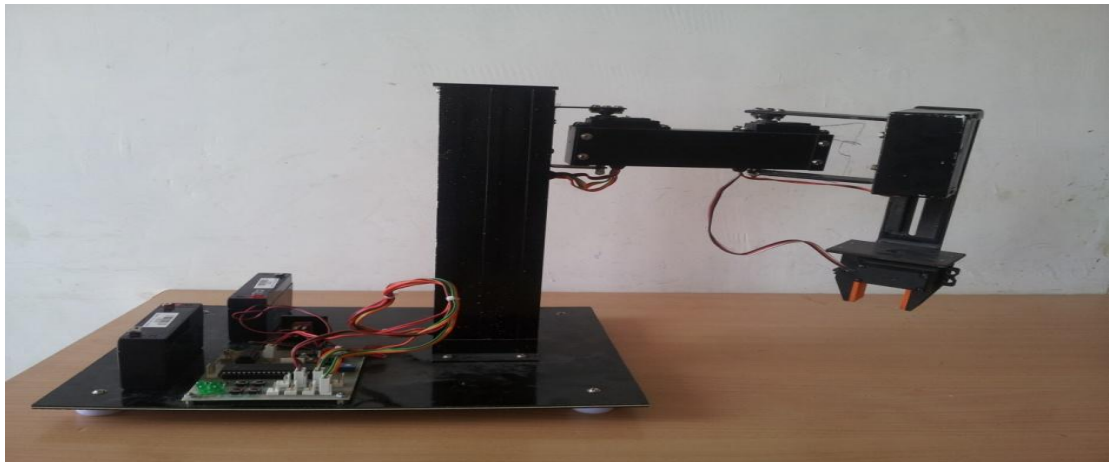
LINEAR STATIC ANALYSIS & DEVELOPMENT OF ROBOTIC ARM



Presented by:

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Dilip V. Dave (09ME07)

Guided by:

Pro. S.G.Patel

Presentation Framework

Introduction

Literature review

Objectives

Methodology

Workspace of SCARA robot

Pro-e design of SCARA robot

Analysis of SCARA Robot using ANSYS

Conclusion

References

Introduction

Human Dream: Build a Human Clown

- Human Arm - Robot manipulator
- Human Leg - Mobile robot
  Legged robot
- Human Eye - Machine vision
- Hand-eye task - Visual servoing
- Listen and talk - Sound recognition
- Think and decide - Artificial intelligence

Introduction(contd….)

Robot:

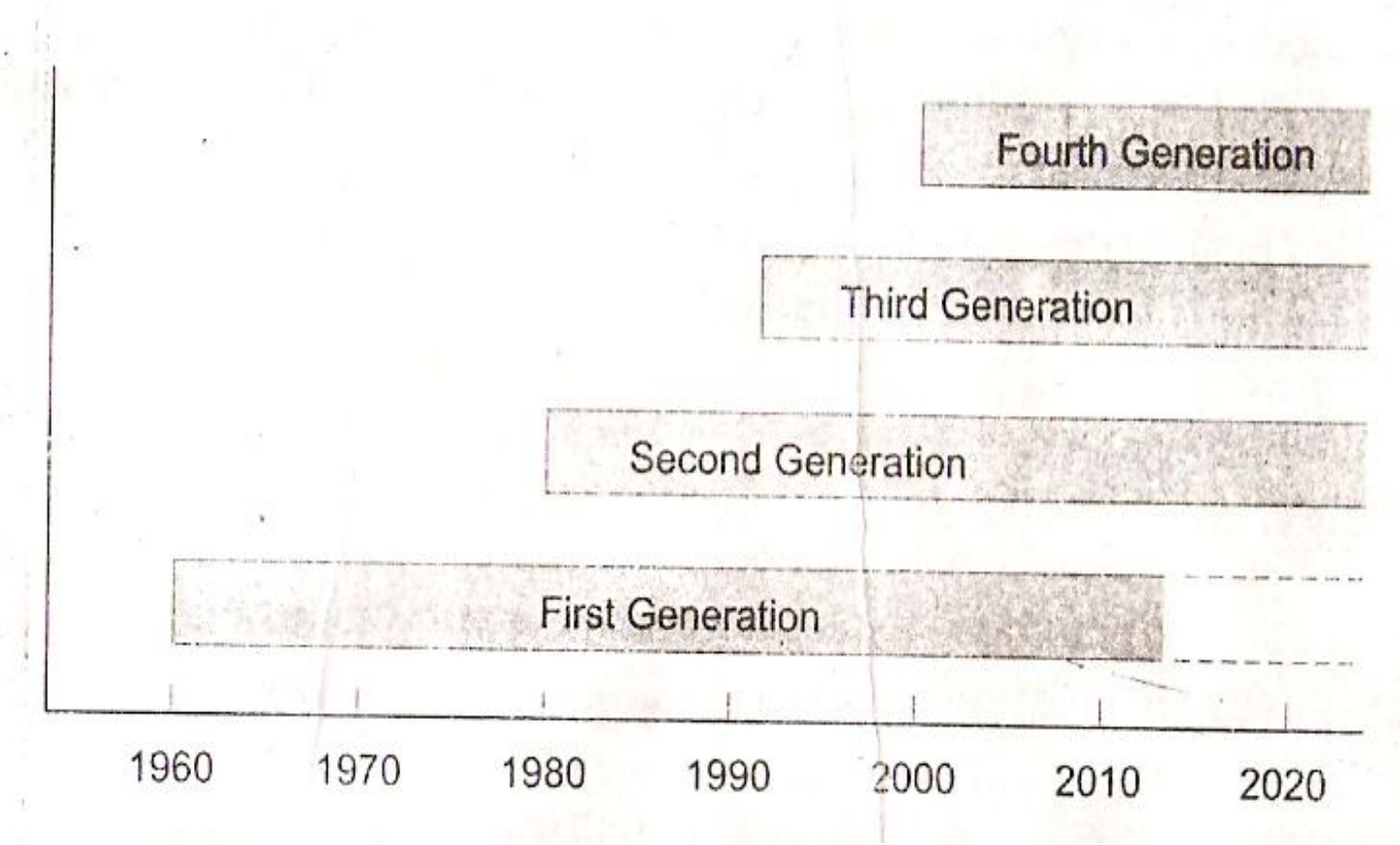
A motorized computer-controlled machine that can be programmed to do a variety of tasks especially repeatable and tiresome ones.

What is linear static analysis?

It allows engineers to test different load conditions & resulting stress & deformation.

Introduction(contd….)

Robot Evolution



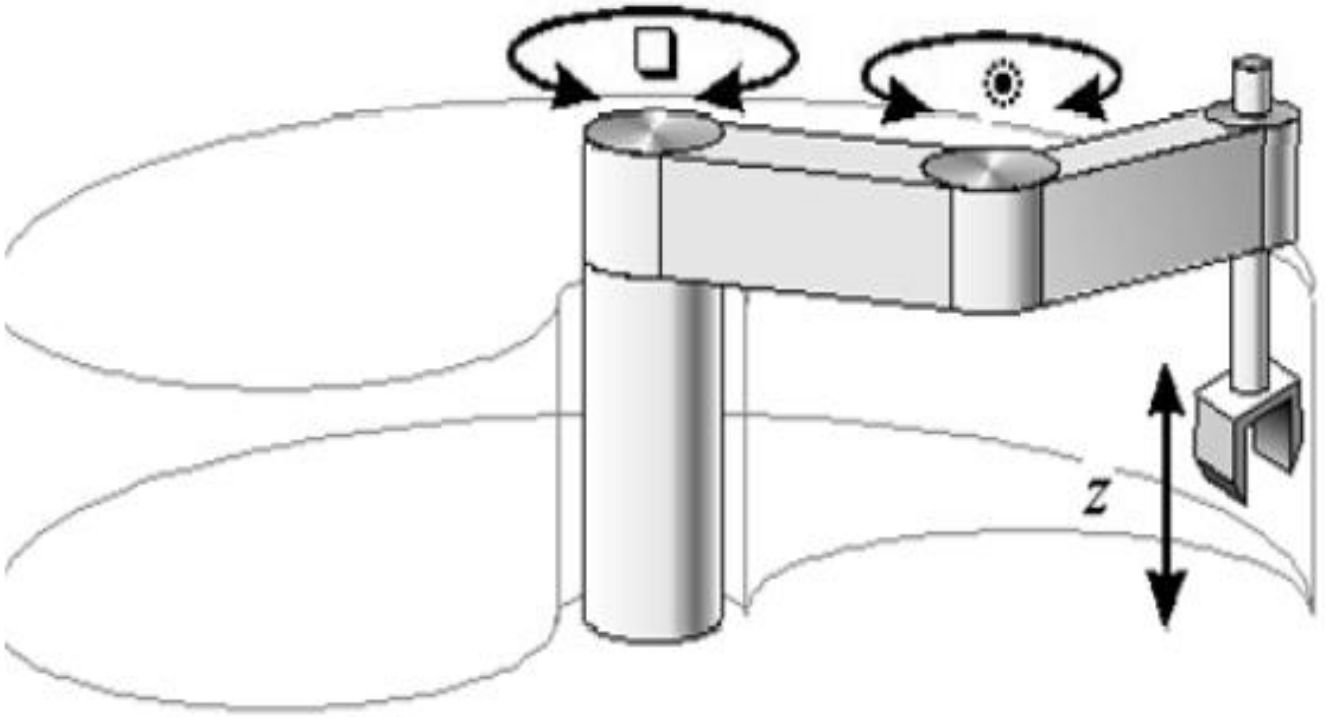
Literature Review

What is SCARA Robot ?

- SCARA (which stands for Selectively Compliant Articulated Robot Arm) is a specialty robot which has two parallel rotary joints to provide compliance in a plane.
- A third prismatic joint allows the arm to translate vertically.
- SCARA robots differ from articulated robots in that its workspace consists of two concentric cylinders.
- The gripper can raise, lower, and rotate to orient the component to be assembled.

Literature Review (contd…)

Workspace of SCARA robot

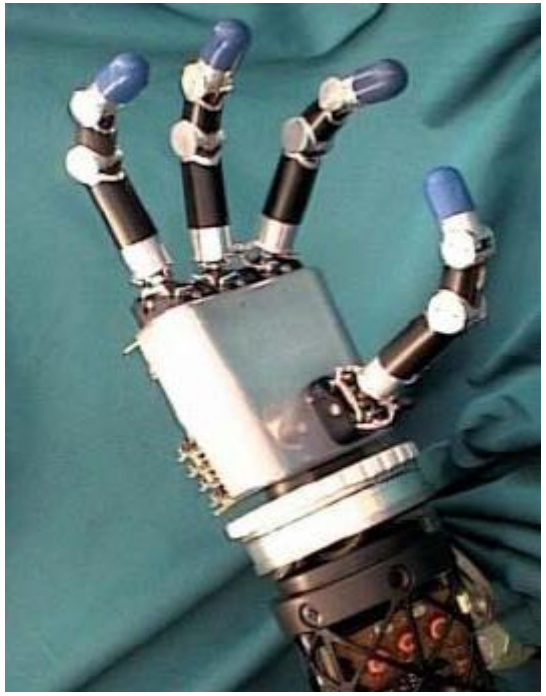


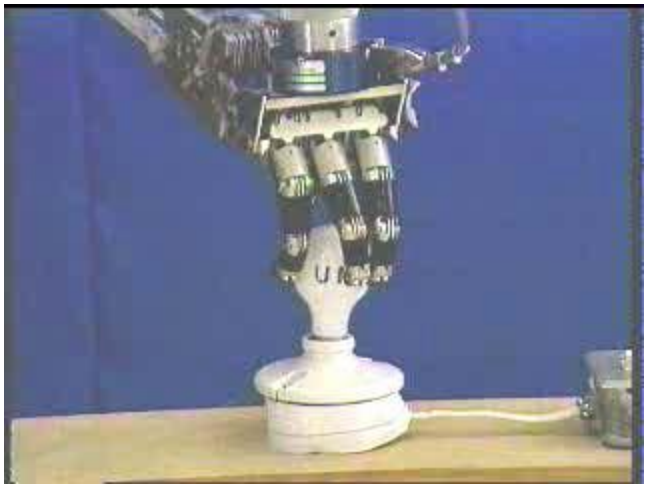
Literature Review (contd…)

