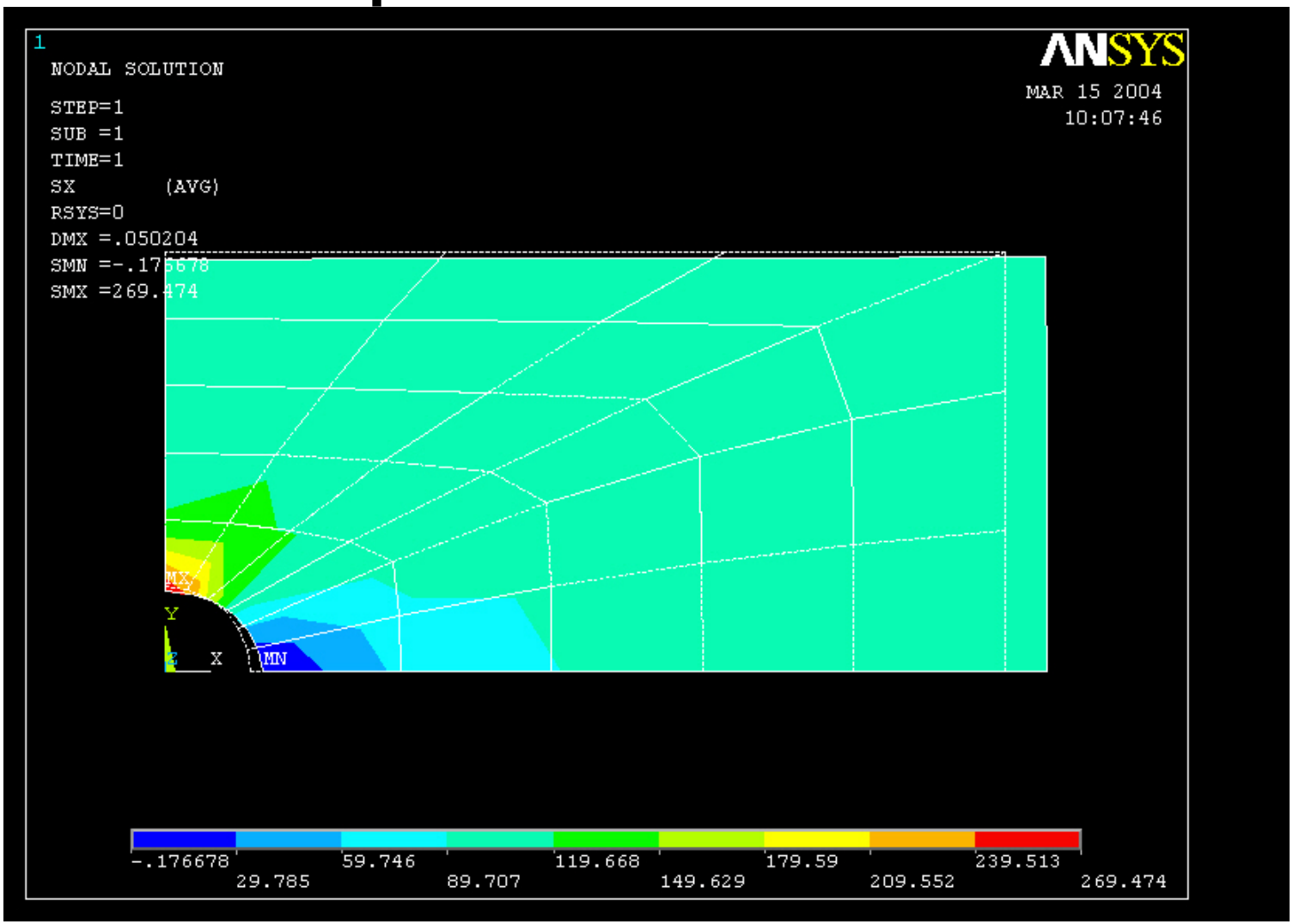
General Postproc > Plot Results > Contour Plot > Nodal Sol



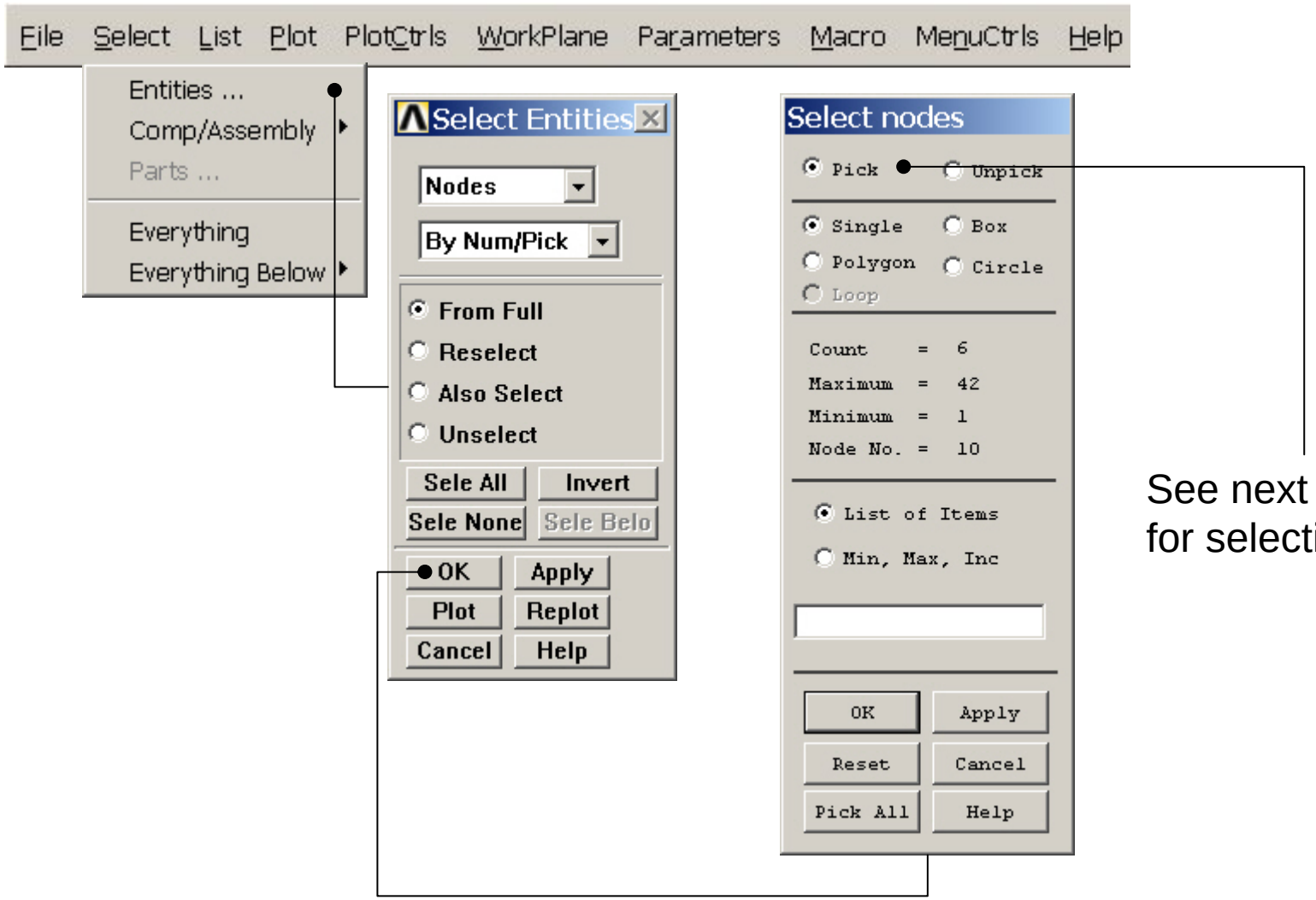
Select Stress

Select SX for stresses in x-direction

Example – Contour Plot

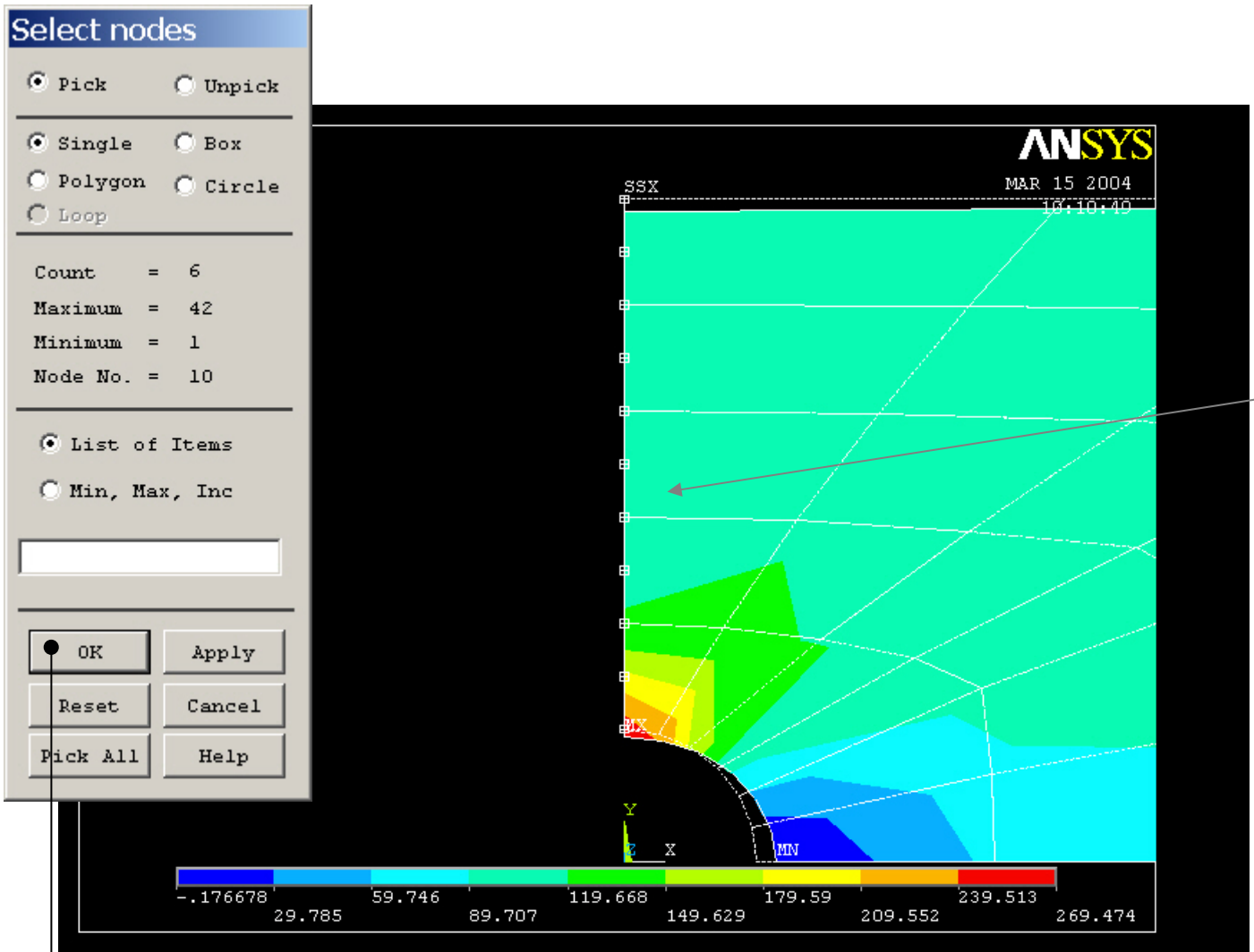


Example – Select - Entities



See next page for selection

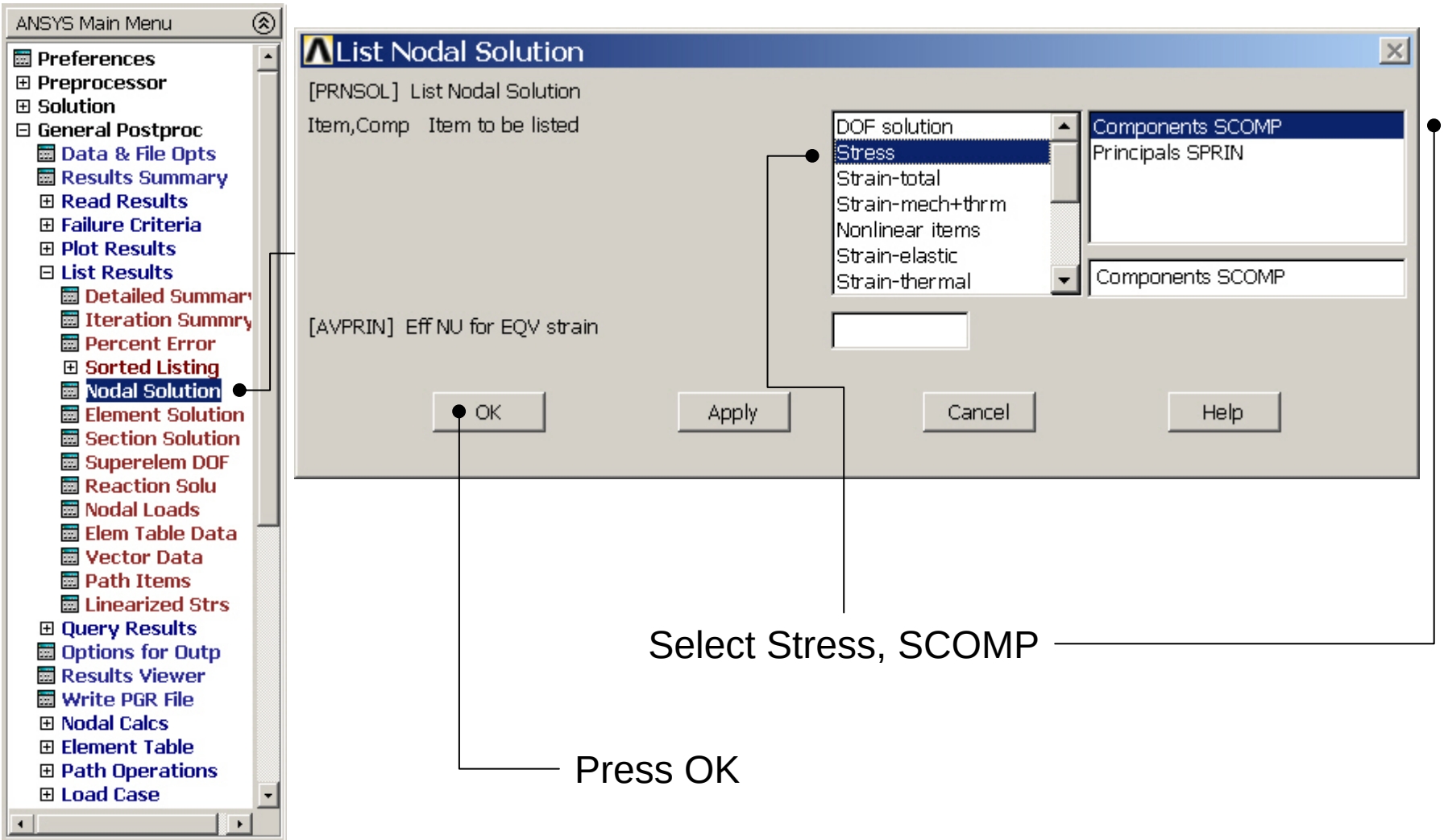
Example – Select Nodes



Select the indicated nodes

Enter OK when finished

Example – List Results



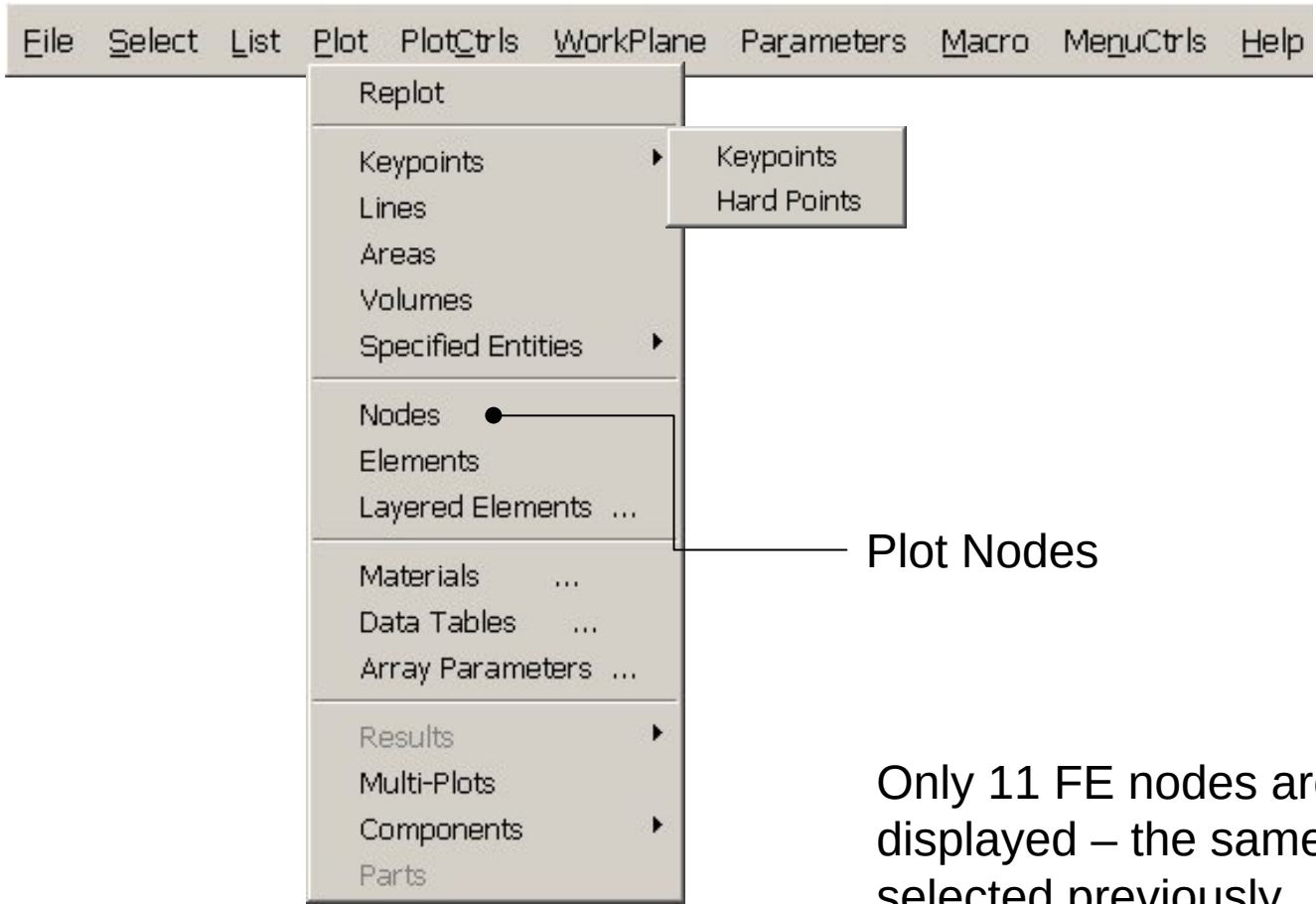
Example – List Results

PRNSOL Command

File

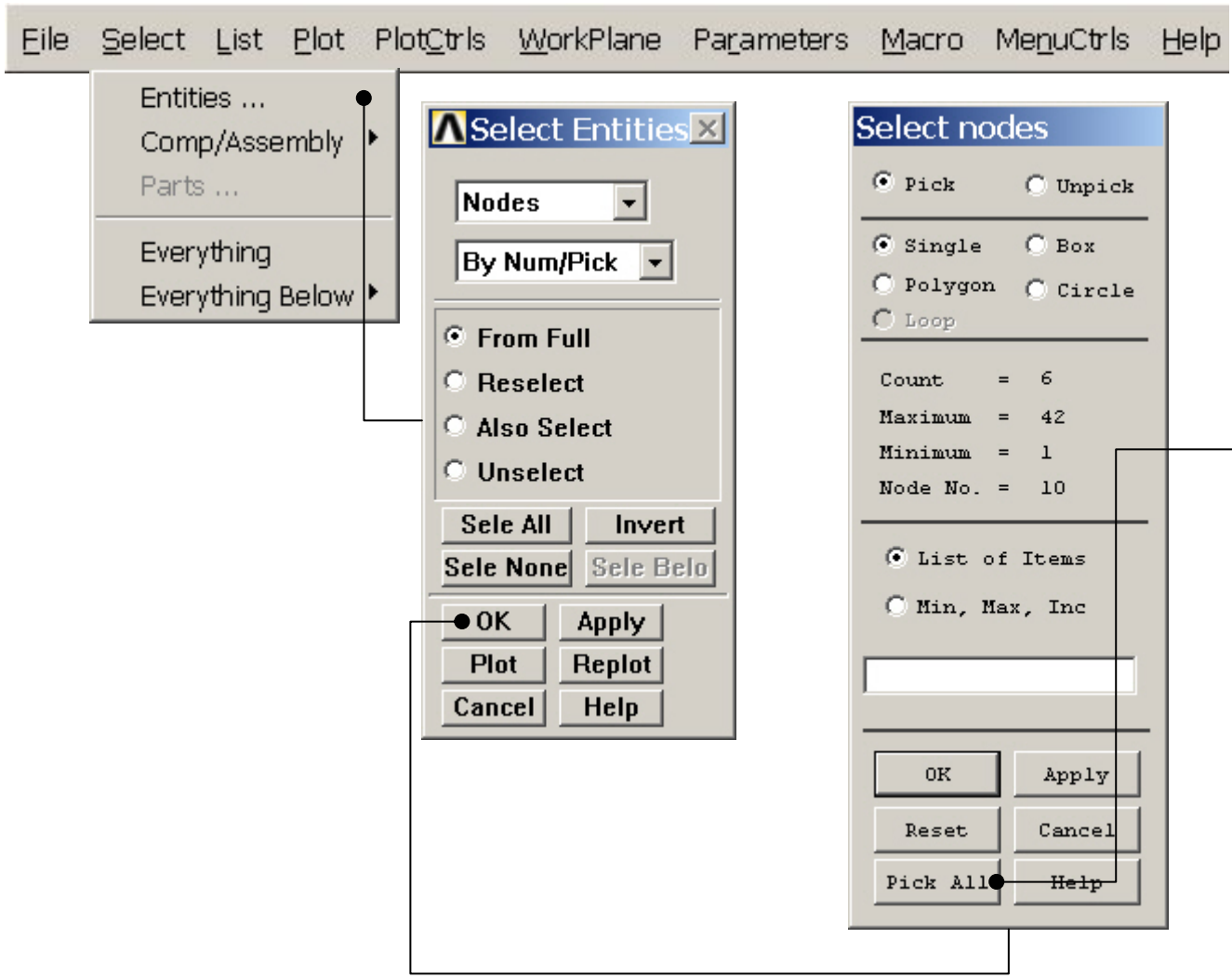
```
PRINT S    NODAL SOLUTION PER NODE

 ***** POST1 NODAL STRESS LISTING *****
 PowerGraphics Is Currently Enabled

 LOAD STEP=     1  SUBSTEP=     1
  TIME=    1.0000      LOAD CASE=   0
 NODAL RESULTS ARE FOR MATERIAL   1

 THE FOLLOWING X,Y,Z VALUES ARE IN GLOBAL COORDINATES

   NODE    SX          SY          SZ          SXY         SYZ         SXZ
     18   93.717     0.64304     0.0000      3.1608      0.0000      0.0000
     24   269.47      22.324     0.0000     -1.9435      0.0000      0.0000
     26   103.11      2.8840     0.0000      2.0059      0.0000      0.0000
     28   107.20      9.7412     0.0000      2.4882      0.0000      0.0000
     30   110.96      20.447     0.0000      3.3758      0.0000      0.0000
     32   122.15      42.057     0.0000     0.71564      0.0000      0.0000

MINIMUM VALUES
NODE         18          18          18          24          18          18
VALUE    93.717     0.64304     0.0000     -1.9435      0.0000      0.0000

MAXIMUM VALUES
NODE         24          32          18          30          18          18
VALUE    269.47      42.057     0.0000      3.3758      0.0000      0.0000
```

Example - Plot - Nodes



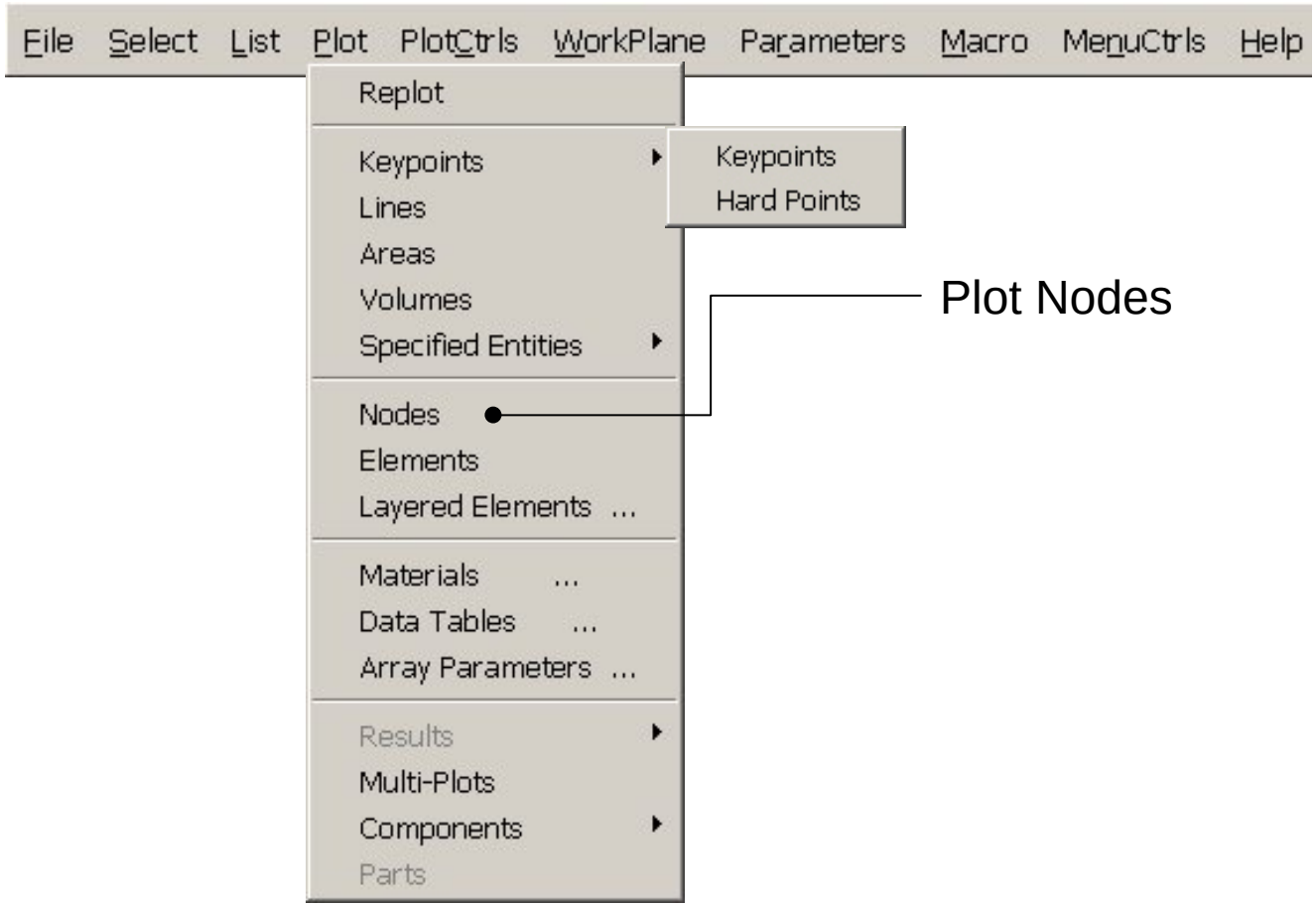
Only 11 FE nodes are displayed – the same nodes as selected previously

