

ANSYS Simulation (2)

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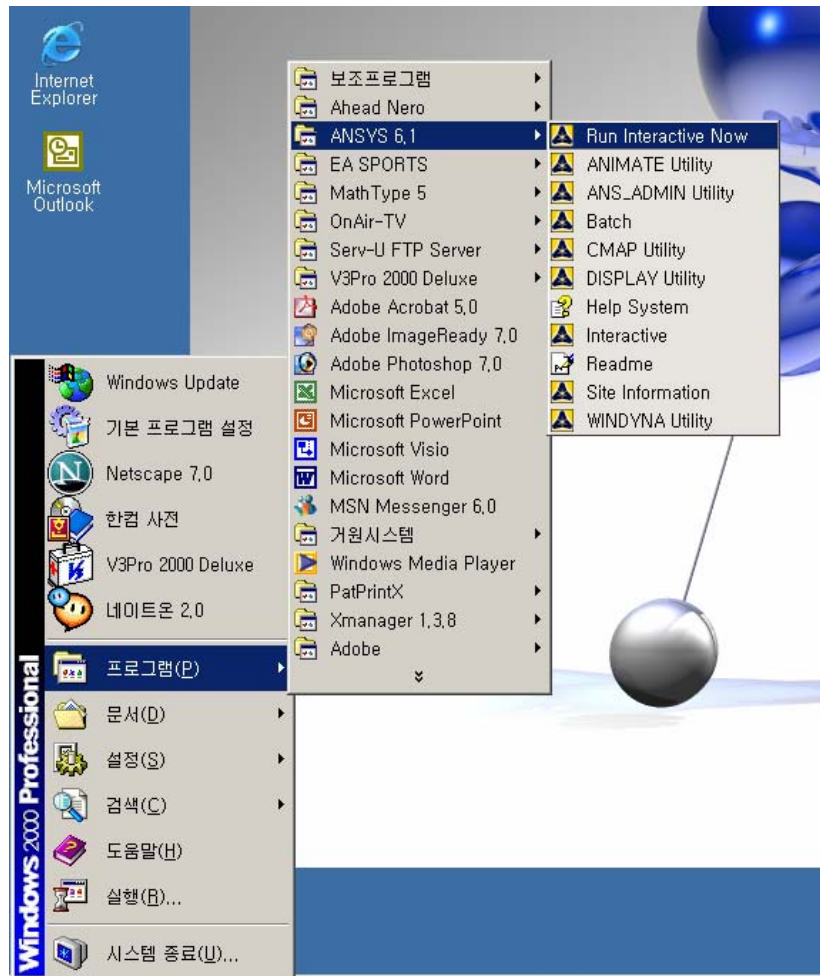
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URL: <http://nml.snu.ac.kr>

ANSYS 실습

- **ANSYS** 구동 : “Run Interactive Now” 메뉴를 선택



ANSYS 실습 (cont'd)

- 환경 설정 : “Interactive” 메뉴를 선택

The image shows a Windows XP desktop environment. The Start menu is open, and the 'ANSYS 6.1' application is selected. The 'Interactive' option is highlighted in the context menu. A dashed yellow line indicates the transition to the ANSYS Interactive 6.1 dialog box on the right. The dialog box is titled 'Interactive 6.1' and contains the following settings:

- Product selection: ANSYS/Multiphysics
- Enable ANSYS Parallel Performance:
- Use ANSYS Drop Test Module:
- Working directory: C:\
- Graphics device name: win32
- Initial jobname: file
- MEMORY REQUESTED (megabytes):
 - Use Default Memory Model:
 - for Total Workspace: 1265
 - for Database: 64
- Read START.ANS file at start-up?: Yes
- Parameters to be defined (-par1 val1 -par2 val2 ...):
- Language Selection: [english]
- Execute a customized ANSYS executable: ...

Buttons at the bottom: Run, Close, Reset, Cancel, About.



ANSYS 실습 (cont'd)

- ANSYS의 작업창 소개 :

The screenshot shows the ANSYS Multiphysics Utility Menu interface. The main window is titled 'ANSYS/Multiphysics Utility Menu' and contains a menu bar (File, Select, List, Plot, PlotCtrls, WorkPlane, Parameters, Macro, MenuCtrls, Help), a toolbar, and a main menu. The main menu is expanded to show options like Preferences, Preprocessor, Solution, General Postproc, TimeHist Postpro, Topological Opt, Design Opt, Prob Design, Radiation Opt, Run-Time Stats, Session Editor, and Finish. A 'Nodes' window is open, displaying '1 NODES' and the ANSYS logo with the date 'MAR 17 2004' and time '02:03:37'. An 'ANSYS 6.1 Output Window' is also open, showing a log of operations including 'Completed pre-check of triangle facets', 'Meshing of volume 1 is complete.', and 'Meshing of volume 1 aborted.' followed by a warning and note. The status bar at the bottom indicates 'Pick a menu item or enter an ANSYS Command (BEGIN)' and shows parameters like 'mat=1', 'type=1', 'real=1', and 'csys=0'. Red callout boxes with arrows point to various parts of the interface: '단축 버튼창' (Shortcut button bar) points to the toolbar; '도구 메뉴창' (Tool menu bar) points to the menu bar; '명령 입력창' (Command input bar) points to the command line; '주메뉴창' (Main menu bar) points to the main menu; '그래픽 출력창' (Graphic output window) points to the Nodes window; and '결과 출력창' (Result output window) points to the Output Window.



ANSYS 실습 (cont'd)

- 입력창의 사용법 :

```
VMESH,ALL
MSHKEY,0
MSHAPE,1,3D
ESIZE,0.9E-6,
VSEL,all
! VOLUME MESHING

VATT, 1,1
VSEL,all
! VOLUME ATTRIBUTION

VEXT, ALL, , ,0,0,0.9E-6,...

PCIRC, 0, 39E-6,

BTOL=1e-12
TOL=1e-10

CSYS, WP

! DEFINE LOCAL COORDINATES SYSTEM

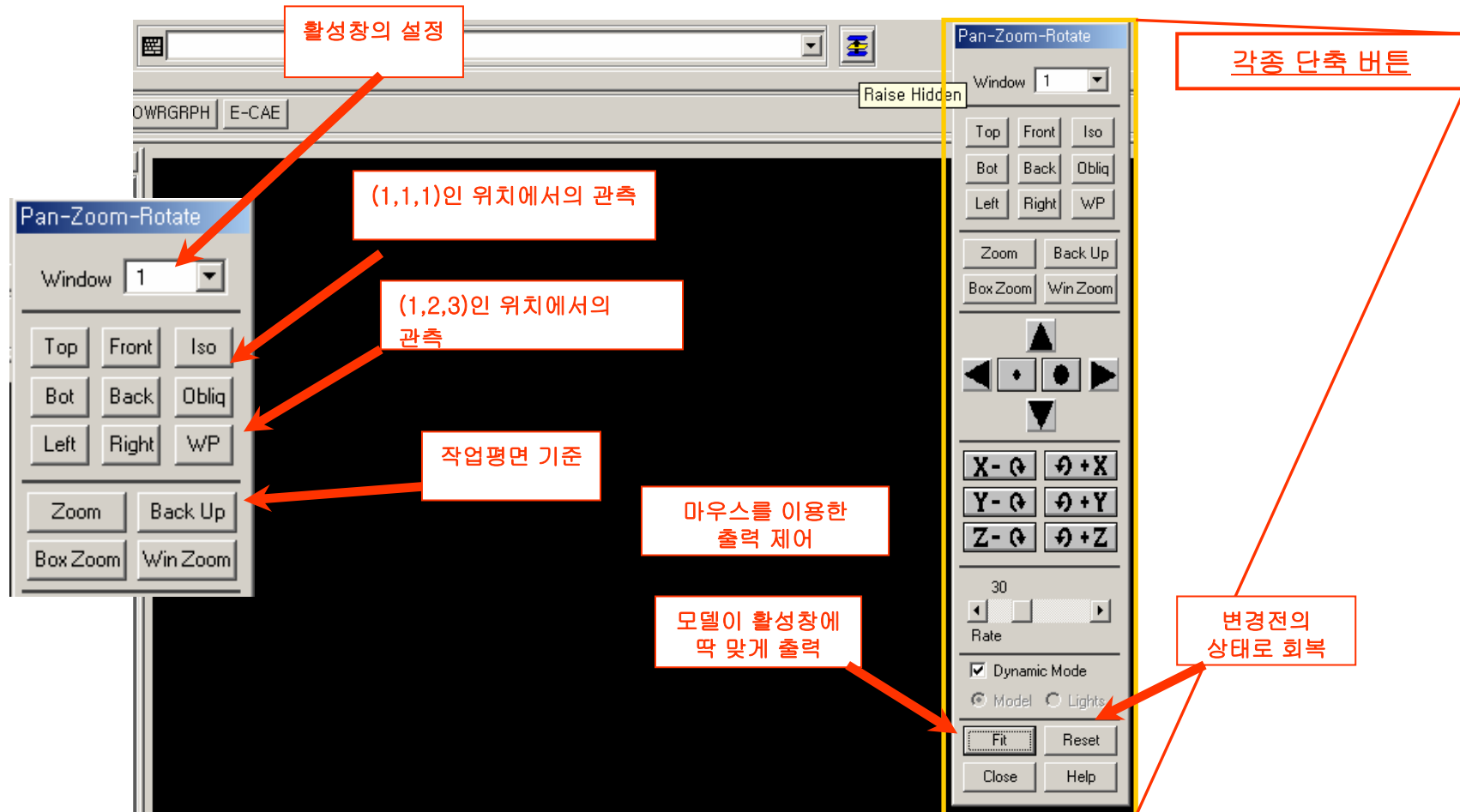
UIMP,1,GXY,GYZ,GXZ,106.3E9,106.3E9,106.36E9
UIMP,1,NUXY,NUYZ,NUXZ,0,27,0,27,0,27
UIMP,1,DENS, , ,3100,
UIMP,1,EX,EY,EZ,270E9,270E9,270E9
ET,1,SOLID64
/PREP7
```

기존에 입력한
명령어들



ANSYS 실습 (cont'd)

- 도구모음상자의 사용법 :



ANSYS 실습 (cont'd)

- 대화상자의 사용법 :