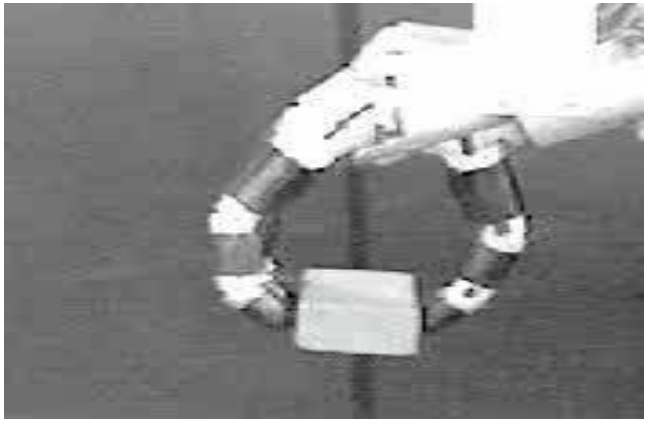
Different types of SCARA robot

Literature Review (contd…)

End Effector







Literature Review (contd…)

Manipulator components:

Arm - Links and joints

Hand - End effector

Actuators and drive

Sensors and transducers

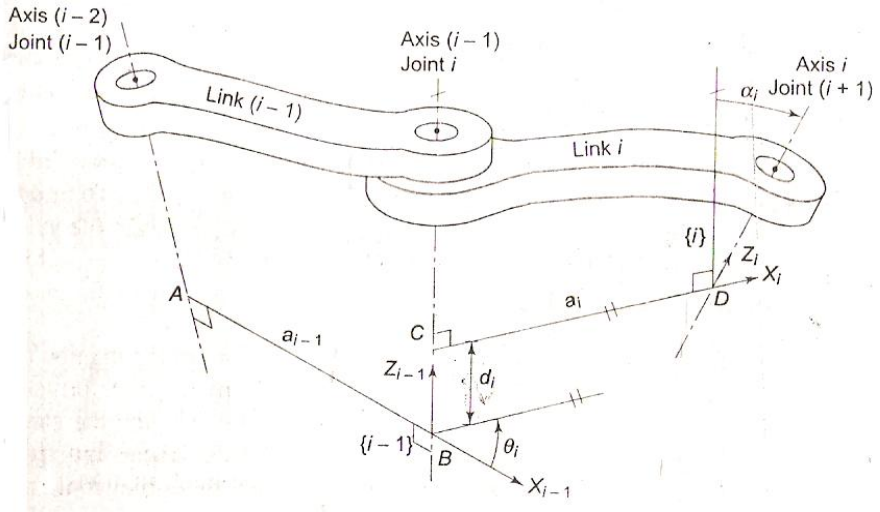
Computer and Electronics

Education via software

Literature Review (contd…)

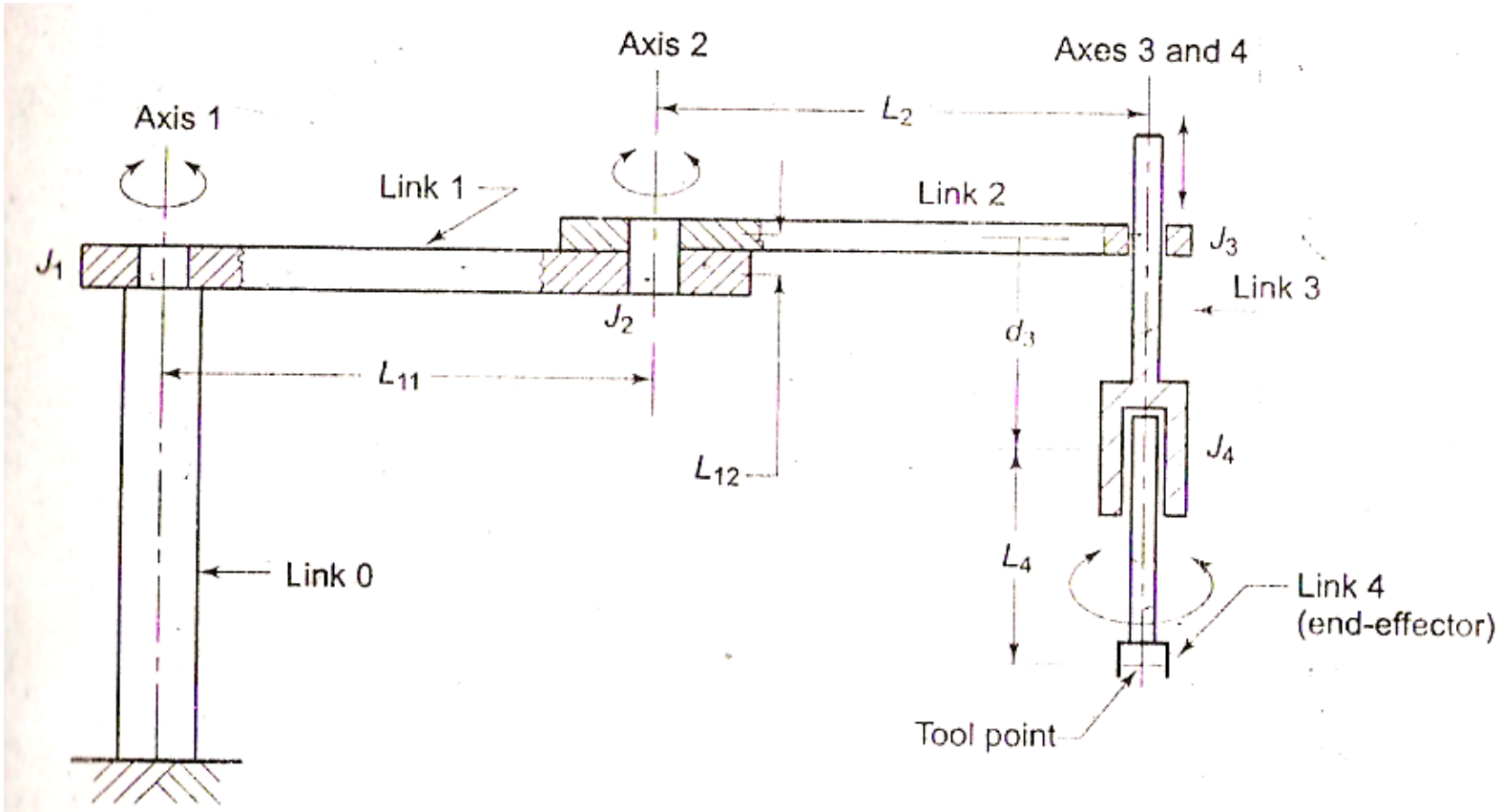
DENAVIT- HARTENBERG (D-H) Notation:

The definition of a manipulator with four joint-link parameters for each link and a systematic procedure for assigning right handed orthonormal coordinate frame, one to each link in a open kinematic chain, was proposed by Denavit and Hartenberg (1955) and is known as Denavit Hartenberg (DH) notation.



Literature Review (contd…)

SCARA MANUPULATOR KINEMATICS



Objectives

Analysis of SCARA robot

Development of SCARA robotic arm.

Methodology

Prepare layout as per combination of prescribe robot movements.

Modelling of SCARA robot .

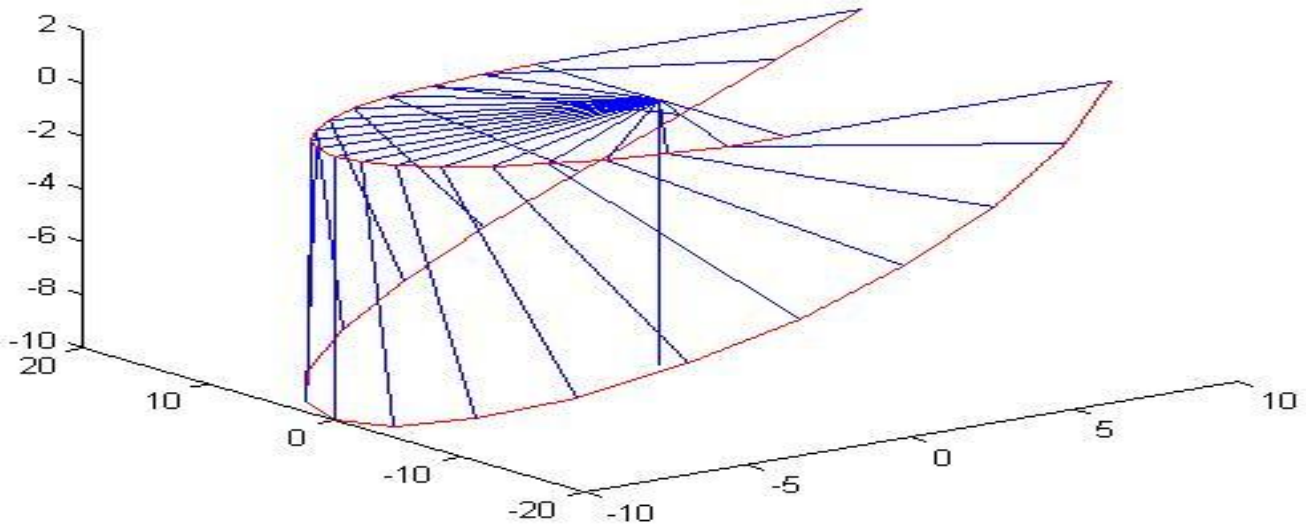
Find out the workspace of robot using MATLAB programming.

Design different parts & whole assembly of robotic arm using Pro-e.

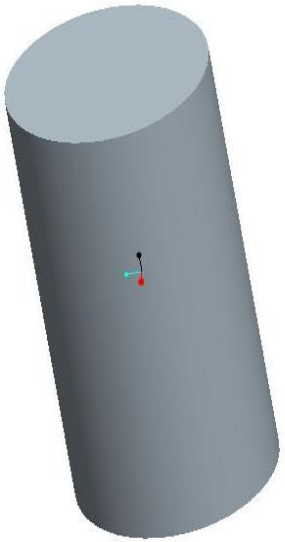
APPLICATIONS OF SCARA ROBOT

Workspace of SCARA robot

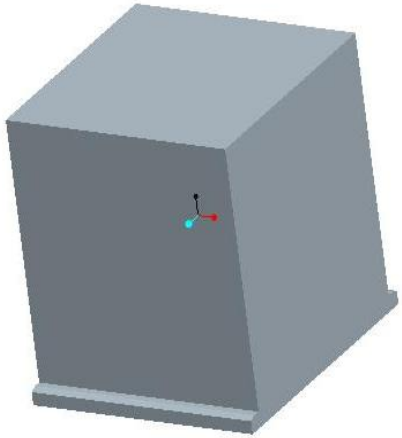
Using forward kinematics method we can find out the position orientation of end effector.