Example – Select - Entities

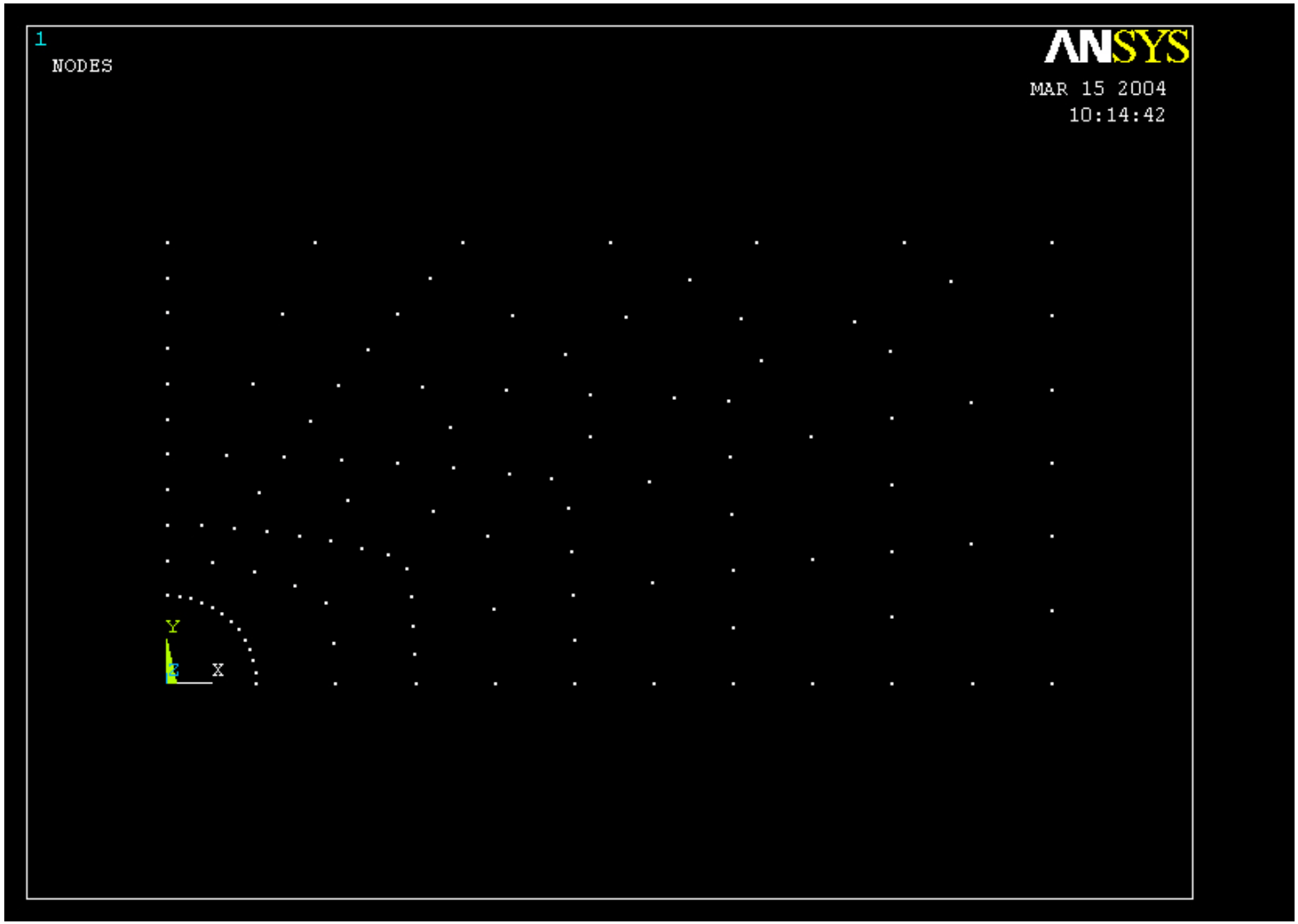


Select Pick All

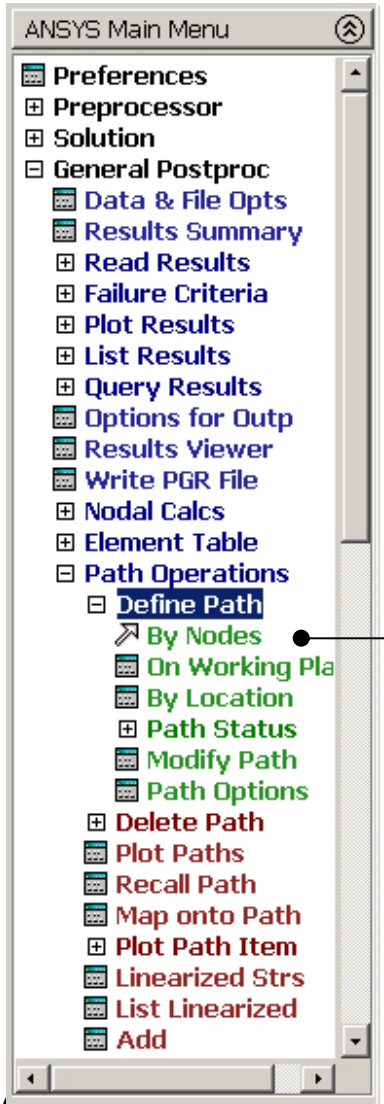
Example - Plot - Nodes

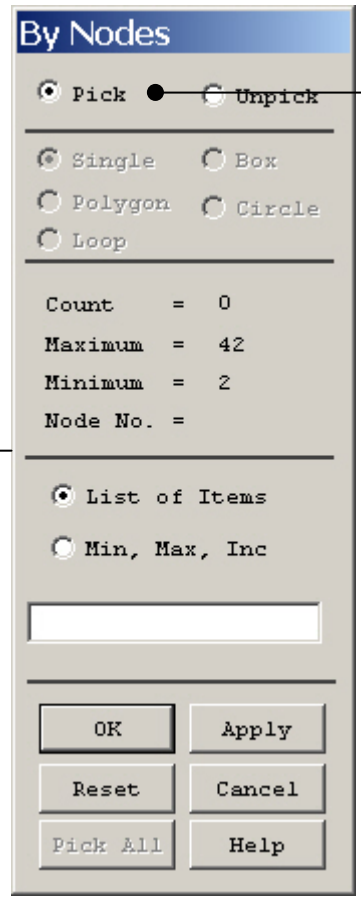


Example - Plot - Nodes



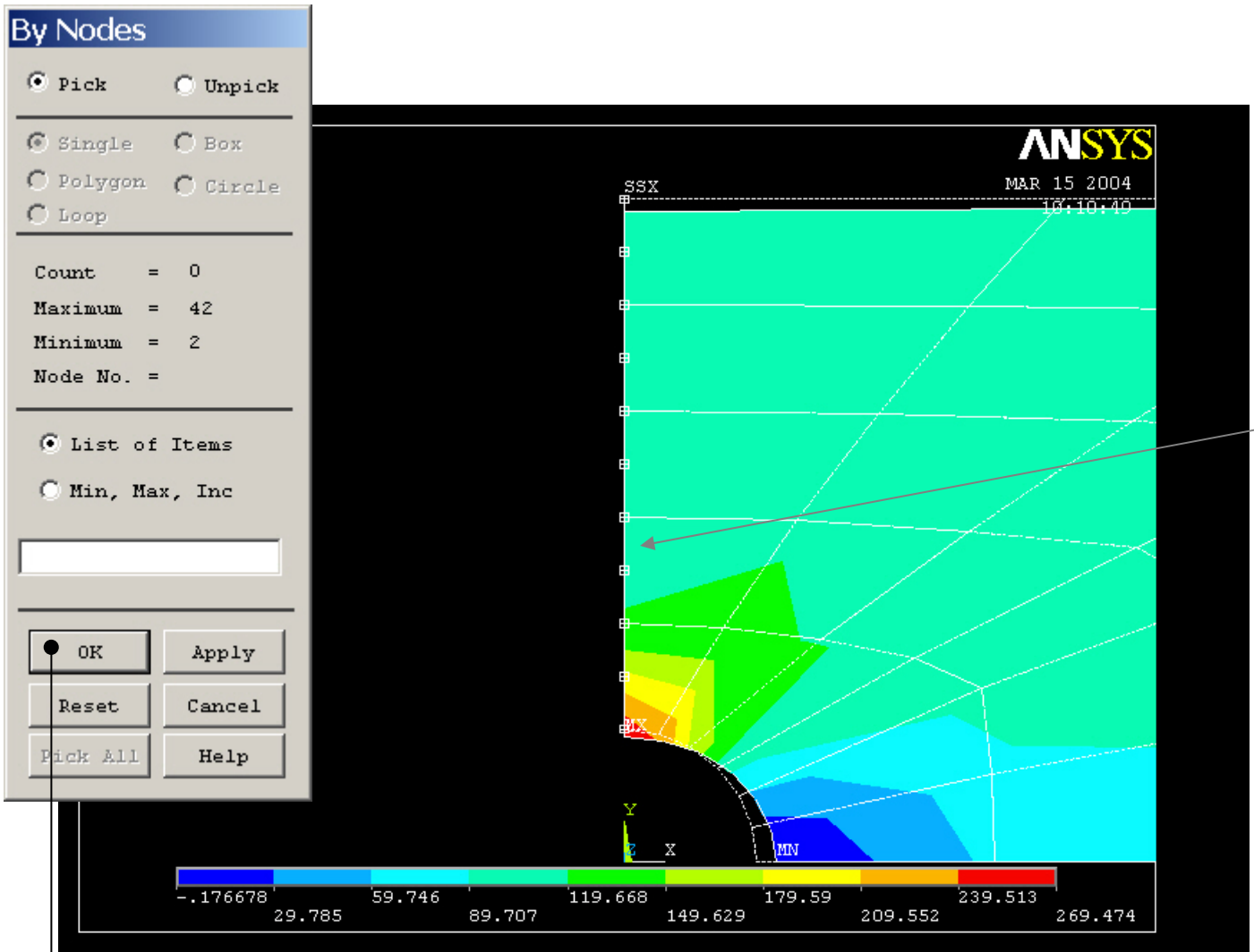
Example – Define Path





See next page for selection

Example – Define Path - By Nodes

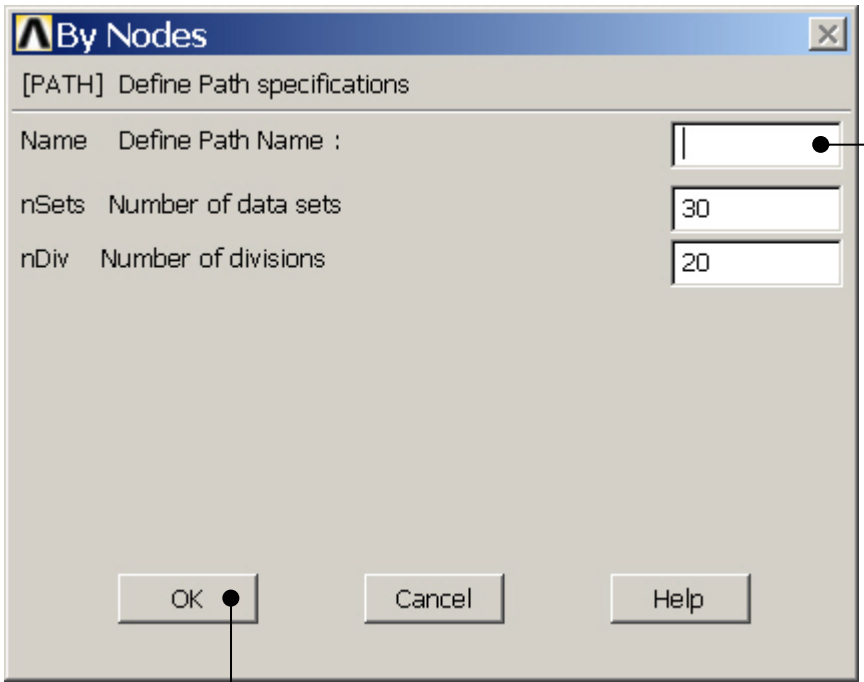


Select the indicated nodes

Note: the selection order is important – start from the hole

Enter OK when finished

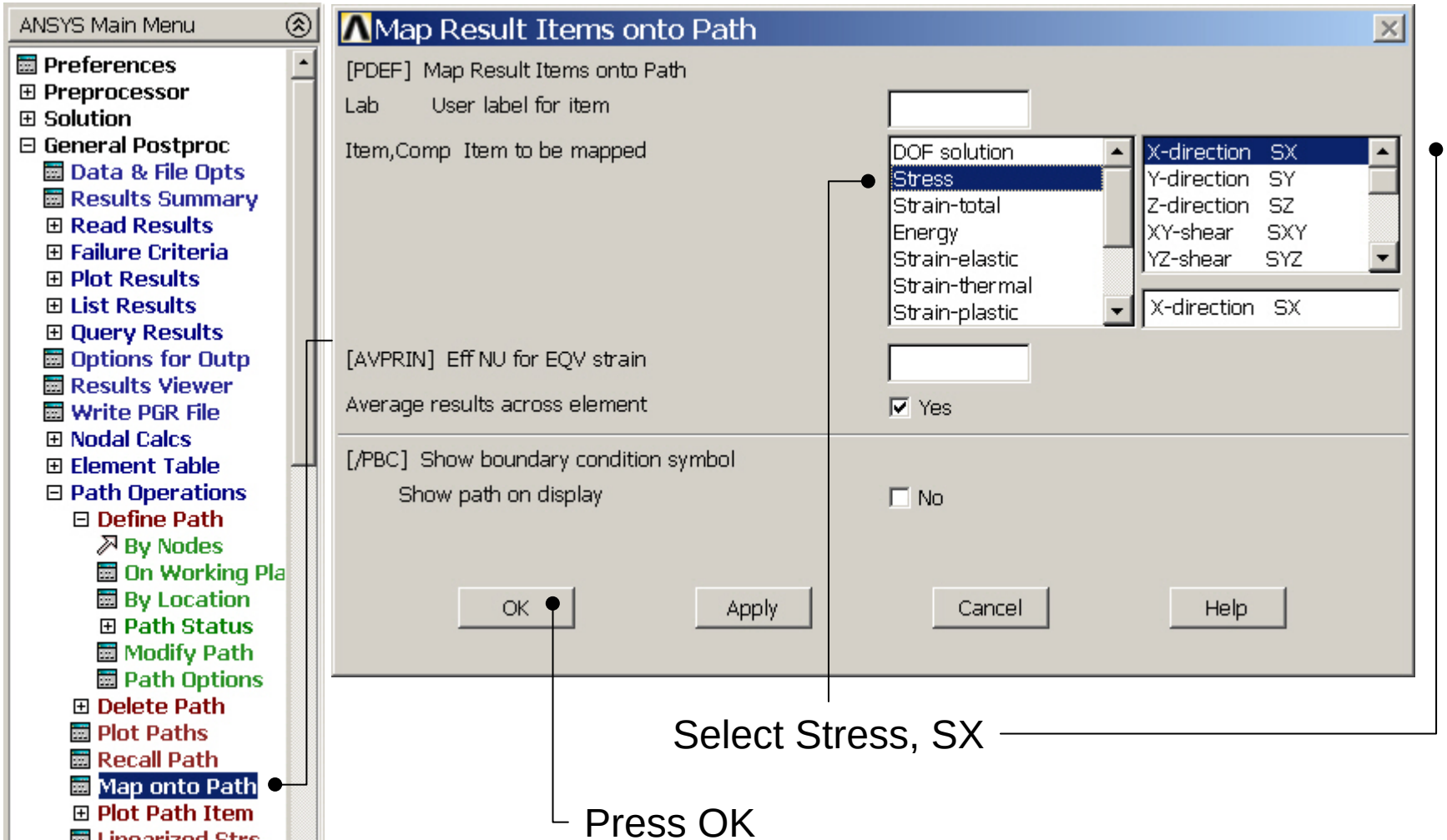
Example – Define Path - By Nodes



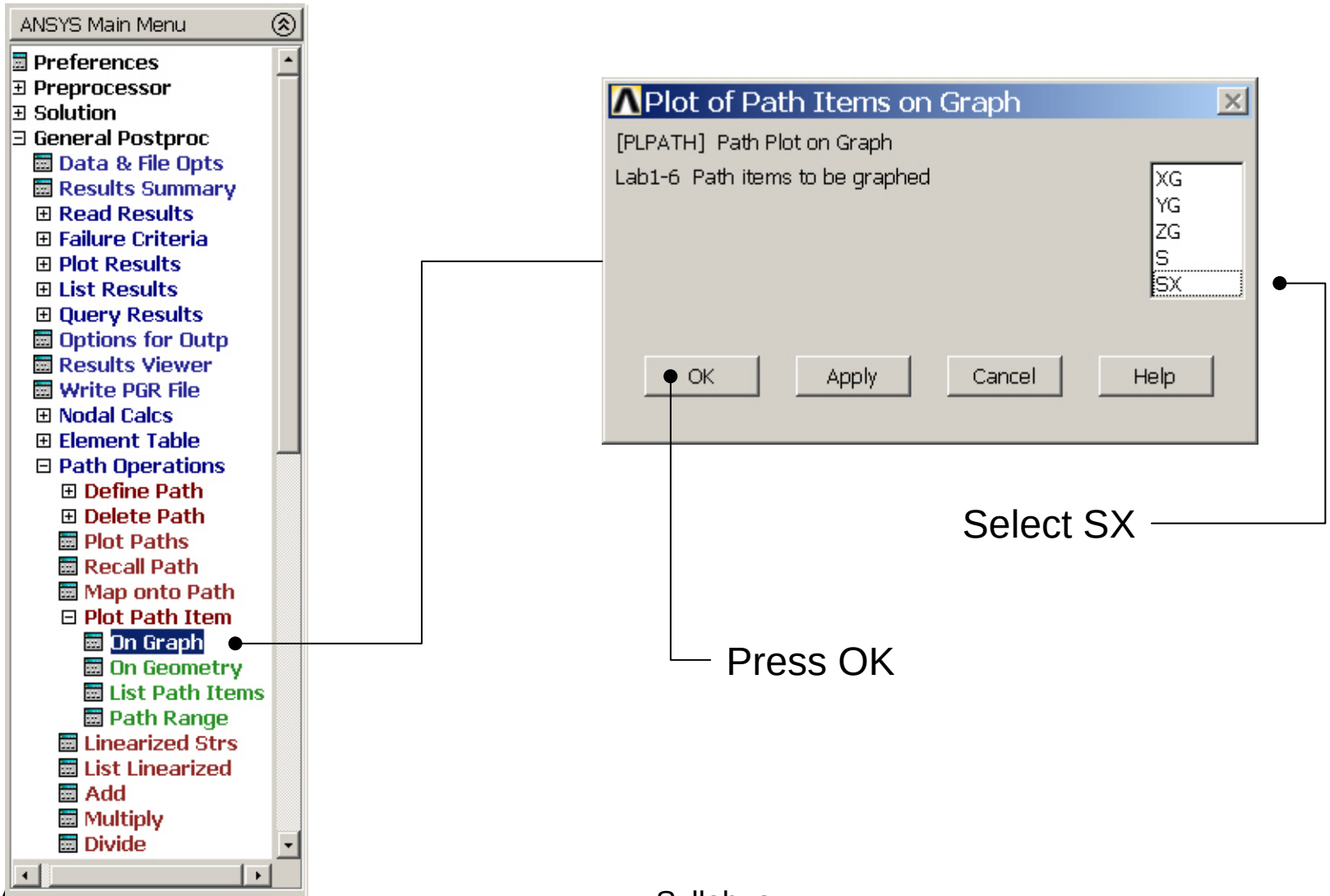
Enter an appropiate name, e.g. SSX

Enter OK

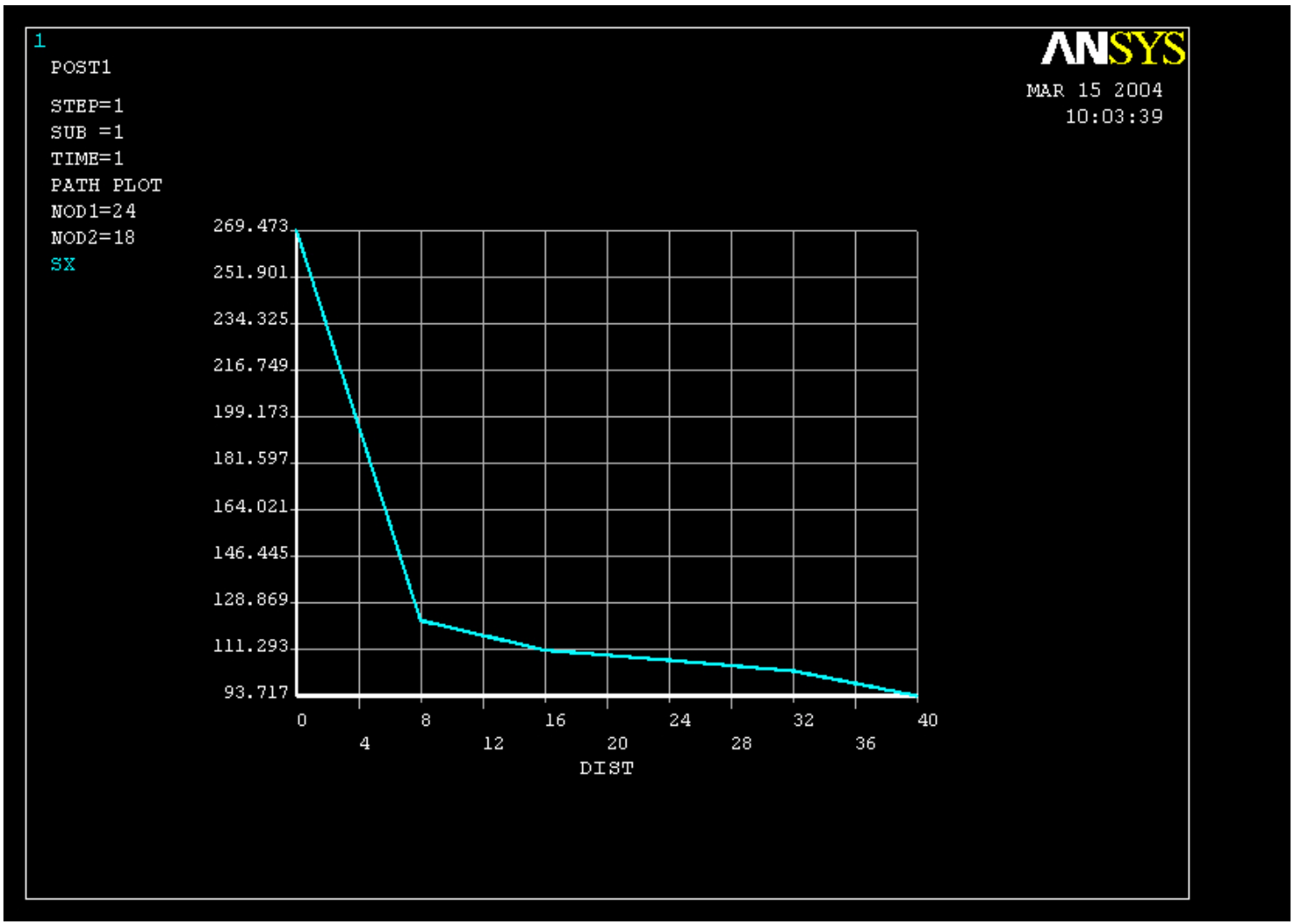
Example – Map onto Path



Example – Plot Path on Graph



Example – Plot Path on Graph



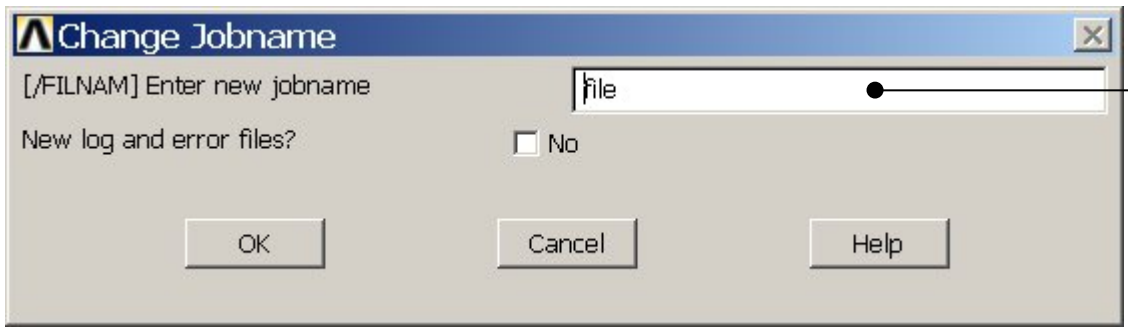
Steps in Submodeling

- The process for using submodeling is as follows:
  - Create and analyze the coarse model.
  - **Create the submodel.**
  - Perform cut boundary interpolation (CBI).
  - Analyze the submodel.
  - Verify that the distance between the cut boundaries and the stress concentration is adequate.

Example - title

Utility Menu > File > Change Jobname — GUI

/jobname, Example0702_fine — Command line entry

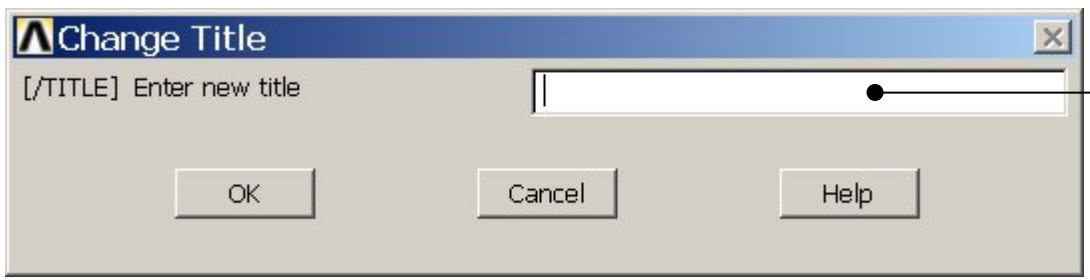


Enter: Example0702_fine

Utility Menu > File > Change Title

/title, Plate with a hole

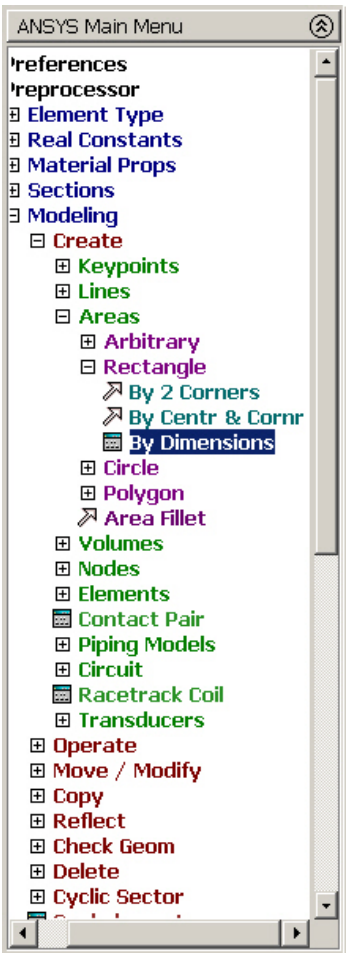
Enter: Plate with a hole

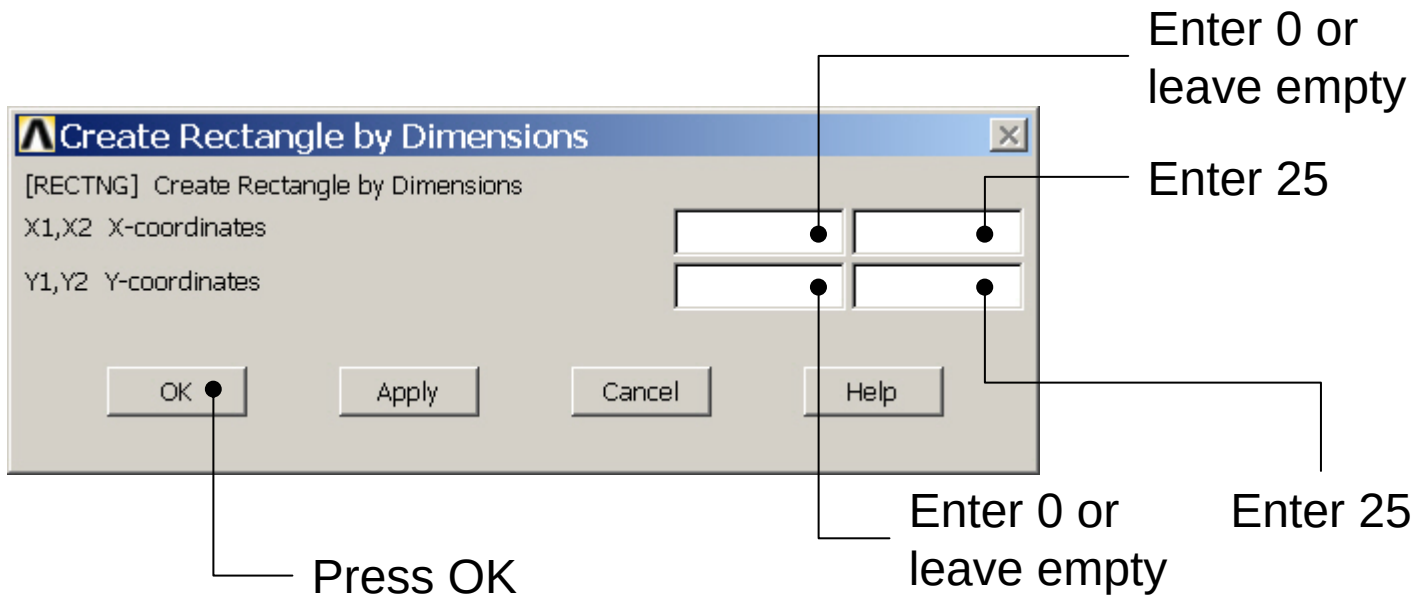


Example – Areas Rectangle

Preprocessor > Modeling > Create > Areas > Rectangle > By Dimensions

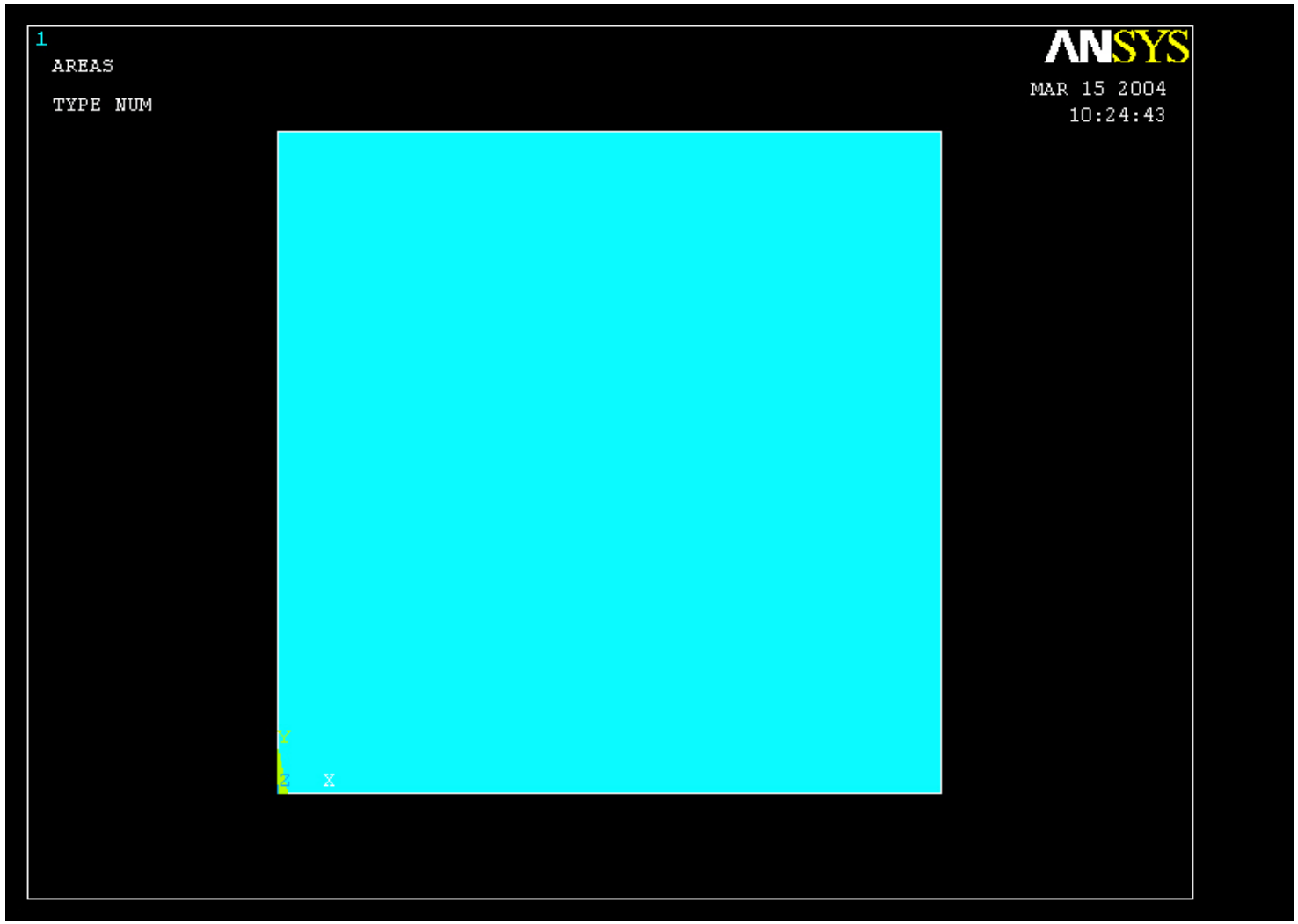
Create an area given by X=(0,25) and Y=(0,25)





Note: Keypoints (4 kp's) and lines (4 lines) are automatically generated (also numbered automatically)

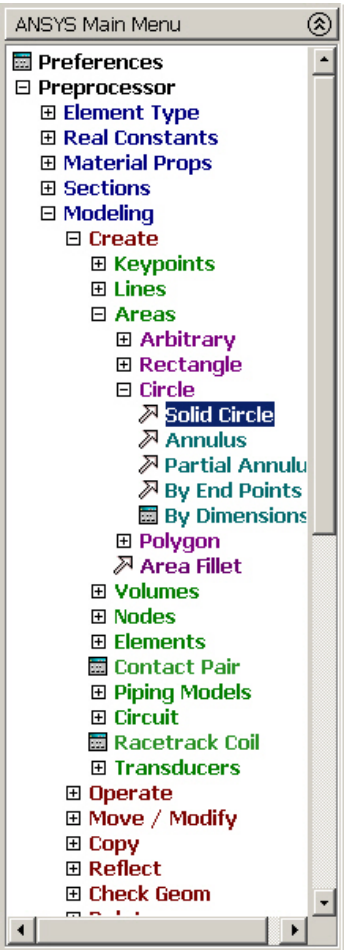
Example – Areas Rectangle

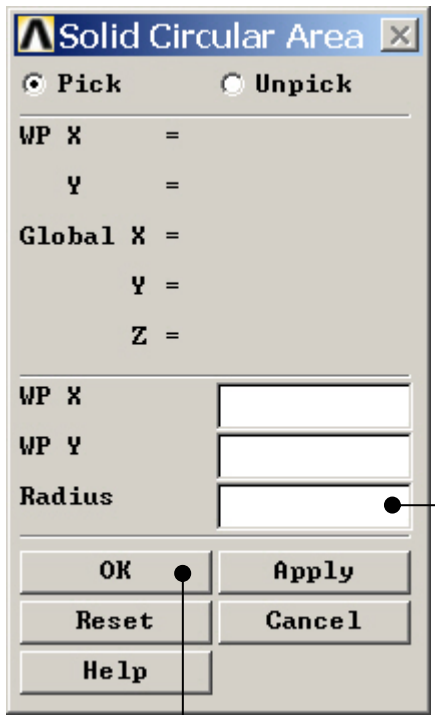


Example – Areas Circle

Preprocessor > Modeling > Create > Areas > Circle > Solid Circle

Create an area given by (X,Y)=(0, 0) and Radius=10



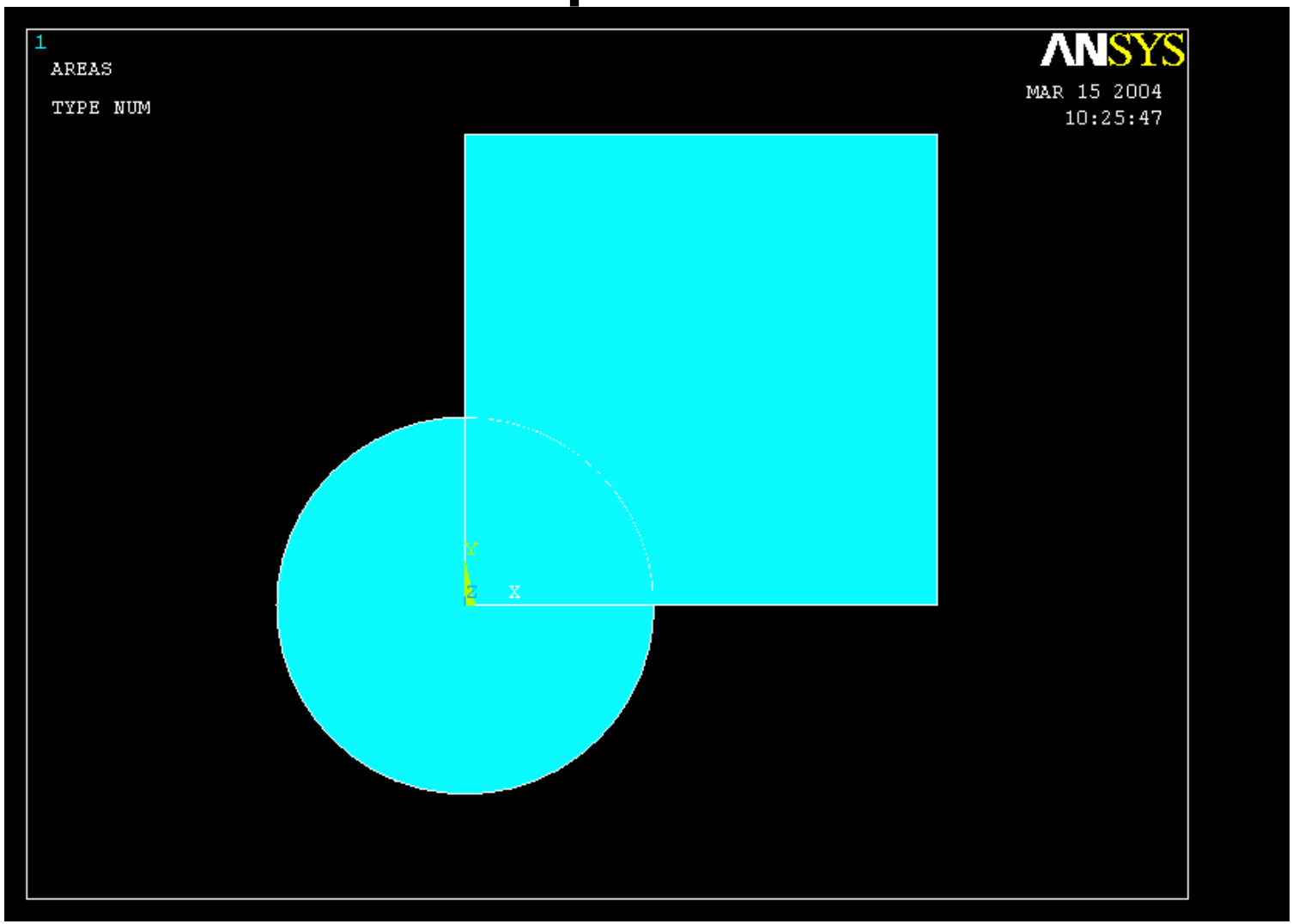


Enter 10

Press OK

Note: Keypoints (4 kp's) and lines (4 lines) are automatically generated (also numbered automatically)