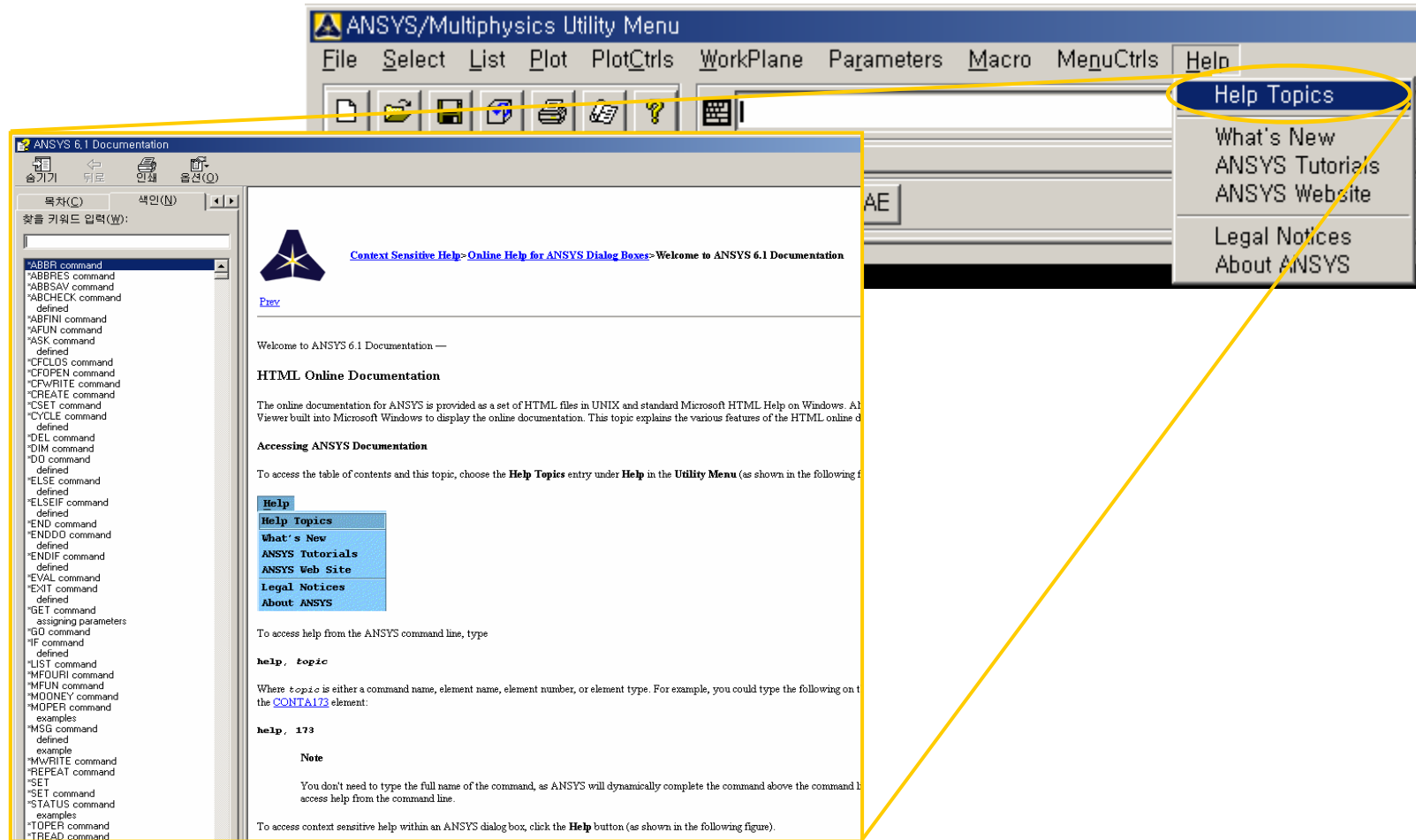
명령수행 후 대화상자 닫힘

명령수행 후 대화상자 유지



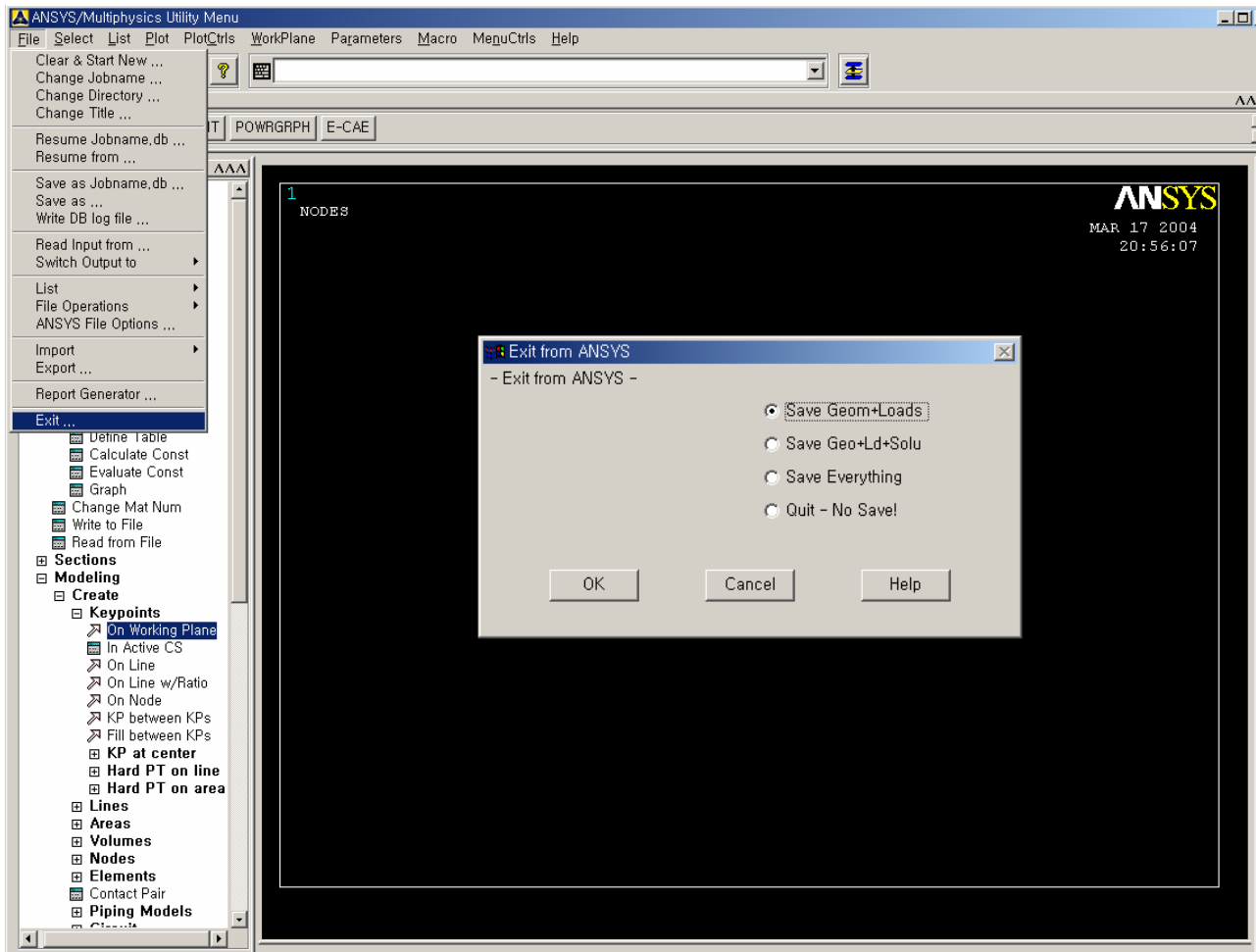
ANSYS 실습 (cont'd)

- 도움말 시스템 :



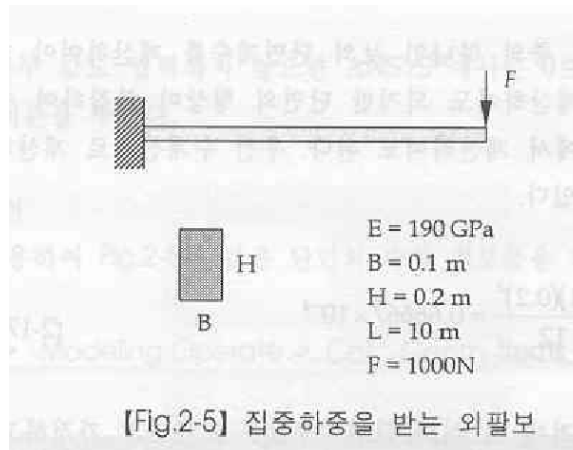
ANSYS 실습 (cont'd)

- 도움말 시스템 : 'OK' button을 눌러 종료



GUI를 통한 ANSYS 예제

- *Beam*의 단면 및 속성 확인



- Analytical solution of moment of inertia :

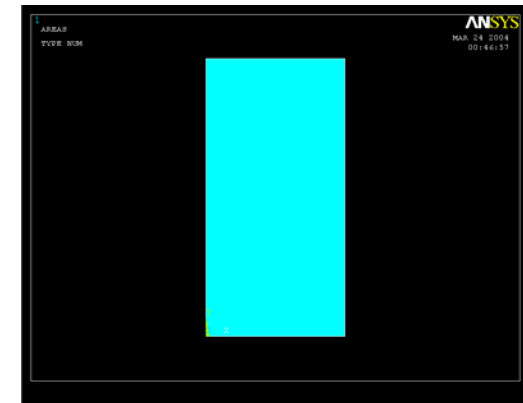
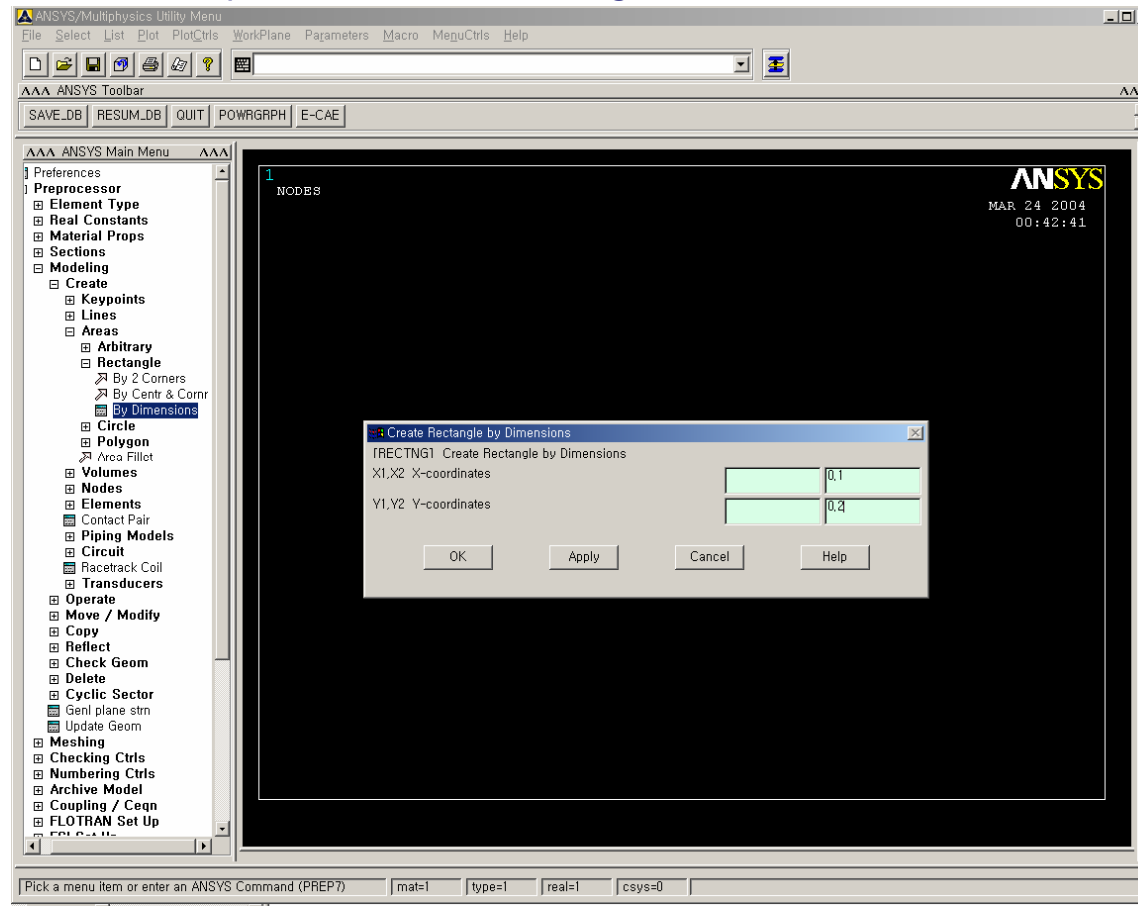
$$I_{xx} = \frac{bh^3}{12} = \frac{(0.1)(0.2)^3}{12} = 0.66667 \times 10^{-4}$$



GUI를 통한 ANSYS 예제 (cont'd)

- 단면의 모델링 :

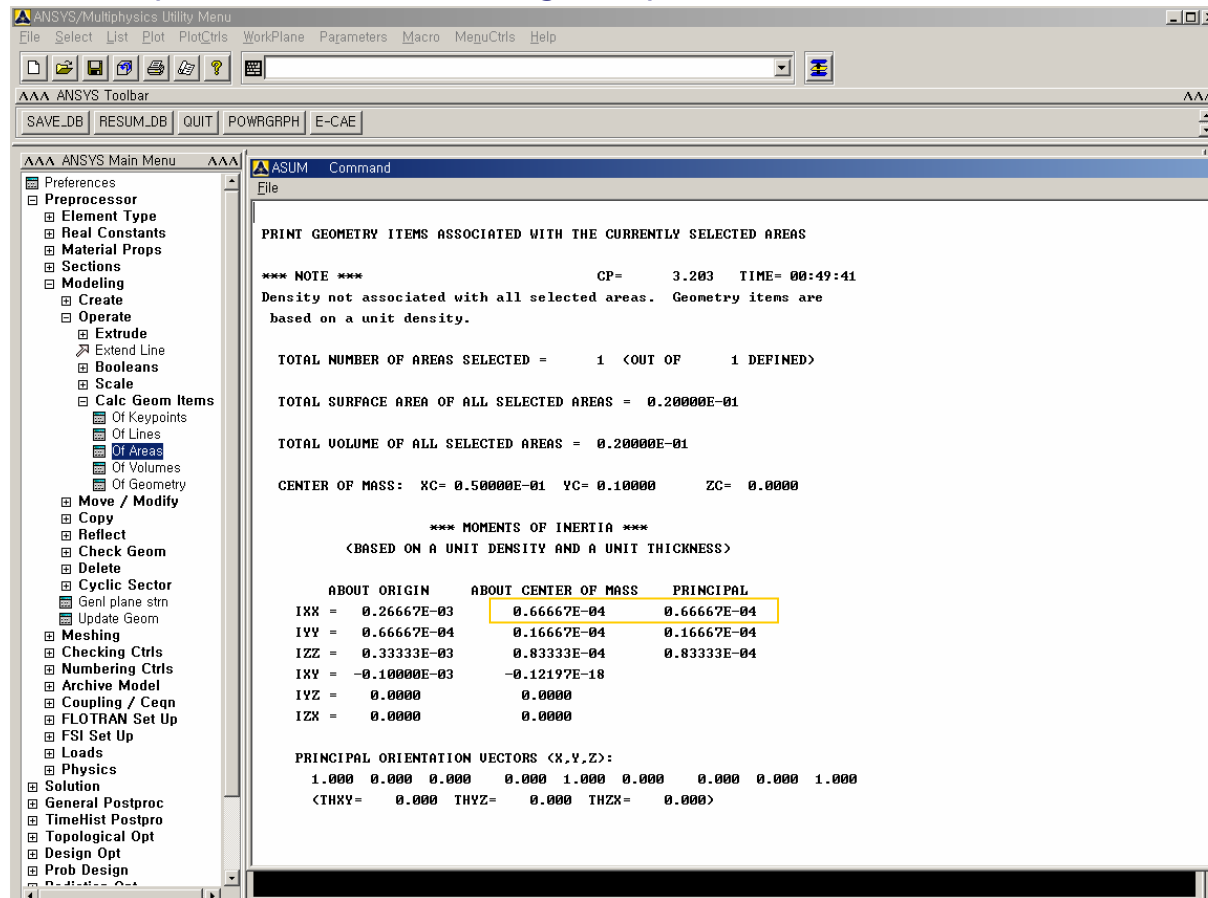
Preprocessor > Modeling > Create > Areas > Rectangle > By Dimensions