Pro-e design of SCARA robot

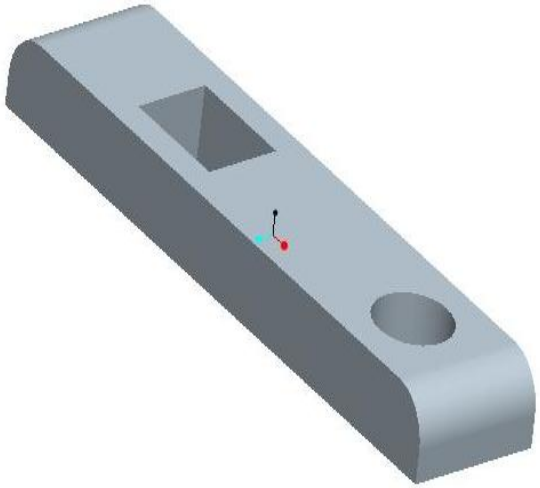


Constructing the cylinder

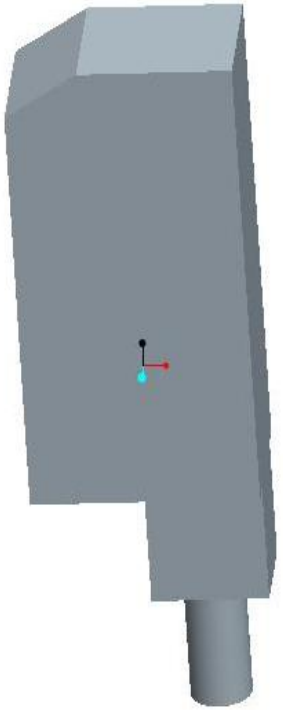


Constructing the small block

Pro-e design of SCARA robot (contd…)

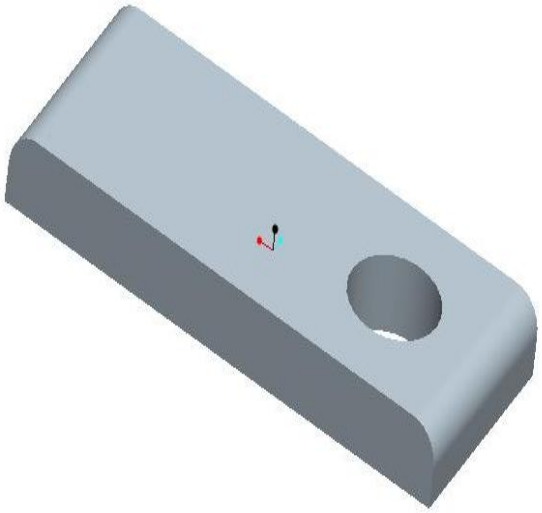


Constructing the small arm

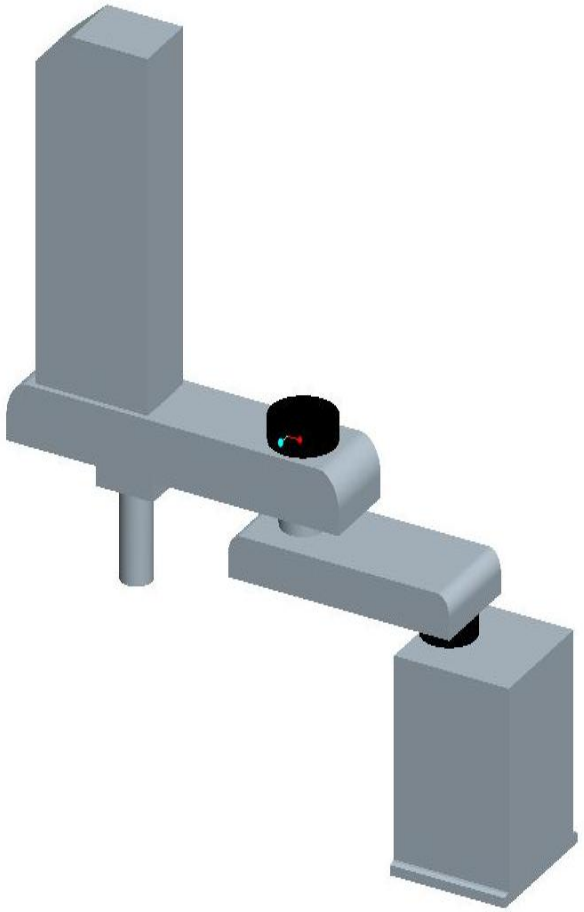


Constructing the top most block

Pro-e design of SCARA robot (contd…)



Constructing the short arm



Constructing the full assembly

INTRODUCTION OF ANSYS

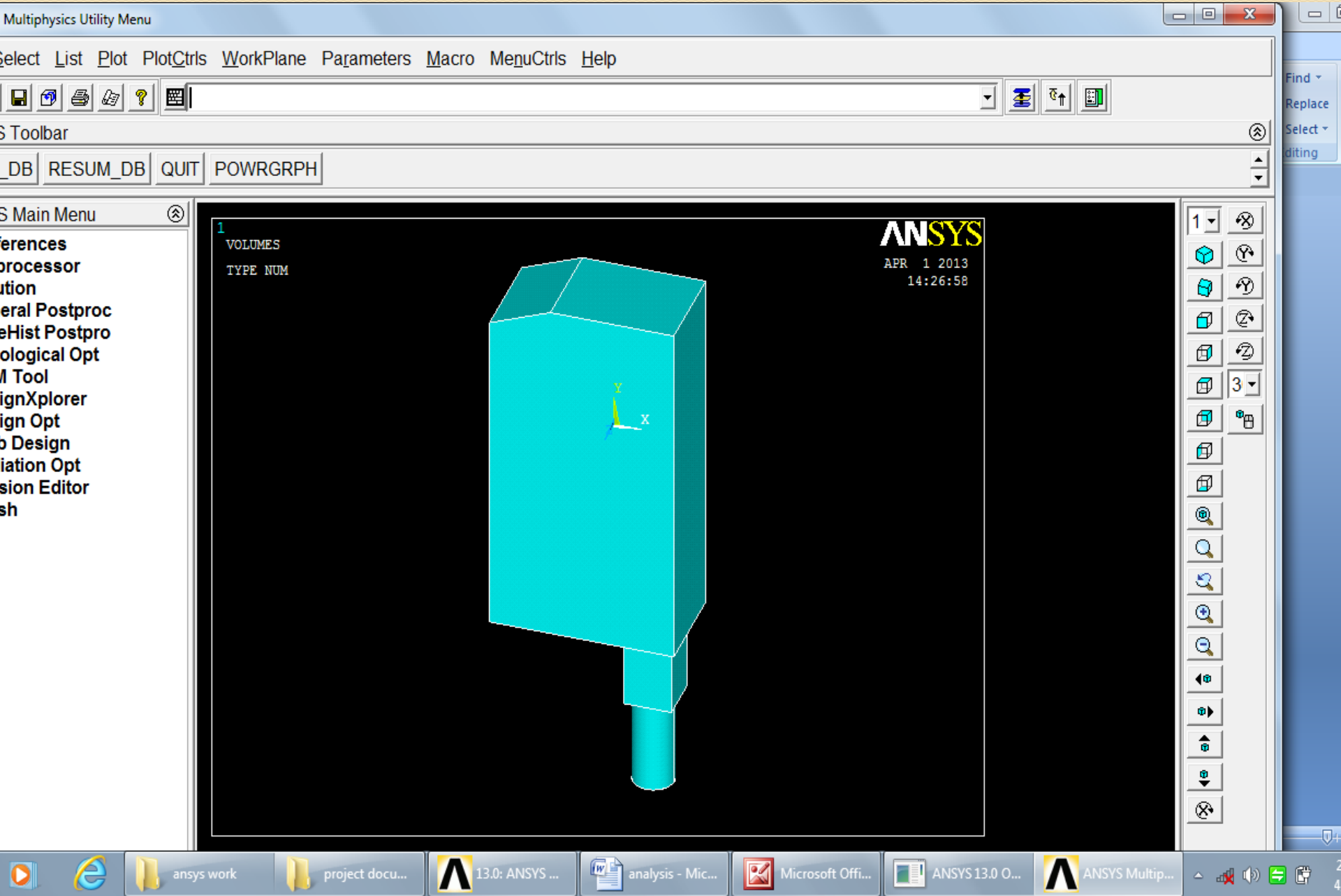
ANSYS is a general purpose finite element analysis (FEA) software package.

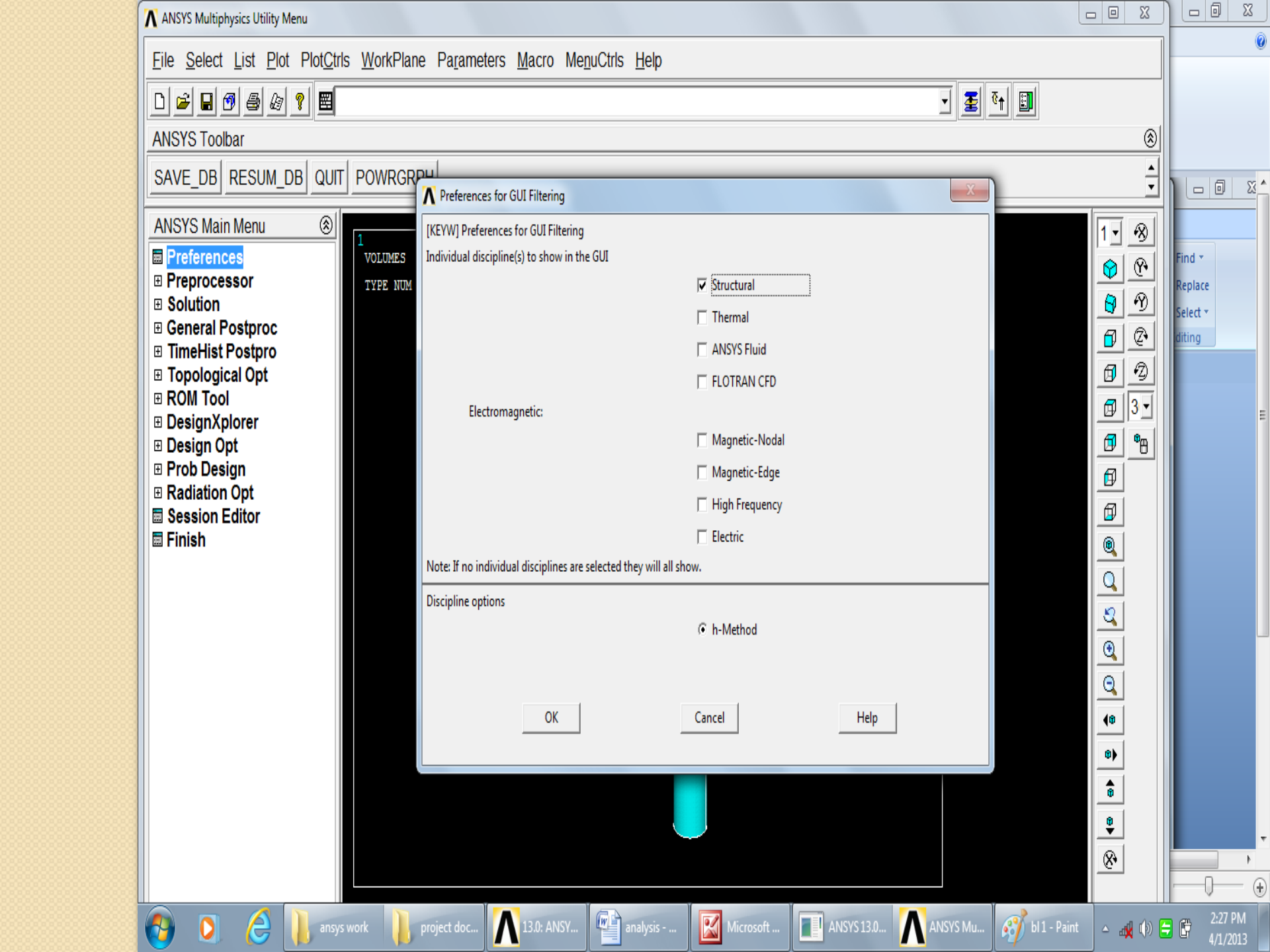
It is founded in 1970 by Dr. John Swansoy.

ANSYS is leading the evolution of CAE tools and technologies, delivering customer value by enabling to improve product development and processes. ANSYS is committed to developing simulation solutions – from mechanical to computational fluid dynamics (CFD) – that illustrate realistic and accurate modeling and simulation of components, subsystems, and systems; replacing hardware prototyping and testing.

ANSYS provides a cost-effective way to explore the performance of products or processes in a virtual environment. This type of product development is termed virtual prototyping.