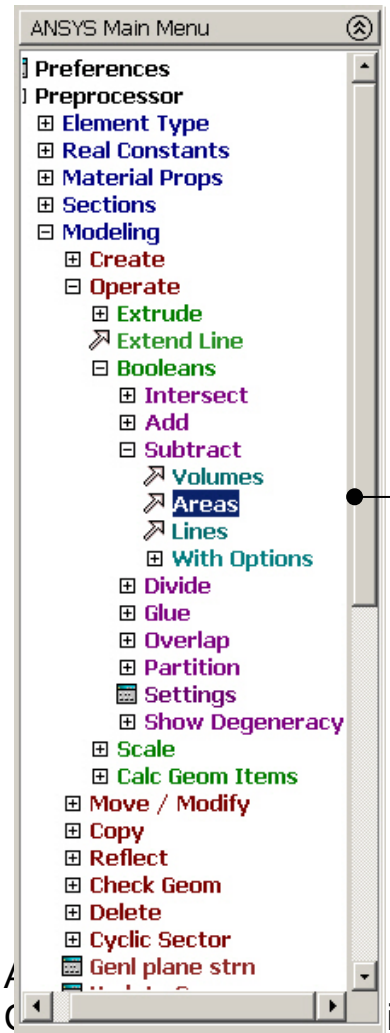
Example - Area

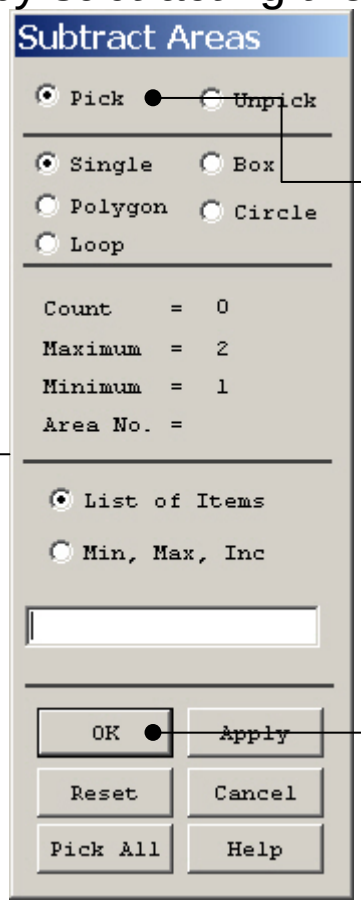


Example - Operate

Preprocessor > Modeling > Operate > Booleans > Subtract > Areas

Create the final area by subtracting the circular area from the rectangular area





Note: Bottom left corner of ANSYS GUI

[ASBA] Pick or enter base areas from which to subtract

Select the rectangular area and press OK

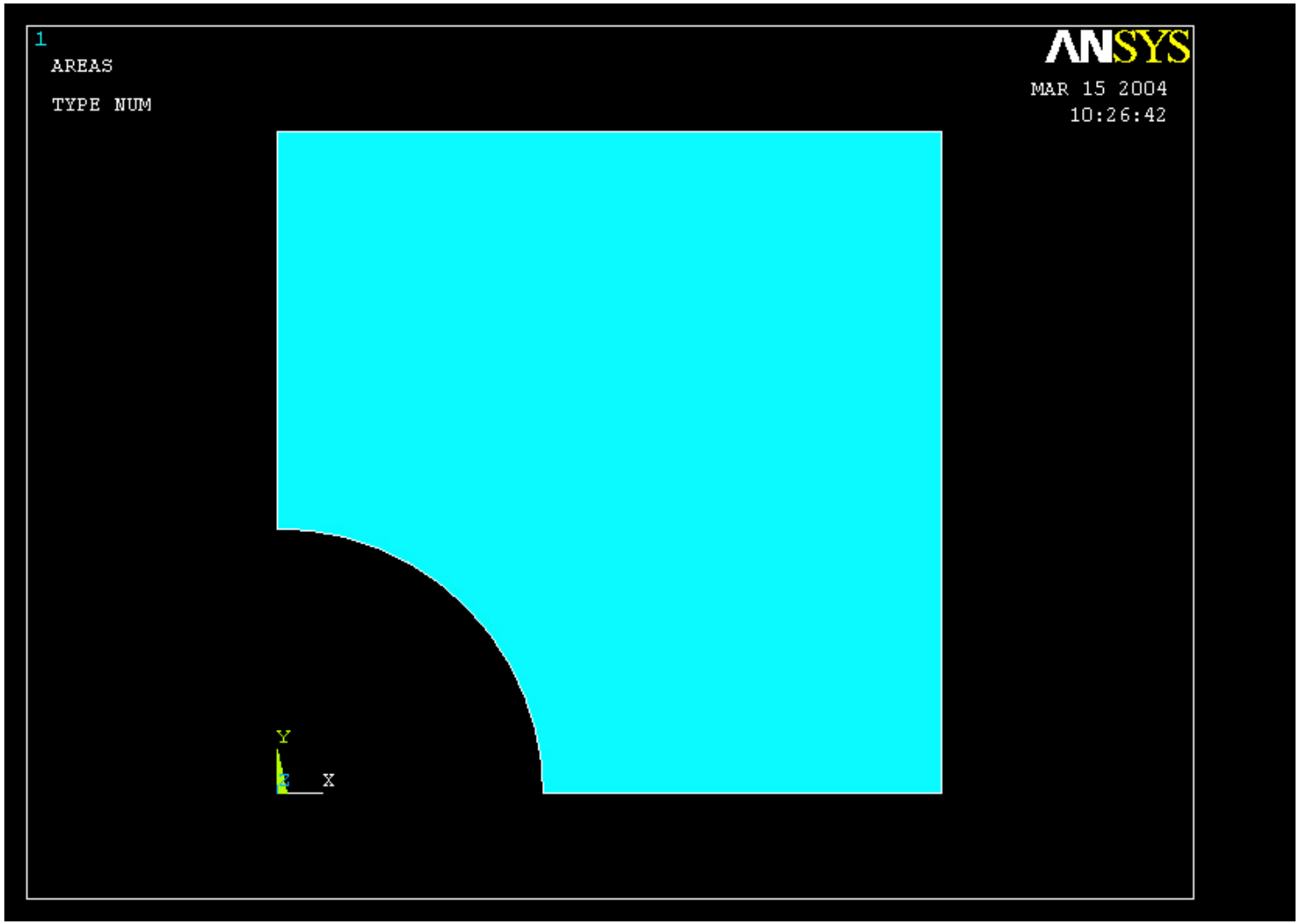
Note: Bottom left corner of ANSYS GUI

Pick or enter areas to be subtracted

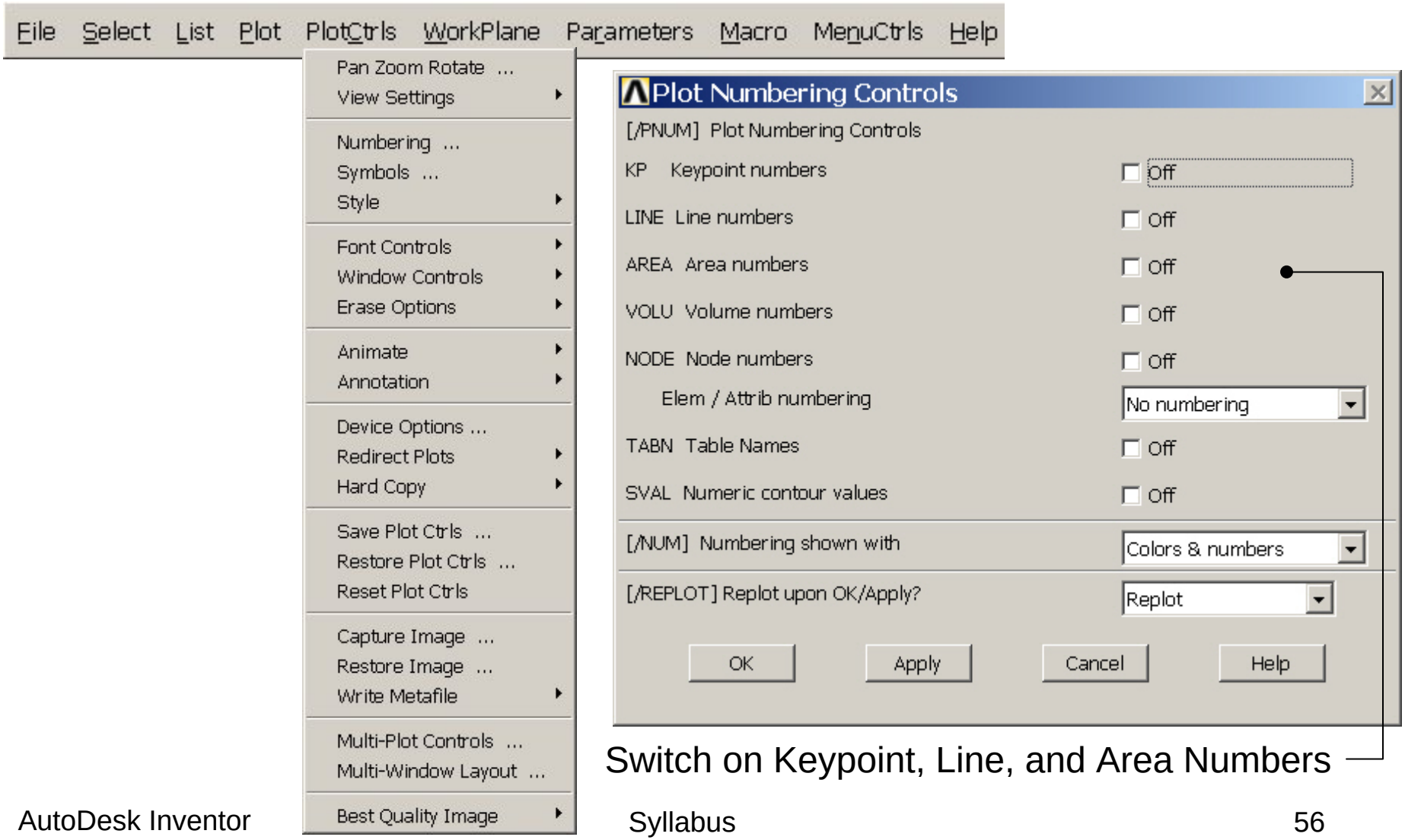
Select the circular area

Press OK

Example – Areas

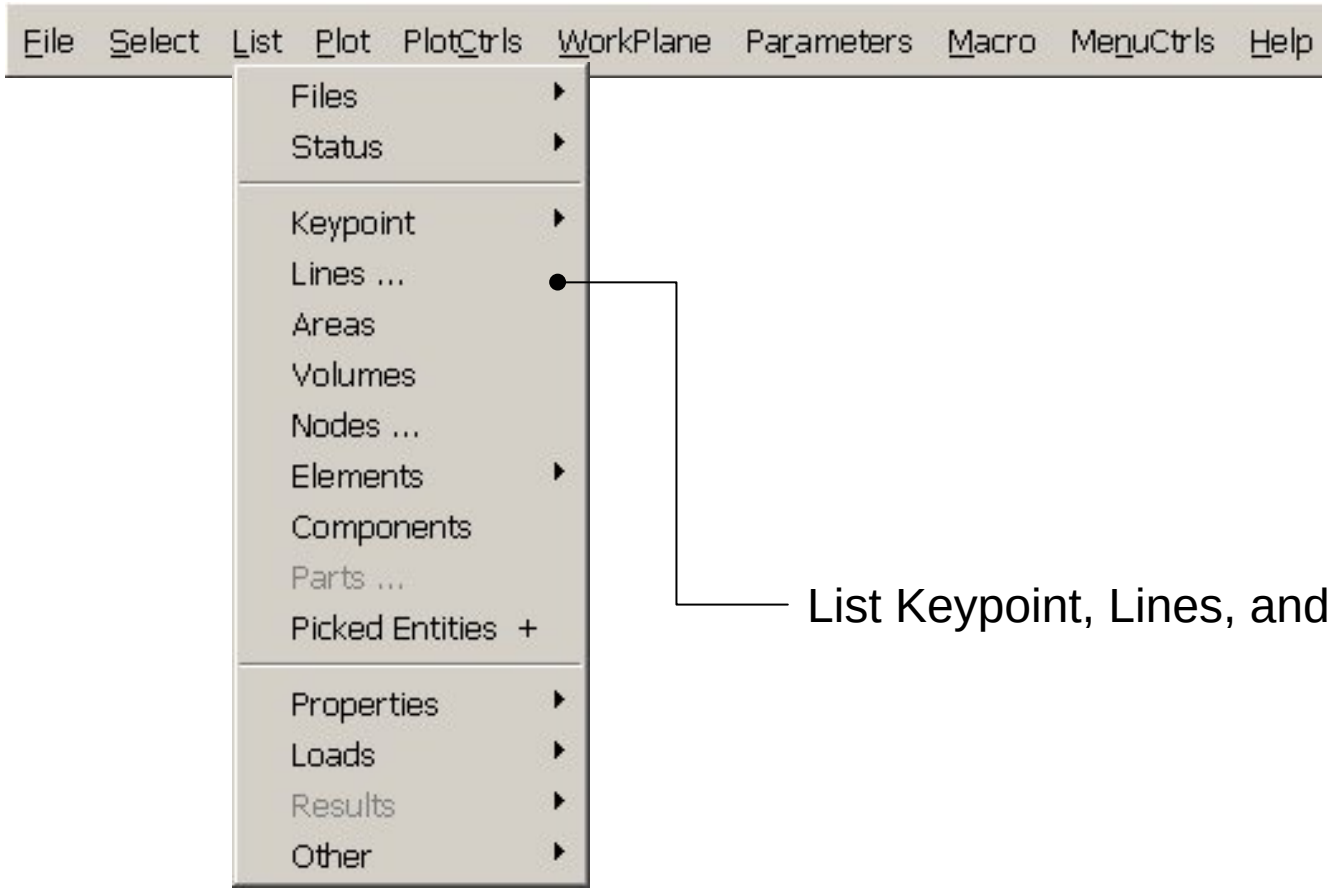


Example - Numbering



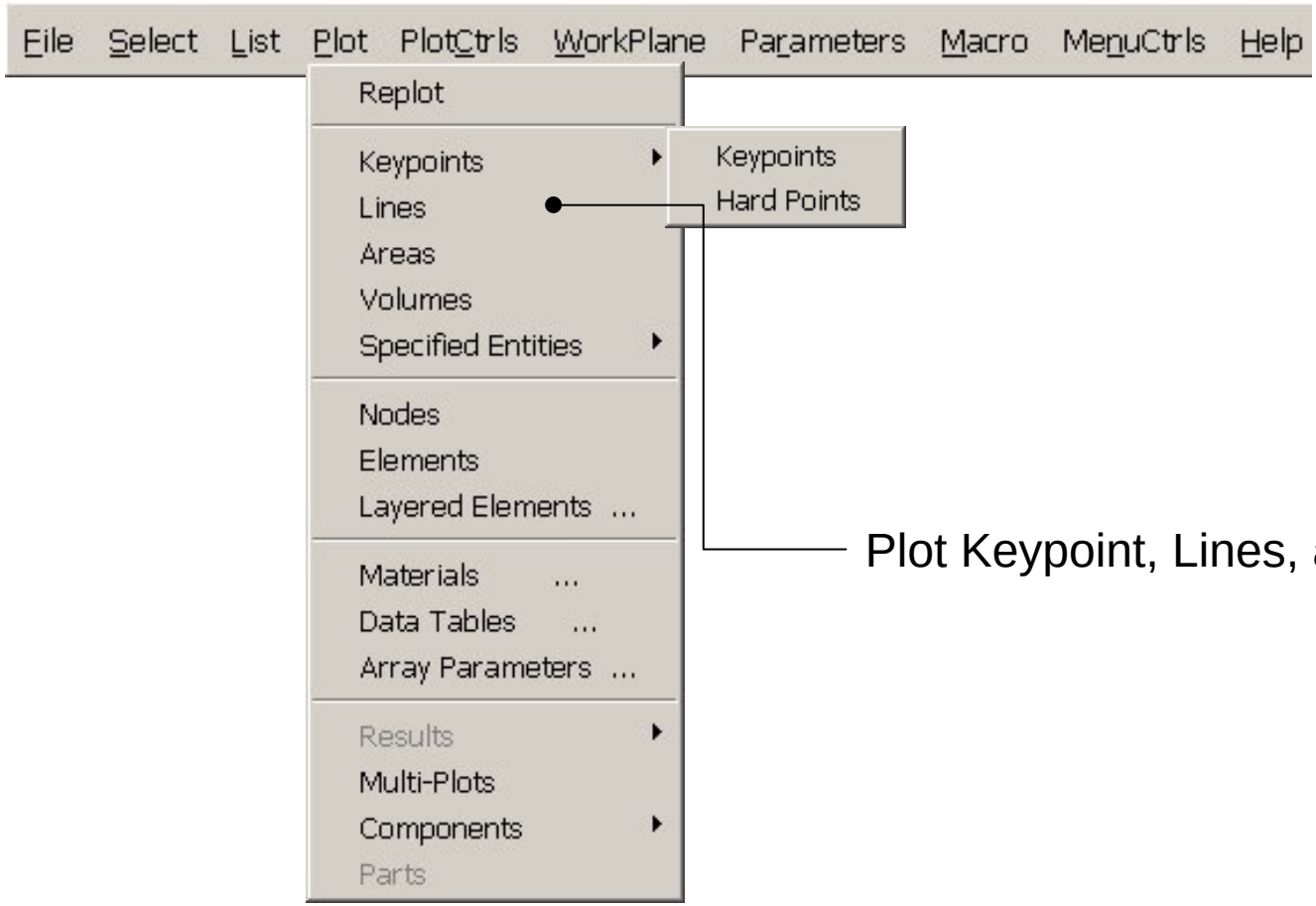
Switch on Keypoint, Line, and Area Numbers

Example - List Menu



List Keypoint, Lines, and Areas

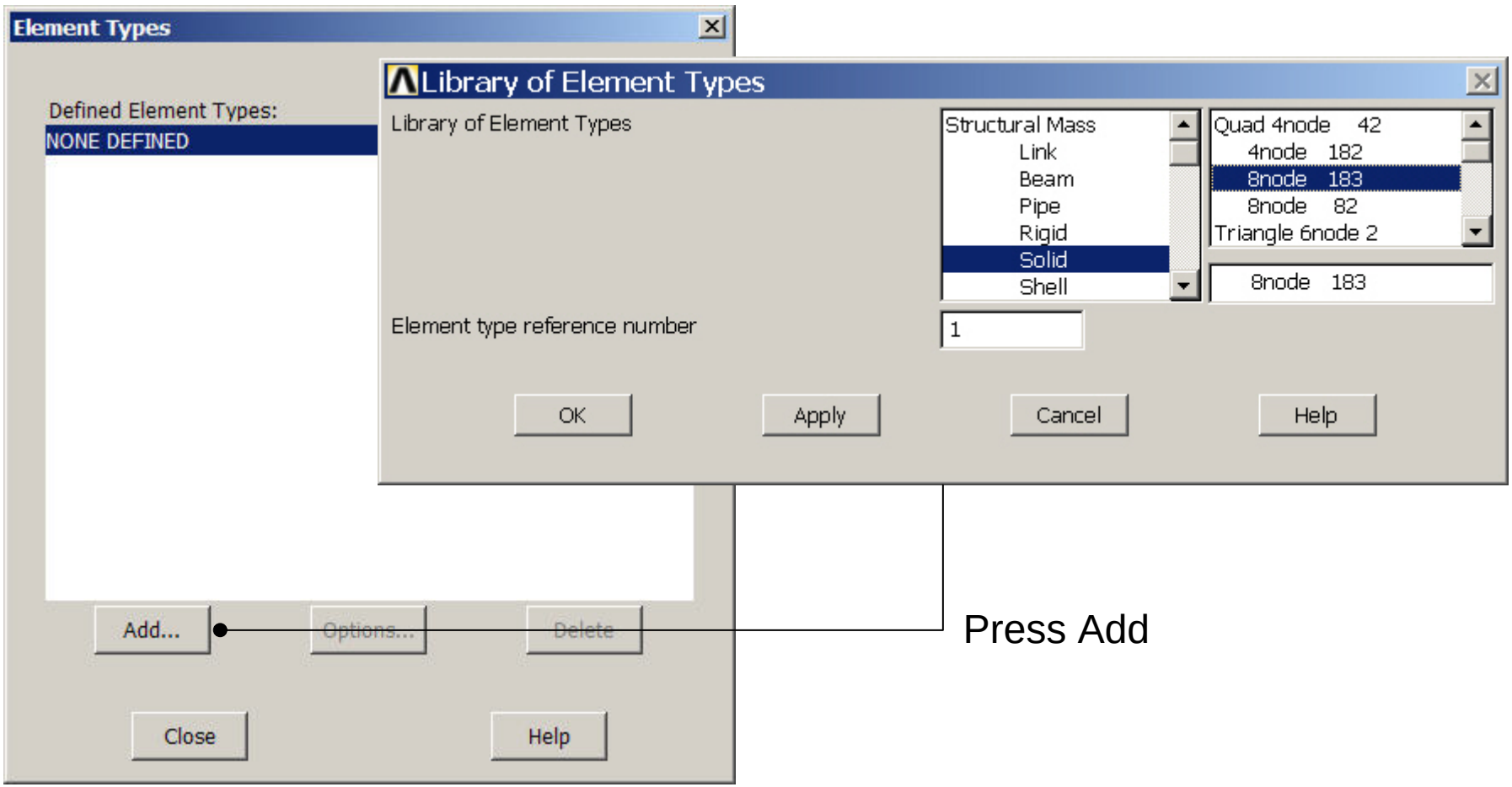
Example - Plot Menu



Plot Keypoint, Lines, and Areas

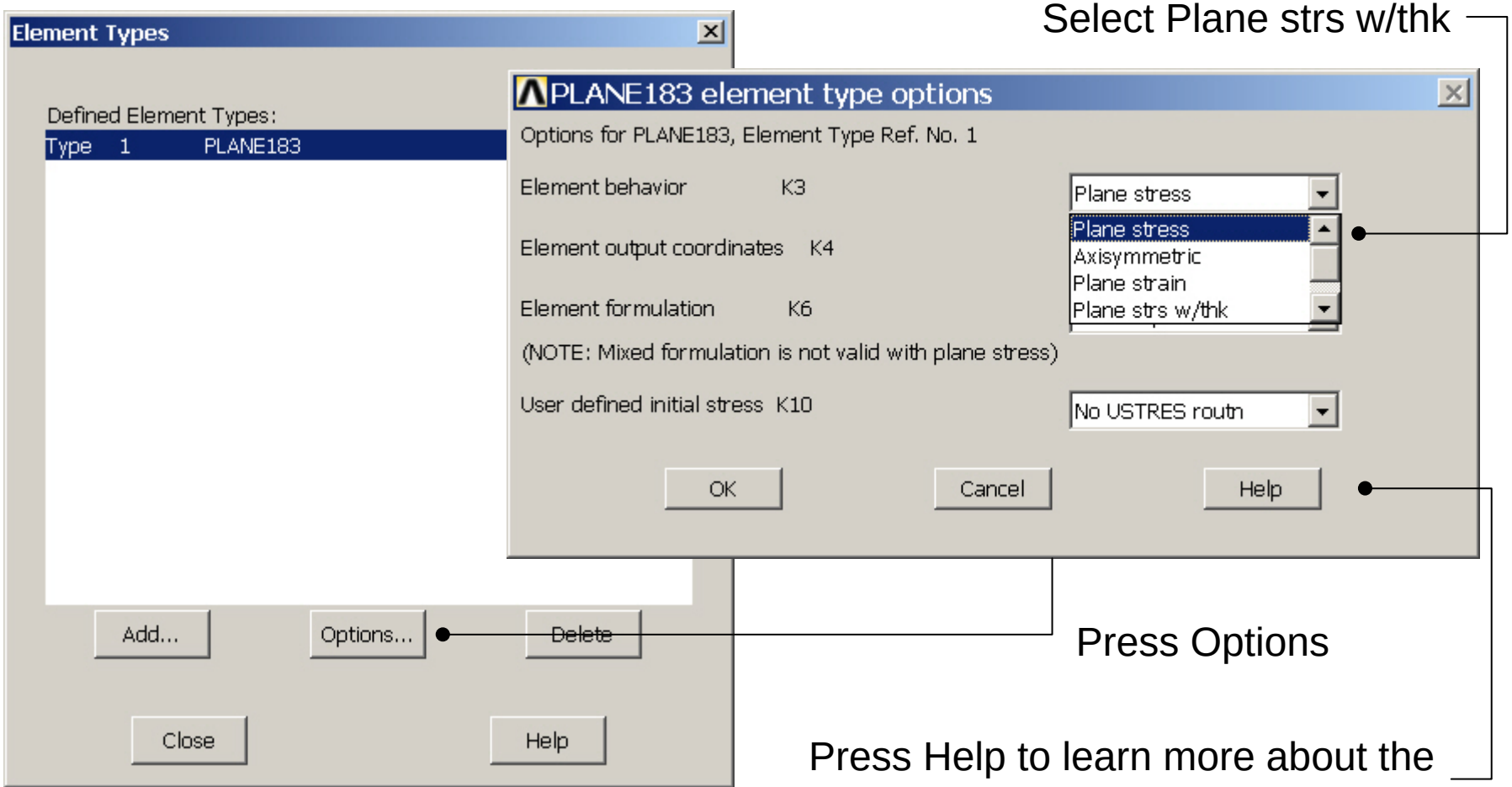
Example – Element Type

Preprocessor > Element Type > Add/Edit/Delete



Example - Element Type

Preprocessor > Element Type > Add/Edit/Delete



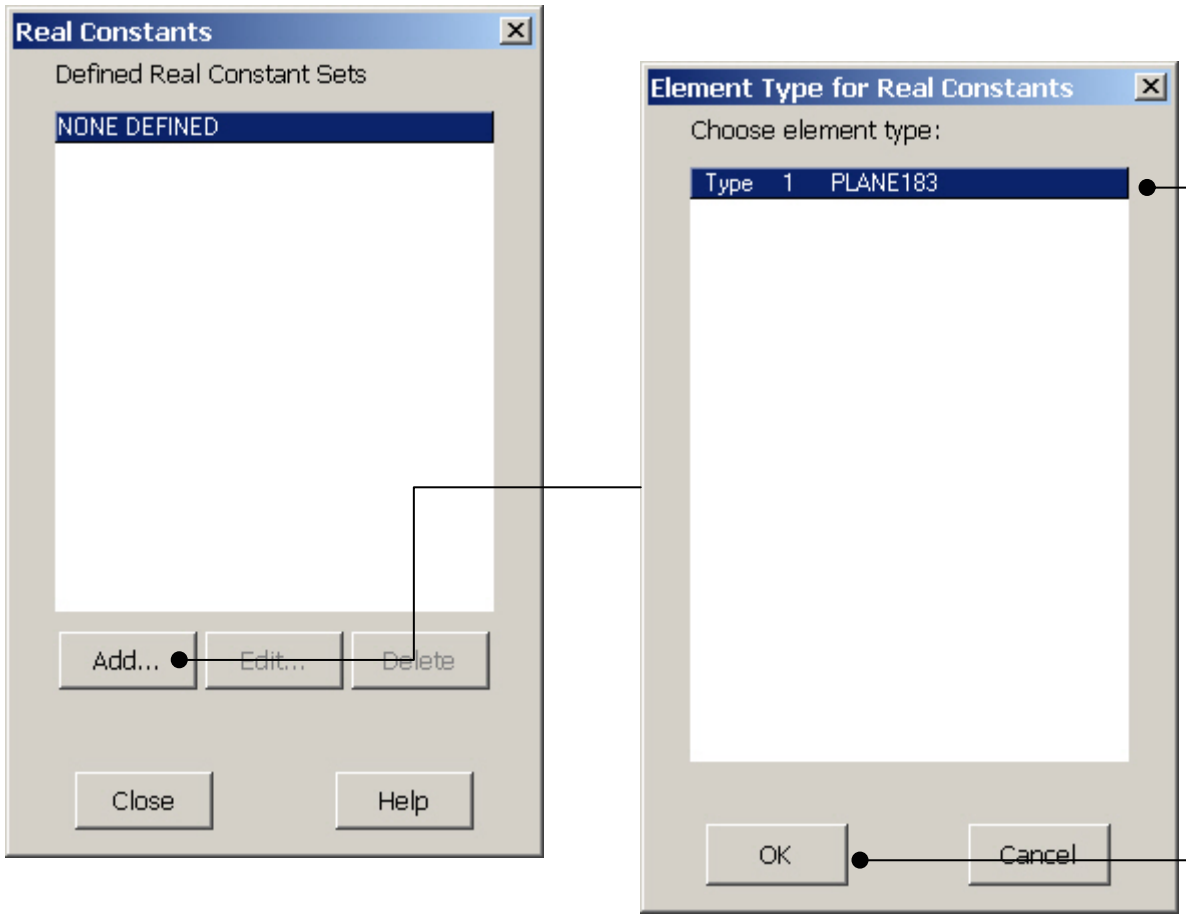
Select Plane strs w/thk

Press Options

Press Help to learn more about the element.