GUI를 통한 ANSYS 예제 (cont'd)

- 단면 속성의 확인 :

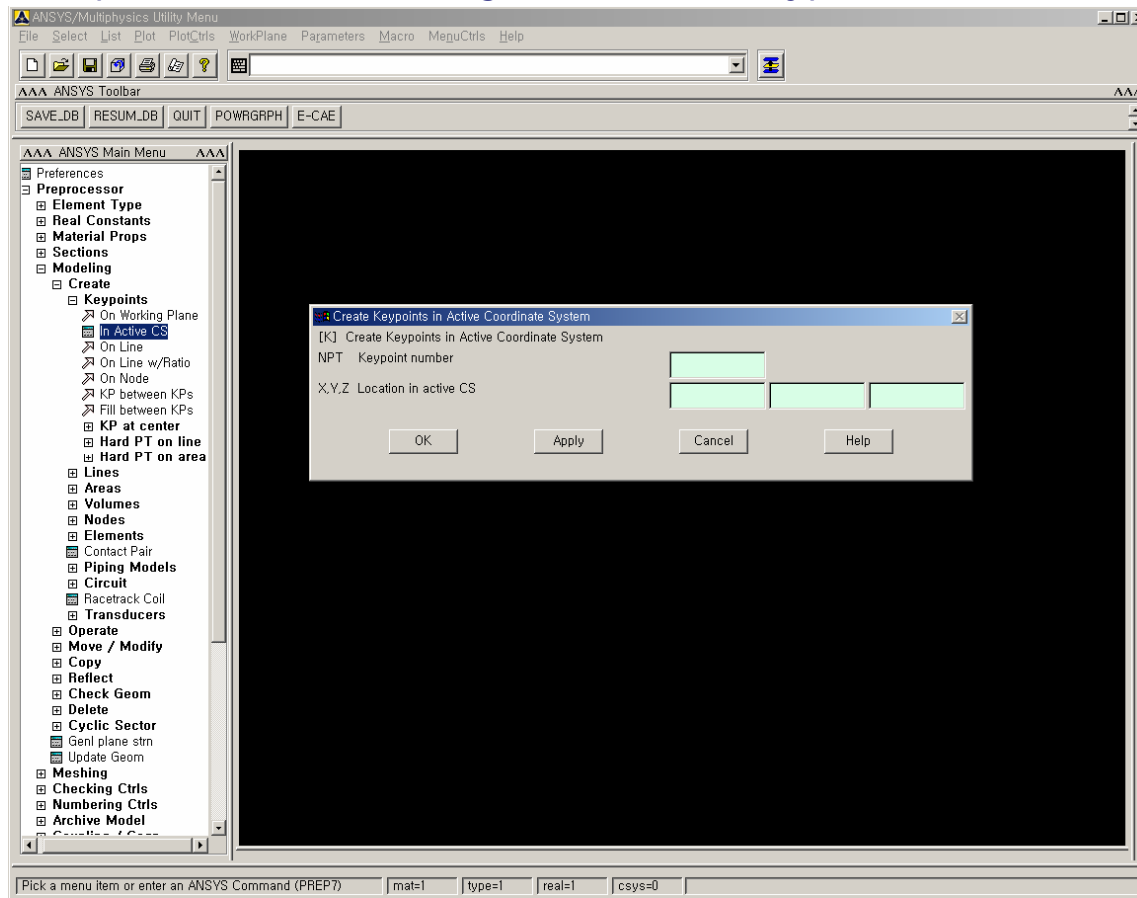
Preprocessor > Modeling > Operate > Calc Geom Items > Rectangle > Of Areas



GUI를 통한 ANSYS 예제 (cont'd)

- 두 점의 생성 : $(0, 0, 0)$

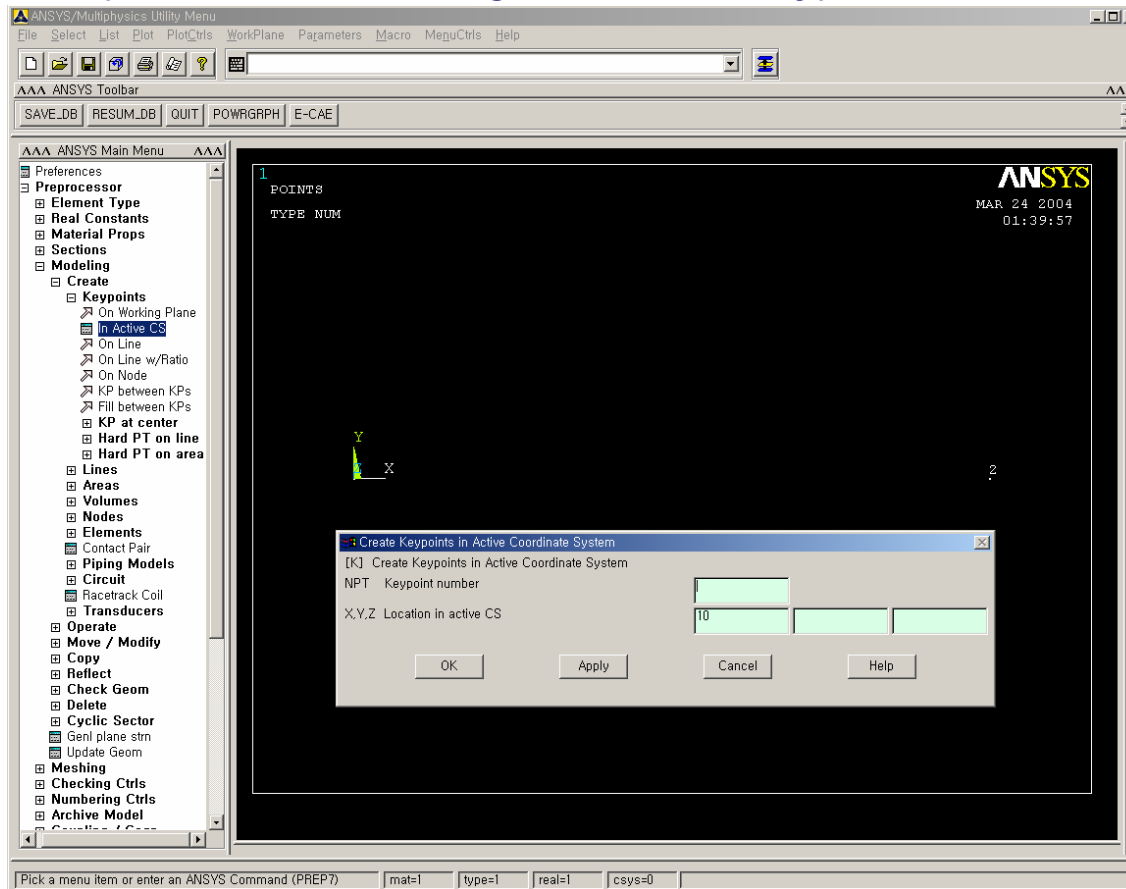
Preprocessor > Modeling > Create > Keypoints > In Active CS



GUI를 통한 ANSYS 예제 (cont'd)

- 두 점의 생성 : $(10, 0, 0)$

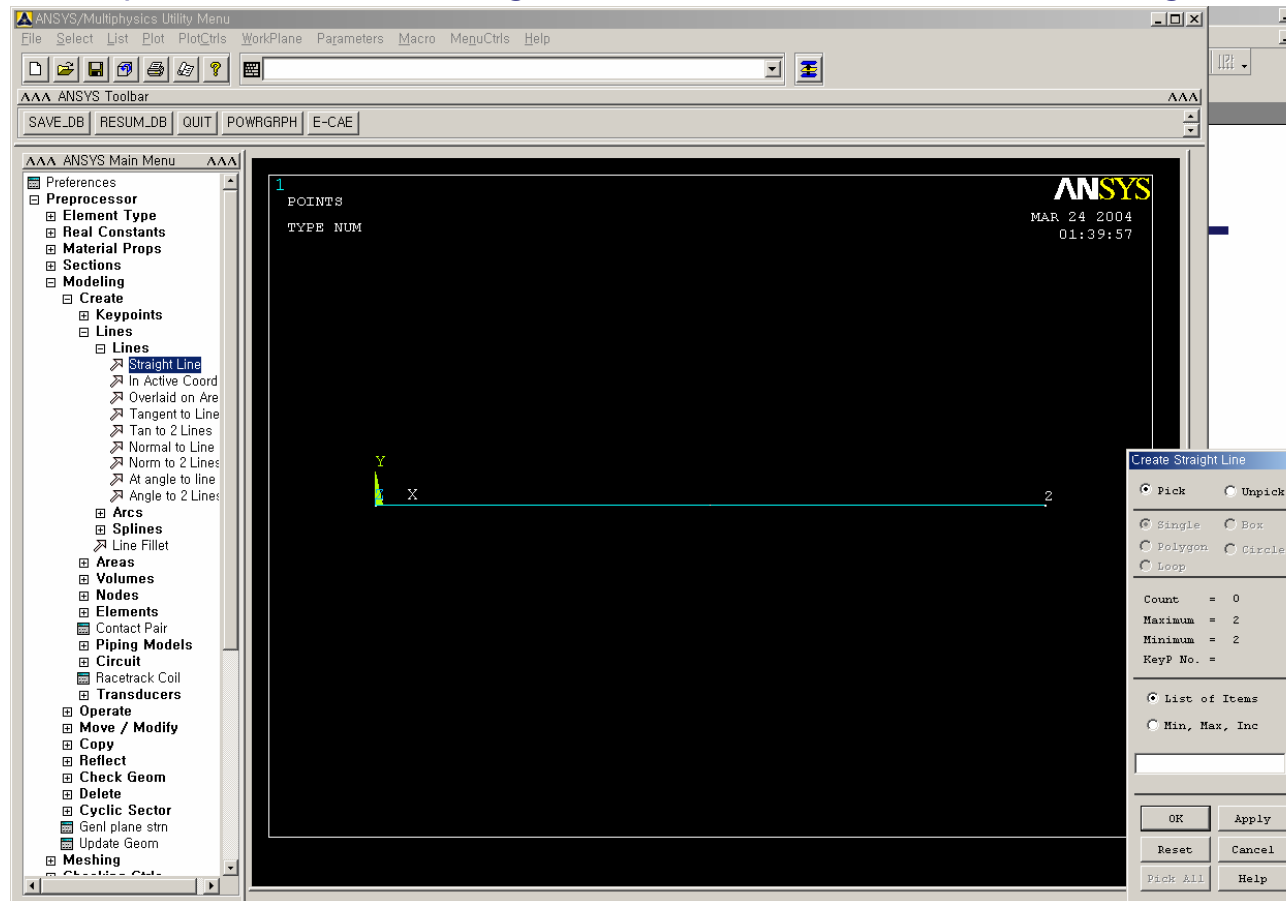
Preprocessor > Modeling > Create > Keypoints > In Active CS



GUI를 통한 ANSYS 예제 (cont'd)

- 직선의 생성 :