ANALYSIS OF MAIN BLOCK

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TimeHist Postpro
Topological Opt
ROM Tool
DesignXplorer
Design Opt
Prob Design
Radiation Opt
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Individual discipline(s) to show in the GUI
Structural
Thermal
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FLOTRAN CFD
Electromagnetic:
Magnetic-Nodal
Magnetic-Edge
High Frequency
Electric
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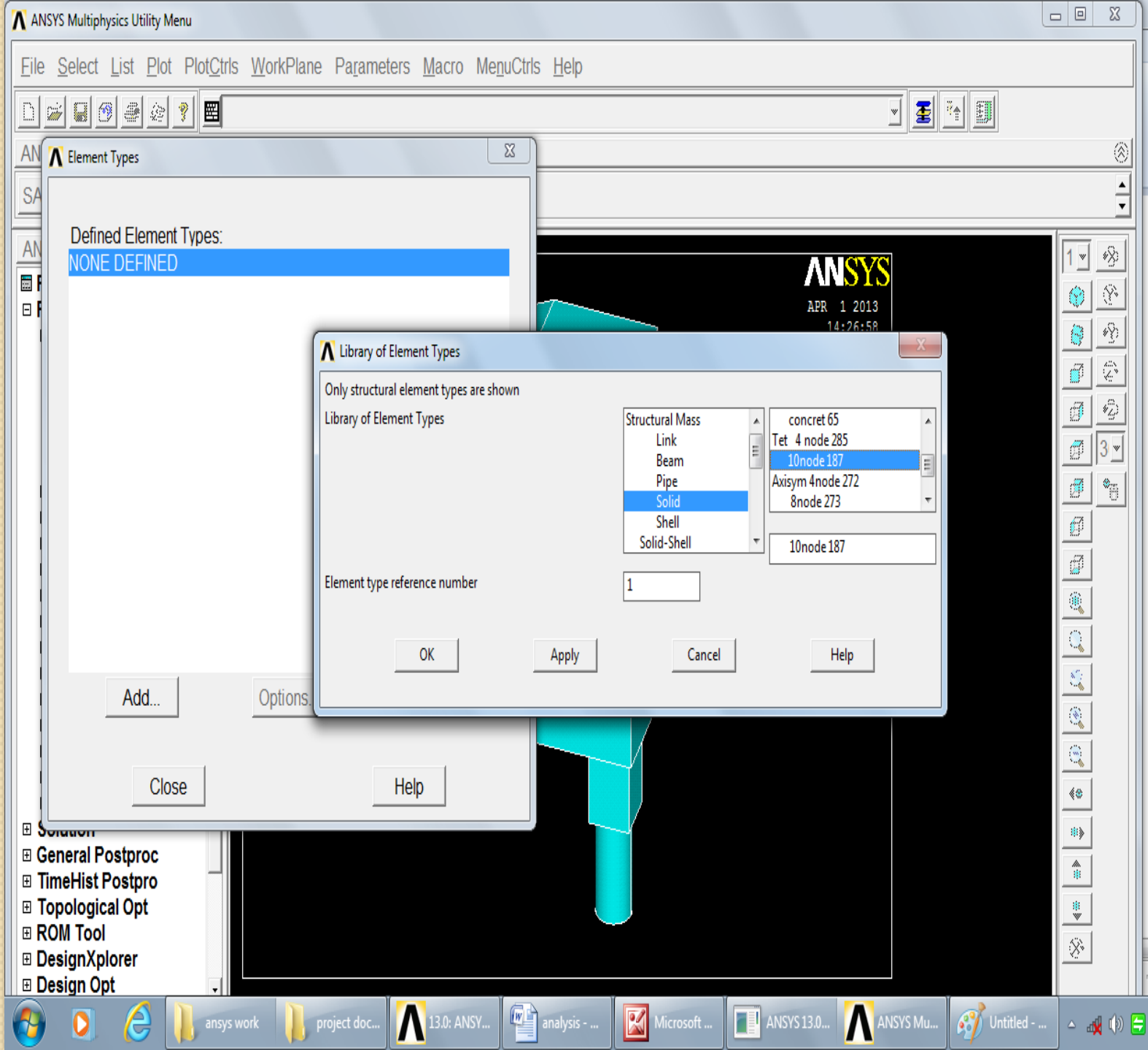
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ANSYS Multiphysics Utility Menu

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ANSYS Toolbar

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ANSYS Main Menu

- Preferences
- Preprocessor
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    - Switch Elem Type
    - Add DOF
    - Remove DOFs
    - Elem Tech Control
  - Real Constants
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  - Modeling
  - Meshing
  - Checking Ctrls
  - Numbering Ctrls
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  - Coupling / Ceqn
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  - Loads
  - Physics
  - Path Operations
- Solution
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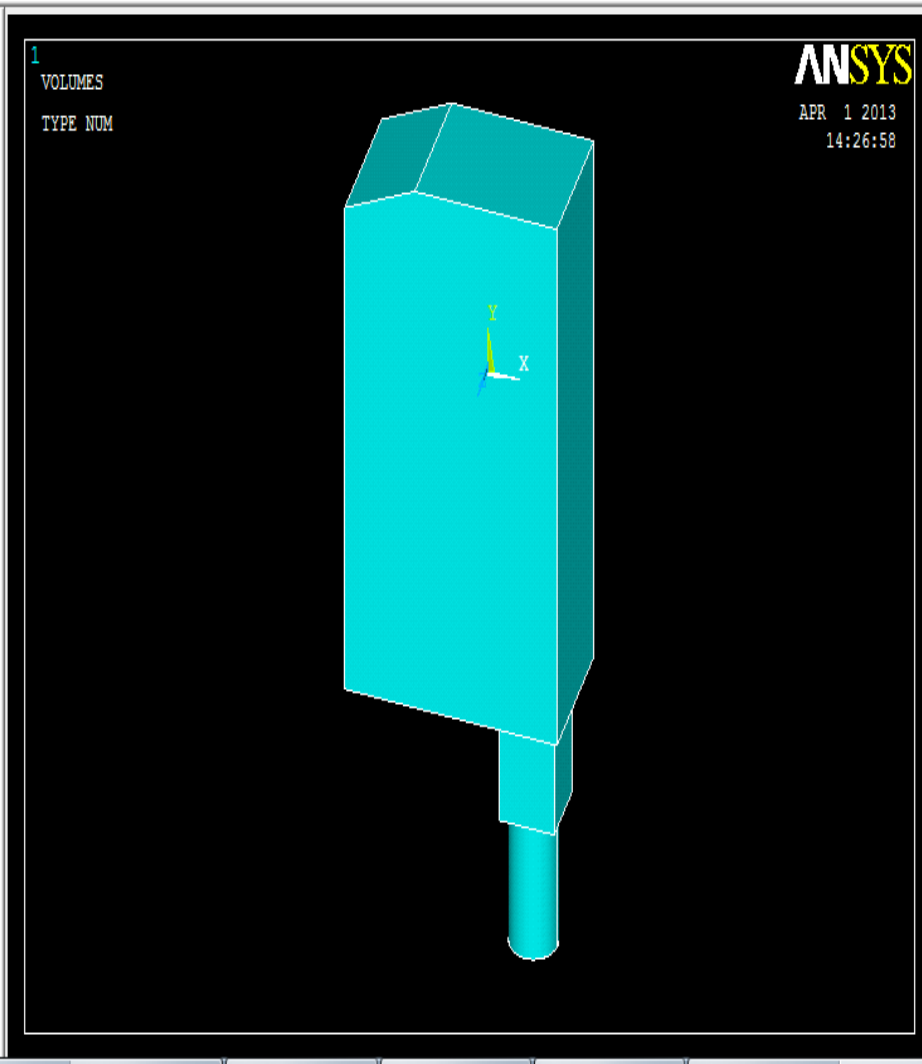

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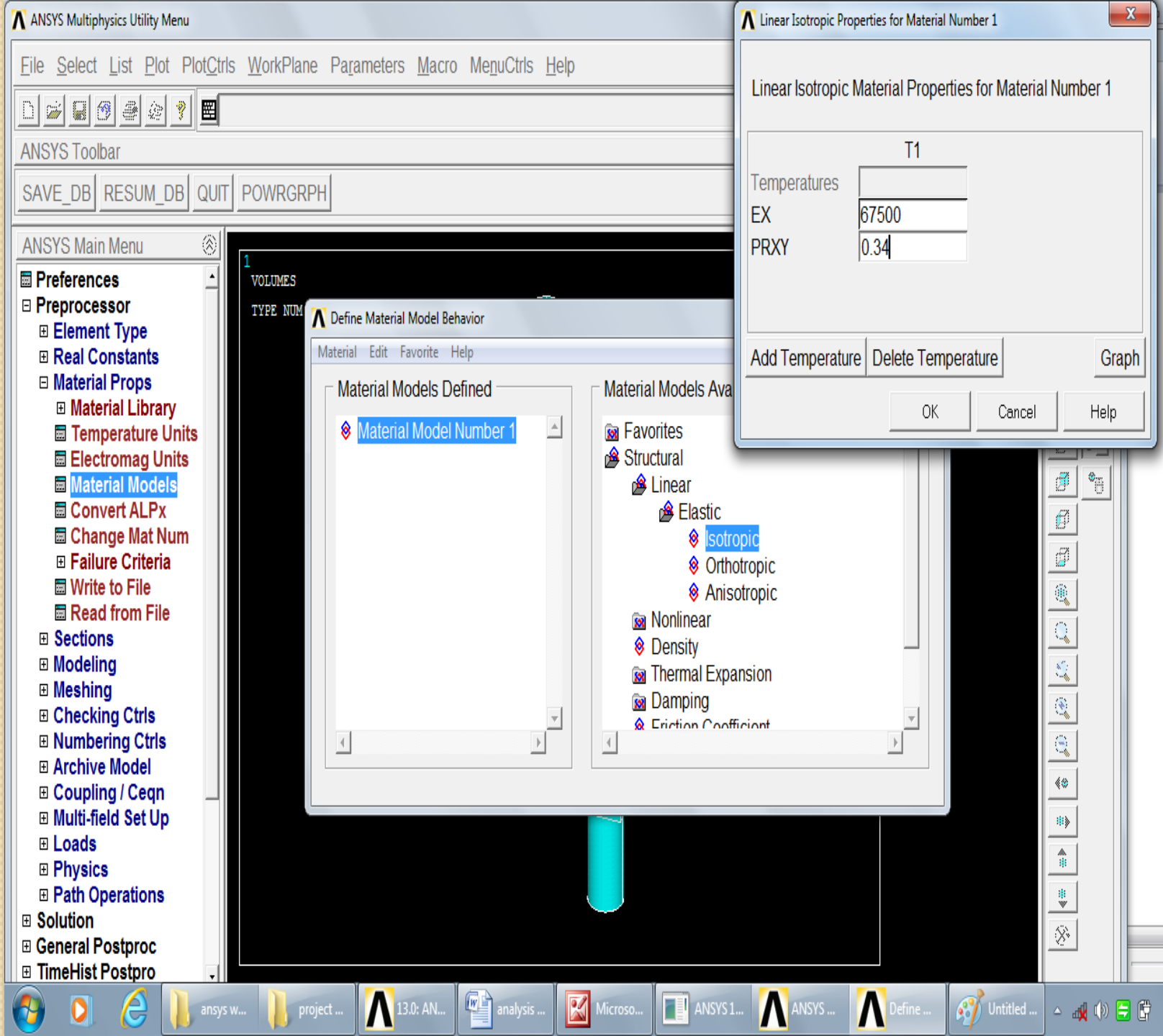
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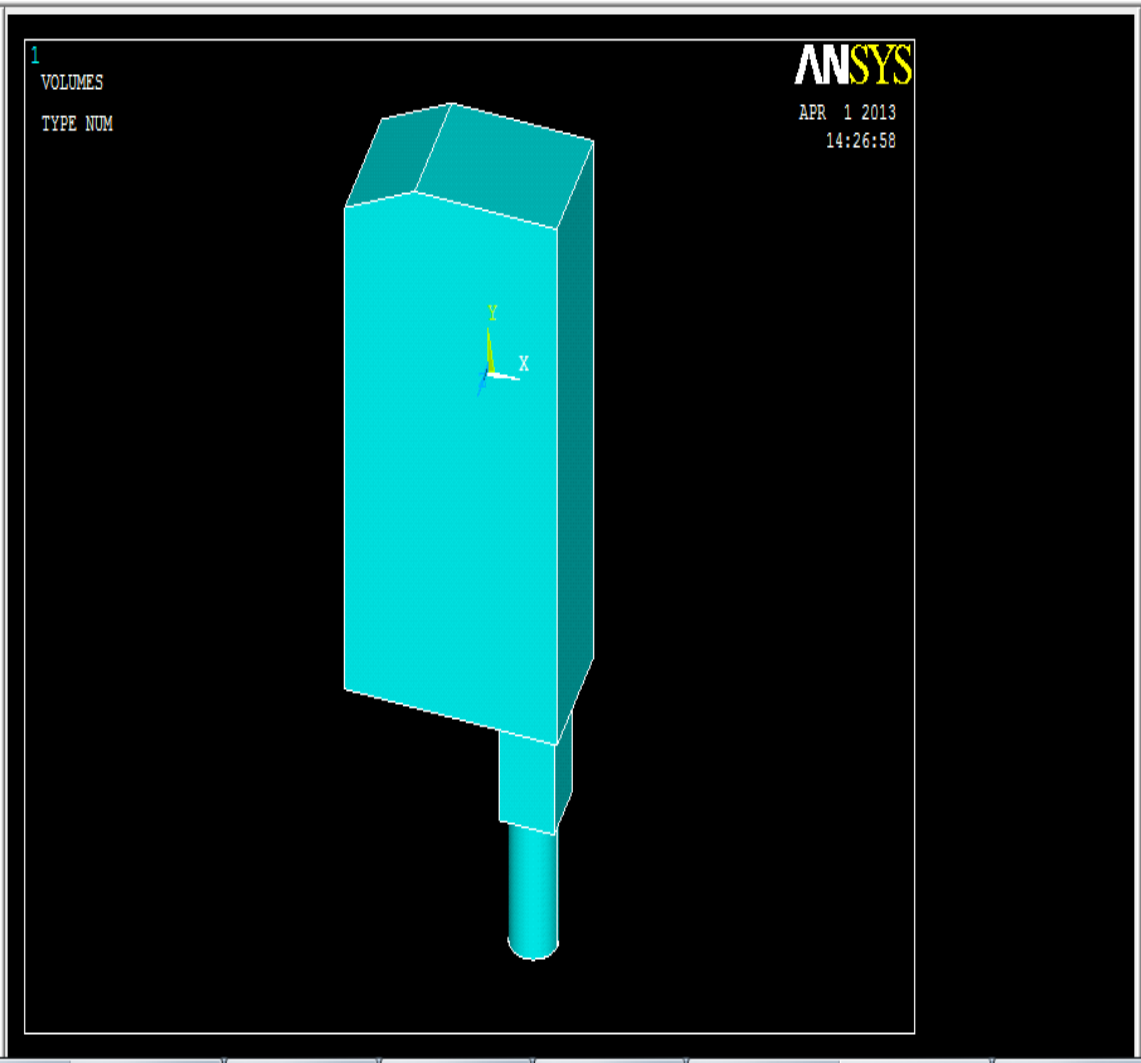