Example – Real Constants

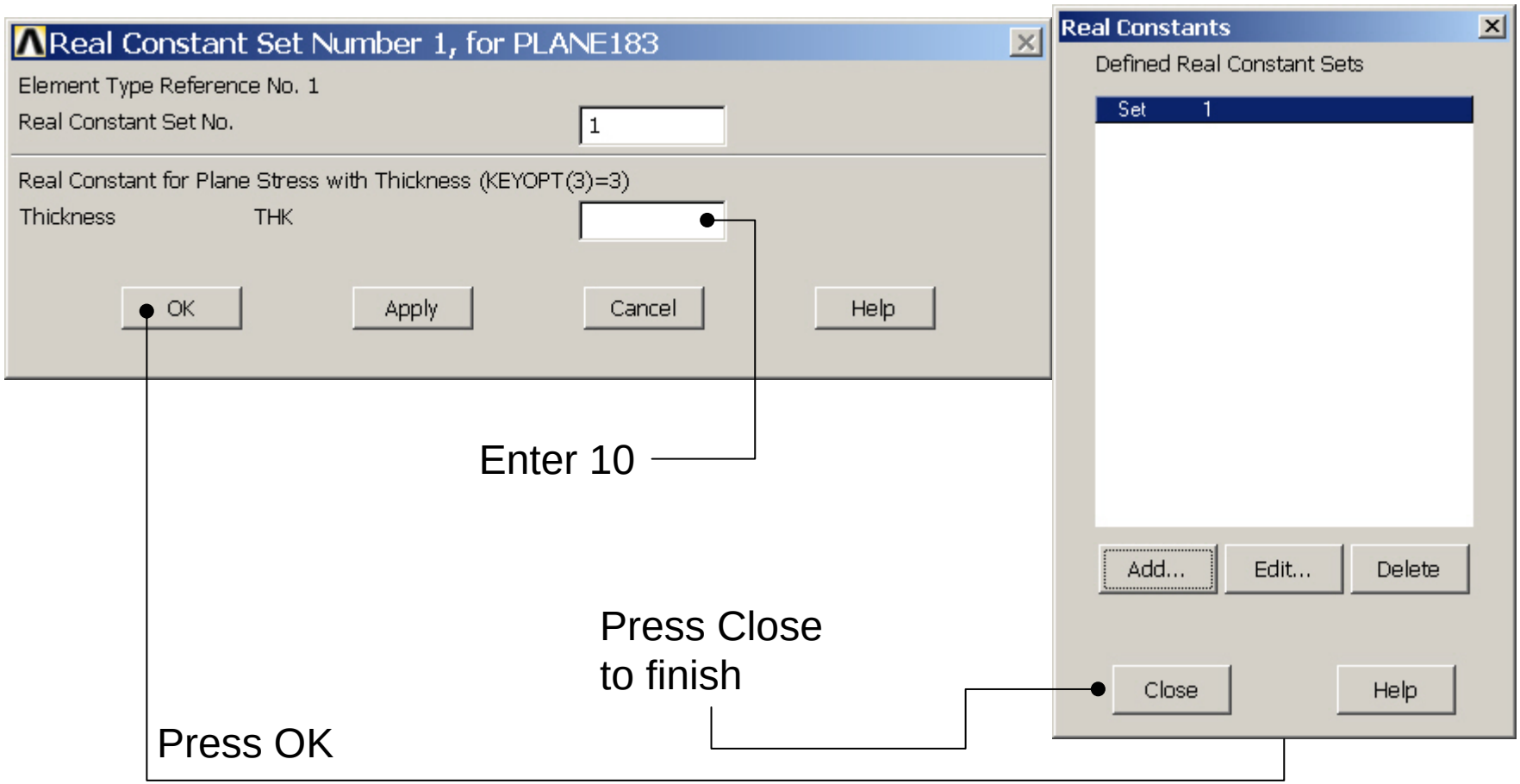
Preprocessor > Real Constants > Add



Place the cursor on the relevant element and press OK

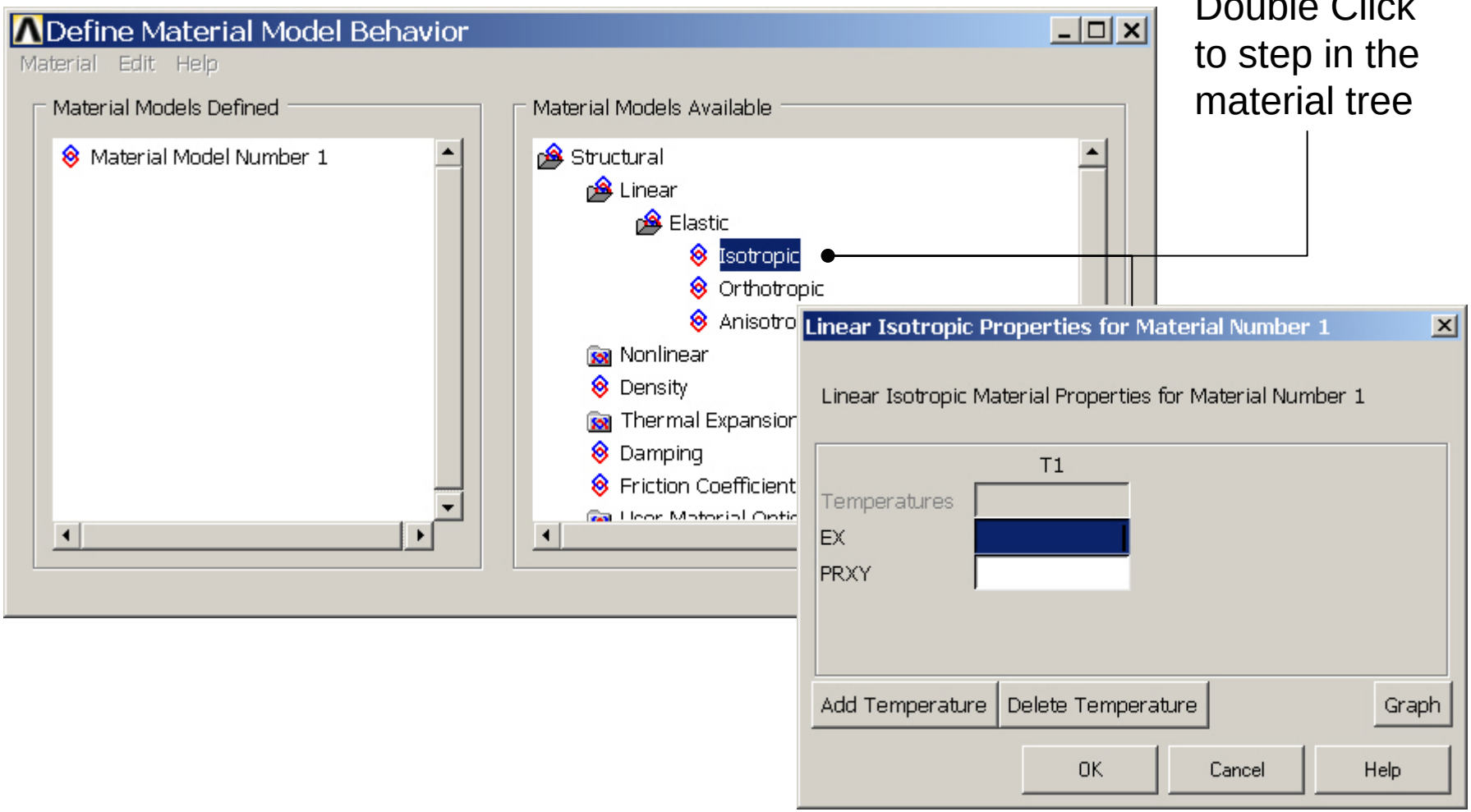
Example - Real Constants

Preprocessor > Real Constants > Add



Example - Material Properties

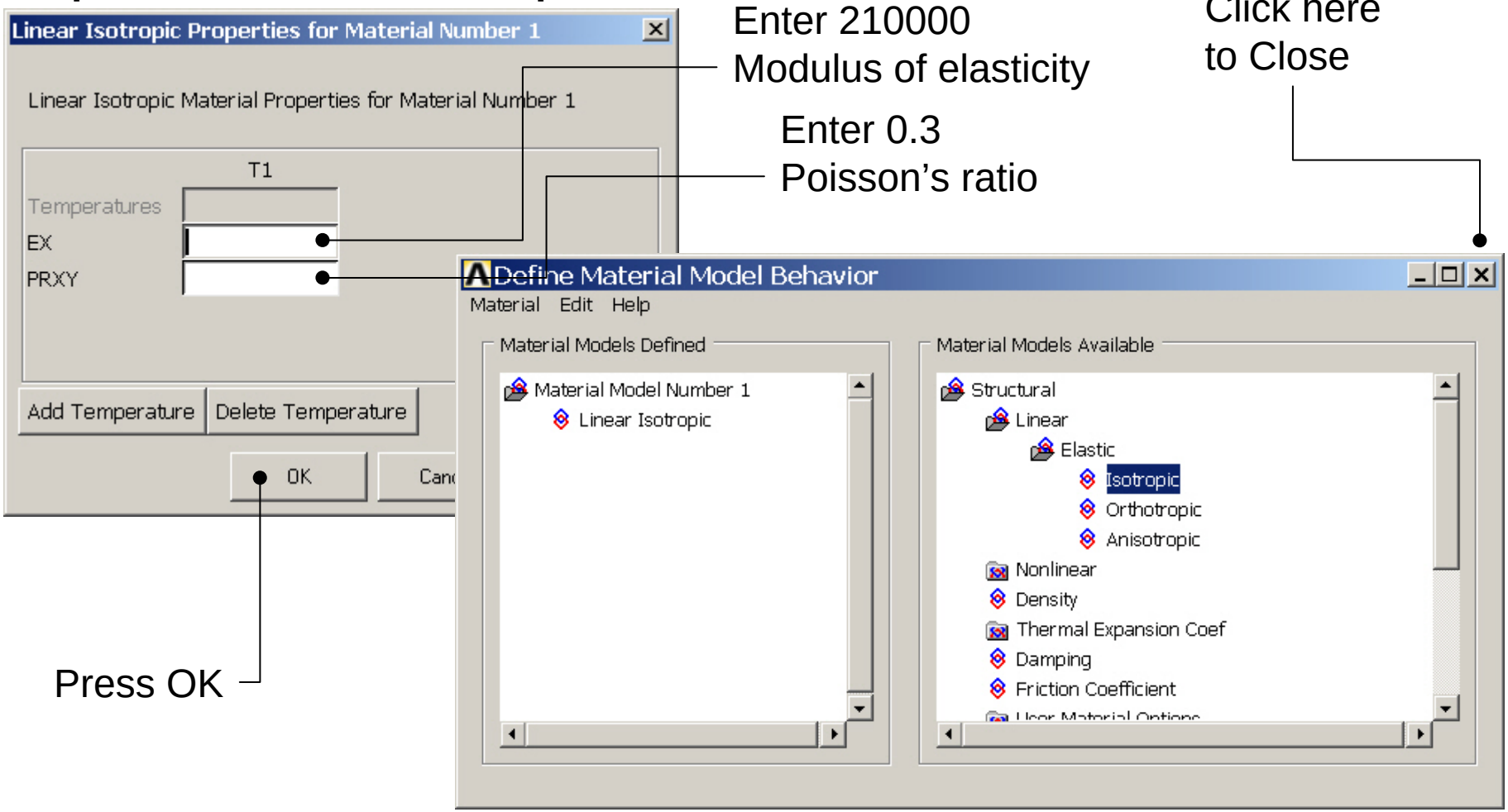
Preprocessor > Material Props > Material Models



Double Click to step in the material tree

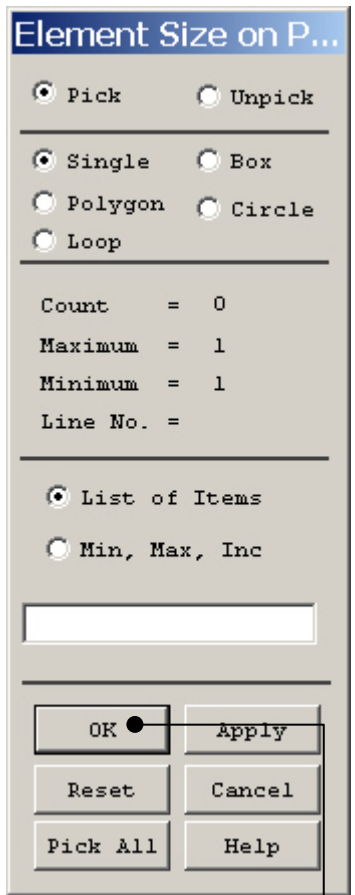
Example - Material Properties

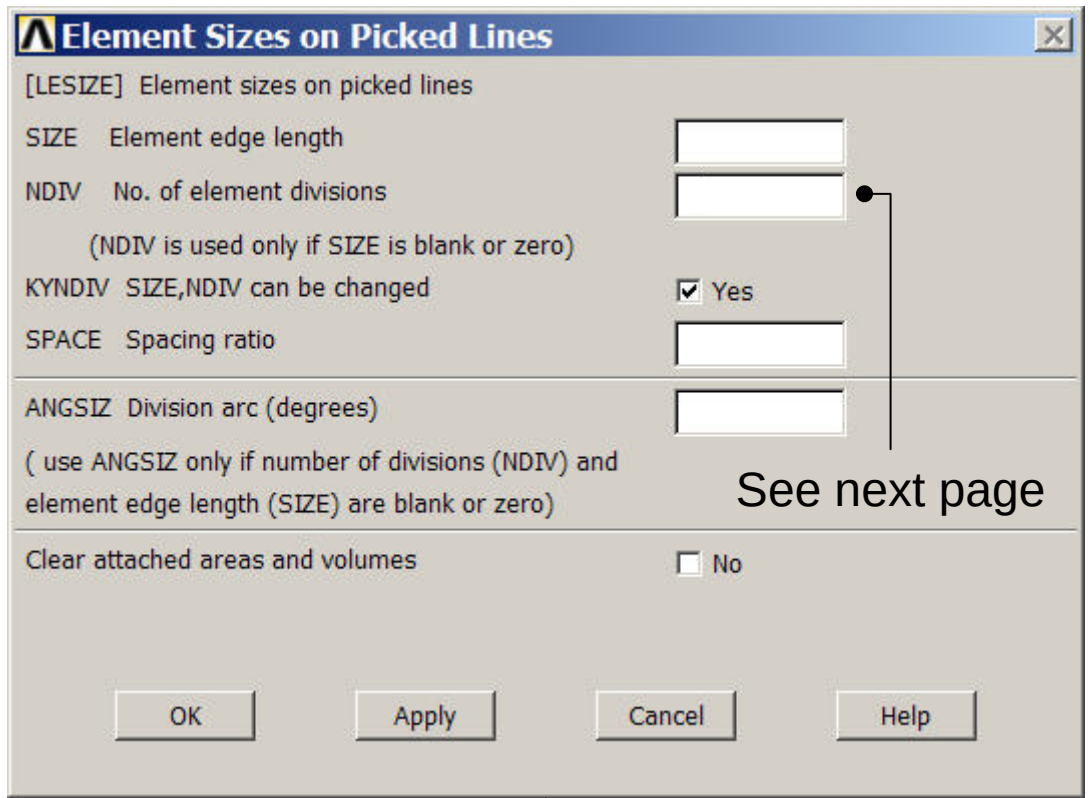
Preprocessor > Material Props > Material Models



Example - Meshing

Preprocessor > Meshing > Size Cntrls > ManualSize > Lines > Picked Lines





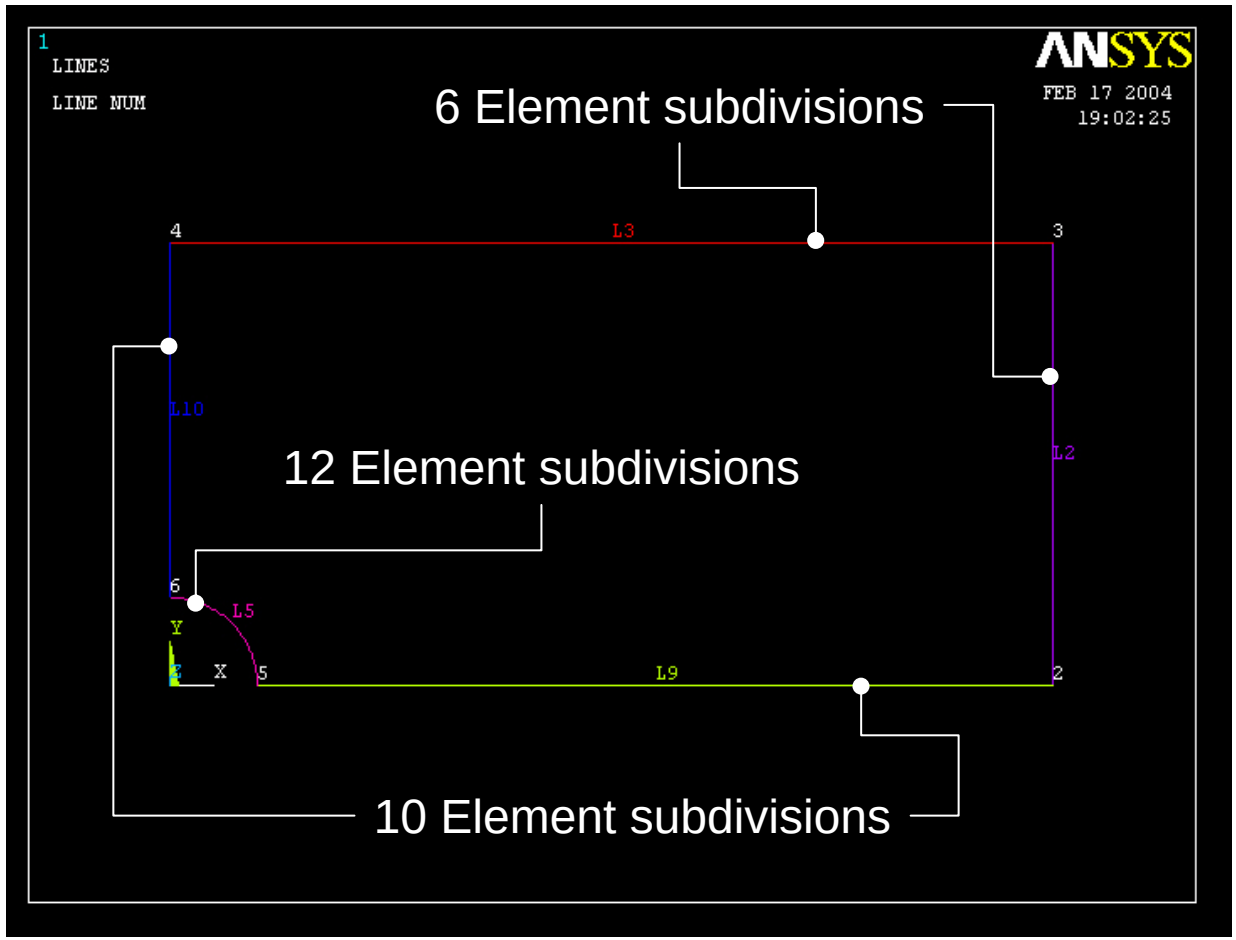
Select/Pick Lines to specify mesh size for

Pick the two longest lines

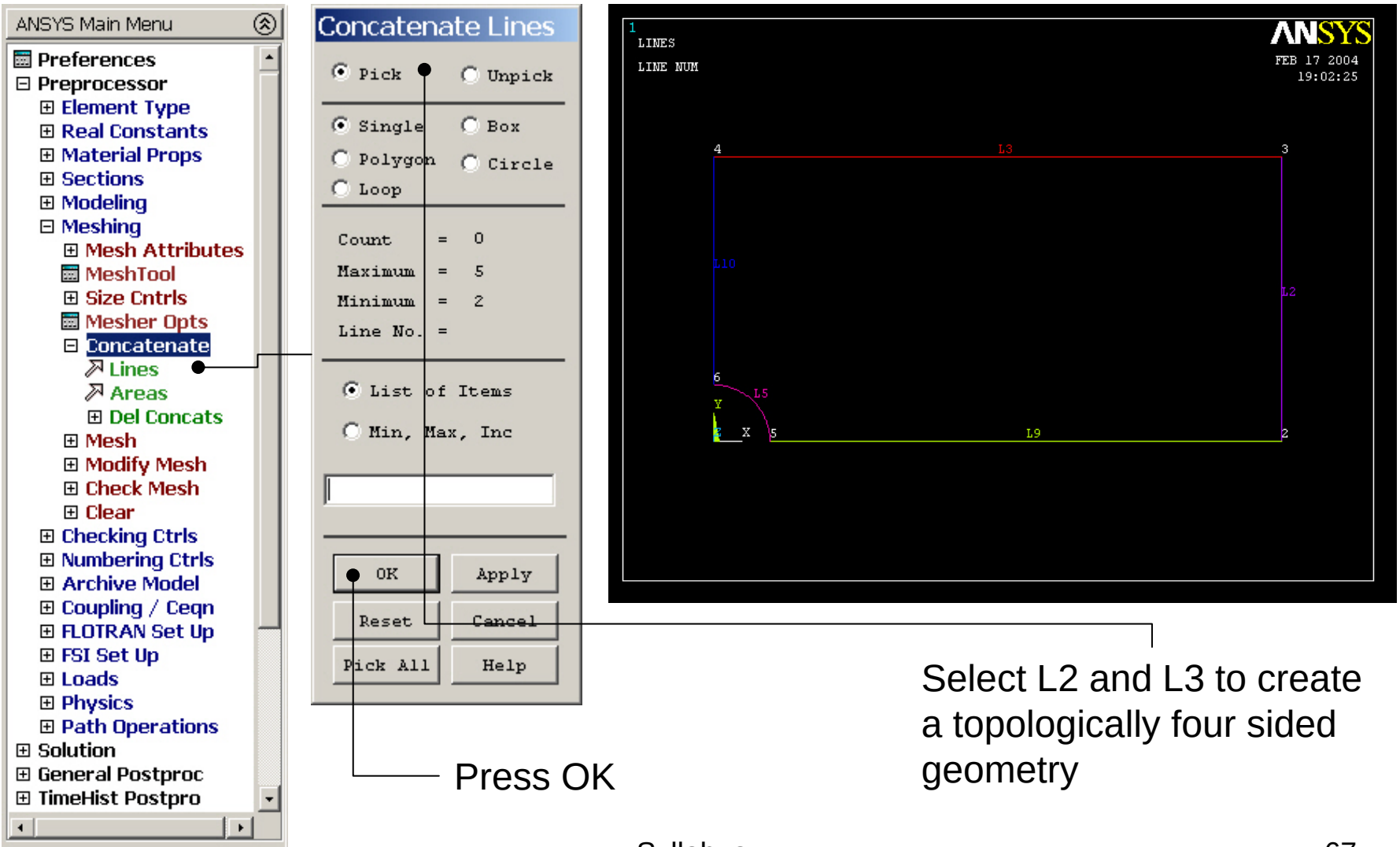
See next page

Press OK when finish with selection

Example – Mesh Size

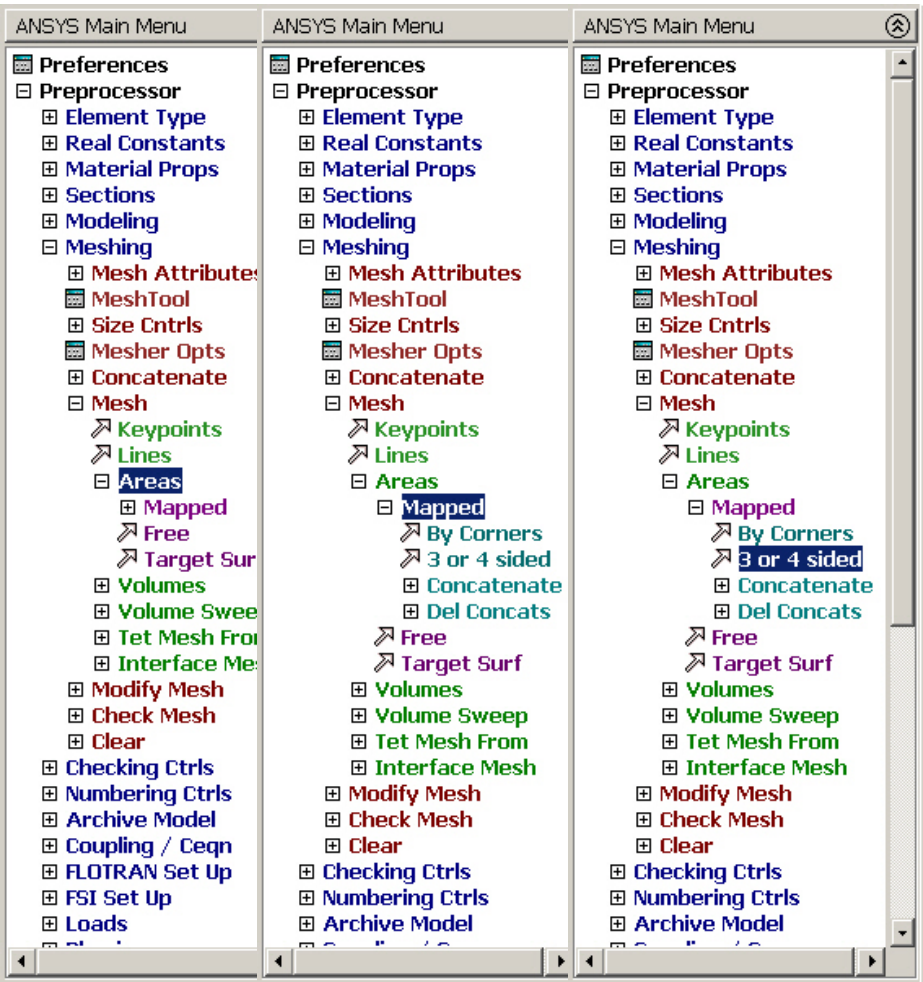


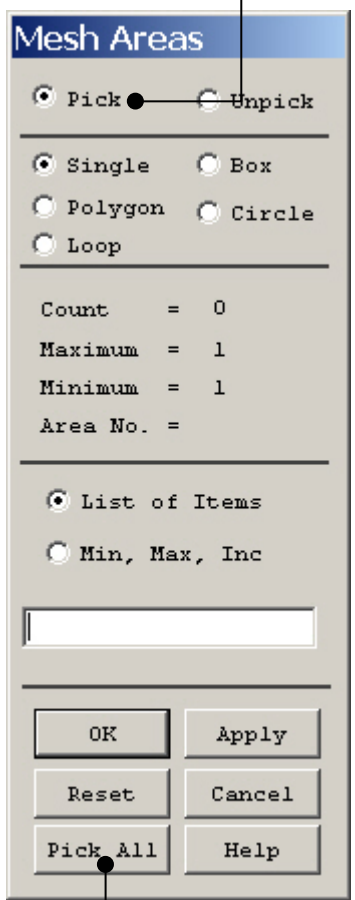
Example – Concatenate Lines



Example - Meshing

Preprocessor > Meshing > Mesh > Areas > Mapped > 3 or 4 sided



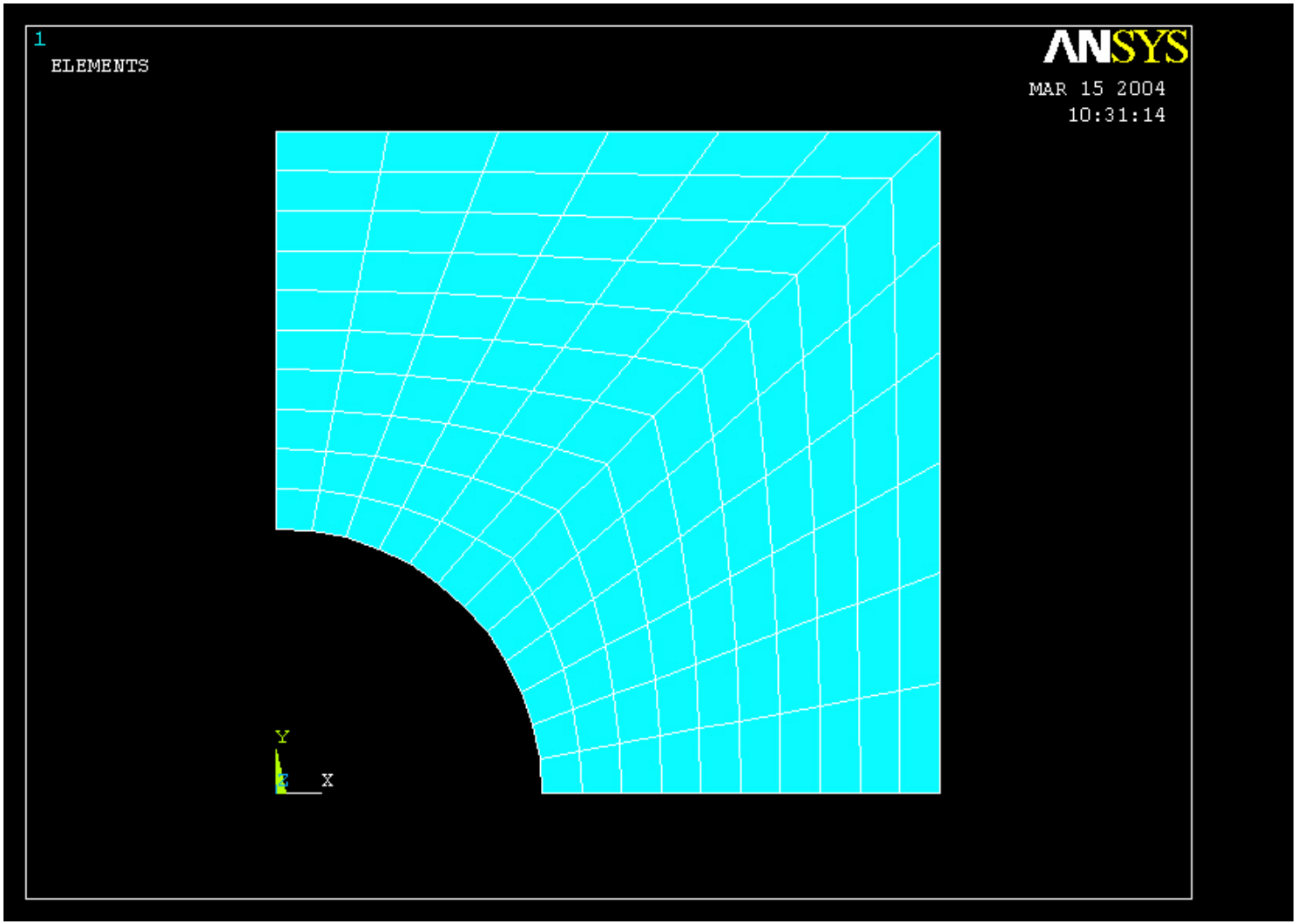


Select individual areas to be meshed

NB: It is often necessary to “Clear” the model for example if Element Type or model geometry is to be changed

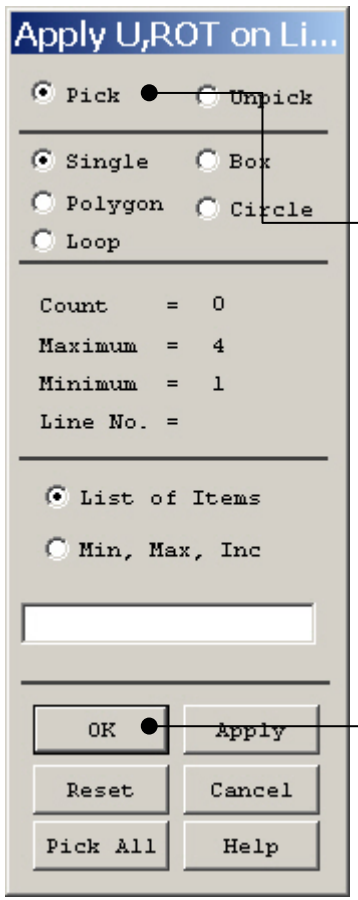
Select all areas defined to be meshed

Example – Mapped Mesh



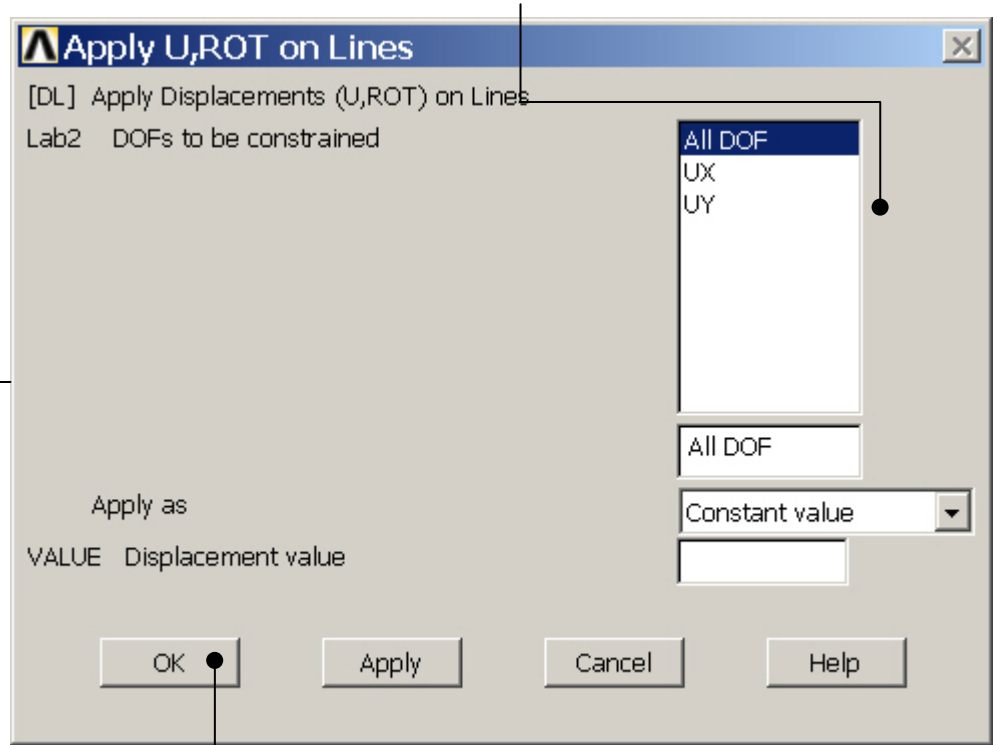
Example – Define Loads

Solution > Define Loads > Apply > Structural > Displacement > On Lines



Select the bottom straight line

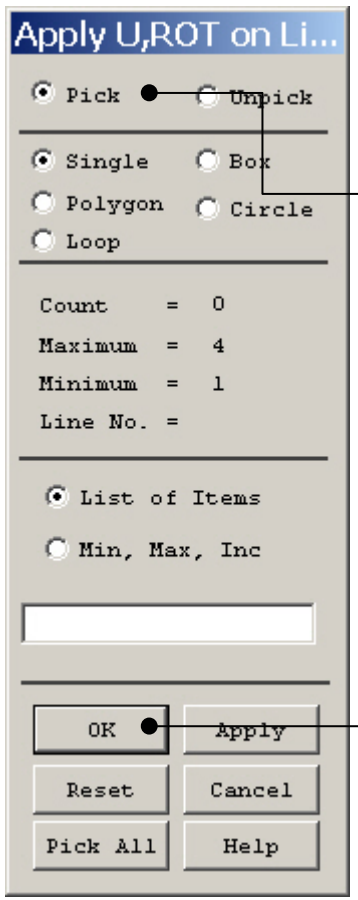
Select UY to fix the plate in the y-direction