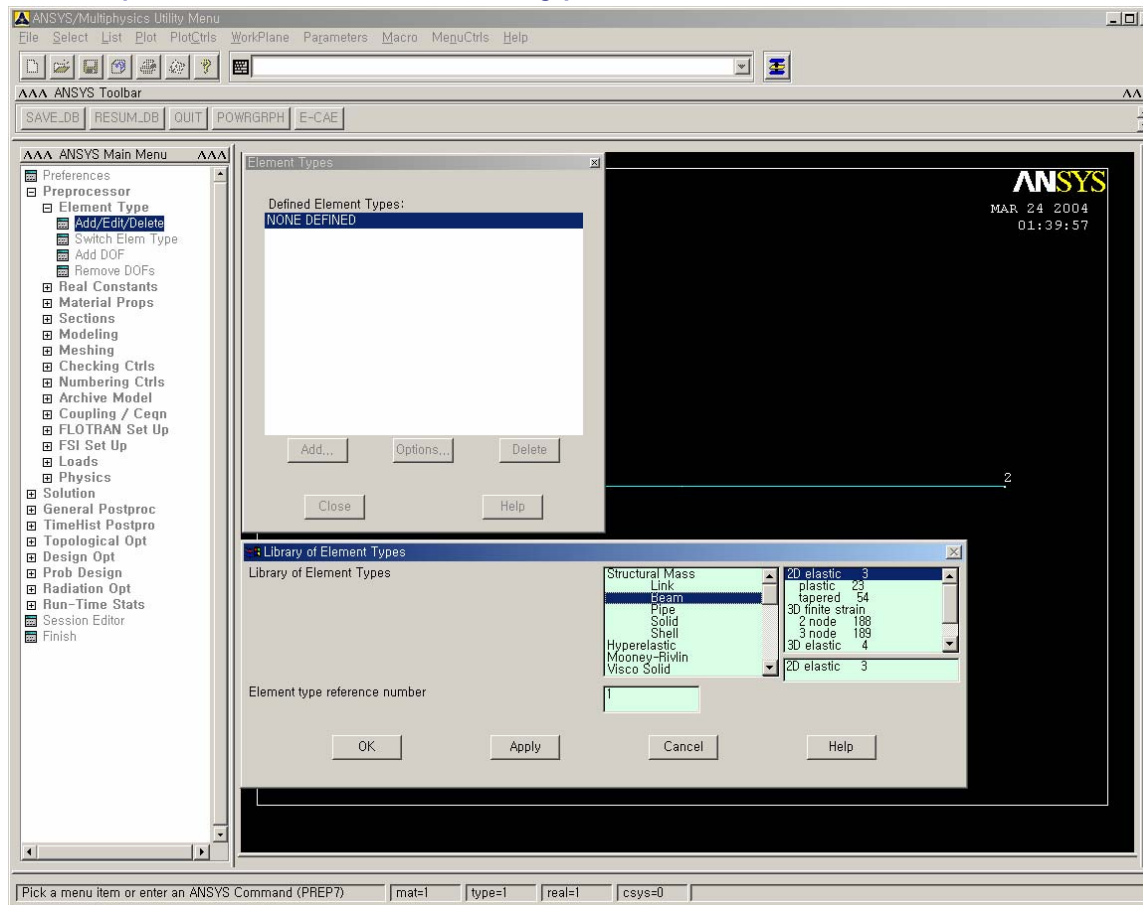
Preprocessor > Modeling > Create > Lines > Lines > Straight Line



GUI를 통한 ANSYS 예제 (cont'd)

- 해석에 사용될 요소의 종류 선택 :

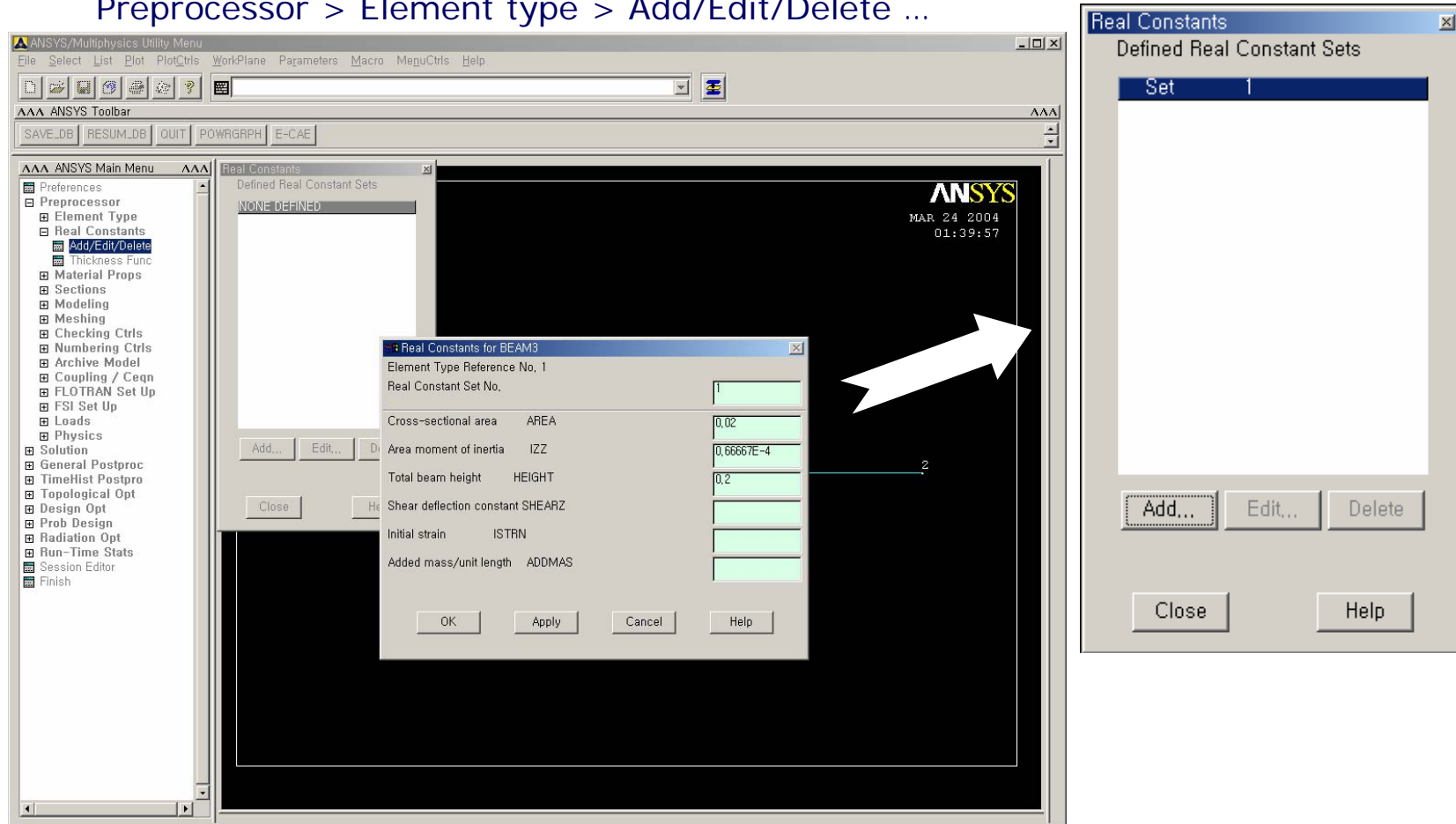
Preprocessor > Element type > Add/Edit/Delete ...



GUI를 통한 ANSYS 예제 (cont'd)

- 요소의 종류에 따른 요소 상수의 성질 :

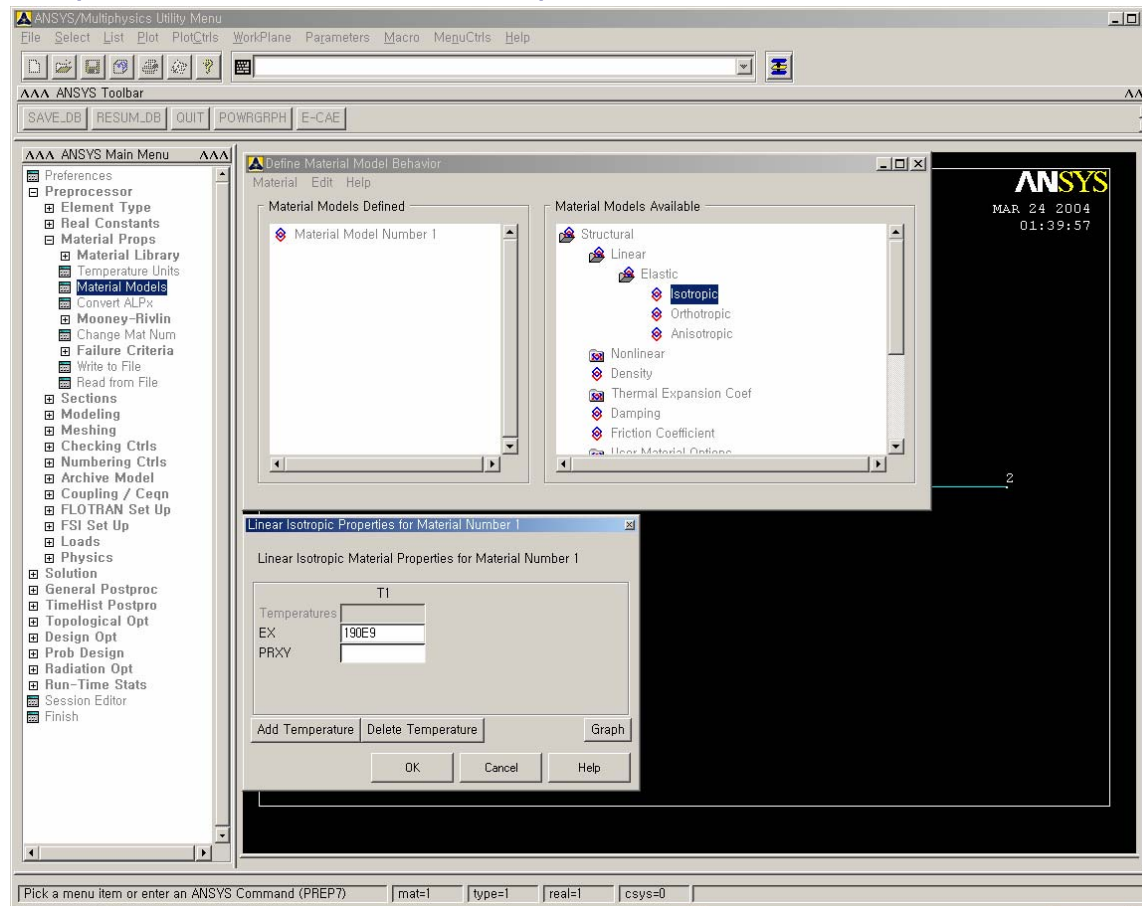
Preprocessor > Element type > Add/Edit/Delete ...



GUI를 통한 ANSYS 예제 (cont'd)

- 재료 물성치의 입력 :

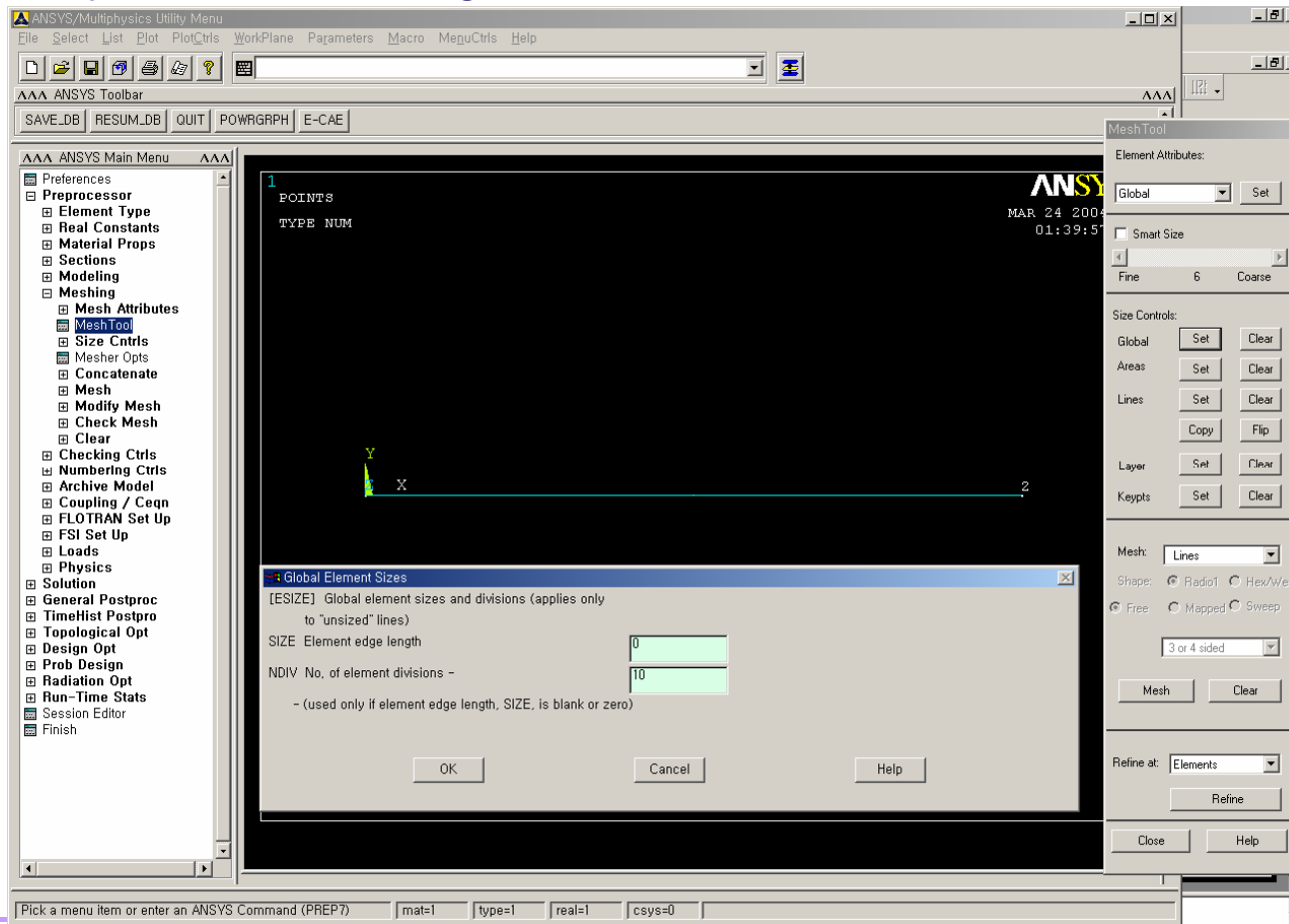
Preprocessor > Material Props > Material Models ...