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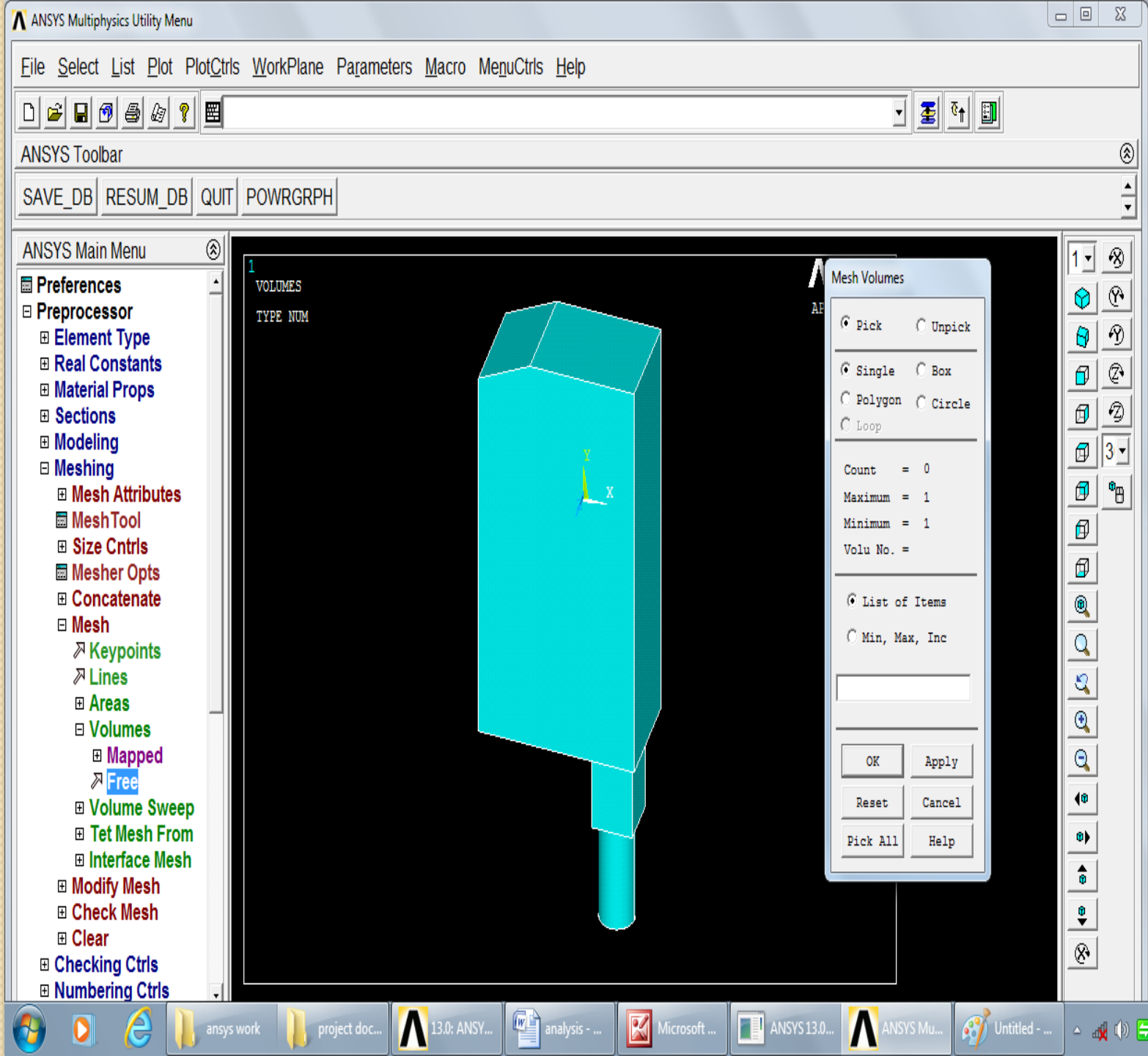
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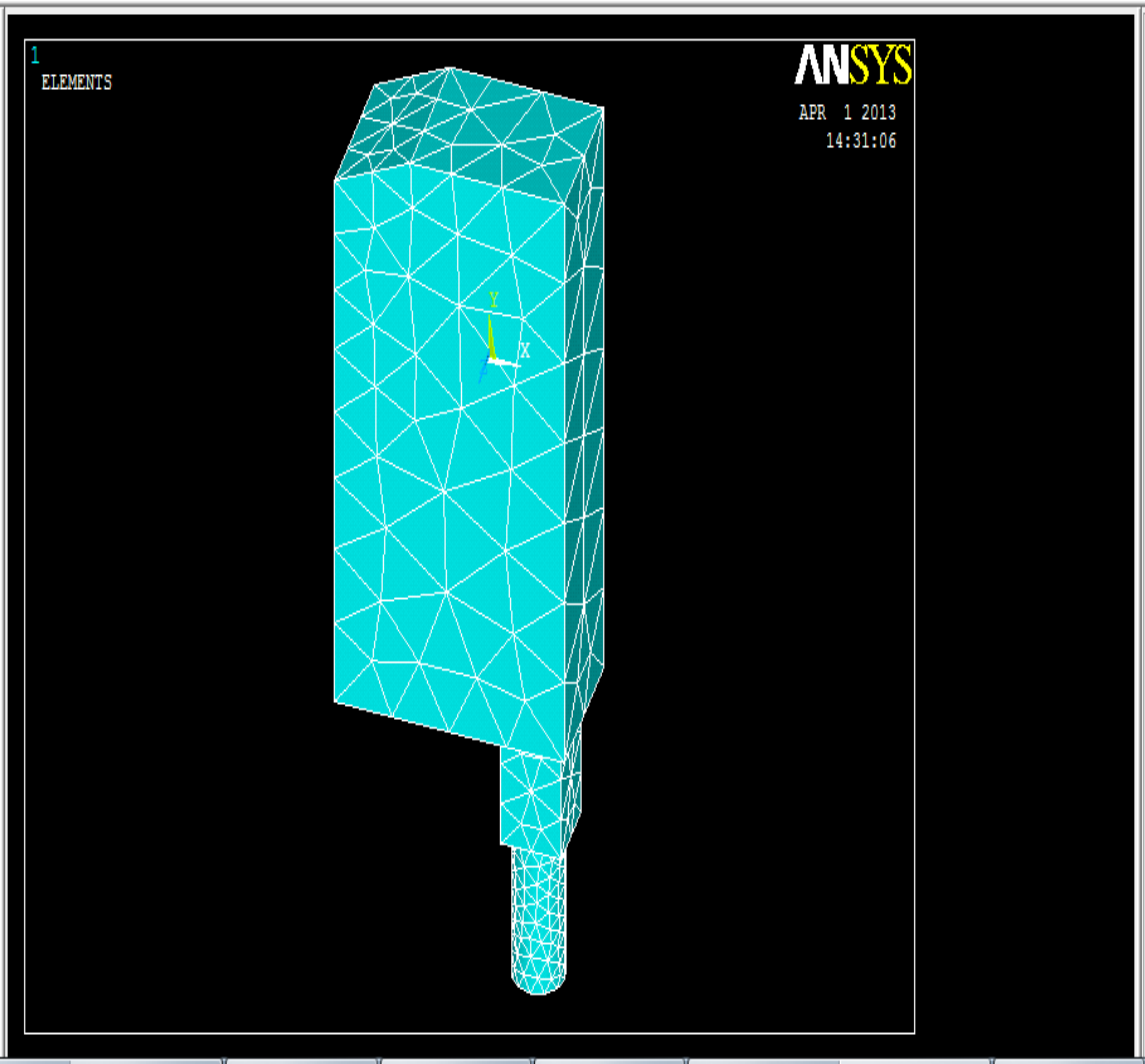