Press OK

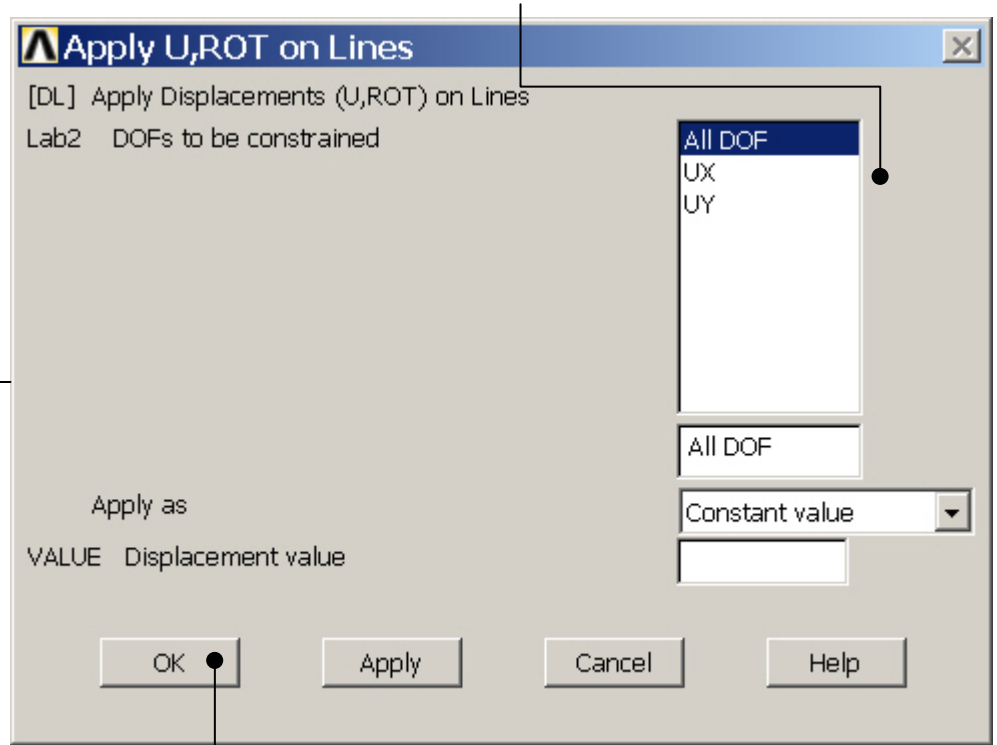
Example – Define Loads

Solution > Define Loads > Apply > Structural > Displacement > On Lines



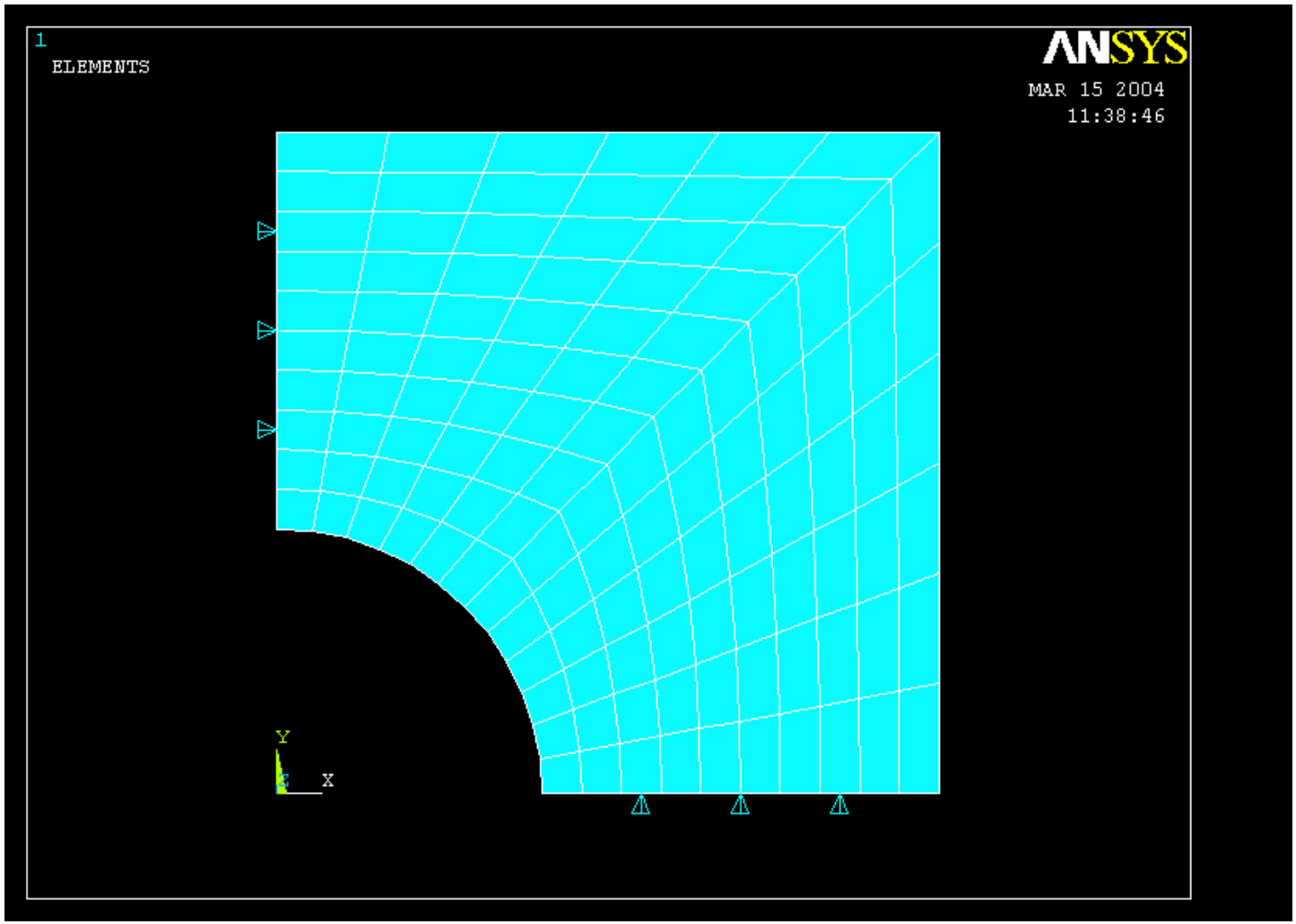
Select the left straight line

Select UX to fix the plate in the x-direction



Press OK

Example - Submodel



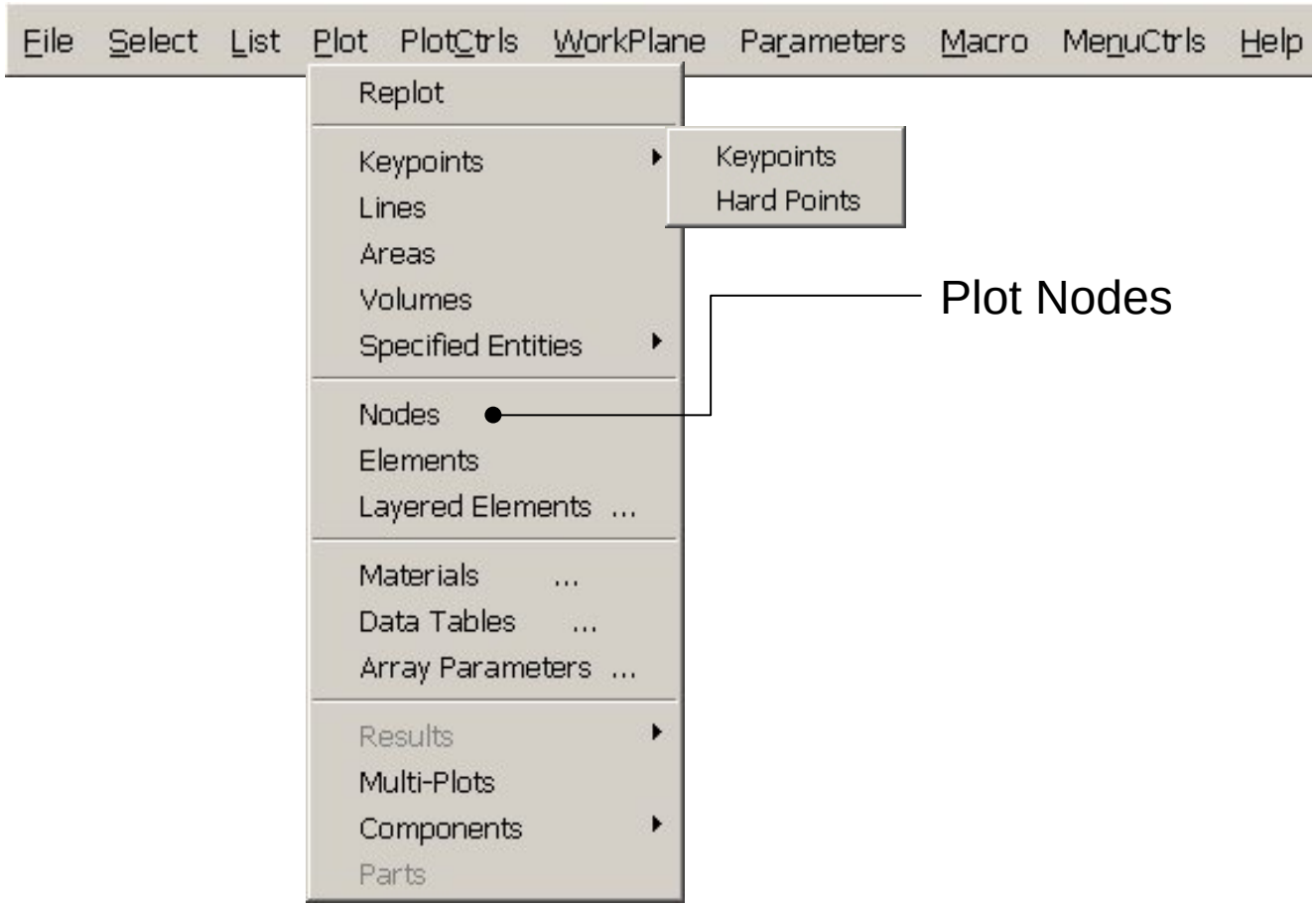
Example - Steps in Submodeling

- The process for using submodeling is as follows:
  - Create and analyze the coarse model.
  - Create the submodel.
  - **Perform Cut Boundary Interpolation (CBI).**
  - Analyze the submodel.
  - Verify that the distance between the cut boundaries and the stress concentration is adequate.

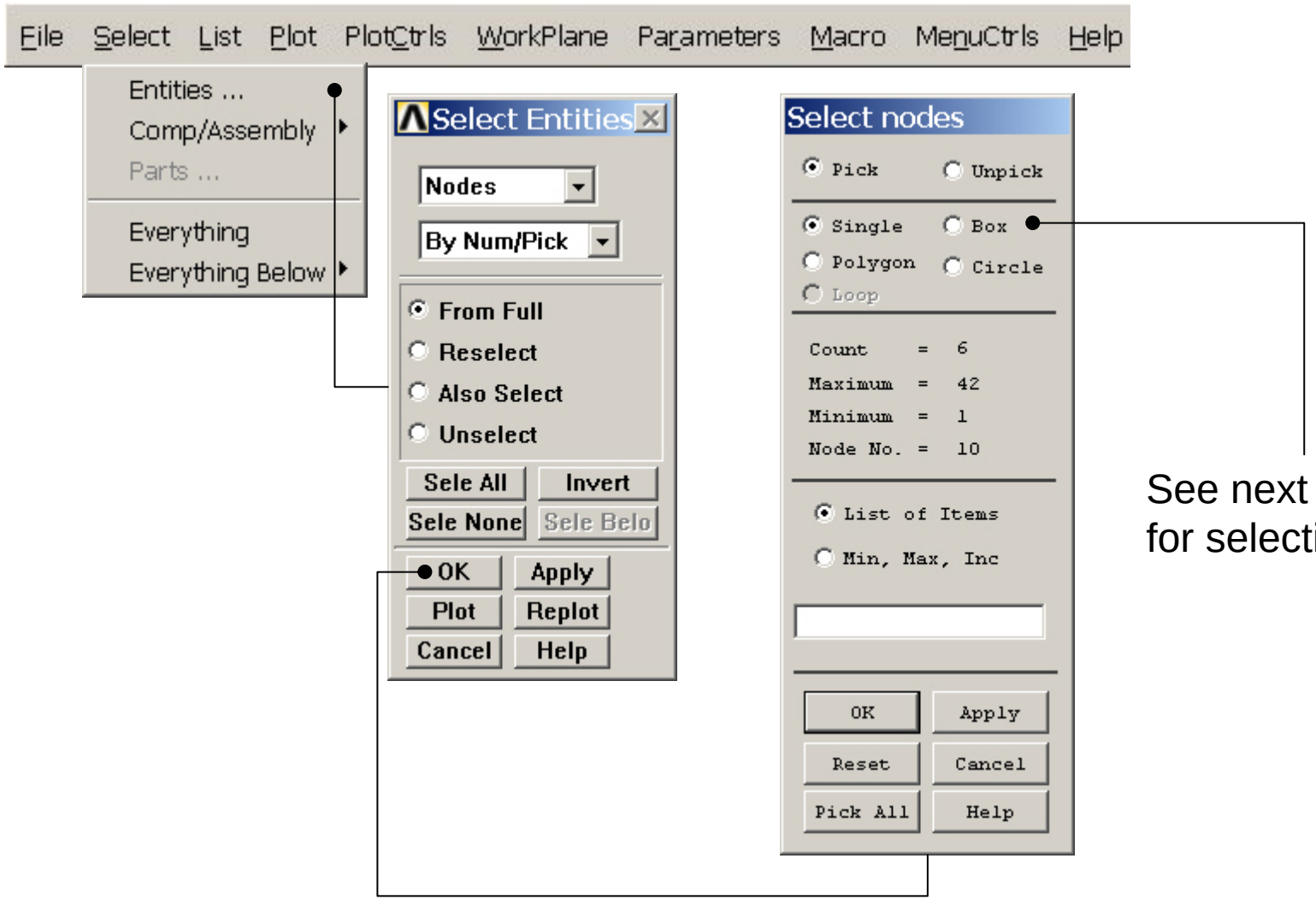
Example – CBI Steps

- The following tasks are involved in performing the cut boundary interpolation:
  1. **Identify and write the cut-boundary nodes**
  2. Restore the full set of nodes, write the database to Jobname.DB
  3. To do the cut boundary interpolation restore the coarse model
  4. Enter POST1
  5. Point to the coarse results file
  6. Read in the desired set of data from the results file
  7. Initiate cut-boundary interpolation
  8. All interpolation work is now done

Example – CBI: Step 1

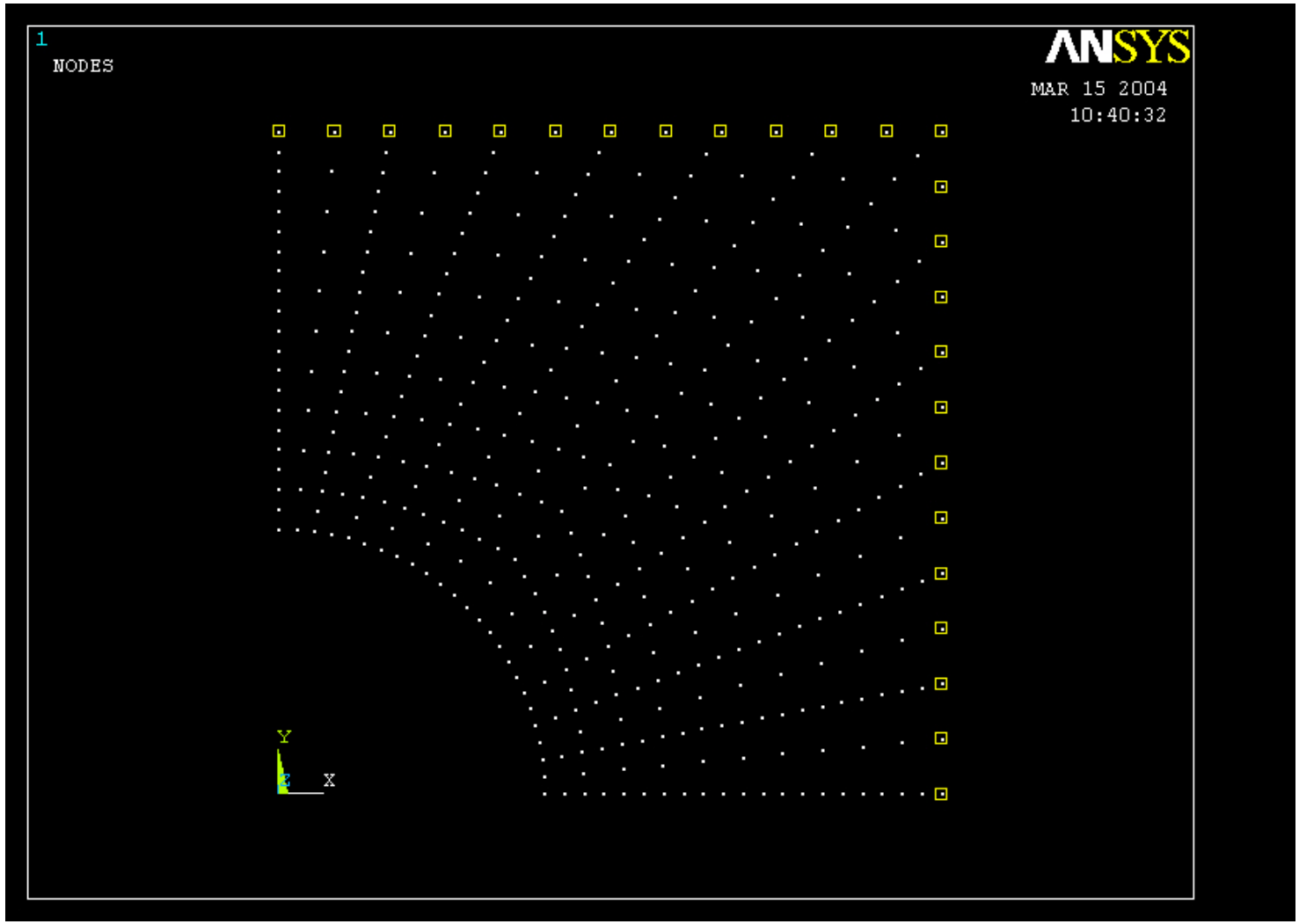


Example – CBI: Step 1

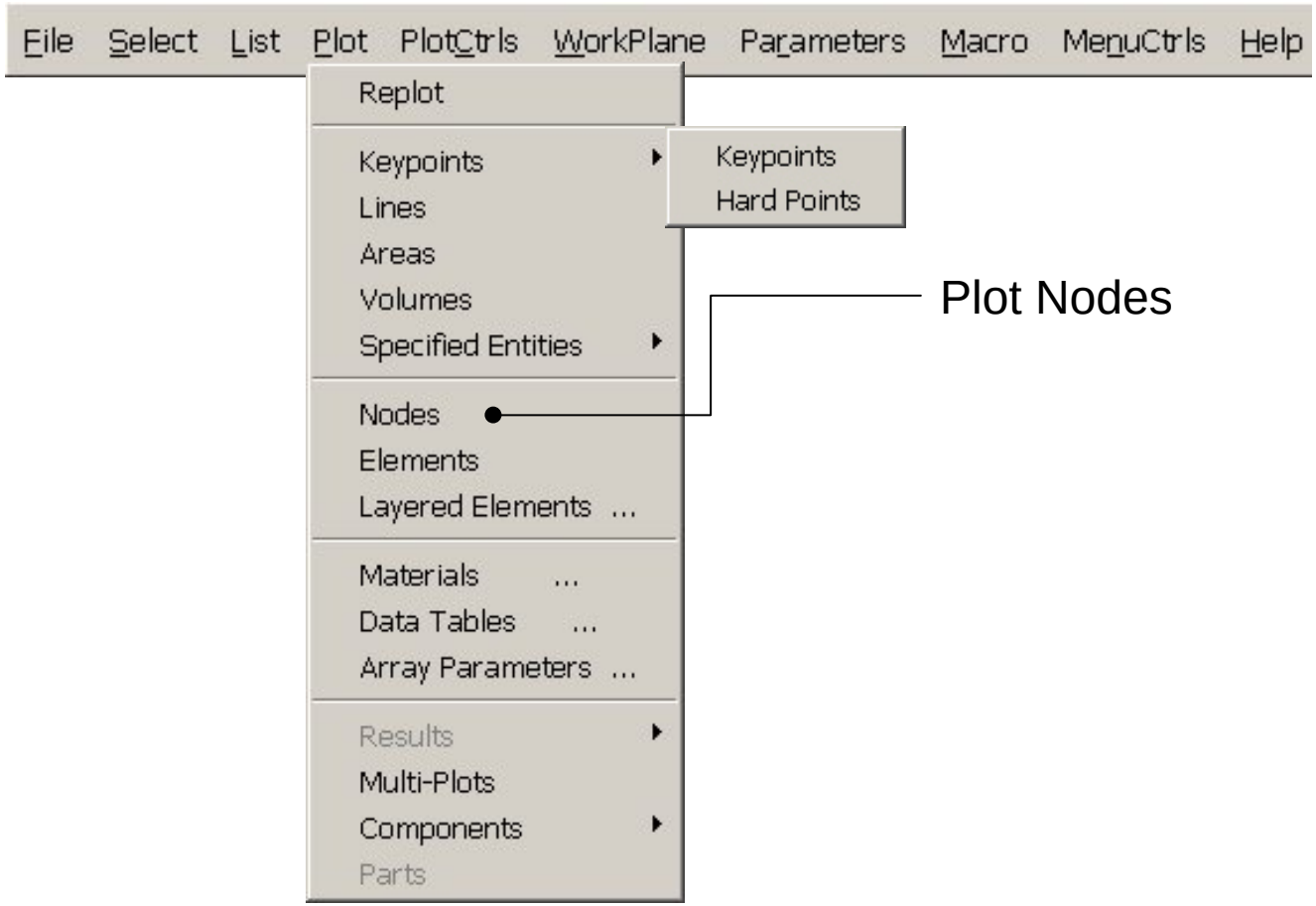


See next page for selection

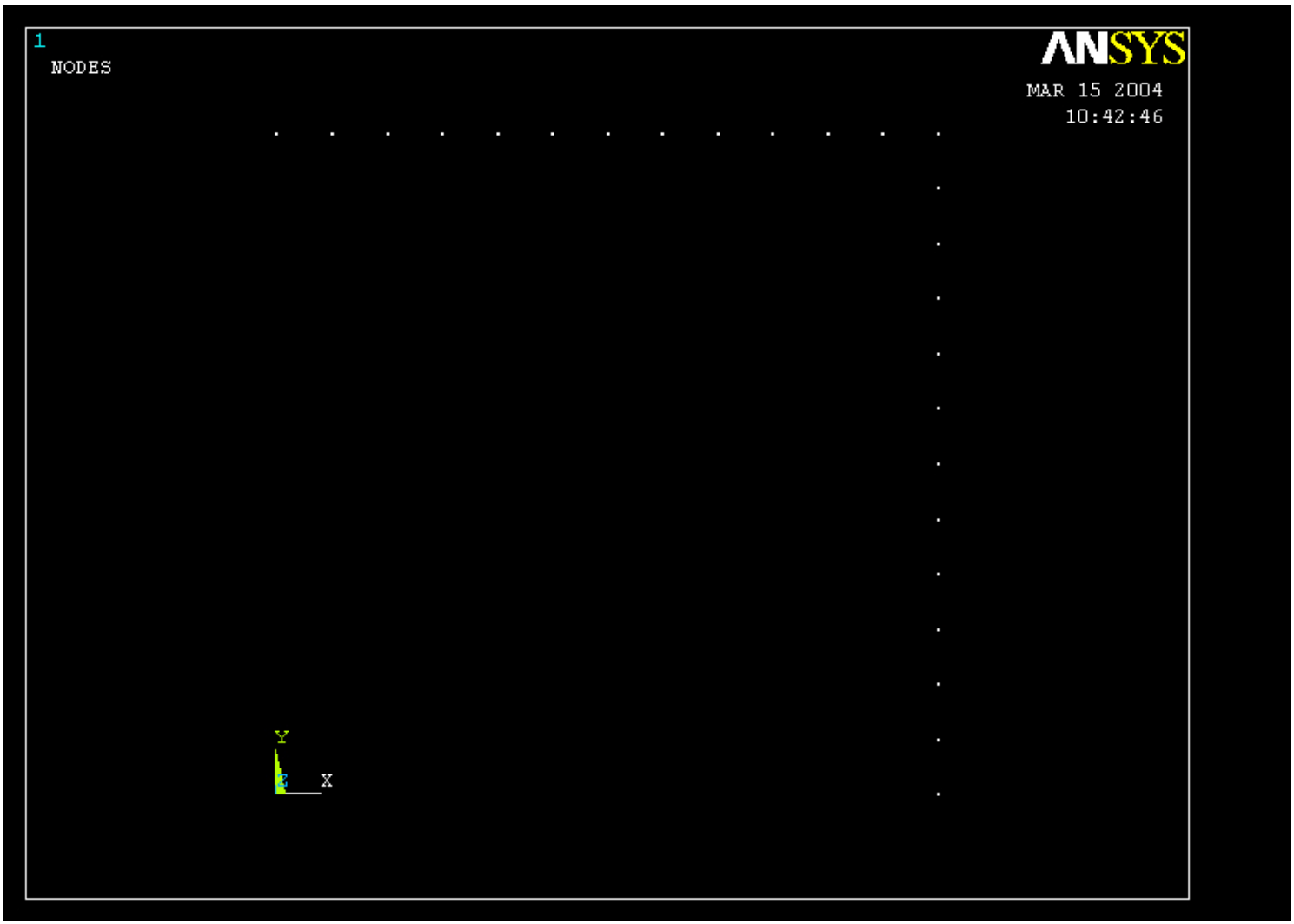
Example – CBI: Step 1



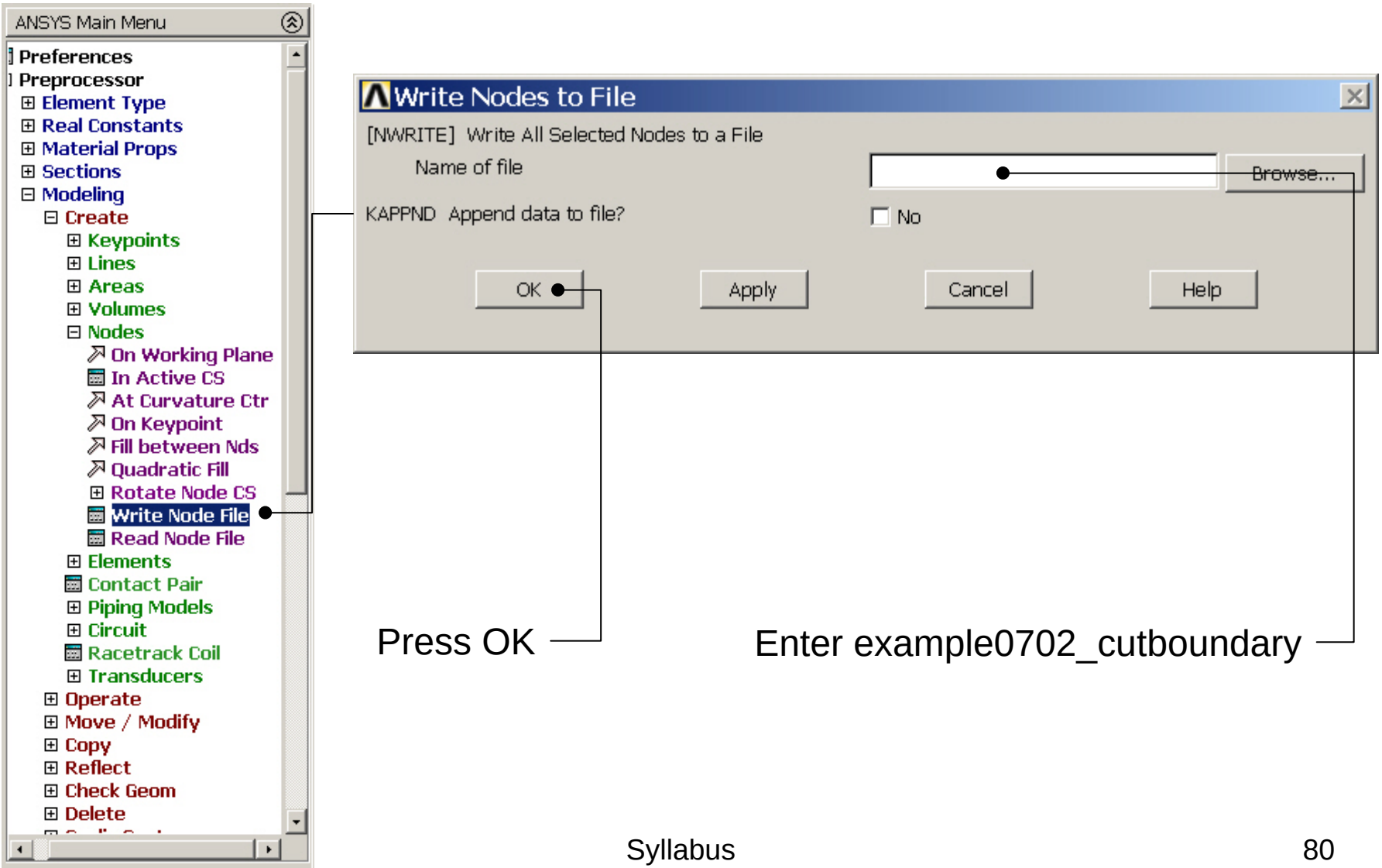
Example – CBI: Step 1



Example – CBI: Step 1



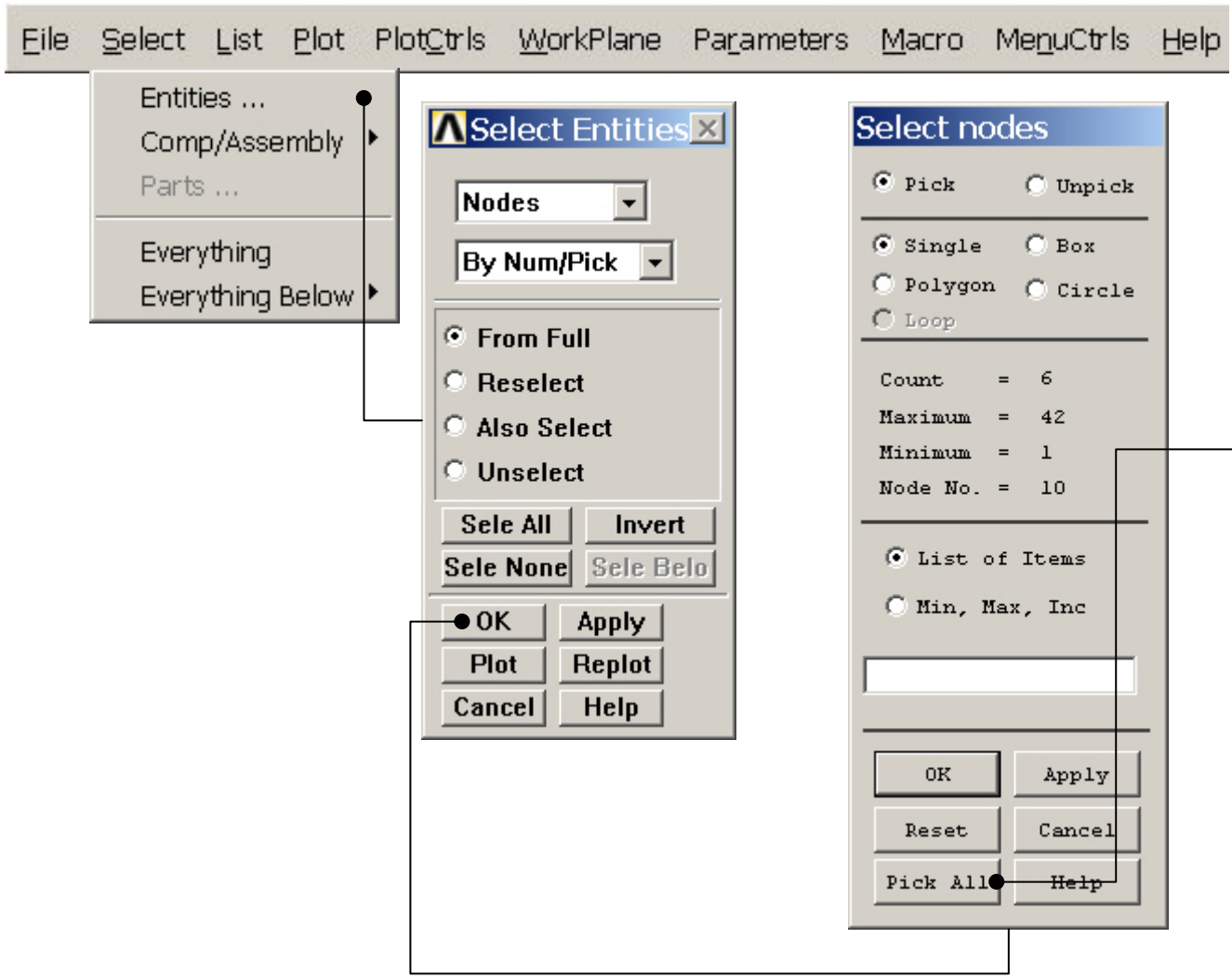
Example – CBI: Step 1



Example - CBI Steps

- The following tasks are involved in performing the cut boundary interpolation:
  1. Identify and write the cut-boundary nodes
  2. **Restore the full set of nodes, write the database to Jobname.DB**
  3. To do the cut boundary interpolation restore the coarse model
  4. Enter POST1
  5. Point to the coarse results file
  6. Read in the desired set of data from the results file
  7. Initiate cut-boundary interpolation
  8. All interpolation work is now done