GUI를 통한 ANSYS 예제 (cont'd)

- 요소망 밀도의 조절 :

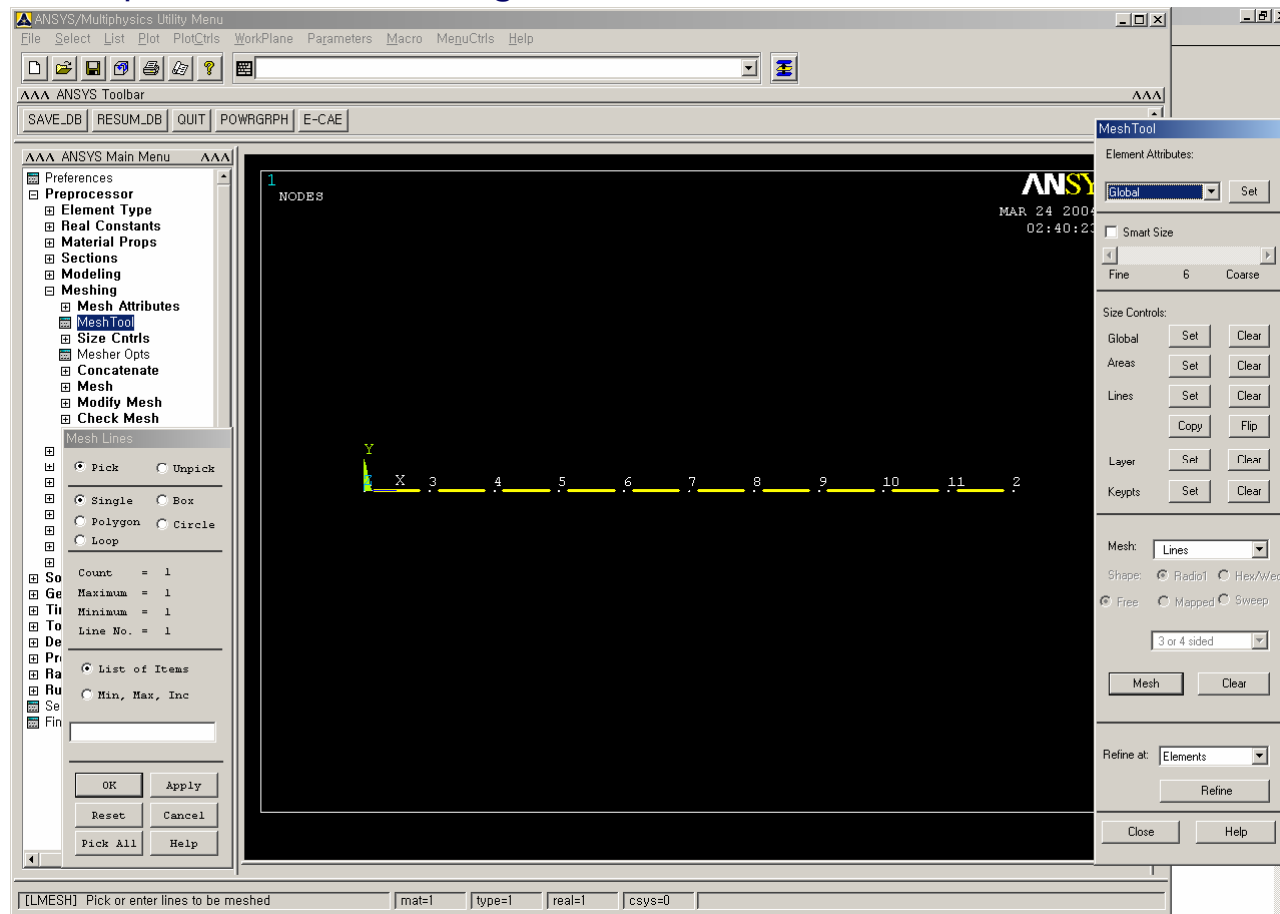
Preprocessor > Meshing > Mesh Tool > Global – set ...



GUI를 통한 ANSYS 예제 (cont'd)

- 요소망 밀도의 조절 (cont'd) :

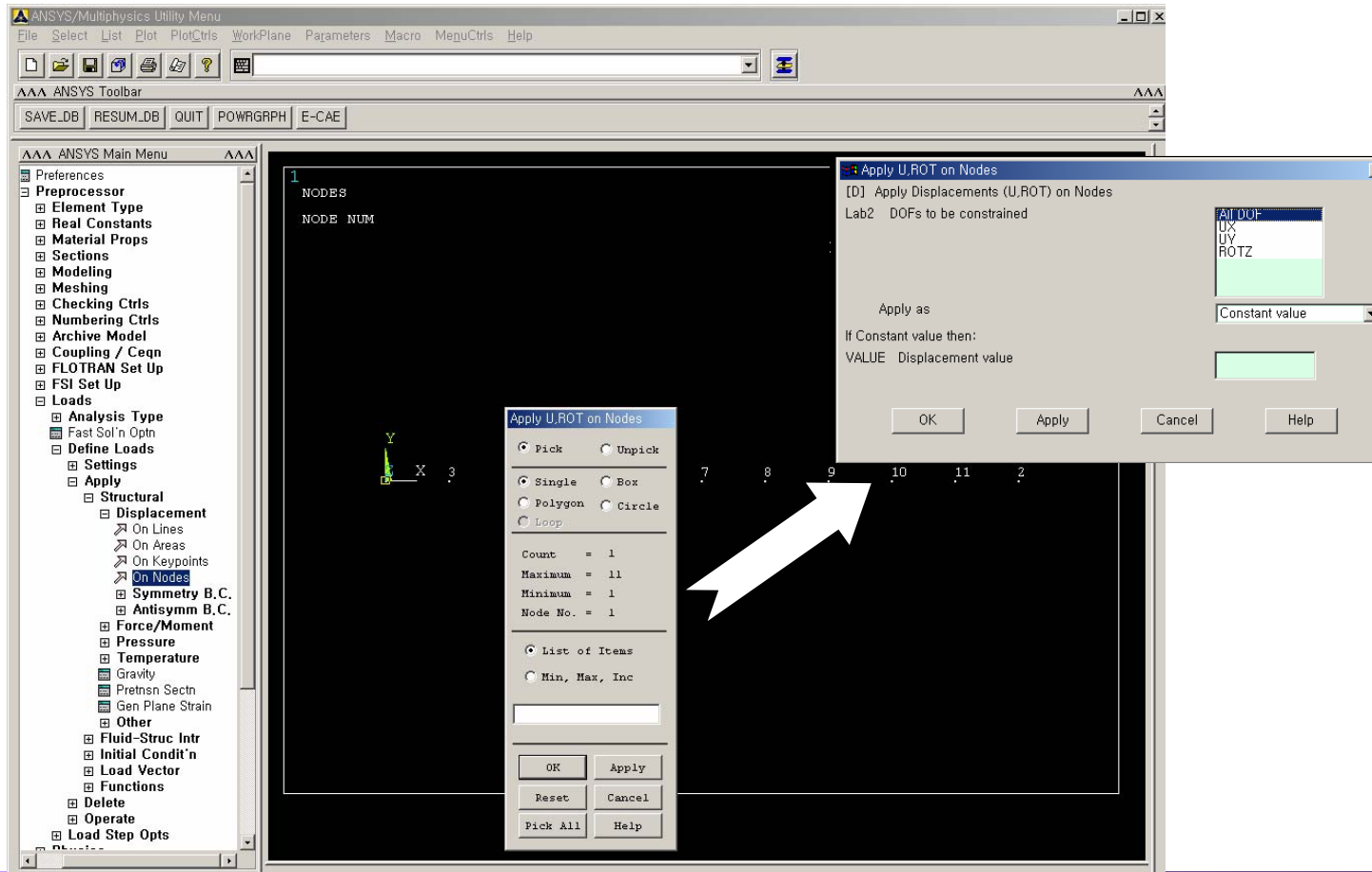
Preprocessor > Meshing > Mesh Tool > Mesh ...



GUI를 통한 ANSYS 예제 (cont'd)

- *경계조건의 적용 :*

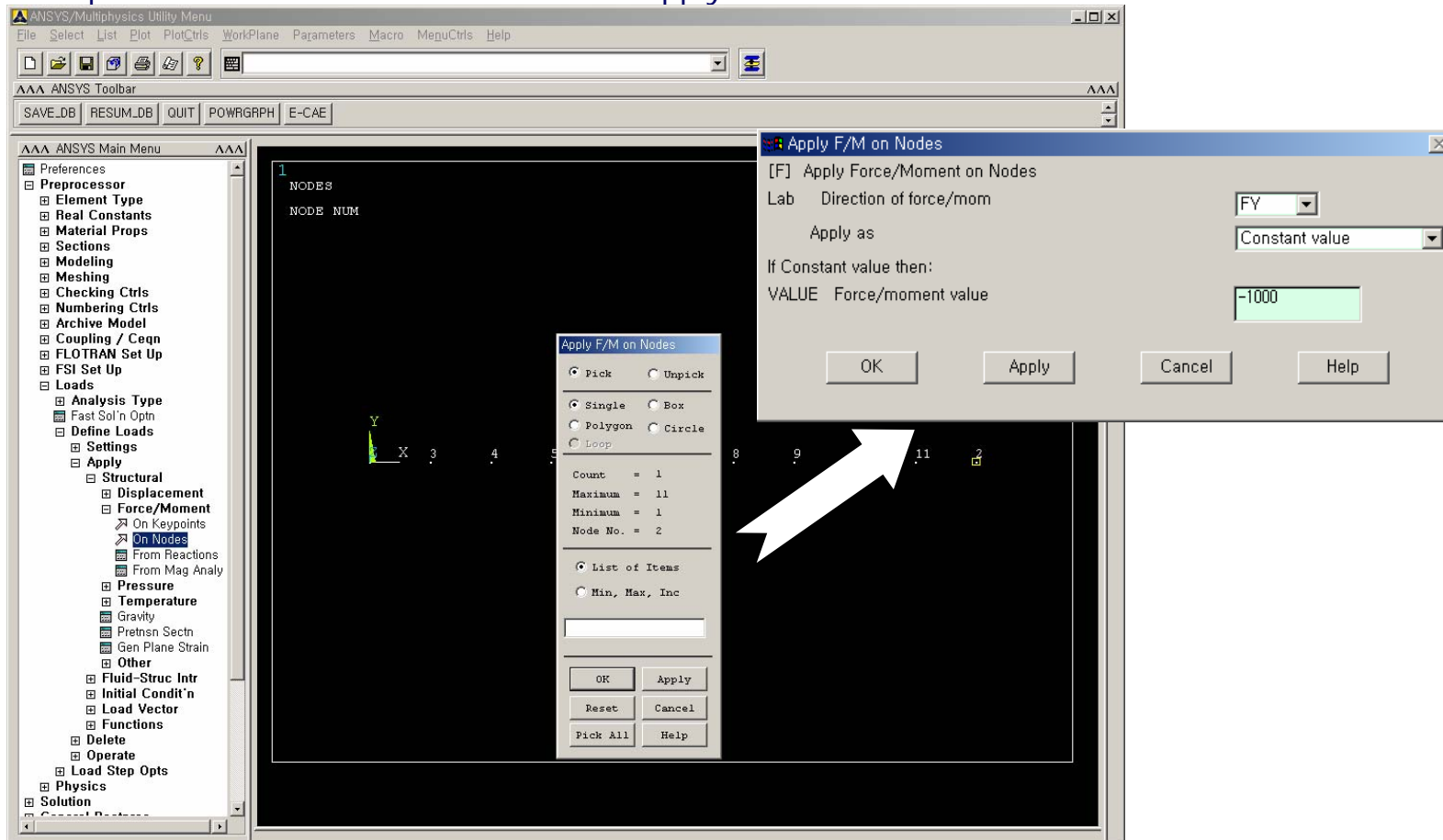
Preprocessor > Loads > Define Loads > Apply > Structural > Displacement > On Nodes