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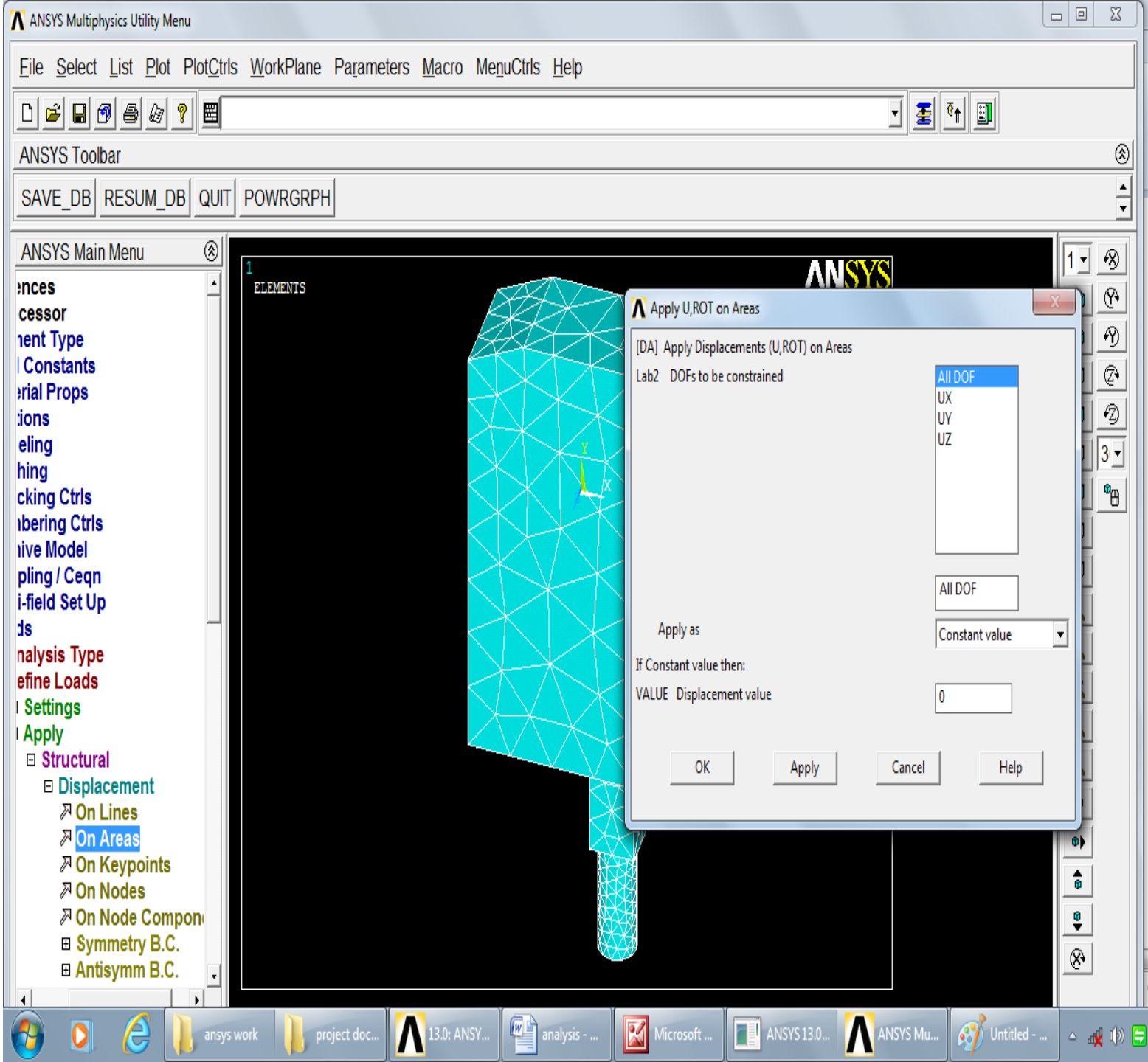
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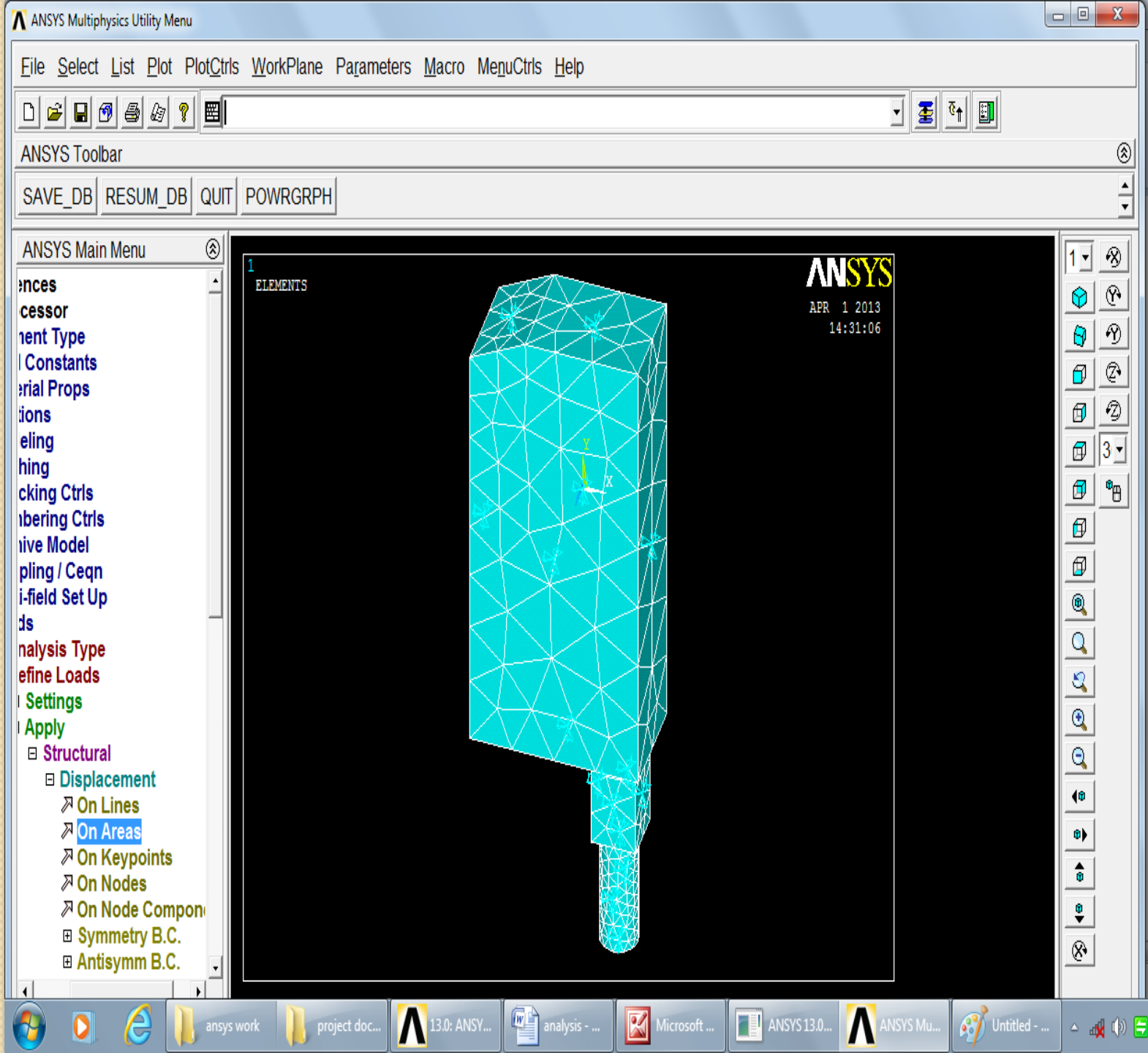
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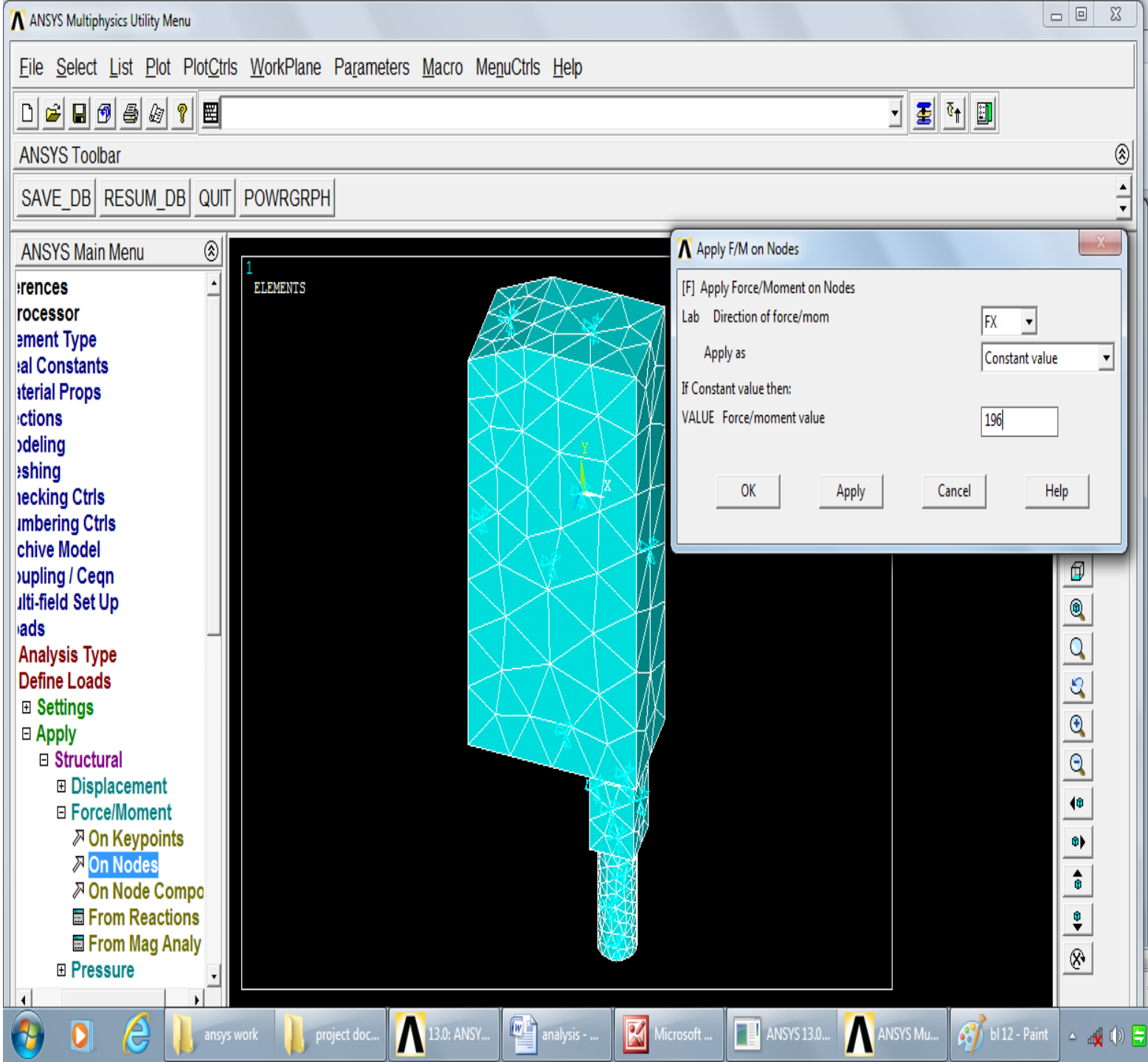
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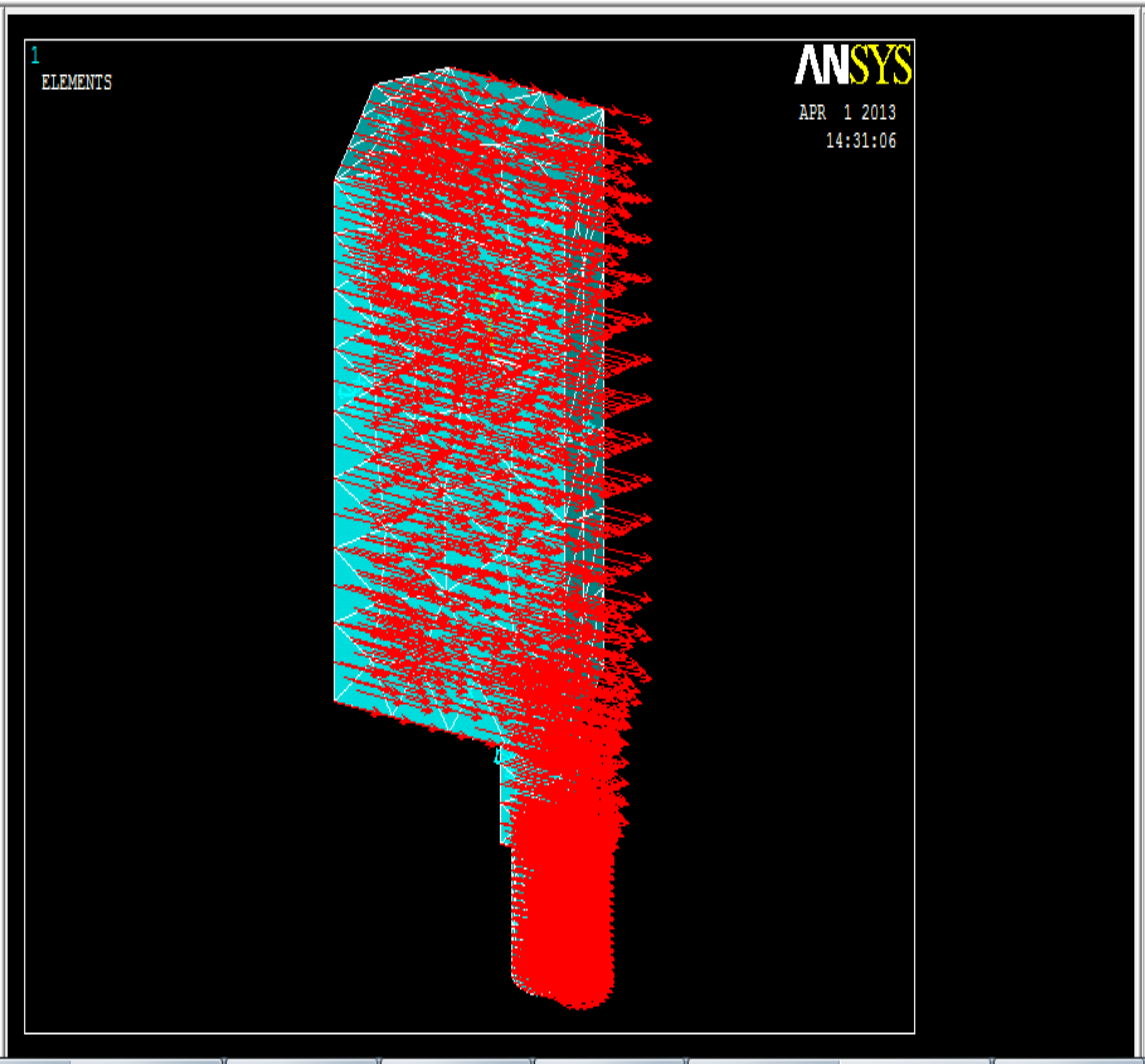