Example – CBI: Step 2

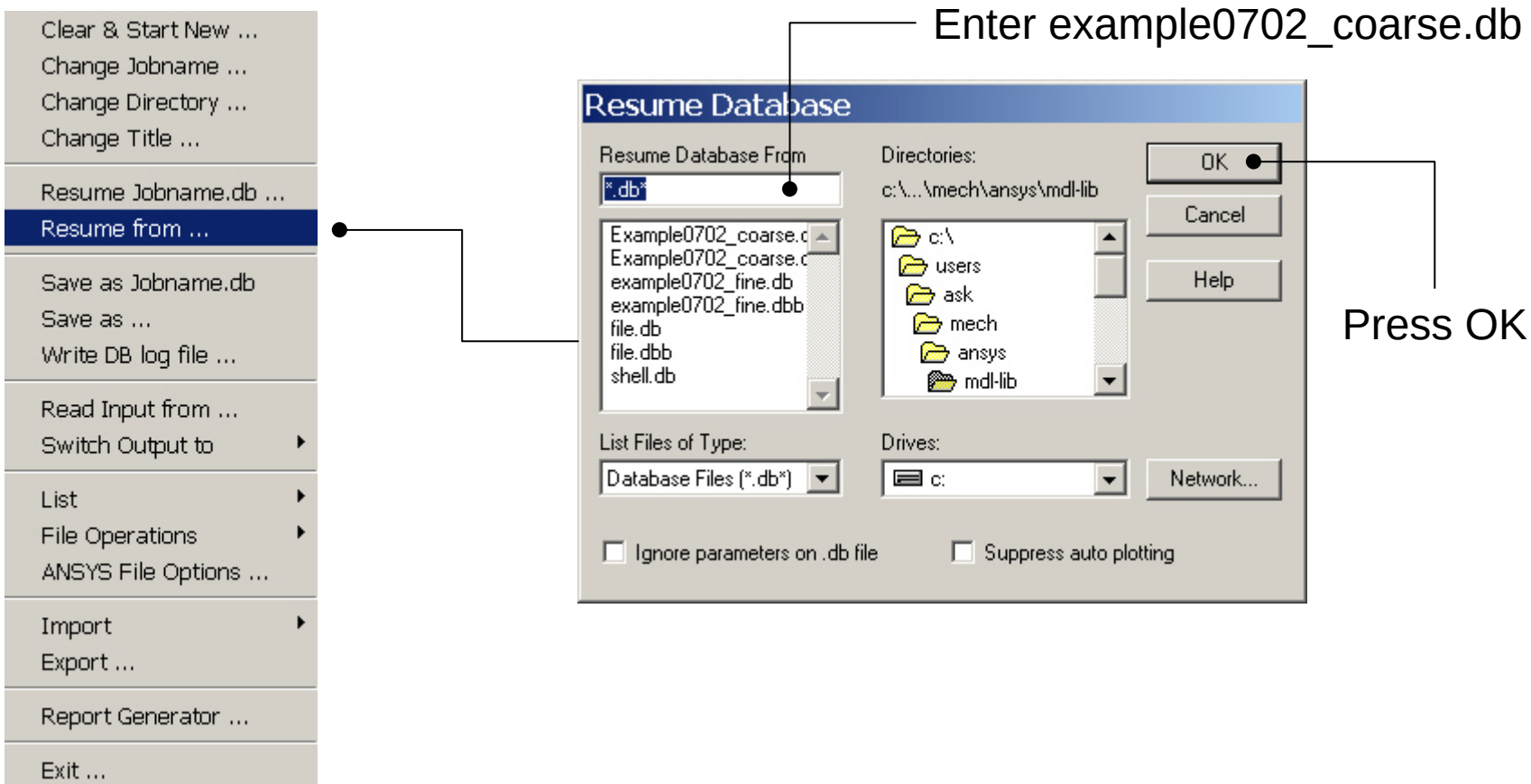


Select Pick All

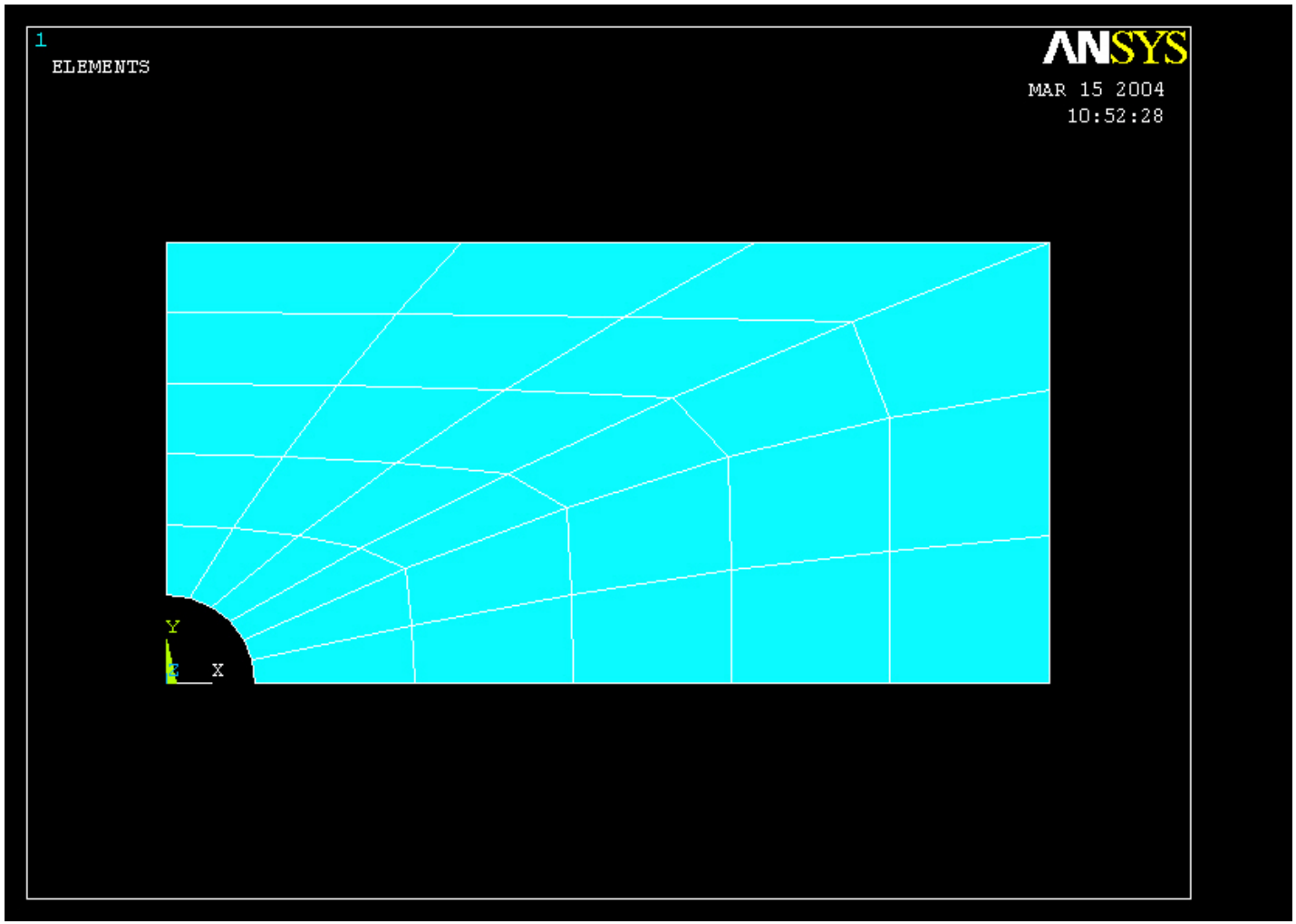
Example - CBI Steps

- The following tasks are involved in performing the cut boundary interpolation:
  1. Identify and write the cut-boundary nodes
  2. Restore the full set of nodes, write the database to Jobname.DB
  3. **To do the cut boundary interpolation restore the coarse model**
  4. Enter POST1
  5. Point to the coarse results file
  6. Read in the desired set of data from the results file
  7. Initiate cut-boundary interpolation
  8. All interpolation work is now done

Example – CBI: Step 3



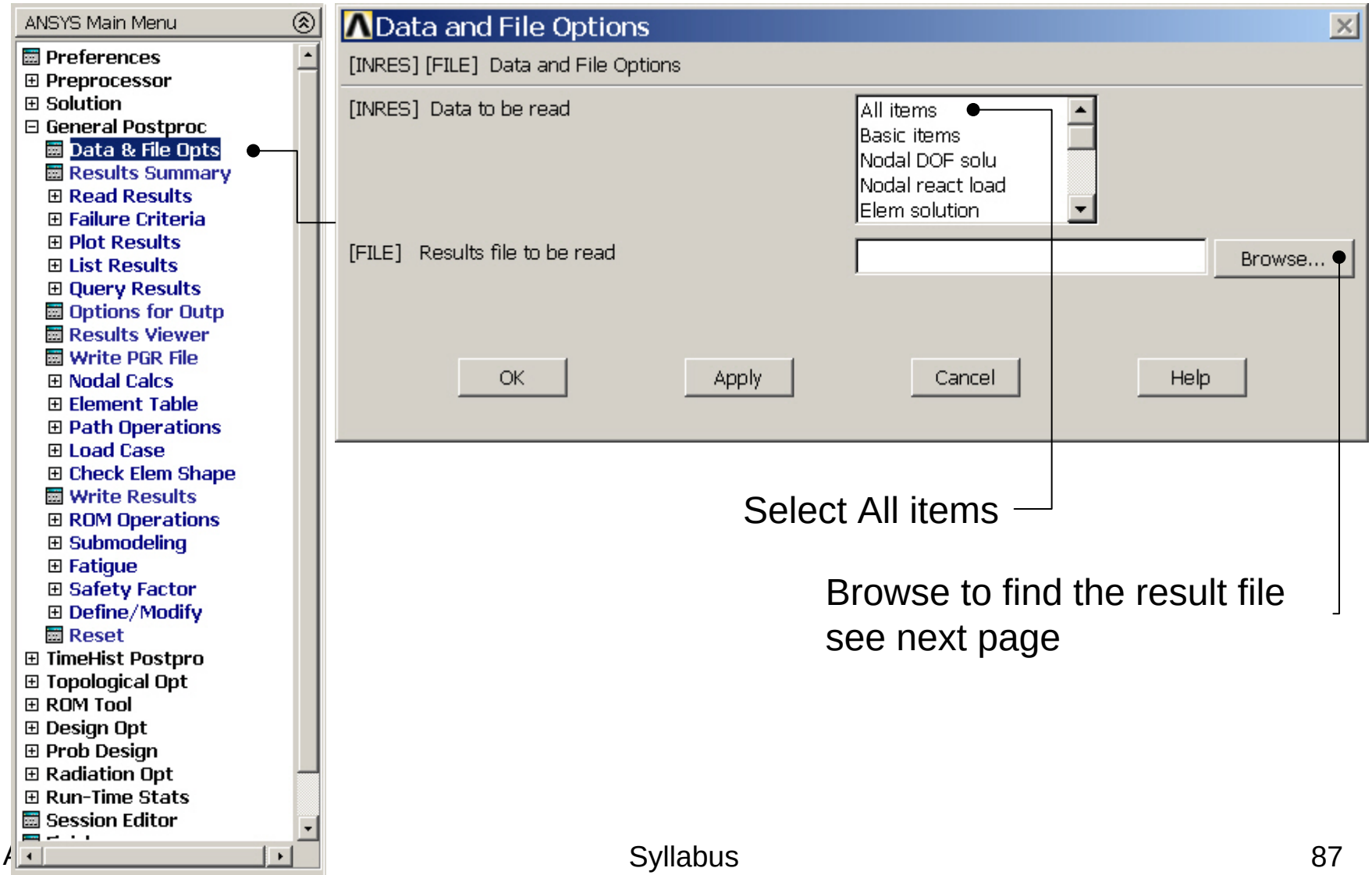
Example – CBI: Step 3



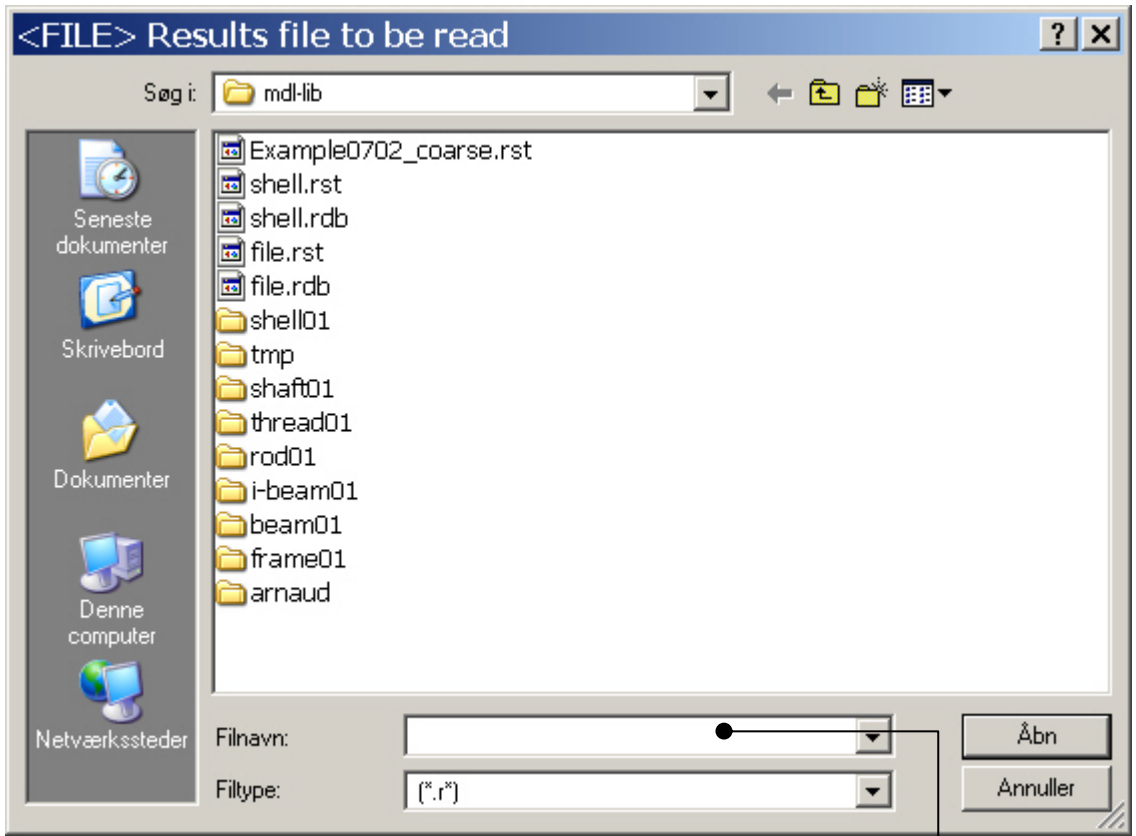
Example - CBI Steps

- The following tasks are involved in performing the cut boundary interpolation:
  1. Identify and write the cut-boundary nodes
  2. Restore the full set of nodes, write the database to Jobname.DB
  3. To do the cut boundary interpolation restore the coarse model
  4. **Enter POST1**
  5. **Point to the coarse results file**
  6. **Read in the desired set of data from the results file**
  7. Initiate cut-boundary interpolation
  8. All interpolation work is now done

Example – CBI: Step 4-6

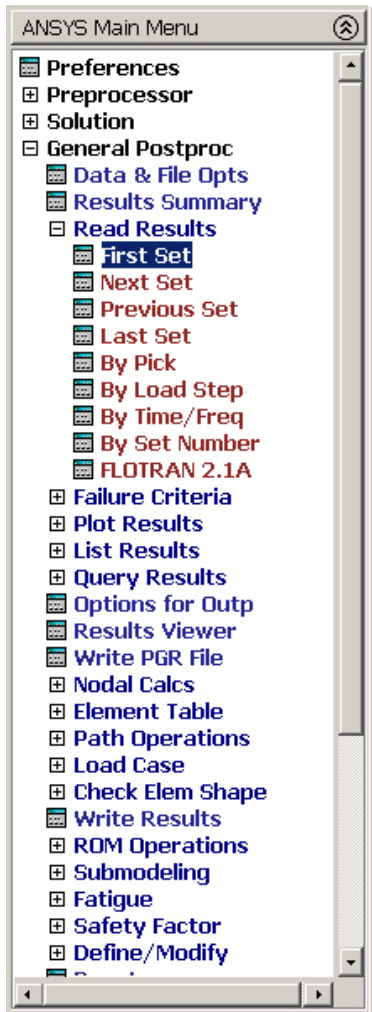


Example – CBI: Step 4-6



Enter example0702_coarse.rst

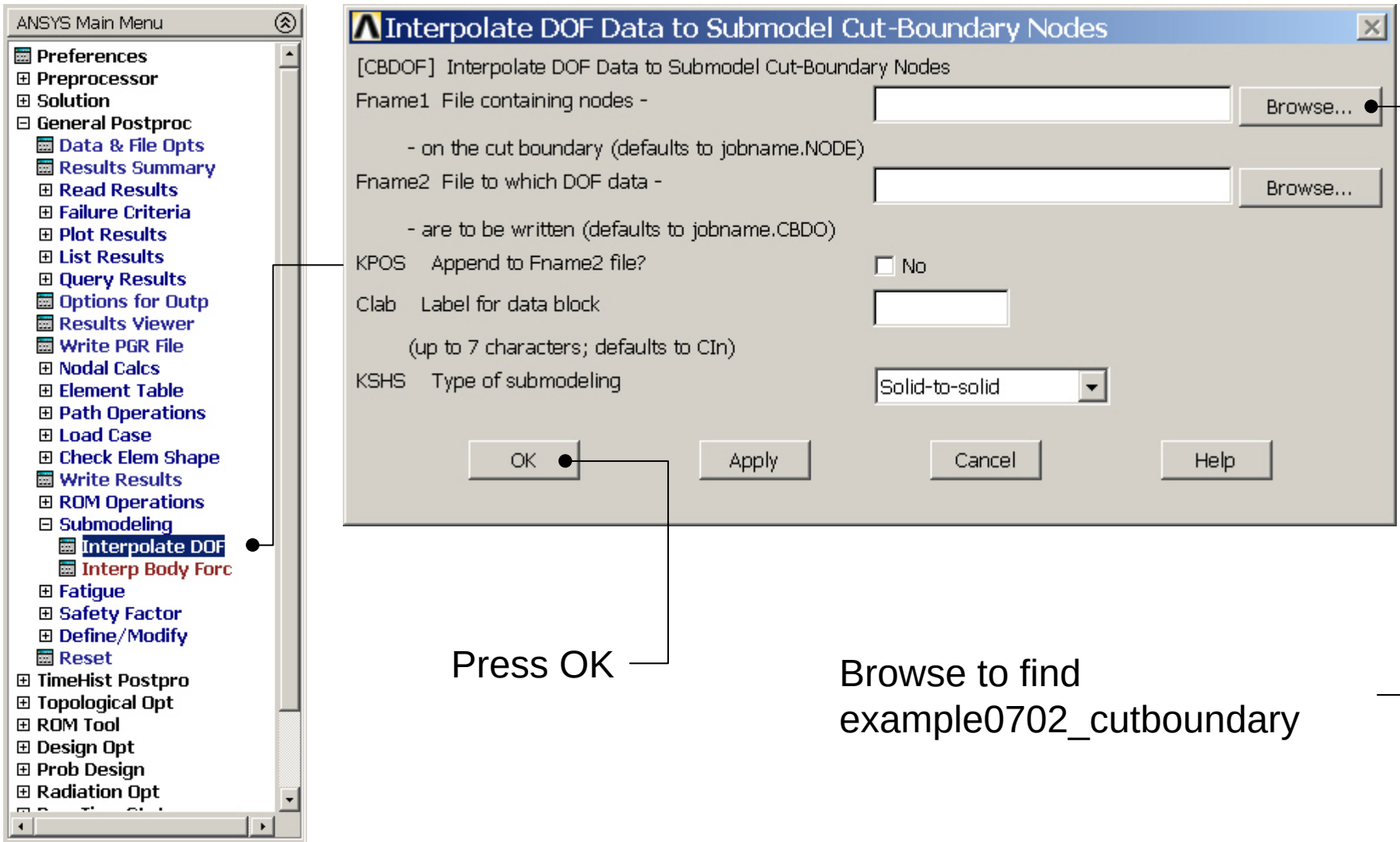
Read the First Set



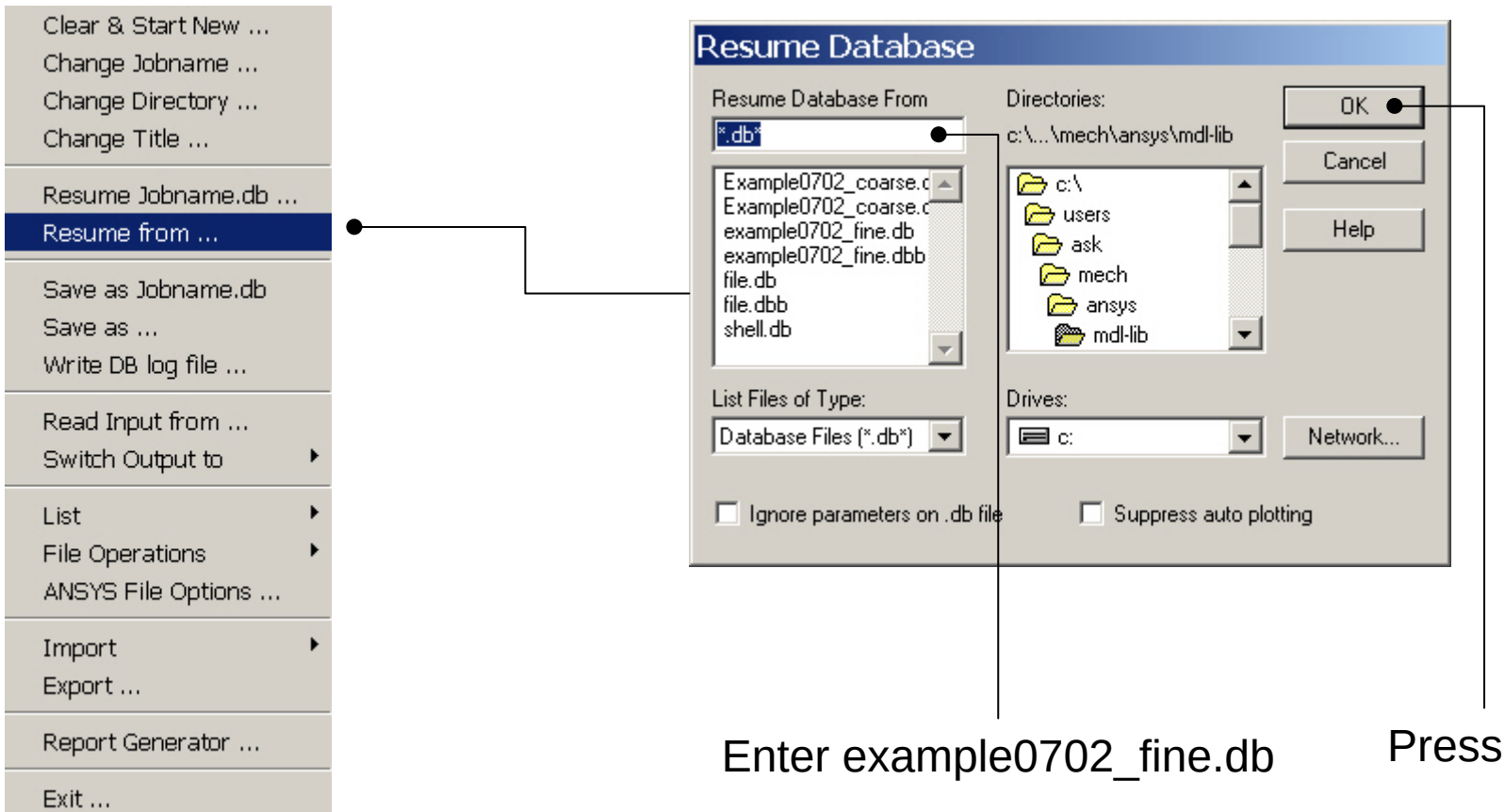
Example - CBI Steps

- The following tasks are involved in performing the cut boundary interpolation:
  1. Identify and write the cut-boundary nodes
  2. Restore the full set of nodes, write the database to Jobname.DB
  3. To do the cut boundary interpolation restore the coarse model
  4. Enter POST1
  5. Point to the coarse results file
  6. Read in the desired set of data from the results file
  7. **Initiate cut-boundary interpolation**
  8. All interpolation work is now done