GUI를 통한 ANSYS 예제 (cont'd)

- 하중조건외 적용 :

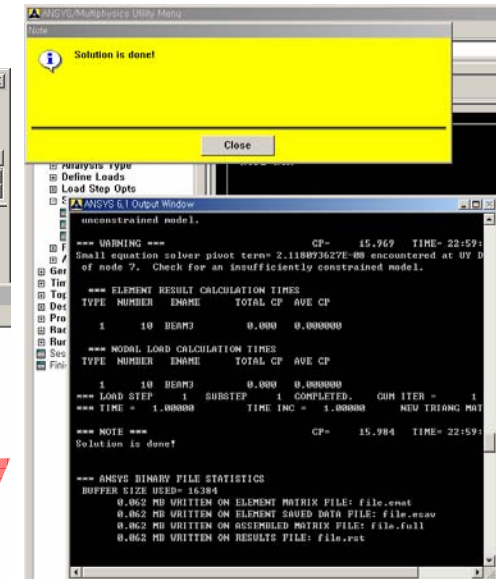
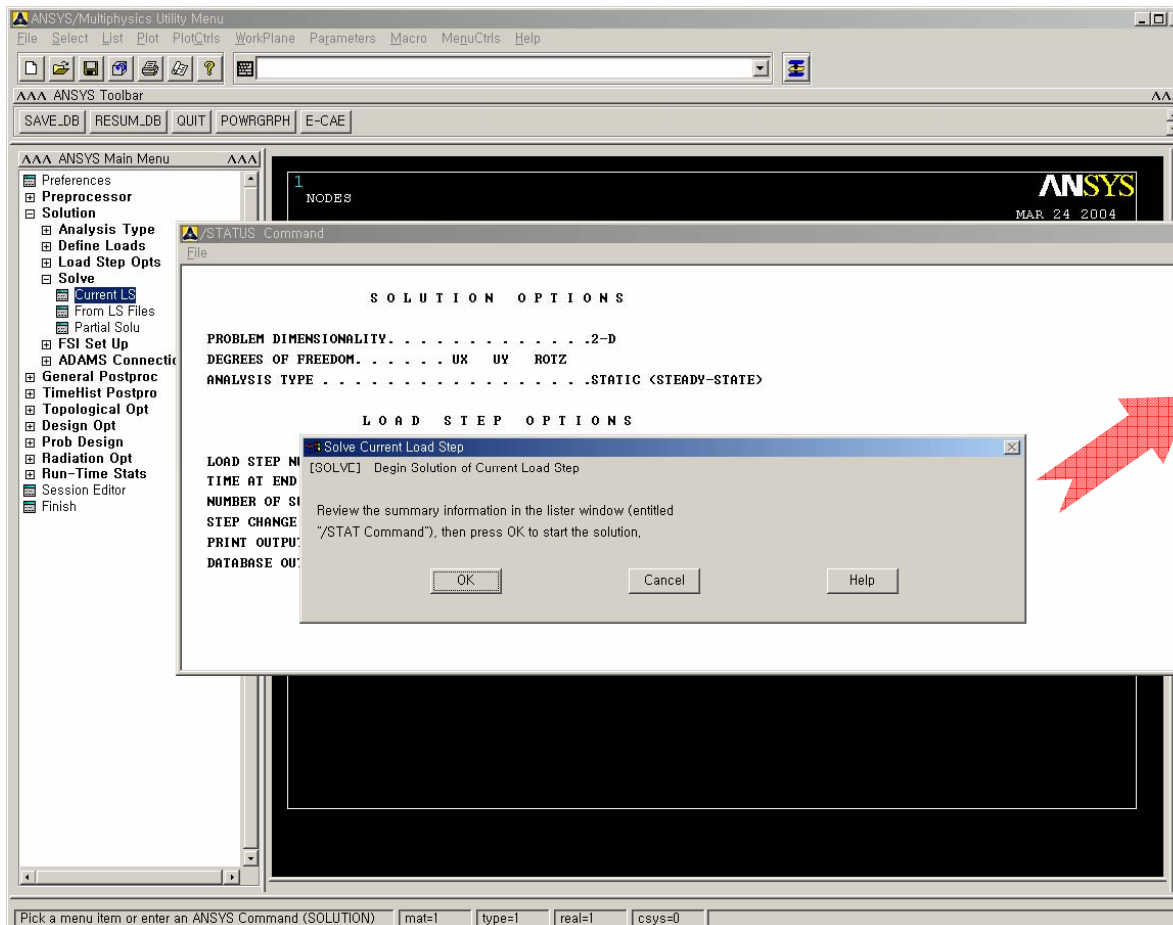
Preprocessor > Loads > Define Loads > Apply > Structural > Force/Moment > On Nodes



GUI를 통한 ANSYS 예제 (cont'd)

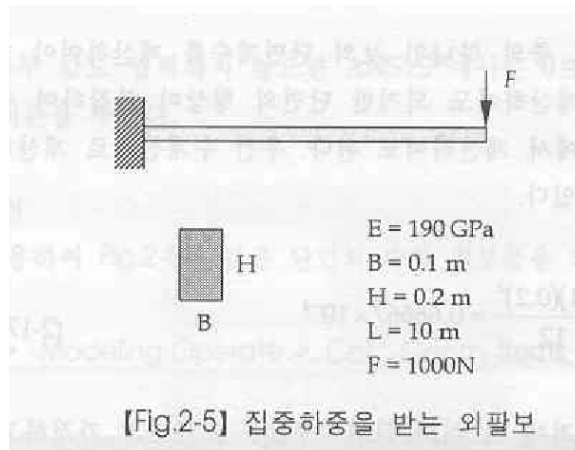
- 해석 단계 :

Solution > Solve > Current LS ...



GUI를 통한 ANSYS 예제 (cont'd)

- 해석결과와의 출력 및 검증 :



- Analytical solution of beam deflection

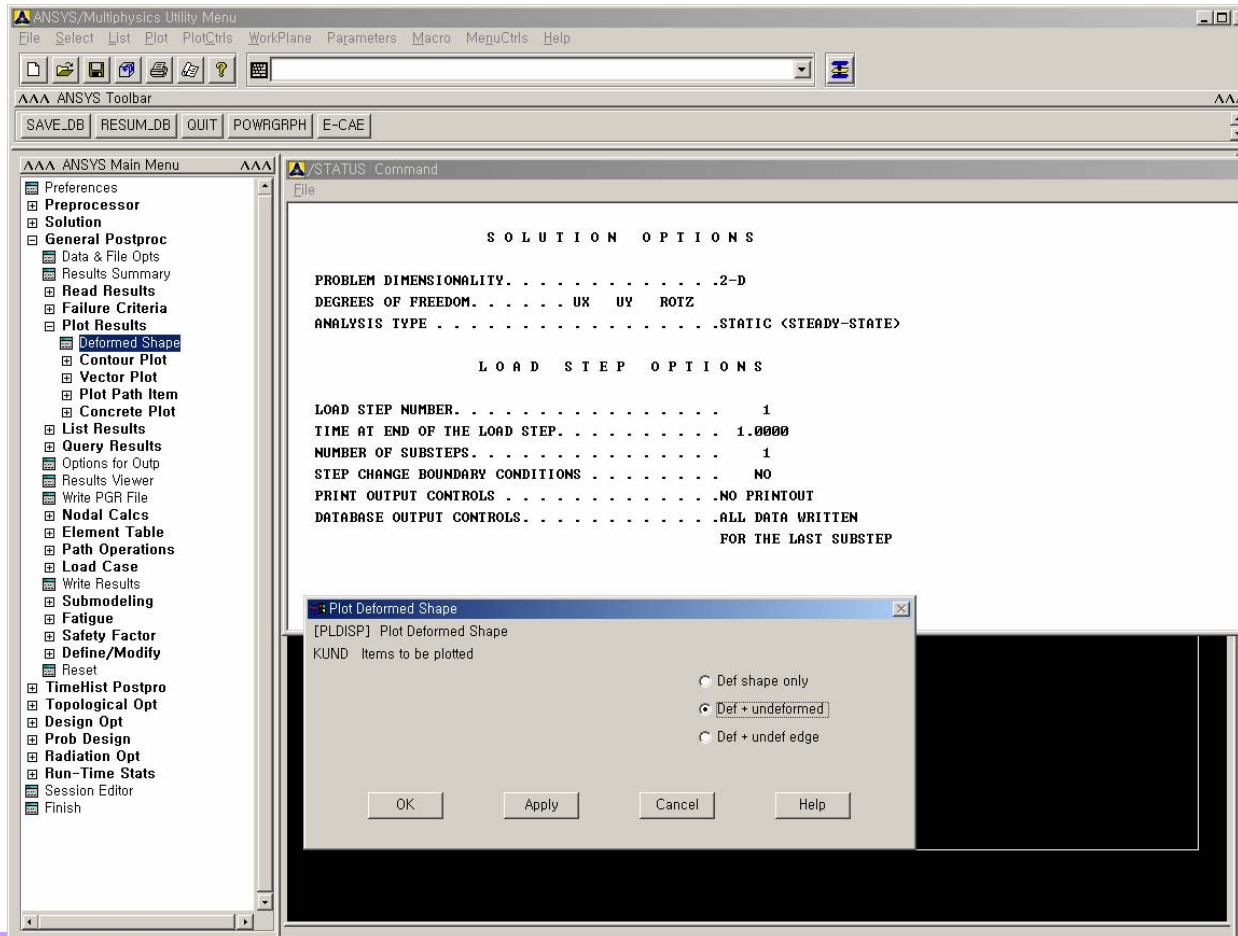
$$\delta = \frac{PL^3}{3EI} = \frac{(-1000)(10)^3}{(3)(190 \times 10^9)(0.66667 \times 10^{-4})} = -0.0263$$



GUI를 통한 ANSYS 예제 (cont'd)

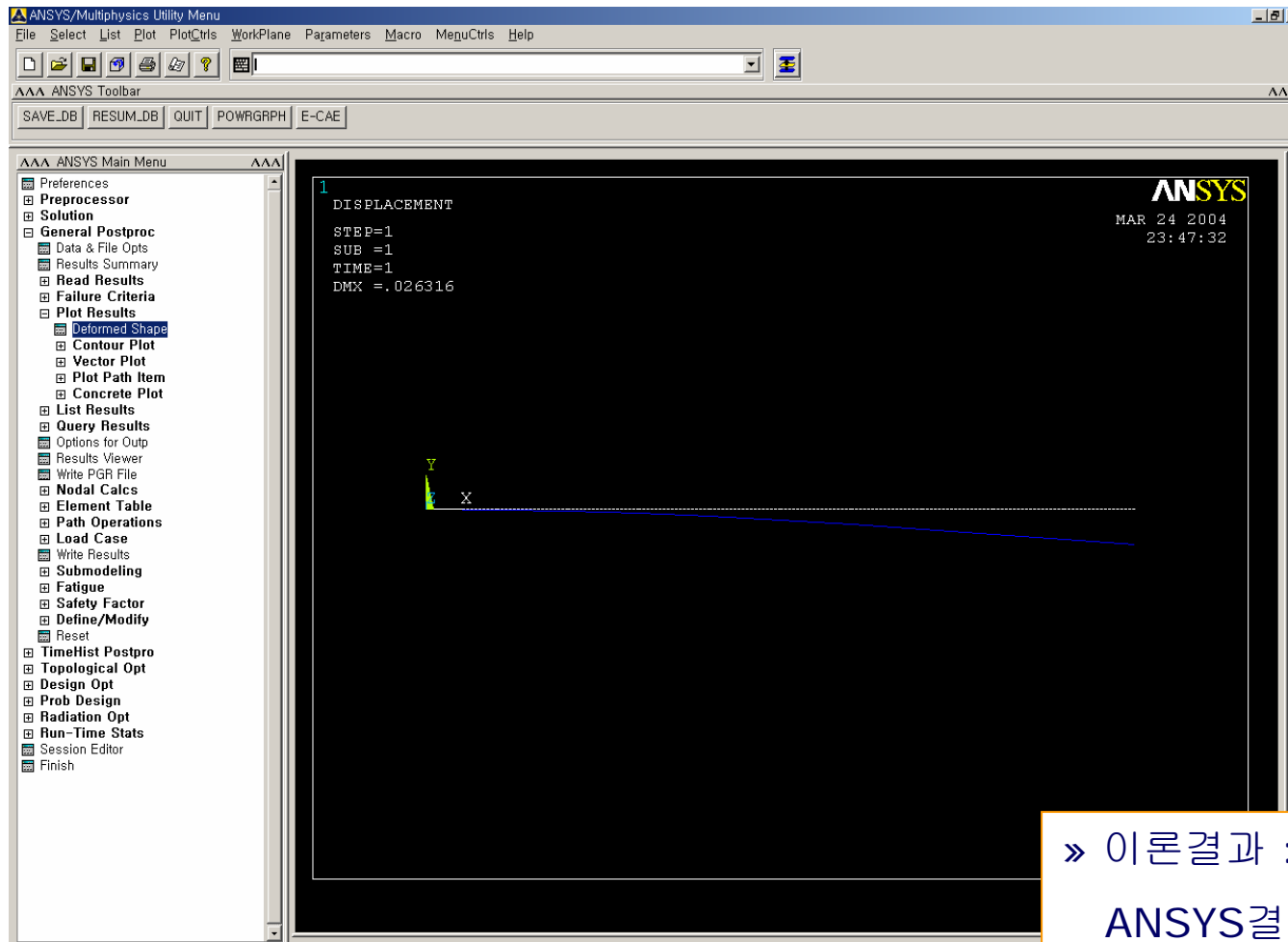
- 해석결과의 출력 및 검증 :

General > Solve > Current LS ...