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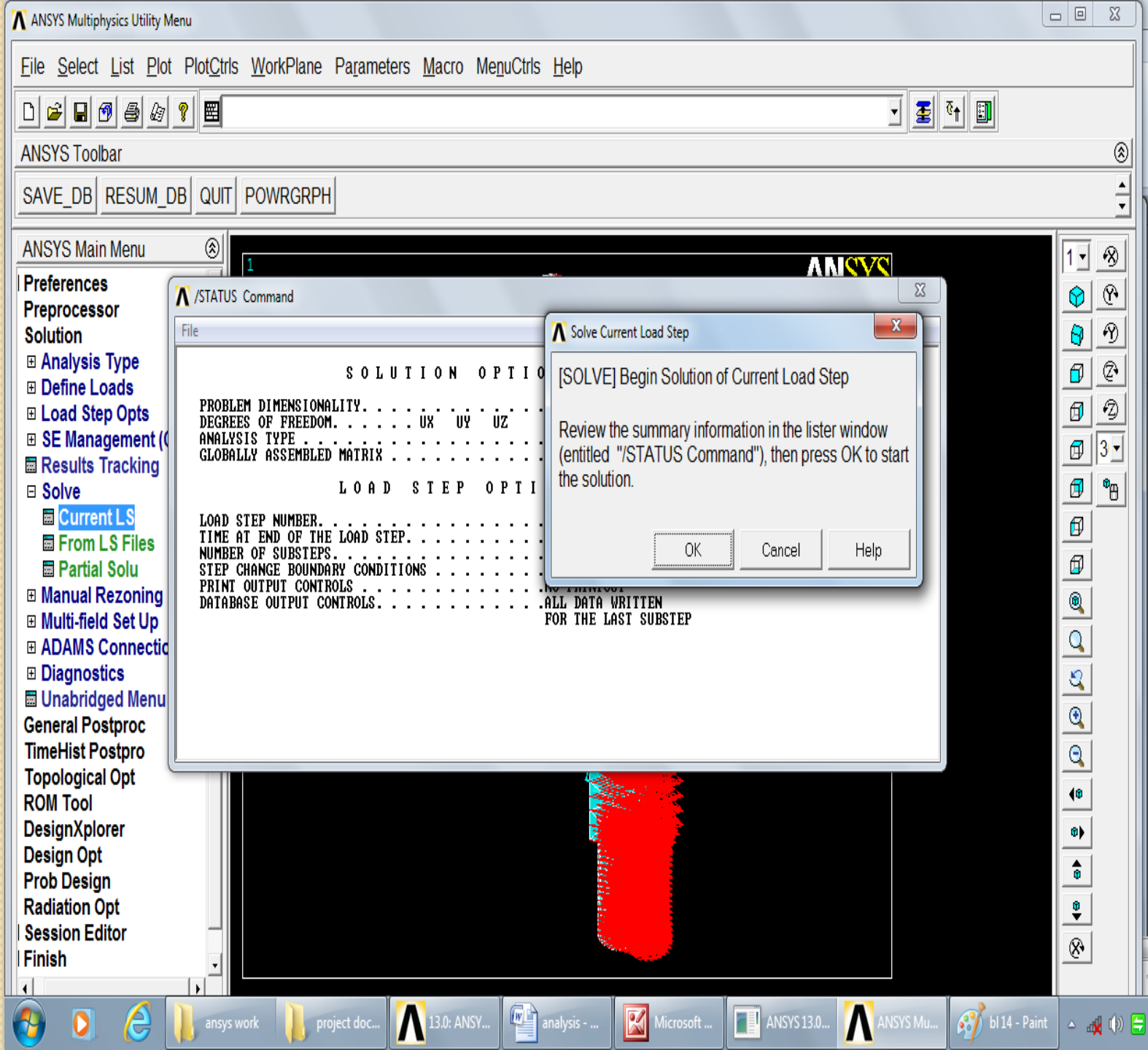
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ANALYSIS TYPE . . . . . .
GLOBALLY ASSEMBLED MATRIX . . . . . .
L O A D S T E P O P T I
LOAD STEP NUMBER. . . . . .
TIME AT END OF THE LOAD STEP. . . . . .
NUMBER OF SUBSTEPS. . . . . .
STEP CHANGE BOUNDARY CONDITIONS . . . . . .
PRINT OUTPUT CONTROLS . . . . . .NO PRINTOUT
DATABASE OUTPUT CONTROLS. . . . . .ALL DATA WRITTEN
FOR THE LAST SUBSTEP
Solve Current Load Step
[SOLVE] Begin Solution of Current Load Step
Review the summary information in the lister window (entitled "/STATUS Command"), then press OK to start the solution.
OK
Cancel
Help
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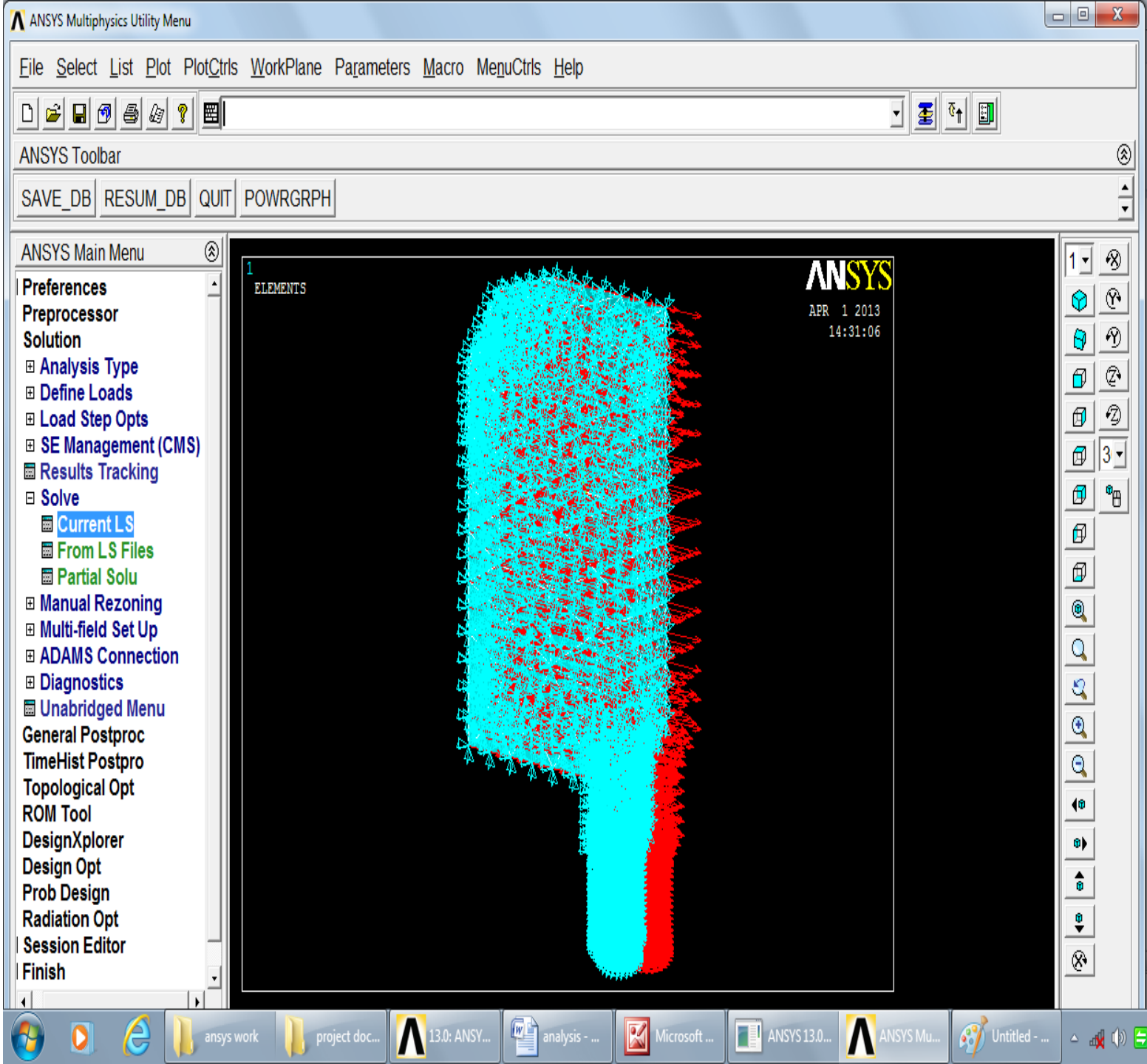
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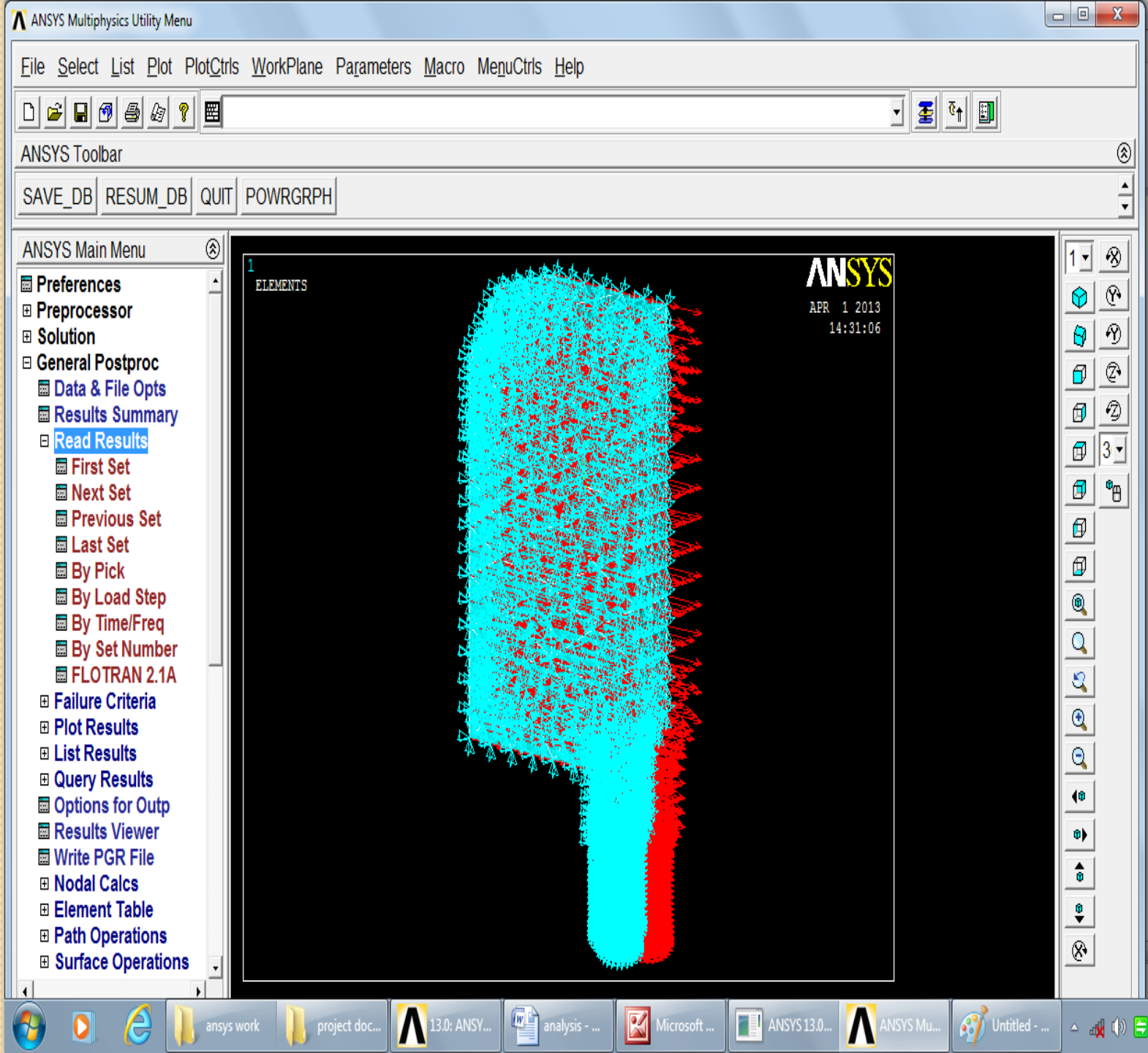
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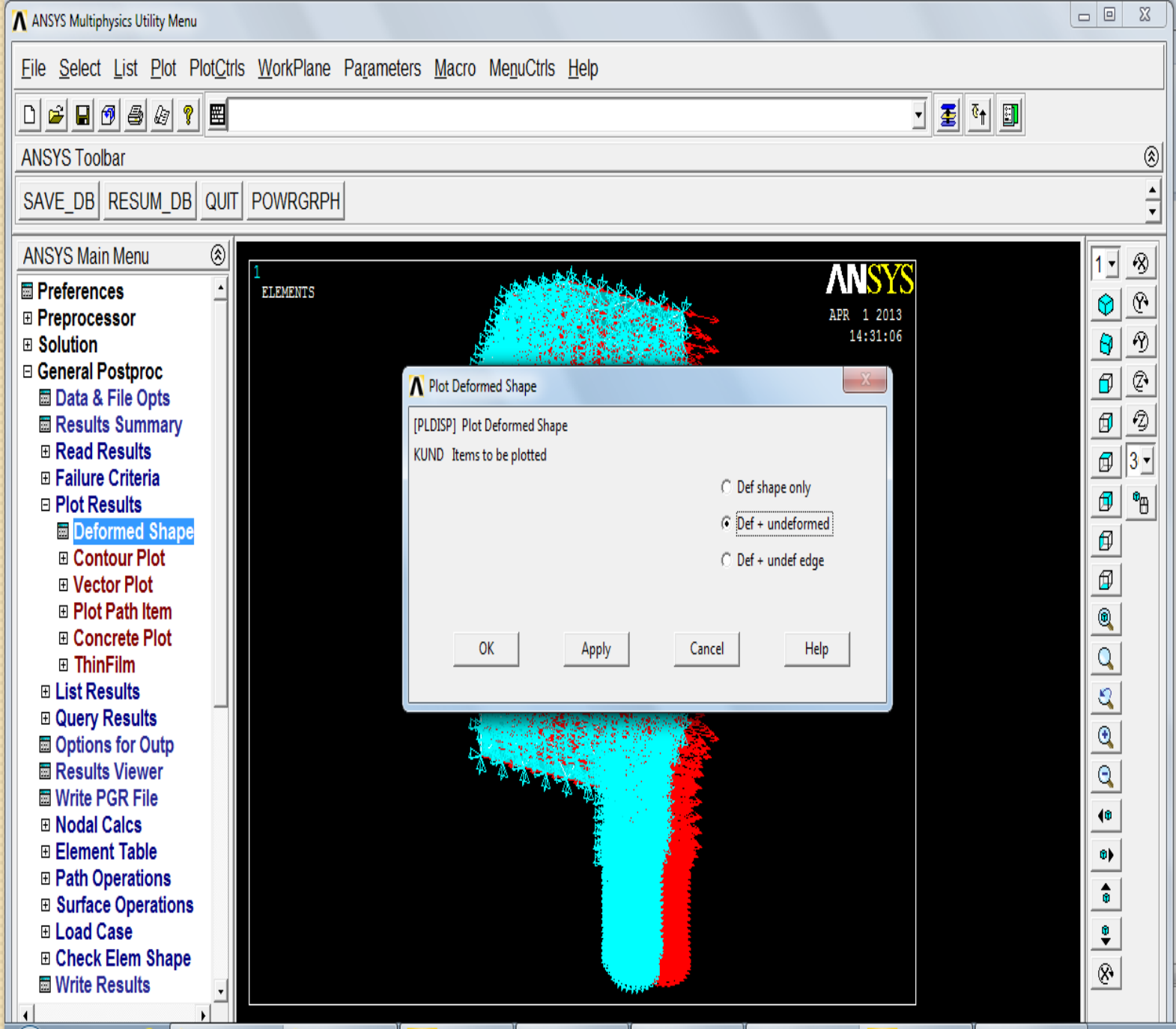
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Path Operations
Surface Operations
Load Case
Check Elem Shape
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Plot Deformed Shape
[PLDISP] Plot Deformed Shape