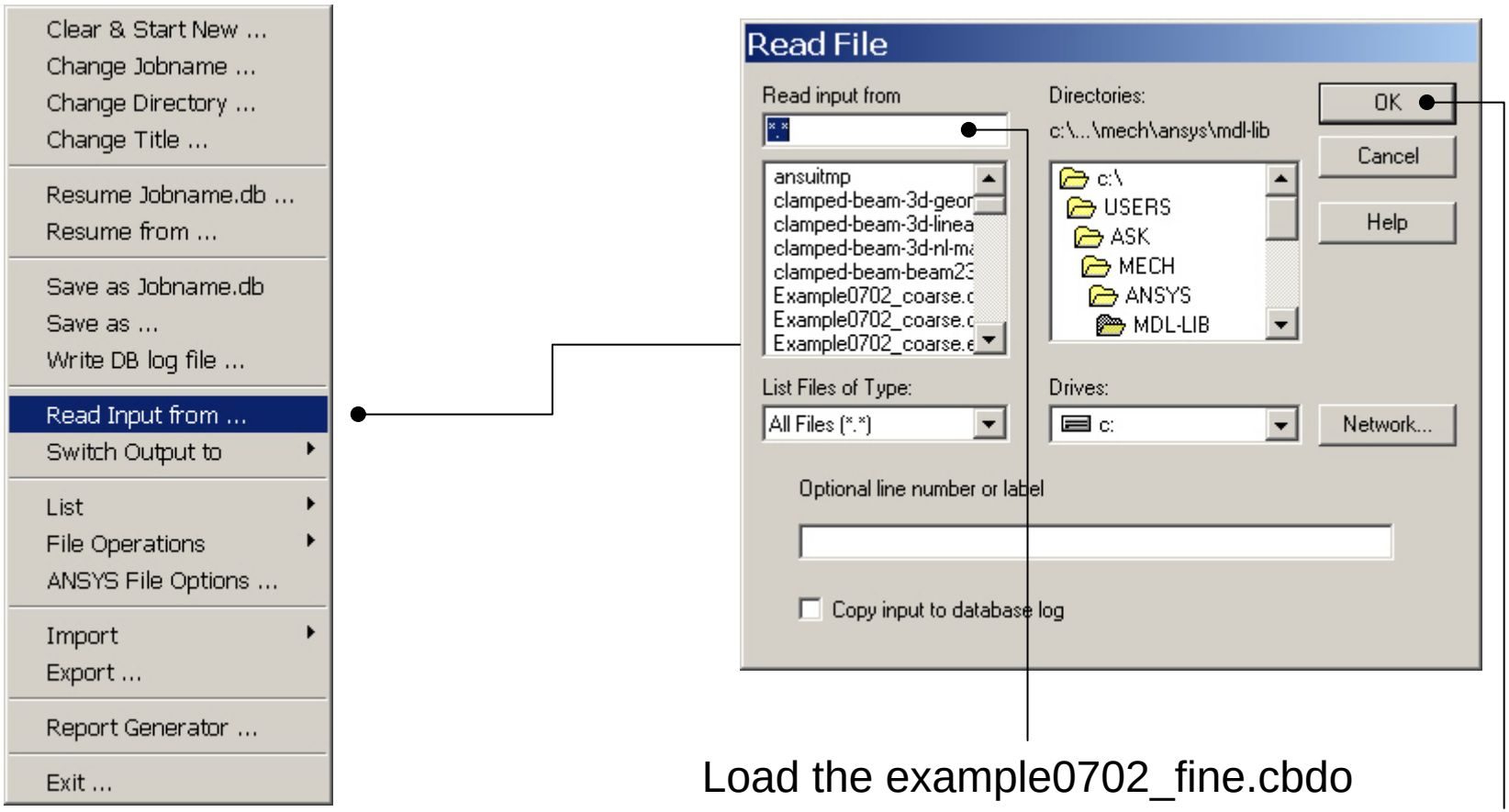
Example – CBI: Step 7



Example – CBI: Step 7



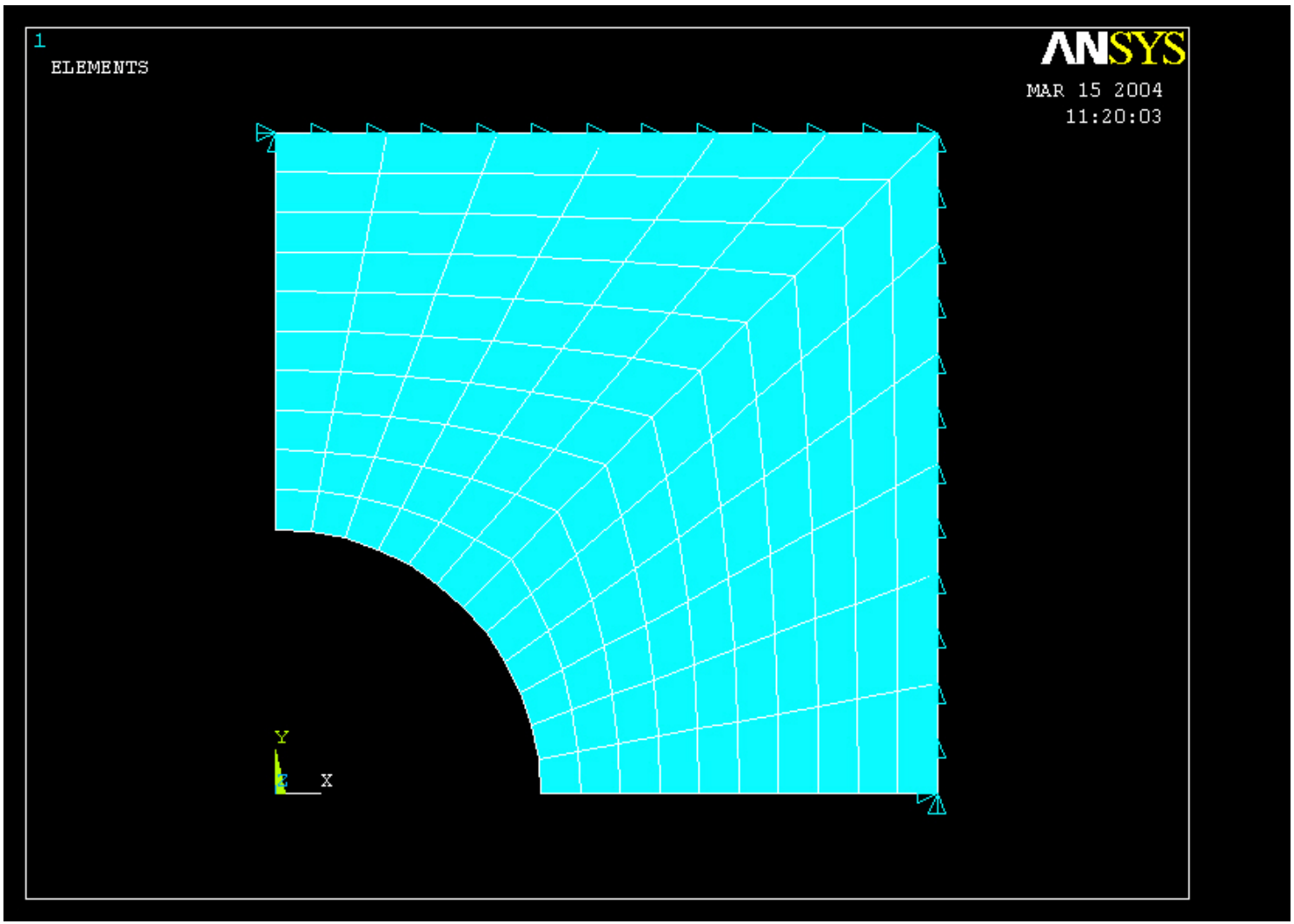
Example – CBI: Step 7



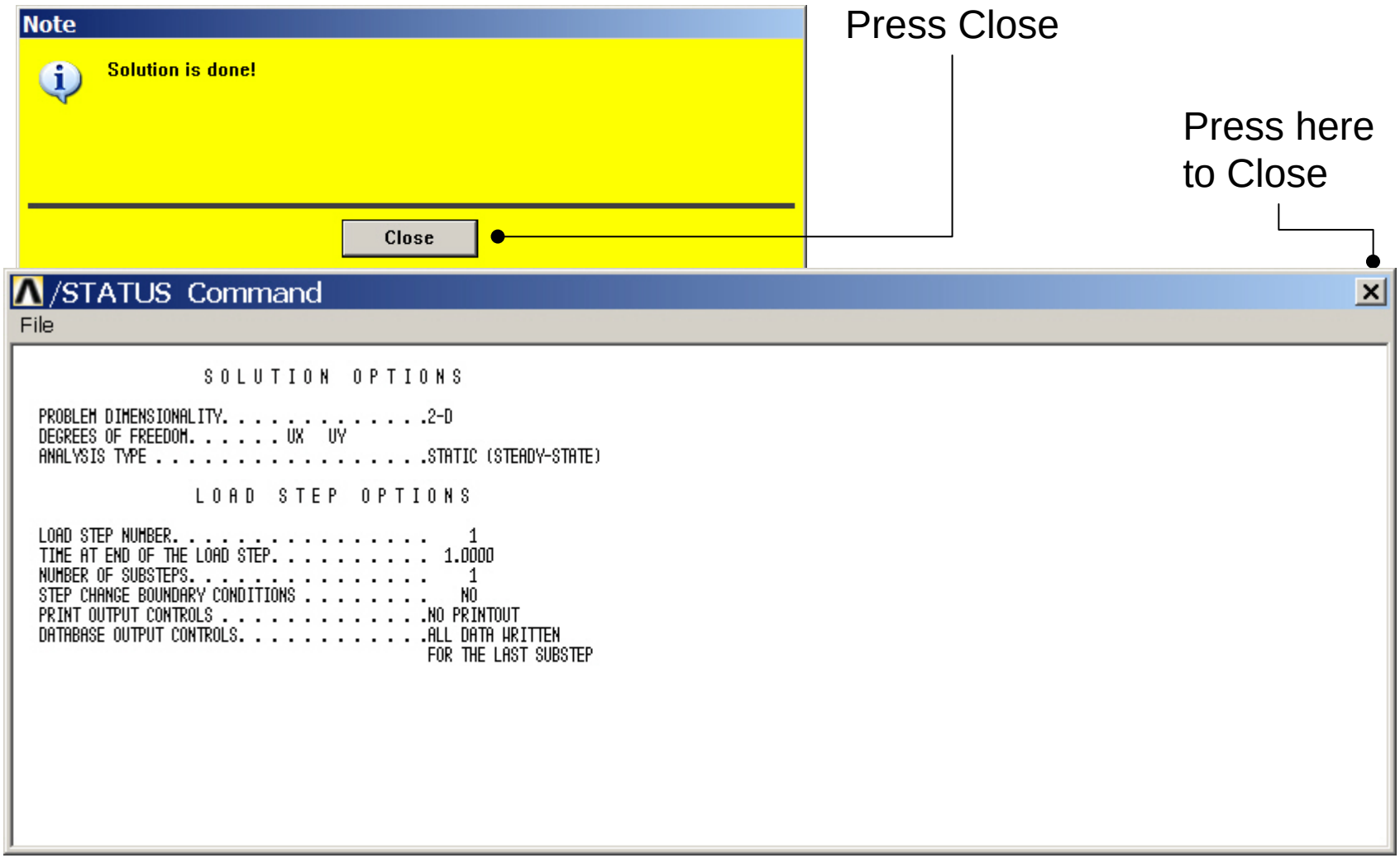
Load the example0702_fine.cbdo

Press OK

Example – CBI: Step 8

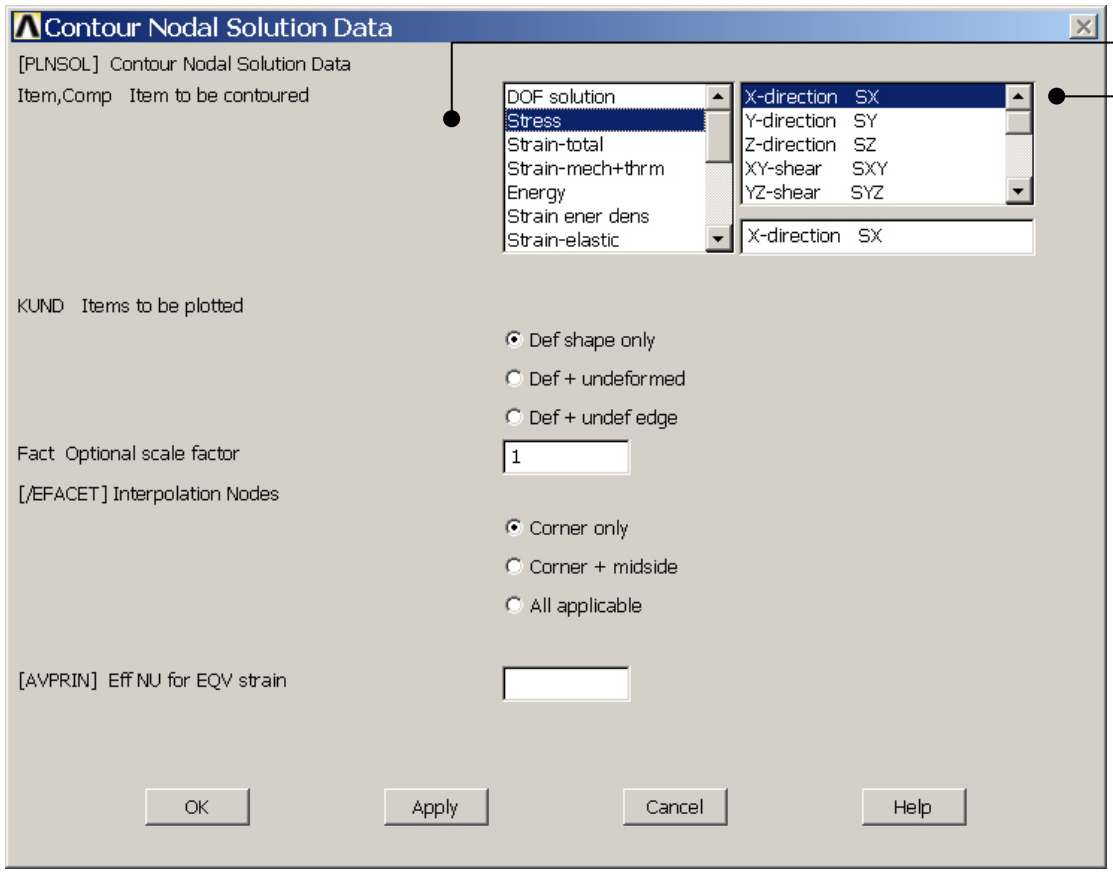


Example - Solve



Example – Contour Plot

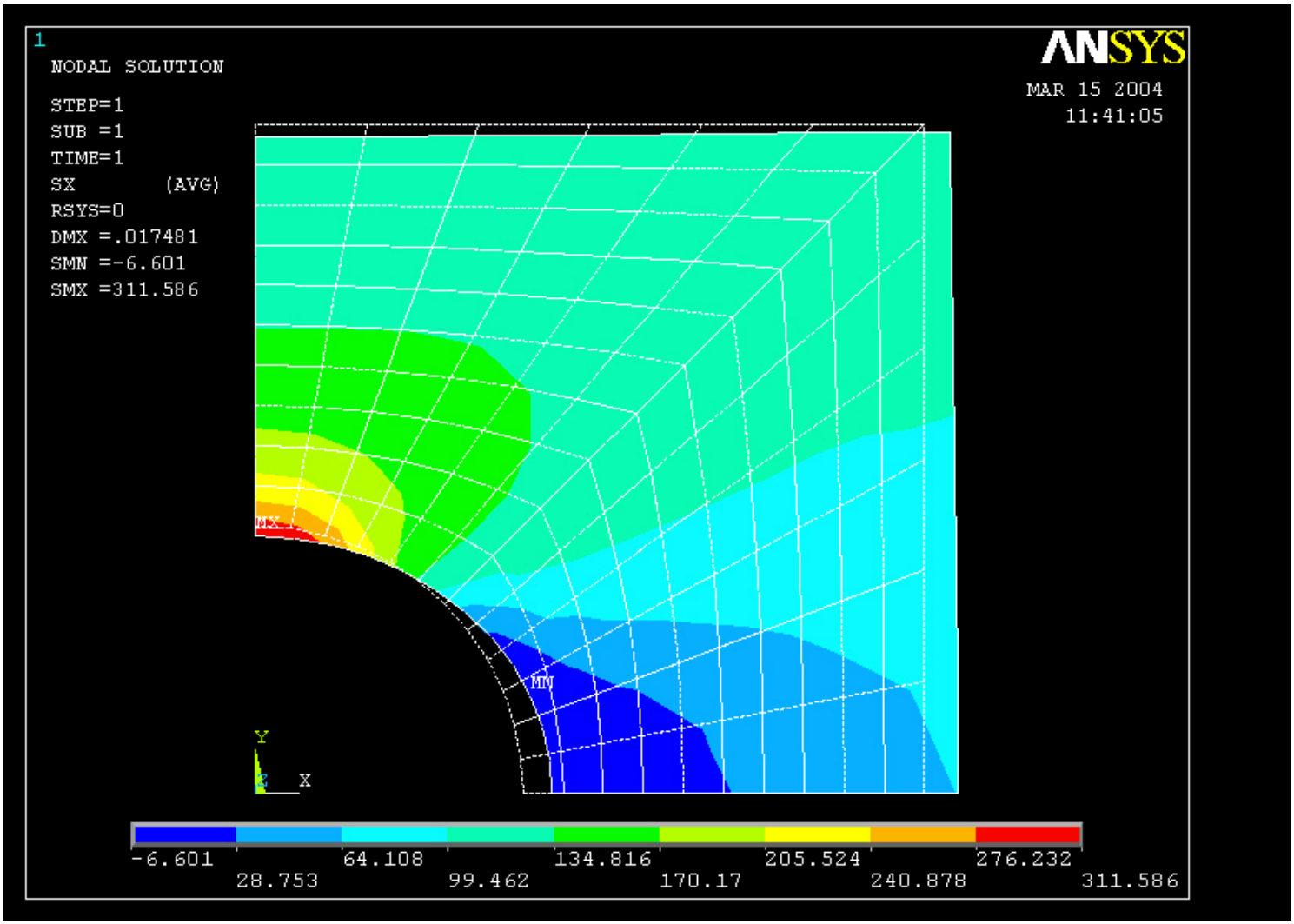
General Postproc > Plot Results > Contour Plot > Nodal Sol



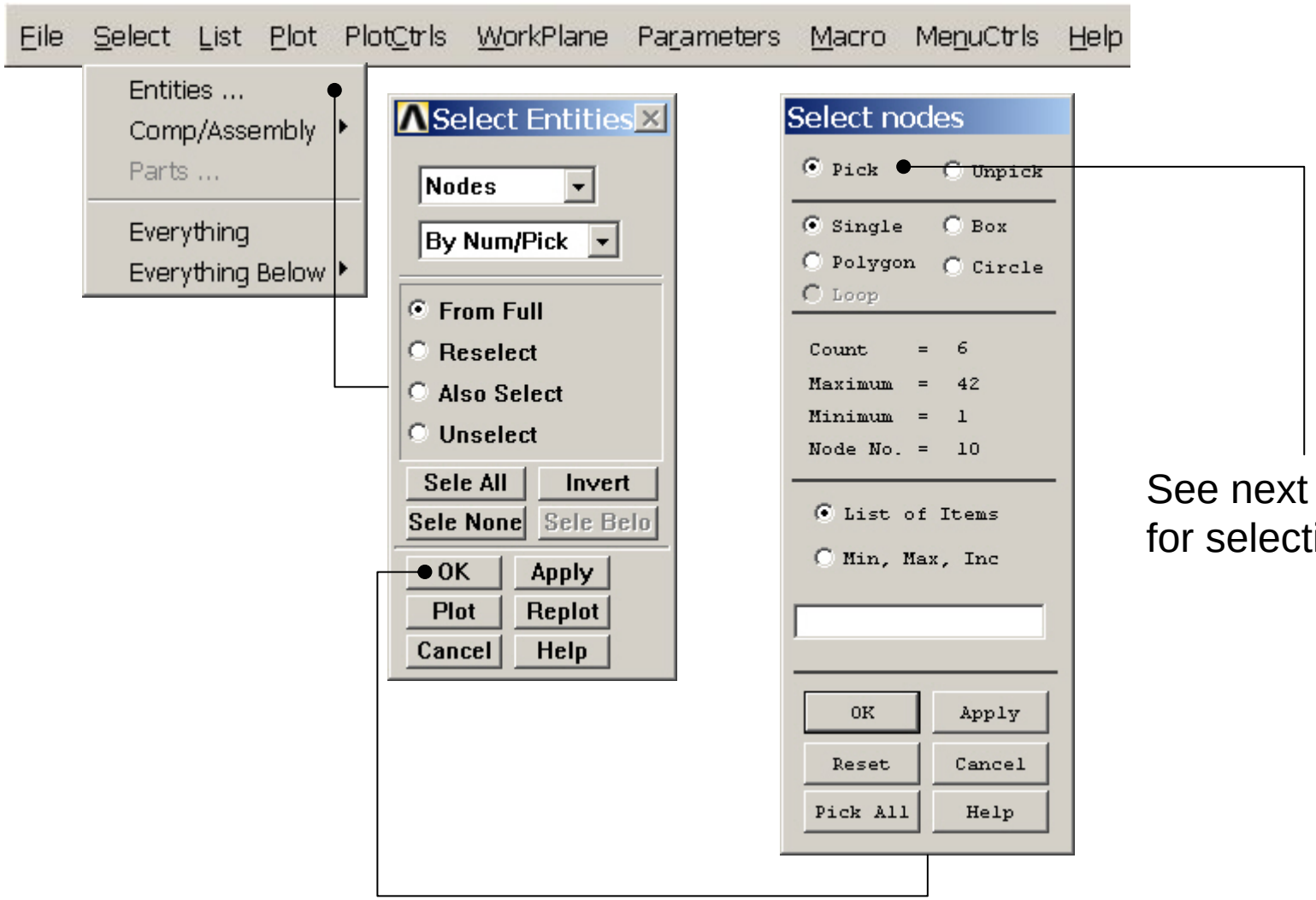
Select Stress

Select SX for stresses in x-direction

Example – Contour Plot

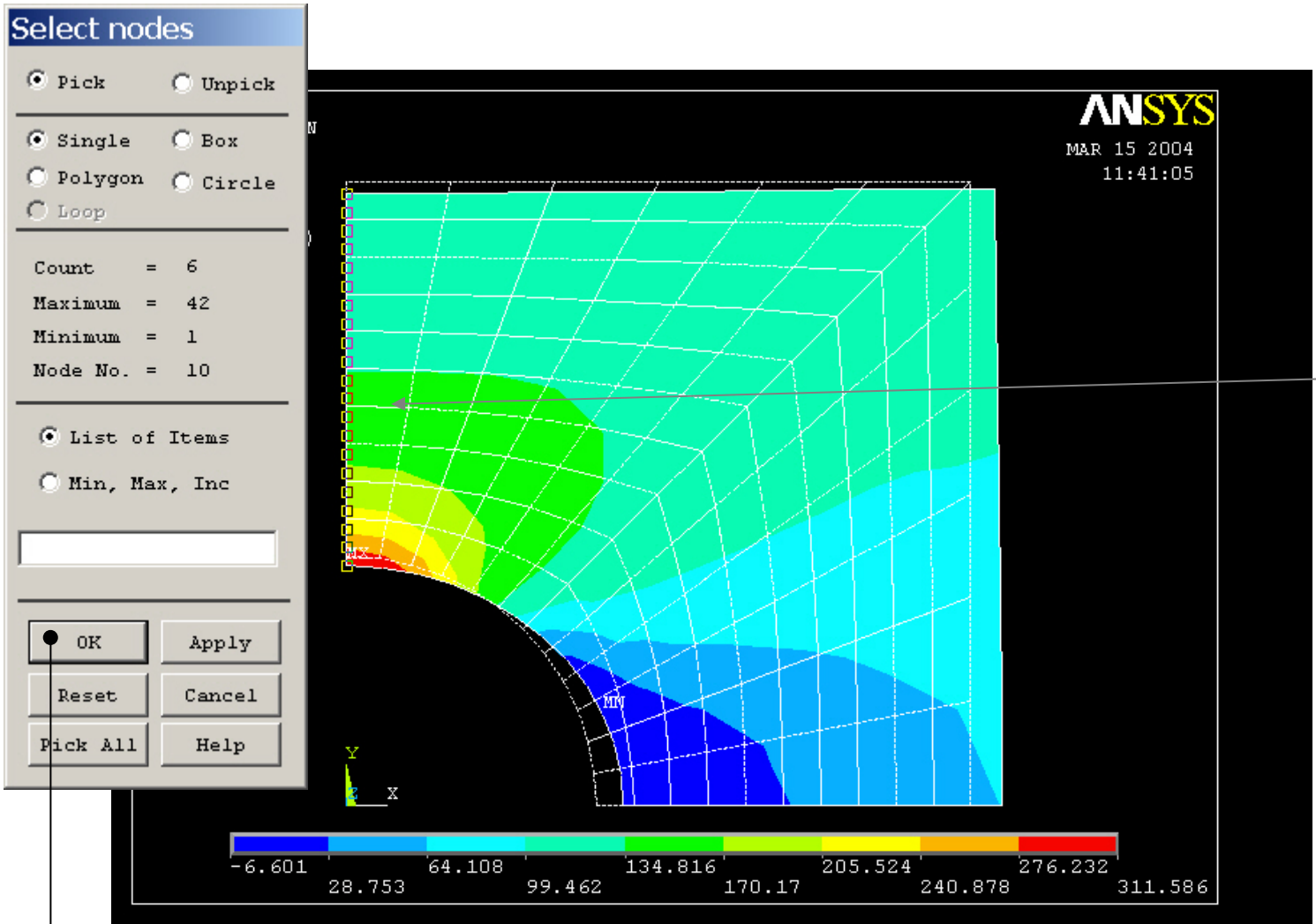


Example – Select - Entities



See next page for selection

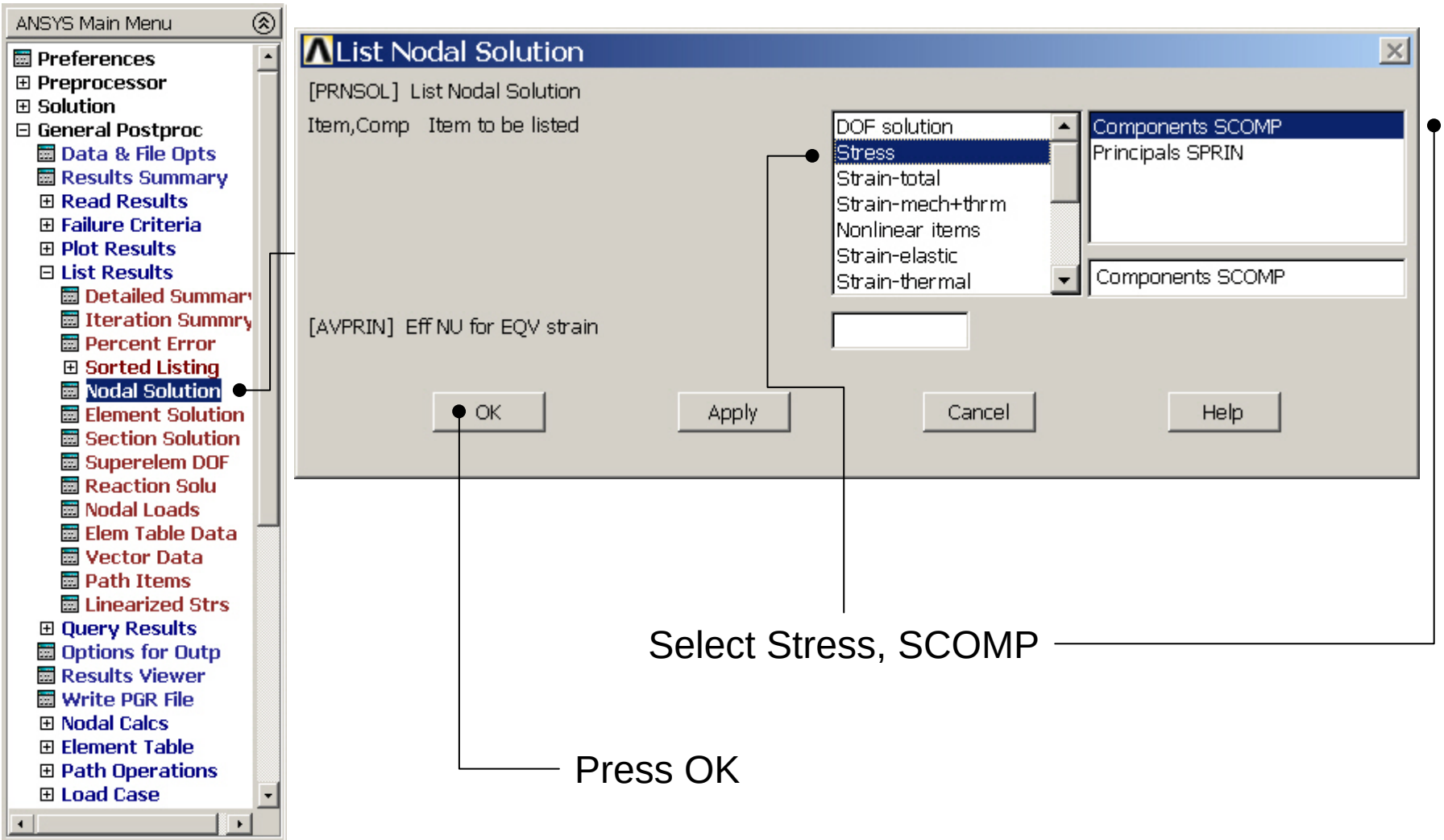
Example – Select Nodes



Select the indicated nodes

Enter OK when finished

Example – List Results



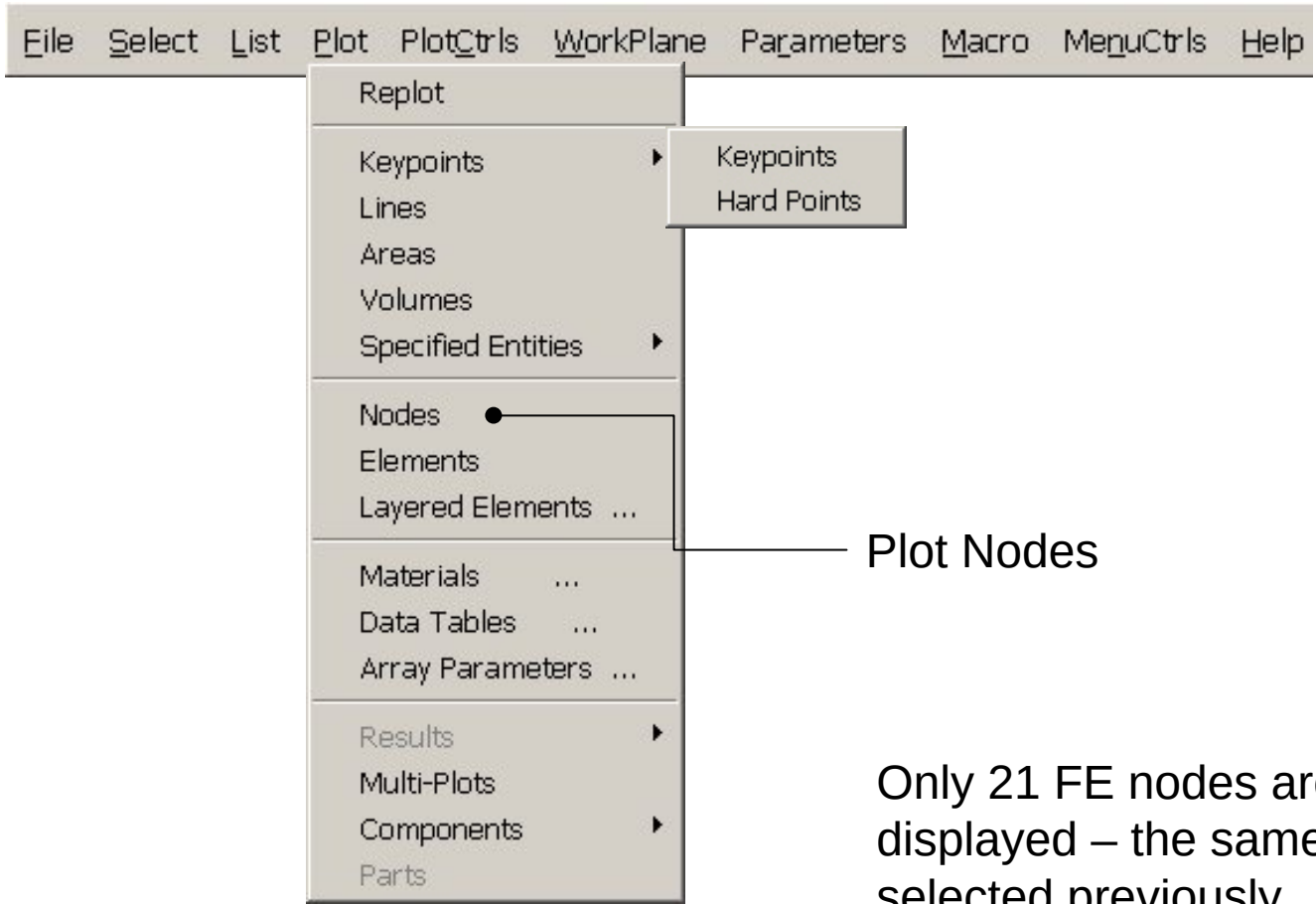
Example – List Results

PRNSOL Command

File

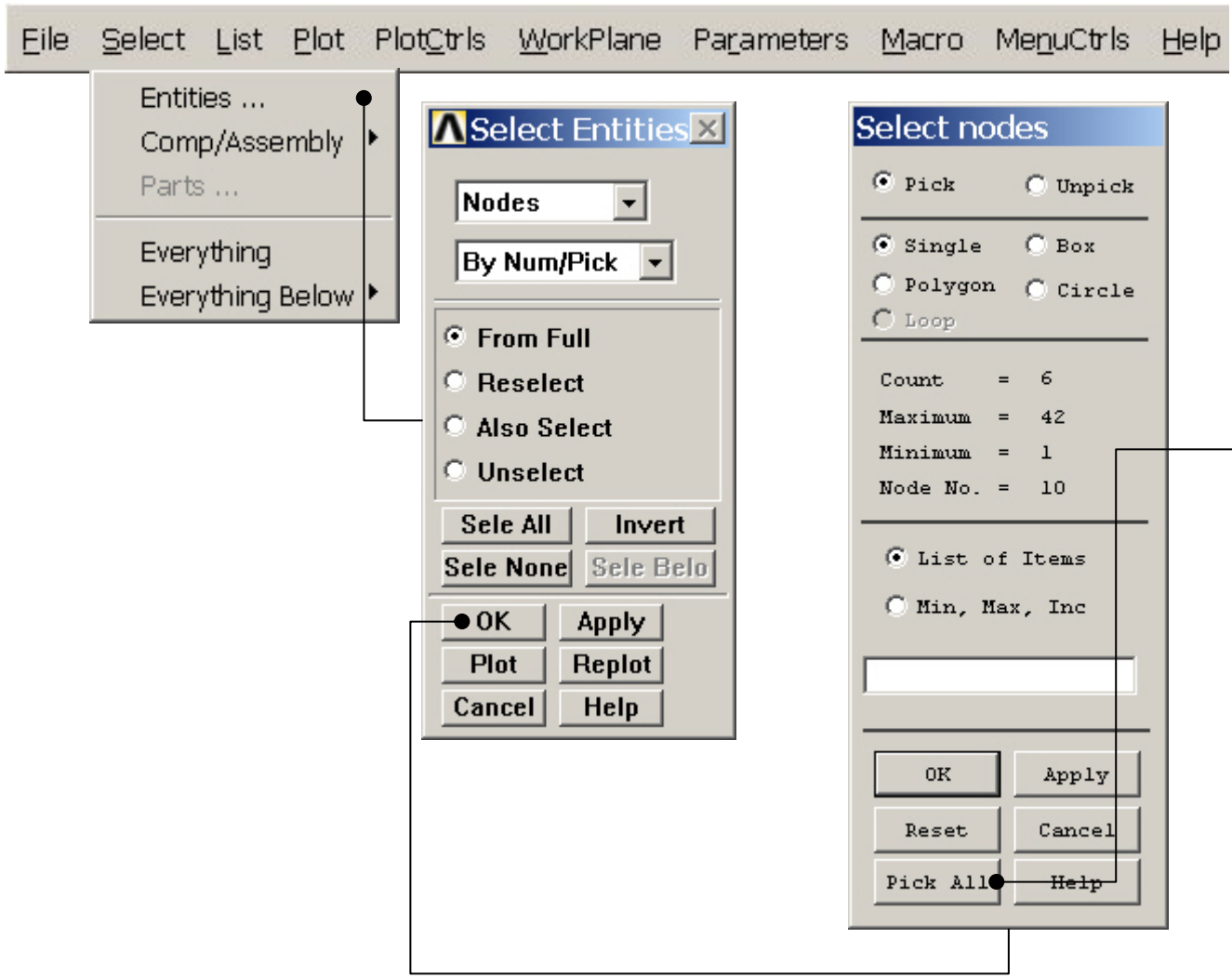
```
PRINT S    NODAL SOLUTION PER NODE

 ***** POST1 NODAL STRESS LISTING *****
 PowerGraphics Is Currently Enabled

 LOAD STEP=     1  SUBSTEP=     1
  TIME=    1.0000      LOAD CASE=   0
 NODAL RESULTS ARE FOR MATERIAL   1

 THE FOLLOWING X,Y,Z VALUES ARE IN GLOBAL COORDINATES

   NODE    SX          SY          SZ          SXY         SYZ         SXZ
     34   111.34      16.173      0.0000      2.3755      0.0000      0.0000
     46   311.59      2.0471      0.0000     -0.28221     0.0000      0.0000
     48   116.68      19.437      0.0000      0.31813     0.0000      0.0000
     50   119.78      22.923      0.0000      0.29830     0.0000      0.0000
     52   123.79      26.304      0.0000      0.16753     0.0000      0.0000
     54   129.10      29.726      0.0000      0.11799     0.0000      0.0000
     56   136.46      33.234      0.0000      0.82362E-01 0.0000      0.0000
     58   147.07      36.536      0.0000      0.43138E-01 0.0000      0.0000
     60   163.05      38.849      0.0000     -0.16767E-01 0.0000      0.0000
     62   188.40      38.299      0.0000     -0.87720E-01 0.0000      0.0000
     64   231.24      30.403      0.0000     -0.20755     0.0000      0.0000

MINIMUM VALUES
NODE        34          46          34          46          34          34
VALUE    111.34      2.0471      0.0000     -0.28221     0.0000      0.0000

MAXIMUM VALUES
NODE        46          60          34          34          34          34
VALUE    311.59      38.849      0.0000      2.3755      0.0000      0.0000
```