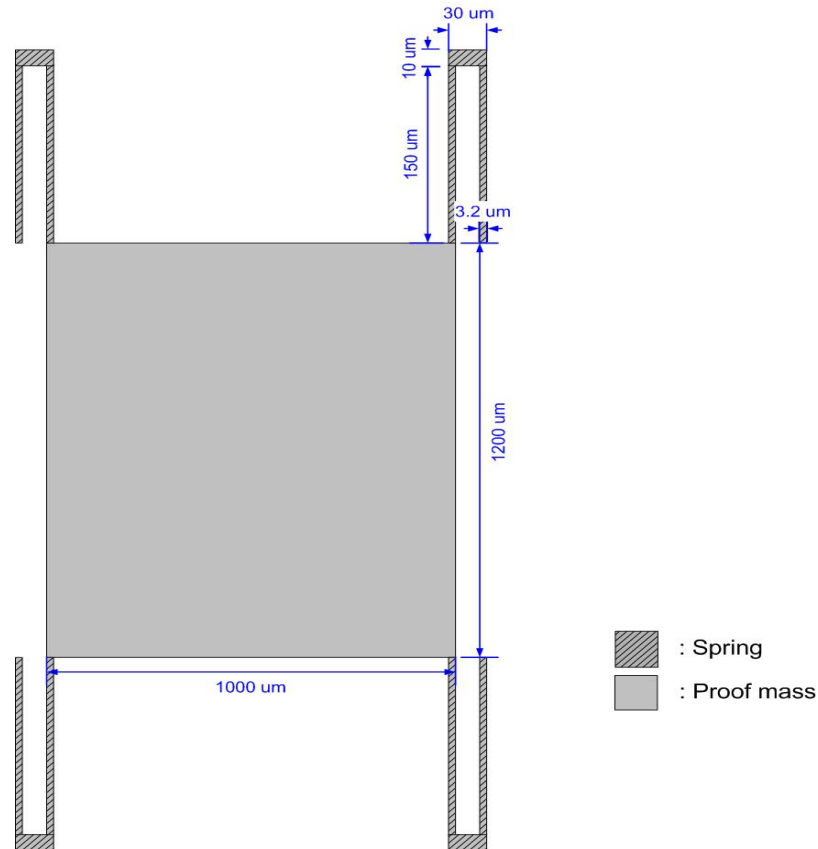
GUI를 통한 ANSYS 예제 (cont'd)

- ANSYS결과와 이론결과 비교 :



Input file 작성을 통한 ANSYS 예제

- 구조물 공진 주파수 해석
 - Schematic



Input file 작성을 통한 ANSYS 예제

- 구조물 공진 주파수 해석 (cont'd)

- 물성치 입력 및 작업 평면계 설정

- /COLOR, PBAK, OFF

- /PREP7

- /TITLE, RESONATOR SIMULATION, March 26, 2004

- ET, 1, SOLID64

- UIMP,1,EX,EY,EZ,168.9E9,168.9E9,168.9E9,

- UIMP,1,DENS, , ,2330,

- ! ρ 1 → Spring PART

- UIMP,1,NUXY,NUYZ,NUXZ,0.262,0.262,0.262,

- UIMP,1,GXY,GYZ,GXZ,66.9E9,66.9E9,66.9E9,

- ET, 2, SOLID64

- UIMP,2,EX,EY,EZ,168.9E9,168.9E9,168.9E9,

- UIMP,2,DENS, , ,0.7*2330,

- ! ρ 2 → Proof Mass PART

- UIMP,2,NUXY,NUYZ,NUXZ,0.262,0.262,0.262,

- UIMP,2,GXY,GYZ,GXZ,66.9E9,66.9E9,66.9E9,

- CSYS, WP

- TOL=1e-9

- BTOL, TOL



Input file 작성을 통한 ANSYS 예제

- 구조물 공진 주파수 해석 (cont'd)
 - 구조물 치수 정의

$T = 40E-6$

$SW = 3.2E-6$! WIDTH OF SPRING

$SL = 150E-6$! LENGTH OF SPRING

$SCW = 30E-6$! WIDTH OF SPRING CONNECTION

$SCH = 10E-6$! HEIGHT OF SPRING CONNECTION

$PW = 500E-6$! WIDTH OF PROOF MASS

$PH = 600E-6$! HEIGHT OF PROOF



Input file 작성을 통한 ANSYS 예제

- 구조물 공진 주파수 해석 (cont'd)
 - 구조물 생성

! PROOF MASS PART

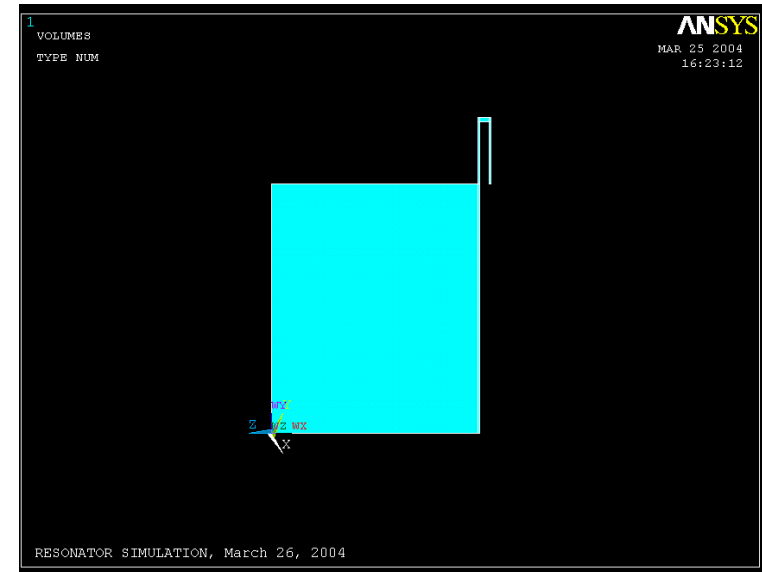
BLOCK, 0, PW, 0, PH, 0, T

! SPRING PART

BLOCK, PW - SW, PW, 0, PH + SL + SCH, 0, T

BLOCK, PW - 2*SW + SCW, PW - SW + SCW, PH, PH + SL + SCH, 0, T

BLOCK, PW - SW, PW - SW + SCW, PH + SL, PH + SL + SCH, 0, T



Input file 작성을 통한 ANSYS 예제

- 구조물 공진 주파수 해석 (cont'd)

- 구조물 생성

- ! VOLUME PARTITION

- VSEL, ALL

- VPTN, ALL

- ! VOLUME ATTRIBUTION

- ! WHOLE STRUCTURE

- VSEL, ALL

- VATT, 1, 1

- ! PROOF MASS PART

- VSEL, S, LOC, X, 0, PW

- VSEL, R, LOC, Y, 0, PH

- VATT, 2, 2



Input file 작성을 통한 ANSYS 예제

- 구조물 공진 주파수 해석 (cont'd)

- 요소망의 생성

- $N = 100$! LENGTH OF SPRING

- $M = 2$! WIDTH OF SPRING

- $O = 4$! THICKNESS OF STRUCTURE

```
LSEL, S, LOC, X, PW - SW + TOL, PW - TOL
```

```
LSEL, A, LOC, X, PW - 2*SW + SCW + TOL, PW - SW + SCW - TOL
```

```
LESIZE, ALL, , , M, 1
```

```
LSEL, S, LOC, Y, PH + TOL, PH + SL - TOL
```

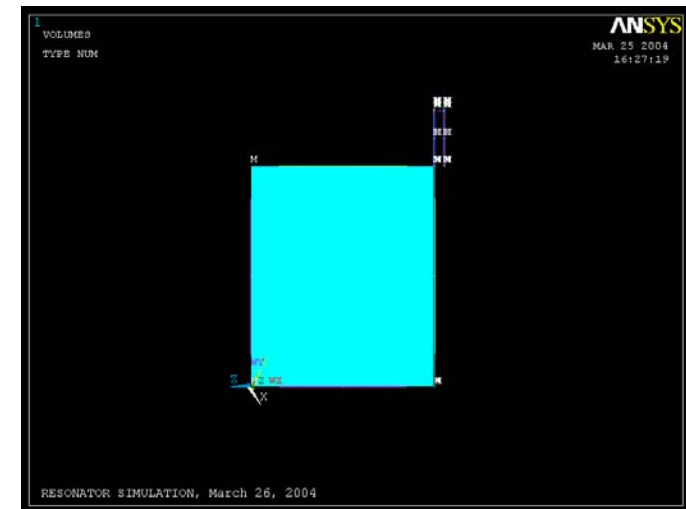
```
LESIZE, ALL, , , N, 1
```

```
LSEL, S, LOC, Z, 0 + TOL, T - TOL
```

```
LESIZE, ALL, , , O, 1
```

```
LSEL, ALL
```

```
LESIZE, ALL, , , 1, 1
```



Input file 작성을 통한 ANSYS 예제

- 구조물 공진 주파수 해석 (cont'd)

- 체적 복사 및 경계 조건 입력

VSEL, ALL

VSYMM,X,ALL, , , ,0,0

VSEL, ALL

VSYMM,Y,ALL, , , ,0,0

NUMMERC, ALL, TOL

VSEL, ALL

VMESH, ALL

NSEL, S, LOC, X, PW - SW + SCW, PW + SW + SCW

NSEL, R, LOC, Y, PH - TOL, PH + TOL

D, ALL, , , , , ALL, , , , ,

NSEL, S, LOC, X, PW - SW + SCW, PW + SW + SCW

NSEL, R, LOC, Y, - (PH - TOL), - (PH + TOL)

D, ALL, , , , , ALL, , , , ,

NSEL, S, LOC, X, - (PW - SW + SCW), - (PW + SW + SCW)

NSEL, R, LOC, Y, PH - TOL, PH + TOL

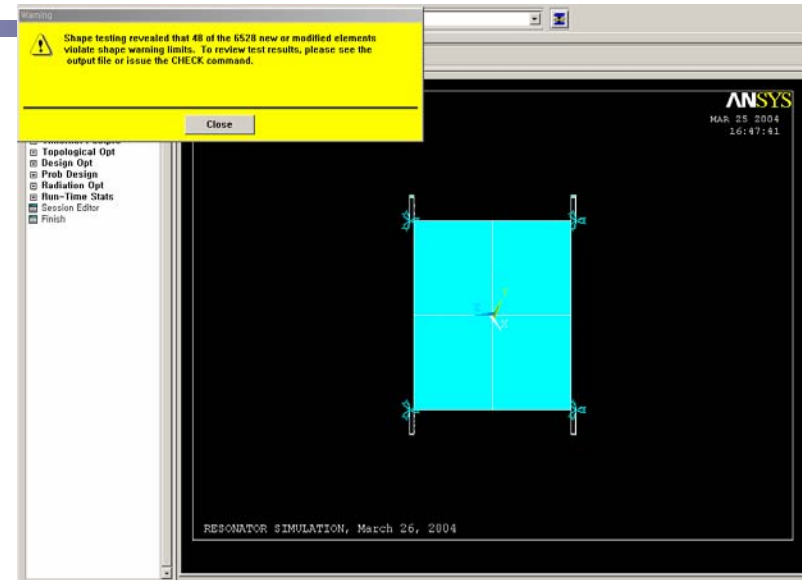
D, ALL, , , , , ALL, , , , ,

NSEL, S, LOC, X, - (PW - SW + SCW), - (PW + SW + SCW)