Example - Plot - Nodes



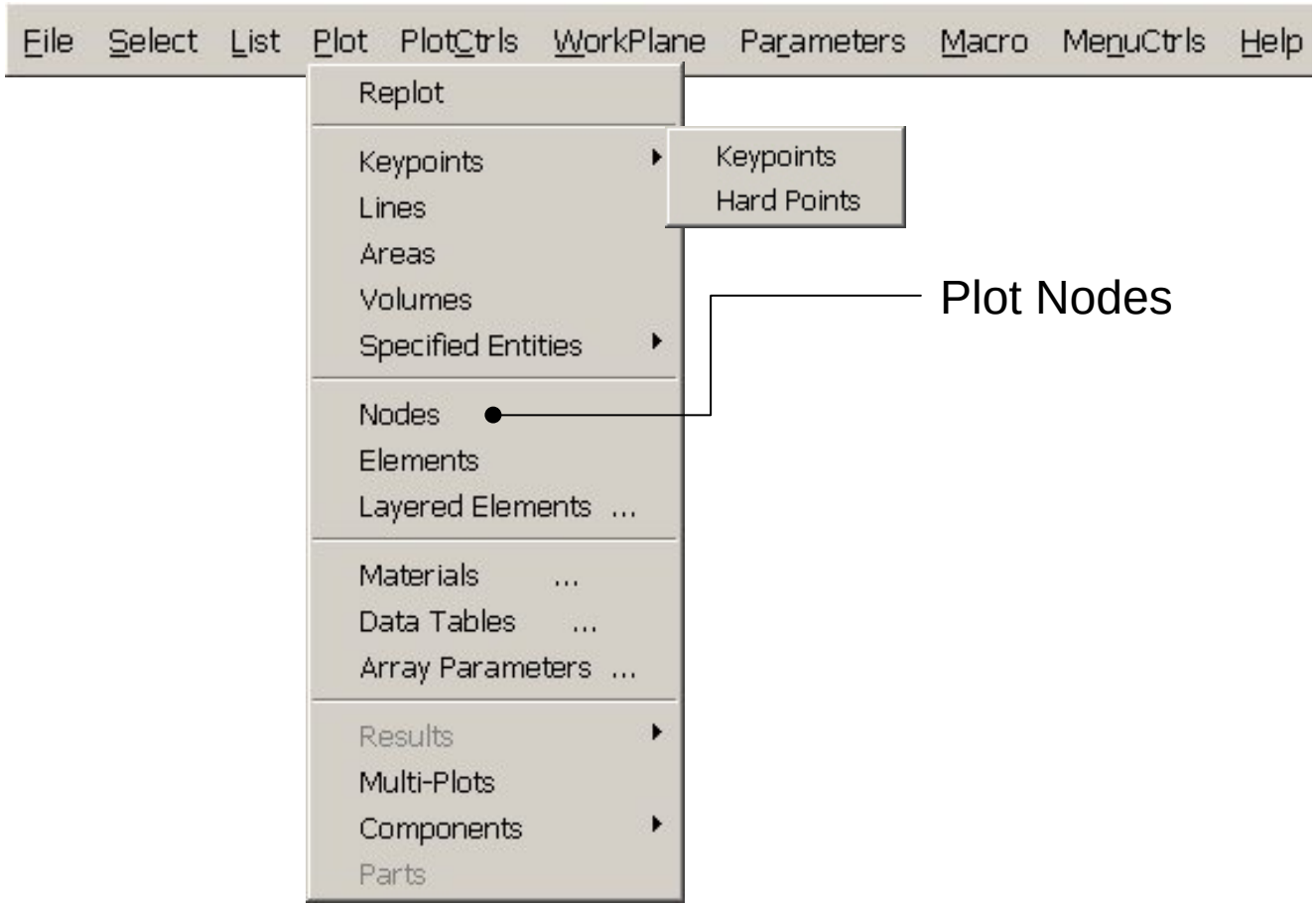
Only 21 FE nodes are displayed – the same nodes as selected previously

Example – Select - Entities

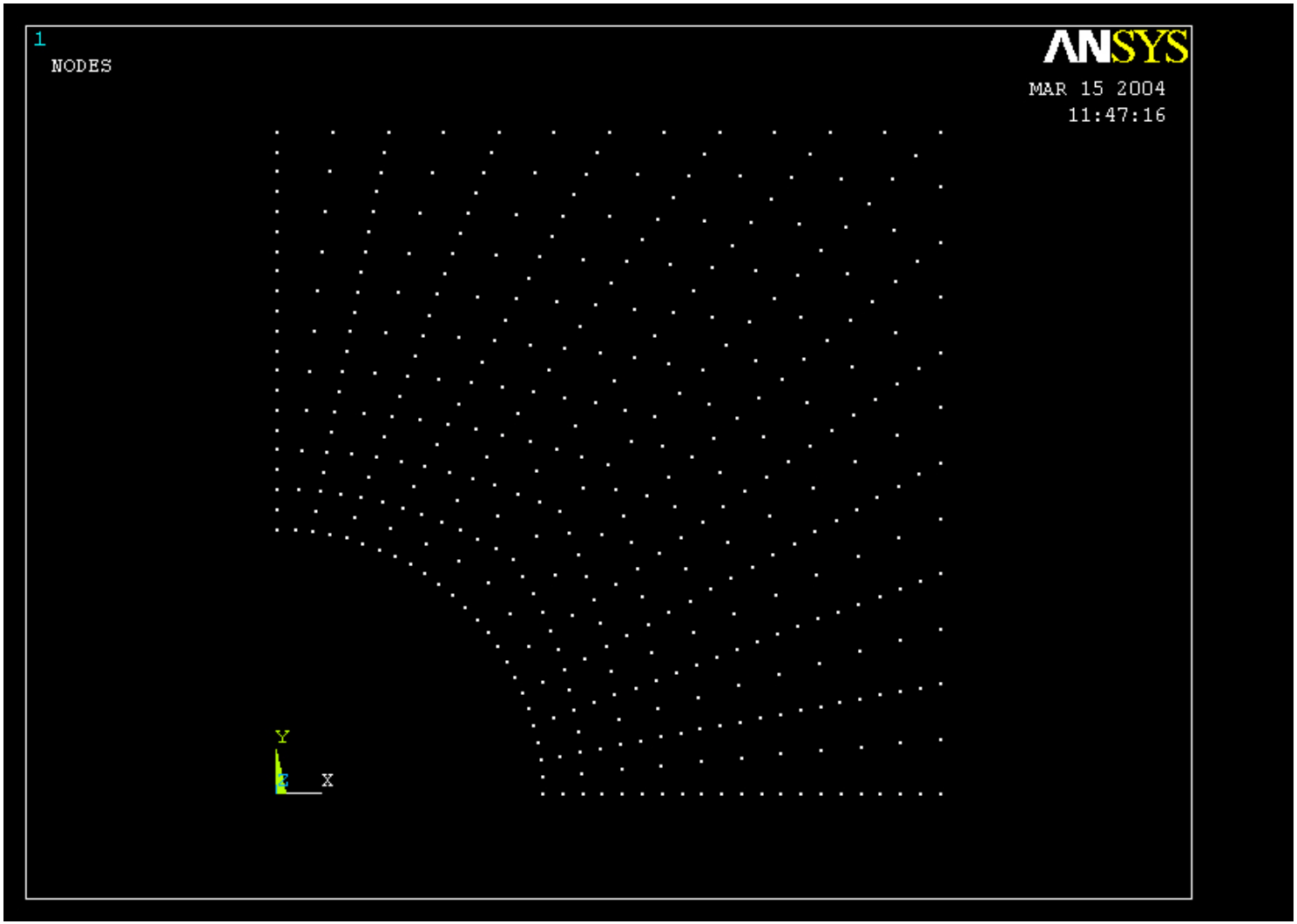


Select Pick All

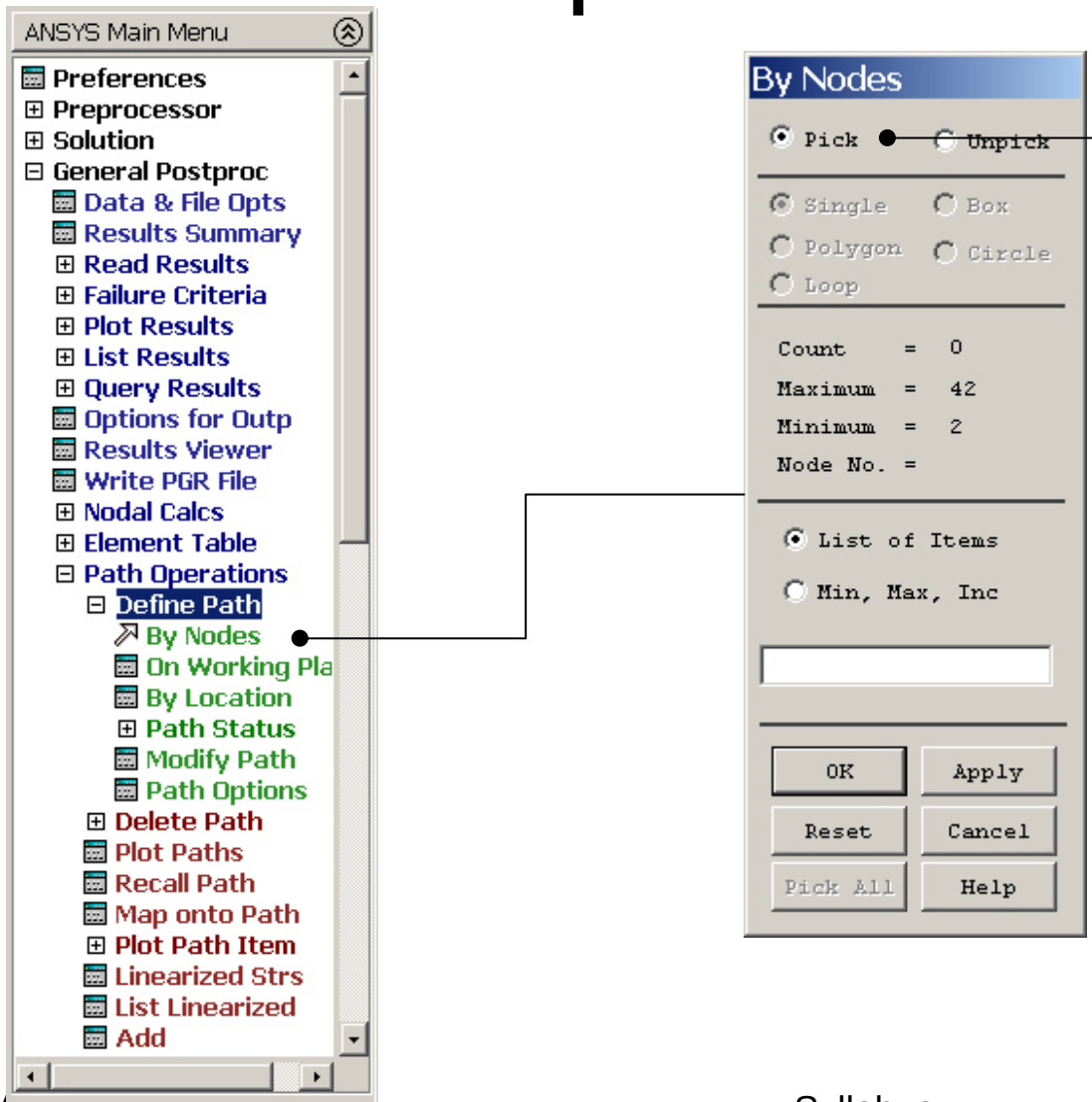
Example - Plot - Nodes



Example - Plot - Nodes

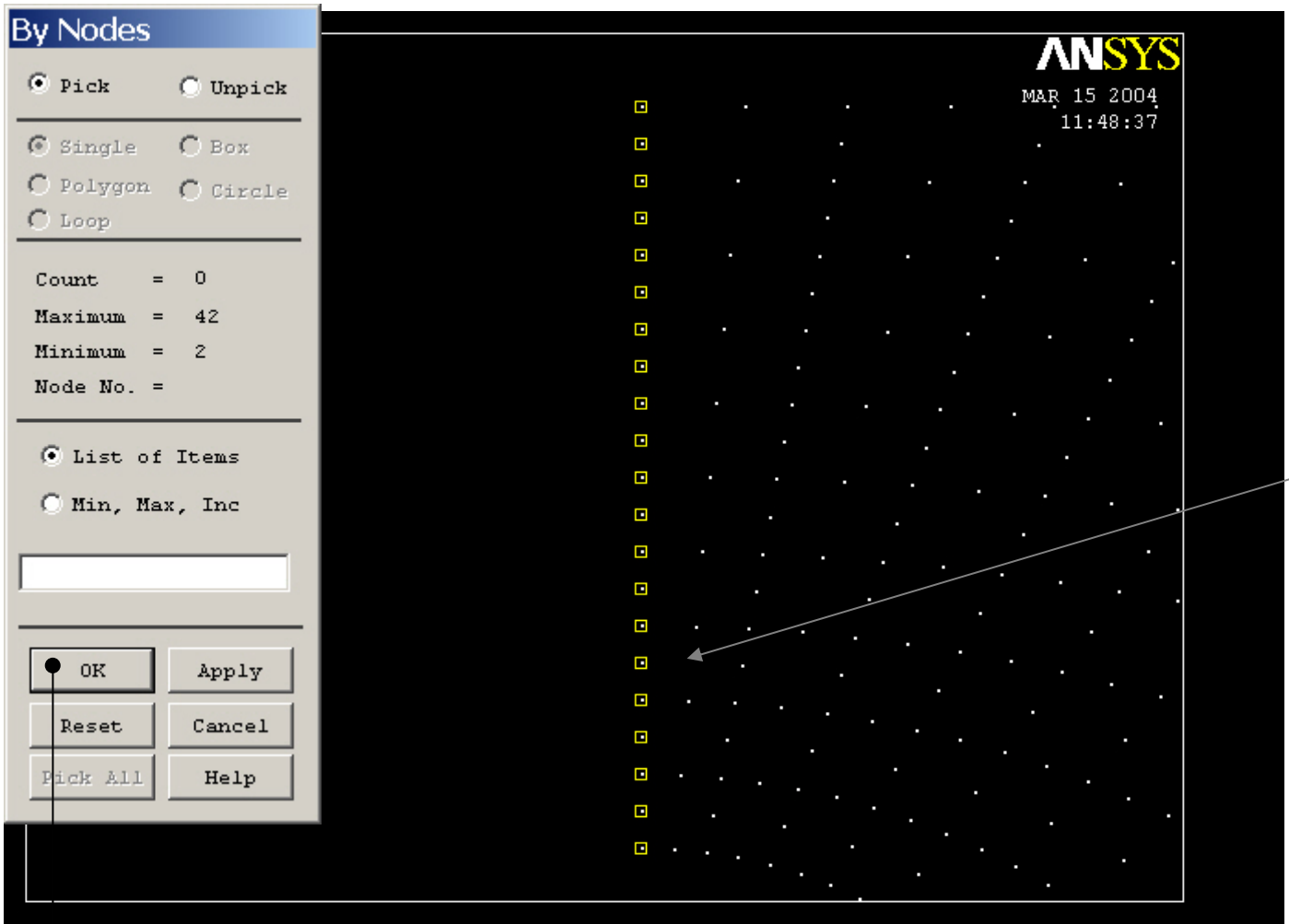


Example – Define Path



See next page for selection

Example – Define Path - By Nodes

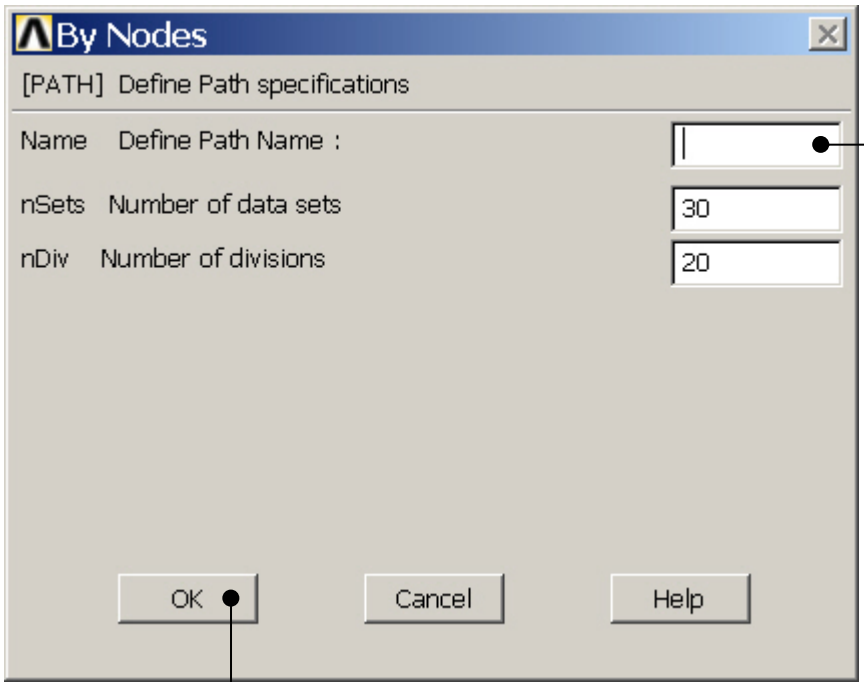


Select the indicated nodes

Note: the selection order is important – start from the hole

Enter OK when finished

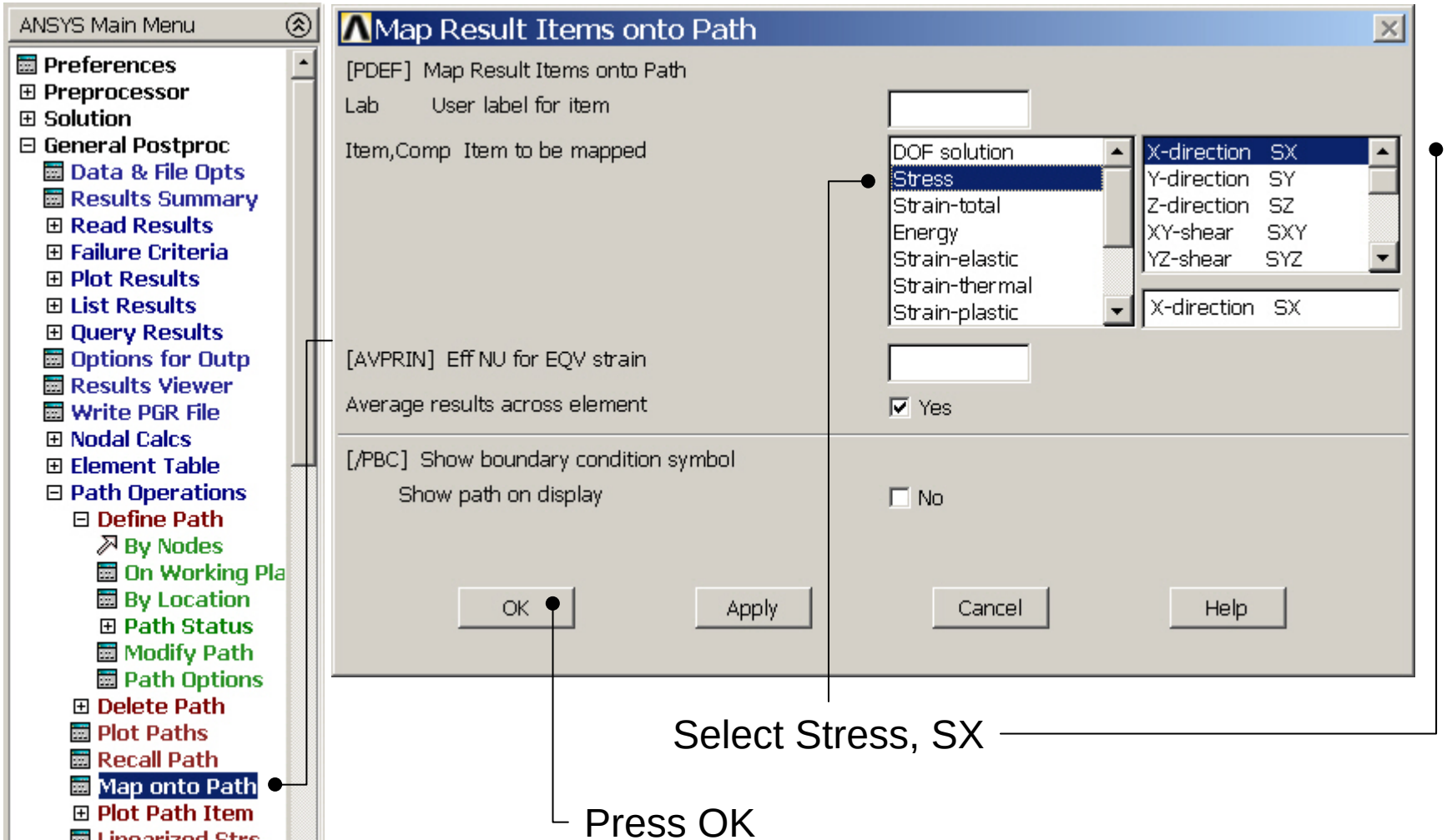
Example – Define Path - By Nodes



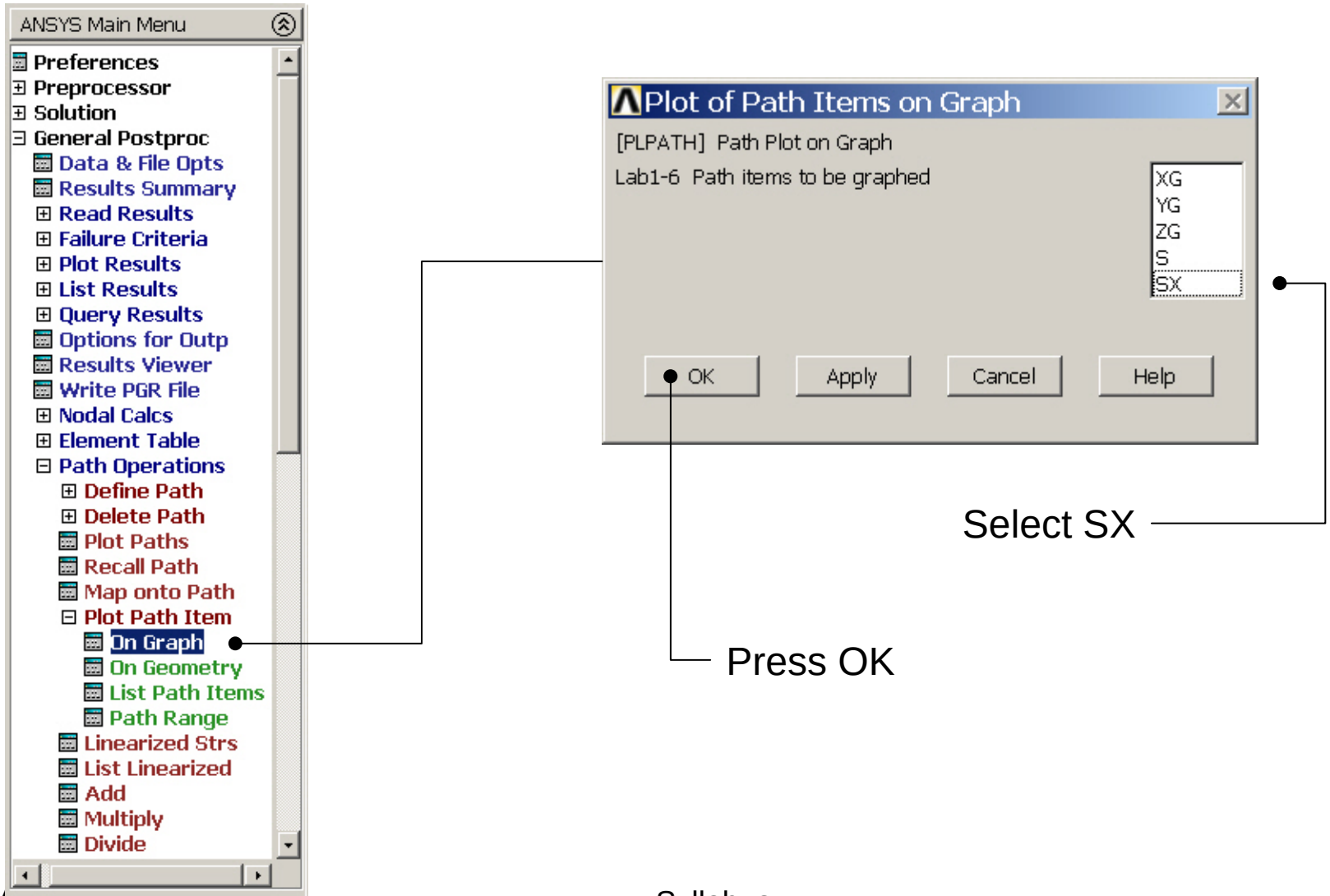
Enter an appropiate name, e.g. SSX

Enter OK

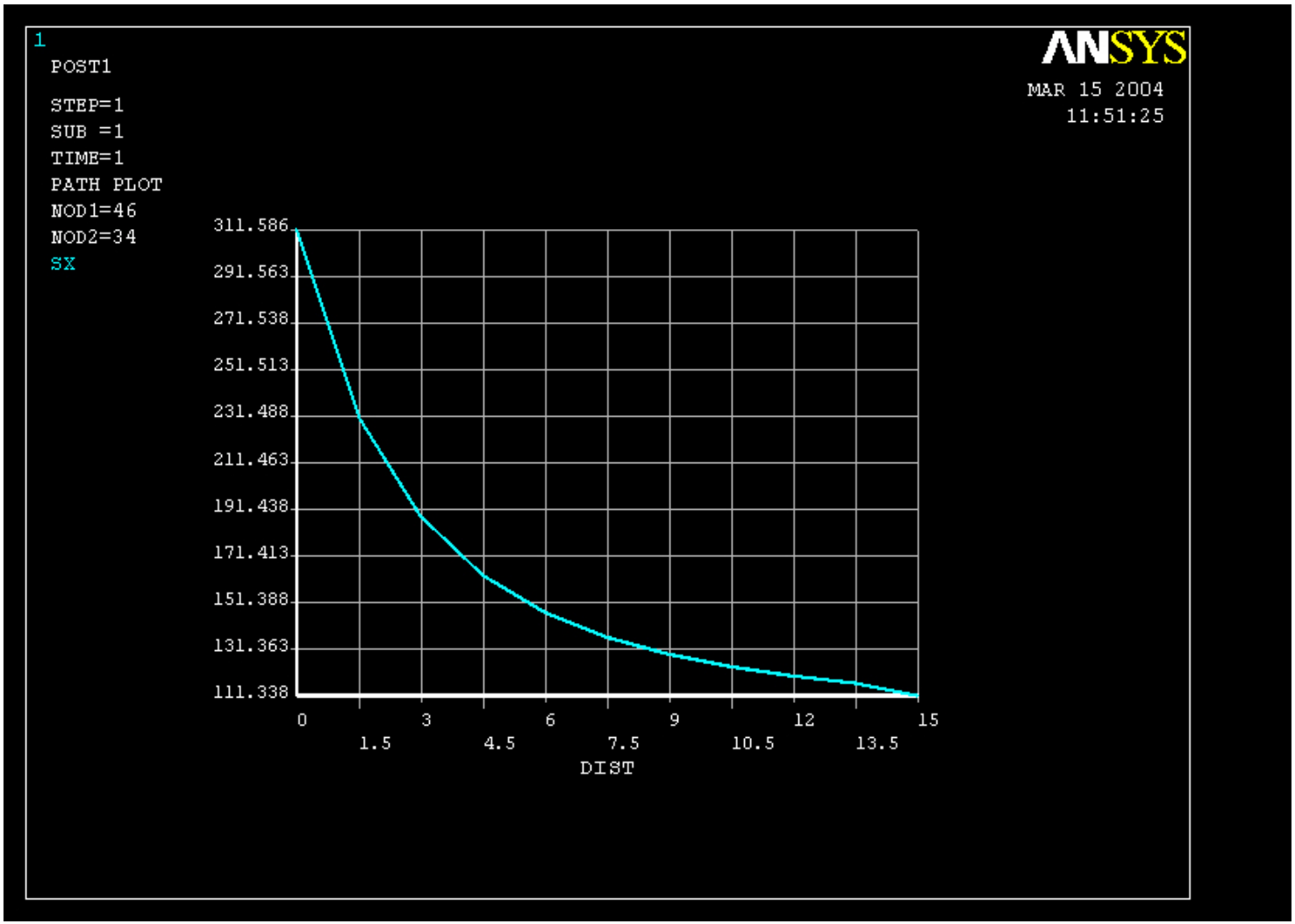
Example – Map onto Path



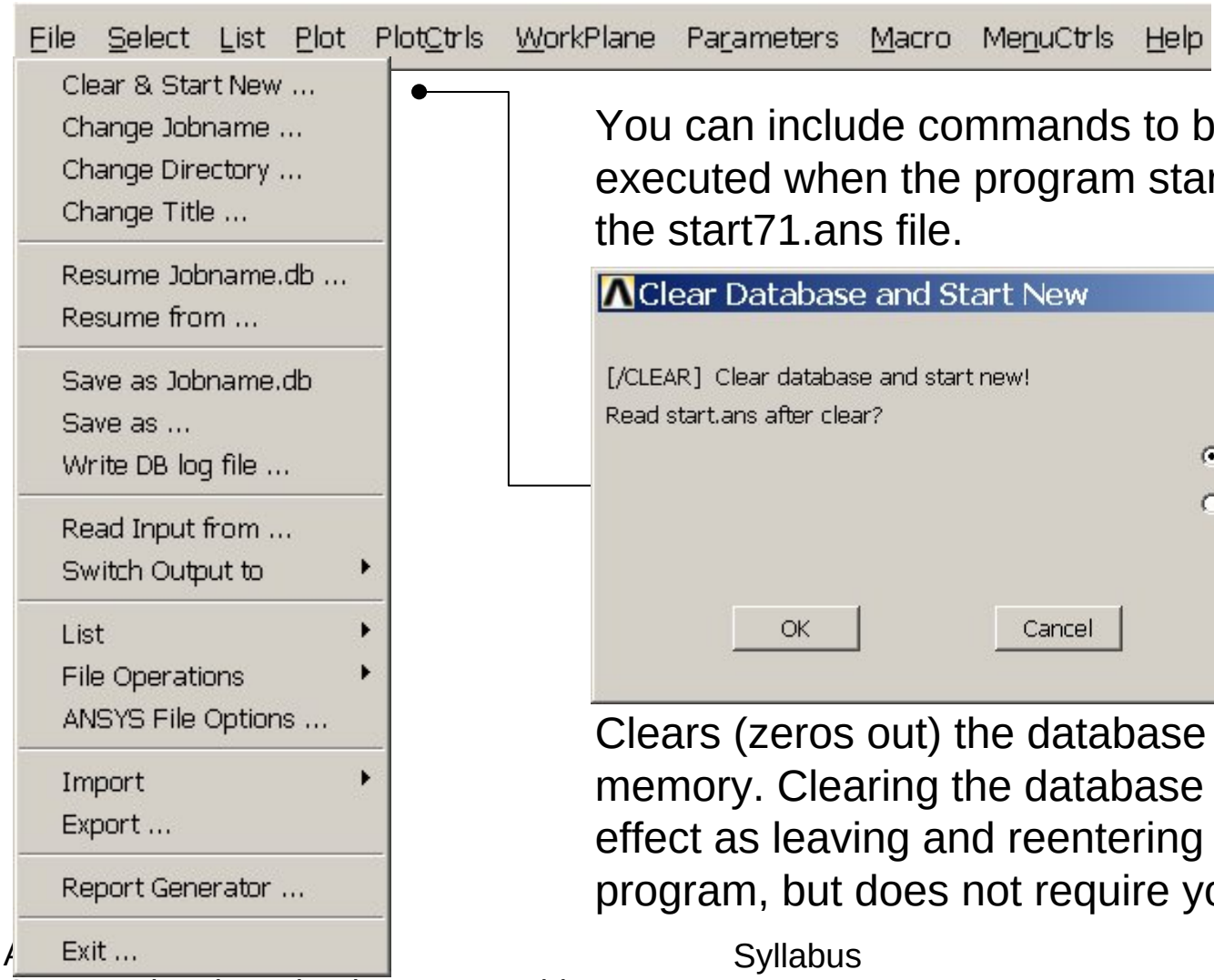
Example – Plot Path on Graph



Example – Plot Path on Graph



File menu



You can include commands to be executed when the program starts up in the start71.ans file.

Clears (zeros out) the database stored in memory. Clearing the database has the same effect as leaving and reentering the ANSYS program, but does not require you to exit.