NSEL, R, LOC, Y, - (PH - TOL), - (PH + TOL)

D, ALL, , , , , ALL, , , , ,

FINISH



Input file 작성을 통한 ANSYS 예제

- 구조물 공진 주파수 해석 (cont'd)

- 해석 결과

```
/SOLUTION
```

```
NSEL, ALL
```

```
ANTYPE, MODAL
```

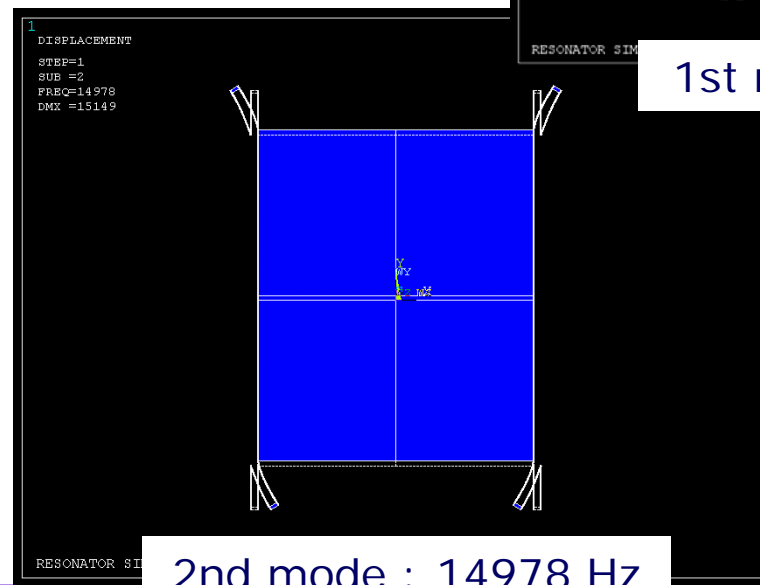
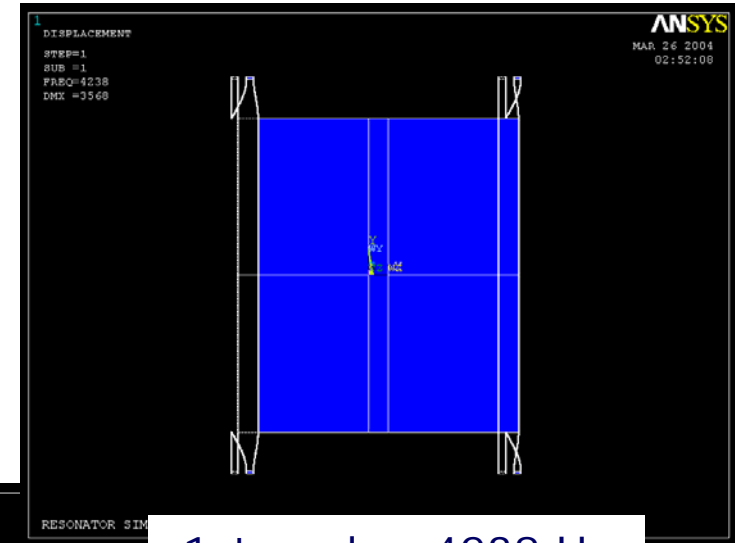
```
MODOPT, LANB, 10
```

```
MXPAND, 10
```

```
OUTPR, NSOL
```

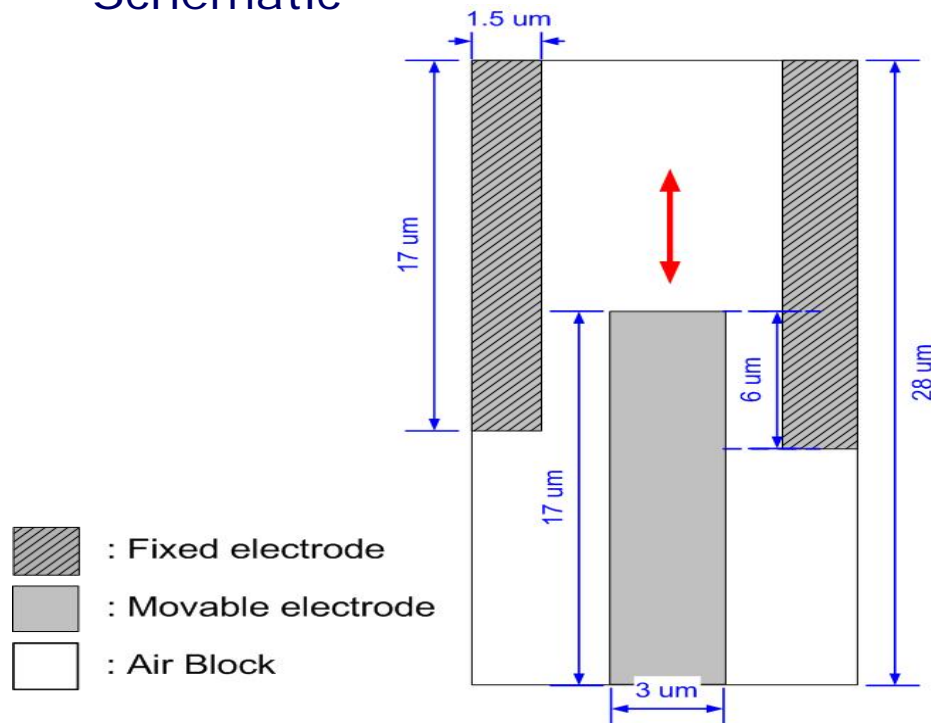
```
SOLVE
```

```
FINISH
```



Input file 작성을 통한 ANSYS 예제

- 정전용량 해석
 - Schematic



$$C = \varepsilon \cdot \frac{A}{d} = 8.854e-12 \times \frac{(6e-6) \times 2}{2e-6} = 5.3124e-11$$



Input file 작성을 통한 ANSYS 예제

- 정전용량 해석 (cont'd)

- 물성치 입력 및 변수 지정

```
/COLOR, PBAK, OFF
```

```
/PREP7
```

```
/TITLE, LATERAL COMB_CAP SIMULATION, March 26, 2004
```

```
ET,1,PLANE121
```

```
MP,PERX,1,1
```

```
! DEFINE DIMENSION OF AIR & COMBS
```

```
ARH = 28E-6
```

```
ARW = 10E-6
```

```
CW = 3E-6
```

```
CH = 17E-6
```

```
Gap = 2E-6
```

```
V1=10
```

```
V0=1
```



Input file 작성을 통한 ANSYS 예제

- 정전용량 해석 (cont'd)

- 구조물 정의

```
RECTNG, - ARW/2, ARW/2, - ARH/2, ARH/2
```

```
ASEL, ALL
```

```
AATT, 1
```

```
ASEL, ALL
```

```
NUMCMP, AREA
```

```
RECTNG, - CW/2, CW/2, - ARH/2, - ARH/2 + CH
```

```
RECTNG, - ARW/2, - ARW/2 + CW/2, ARH/2 - CH, ARH/2
```

```
RECTNG, ARW/2 - CW/2, ARW/2, ARH/2 - CH, ARH/2
```

```
ASBA,1,2,,DELETE,DELETE
```

```
ASBA,5,3,,DELETE,DELETE
```

```
ASBA,1,4,,DELETE,DELETE
```



Input file 작성을 통한 ANSYS 예제

- 정전용량 해석 (cont'd)
 - 요소망의 생성 및 경계/전압 부여

```
MSHAPE,1,2D
```

```
ESIZE,1E-6,0
```

```
ASEL,ALL
```

```
AMESH,ALL
```

```
NSEL,S,LOC,Y, - ARH/2, - ARH/2 + CH
```

```
NSEL,R,LOC,X, - CW/2, CW/2
```

```
D,ALL,VOLT,10
```

```
NSEL,S,LOC,Y, ARH/2 - CH, ARH/2
```

```
NSEL,R,LOC,X, - ARW/2, - ARW/2 + CW/2
```

```
D,ALL,VOLT,1
```

```
NSEL,S,LOC,Y, ARH/2 - CH, ARH/2
```

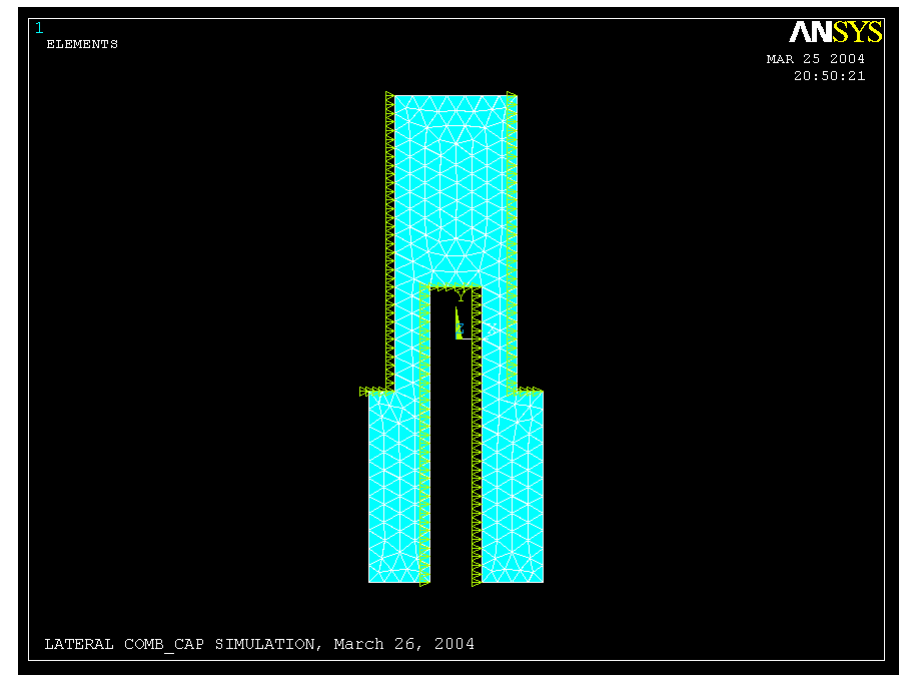
```
NSEL,R,LOC,X, ARW/2 - CW/2, ARW/2
```

```
D,ALL,VOLT,1
```

```
ESEL,ALL
```

```
NSEL,ALL
```

```
FINISH
```



Input file 작성을 통한 ANSYS 예제

- 정전용량 해석 (cont'd)

- 해석 결과

- /SOLUTION

- SOLVE

- /POST1

- ESEL,S,MAT,,1

- ETABLE,SENE,SENE

- ETABLE,EFX,EF,X

- ETABLE,EFY,EF,Y

- /NUMBER,1

- PLNSOL,VOLT

- PLVECT,EFX,EFY

- SSUM

- *GET,W,SSUM,,ITEM,SENE

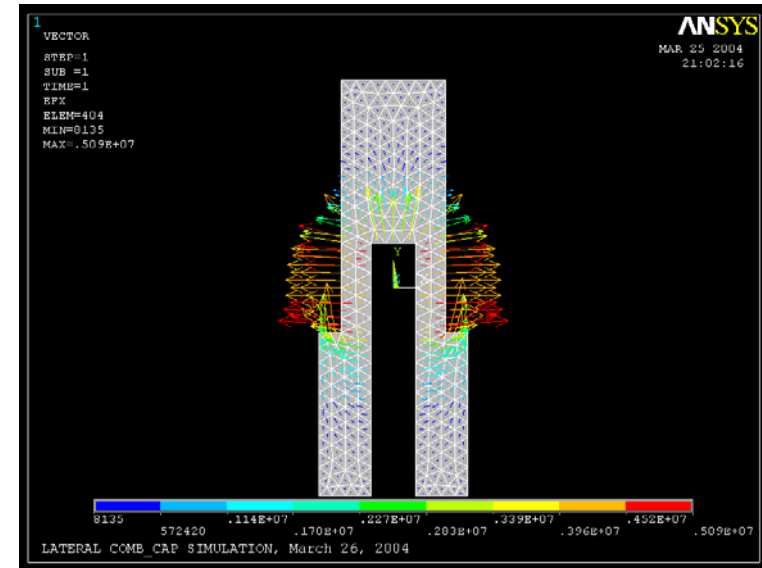
- C=(W*2)/81

- *STATUS,C

- FINISH

! DISPLAY EQUIPOTENTIAL LINES

! DISPLAY VECTOR ELECTRIC FIELD (VECTOR)



» 이론결과 : 5.312e-11

ANSYS결과 : 8.742e-11