KUND Items to be plotted
Def shape only
Def + undeformed
Def + undef edge
OK
Apply
Cancel
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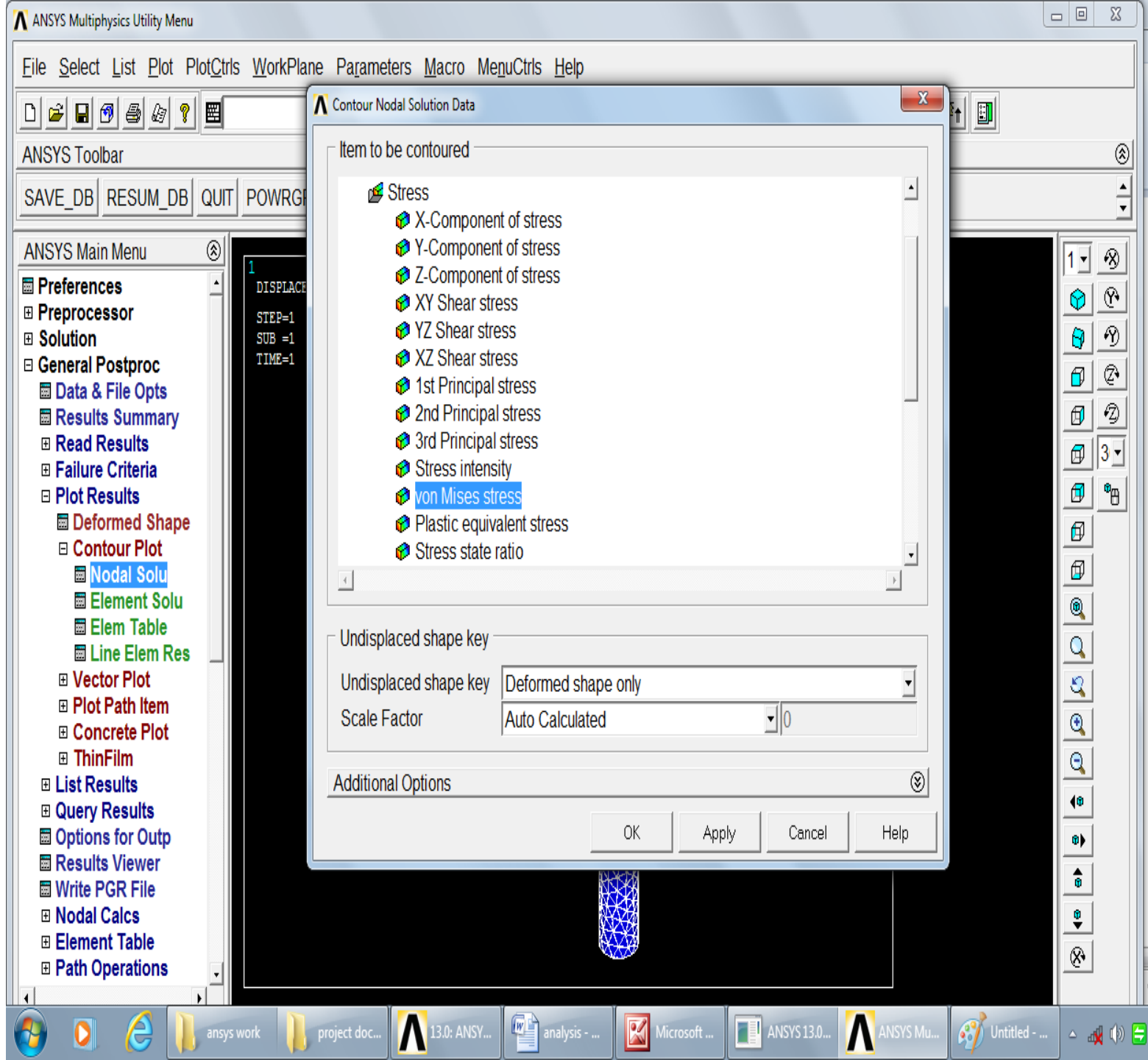
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STEP=1
SUB =1
TIME=1
Contour Nodal Solution Data
Item to be contoured
Stress
X-Component of stress
Y-Component of stress
Z-Component of stress
XY Shear stress
YZ Shear stress
XZ Shear stress
1st Principal stress
2nd Principal stress
3rd Principal stress
Stress intensity
von Mises stress
Plastic equivalent stress
Stress state ratio
Undisplaced shape key
Undisplaced shape key
Deformed shape only
Scale Factor
Auto Calculated
0
Additional Options
OK
Apply
Cancel
Help
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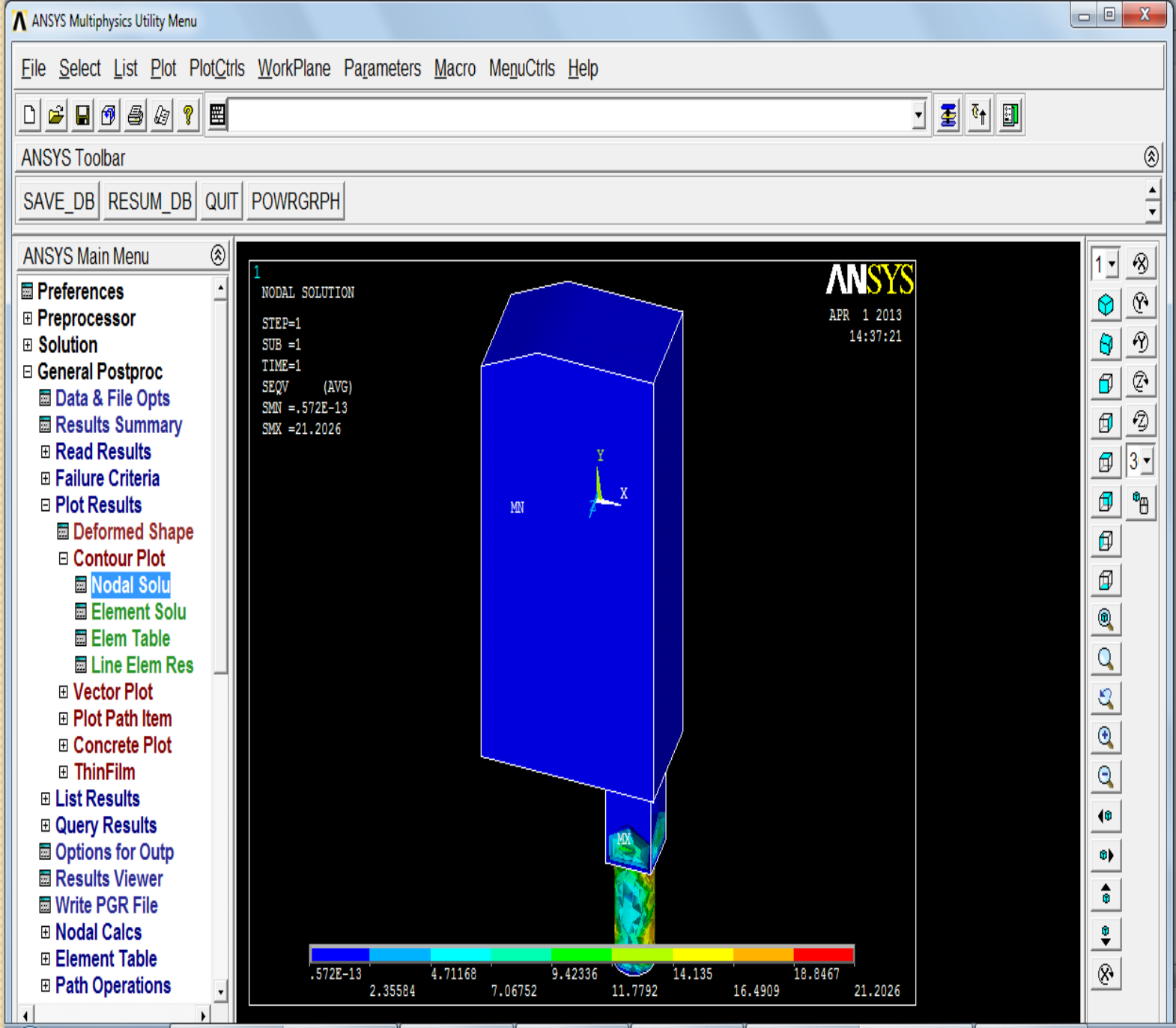
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STEP=1
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SEQV (AVG)
SMN =.572E-13
SMX =21.026
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APR 1 2013
14:37:21
MN
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.572E-13
2.35584
4.71168
7.06752
9.42336
11.7792
14.135
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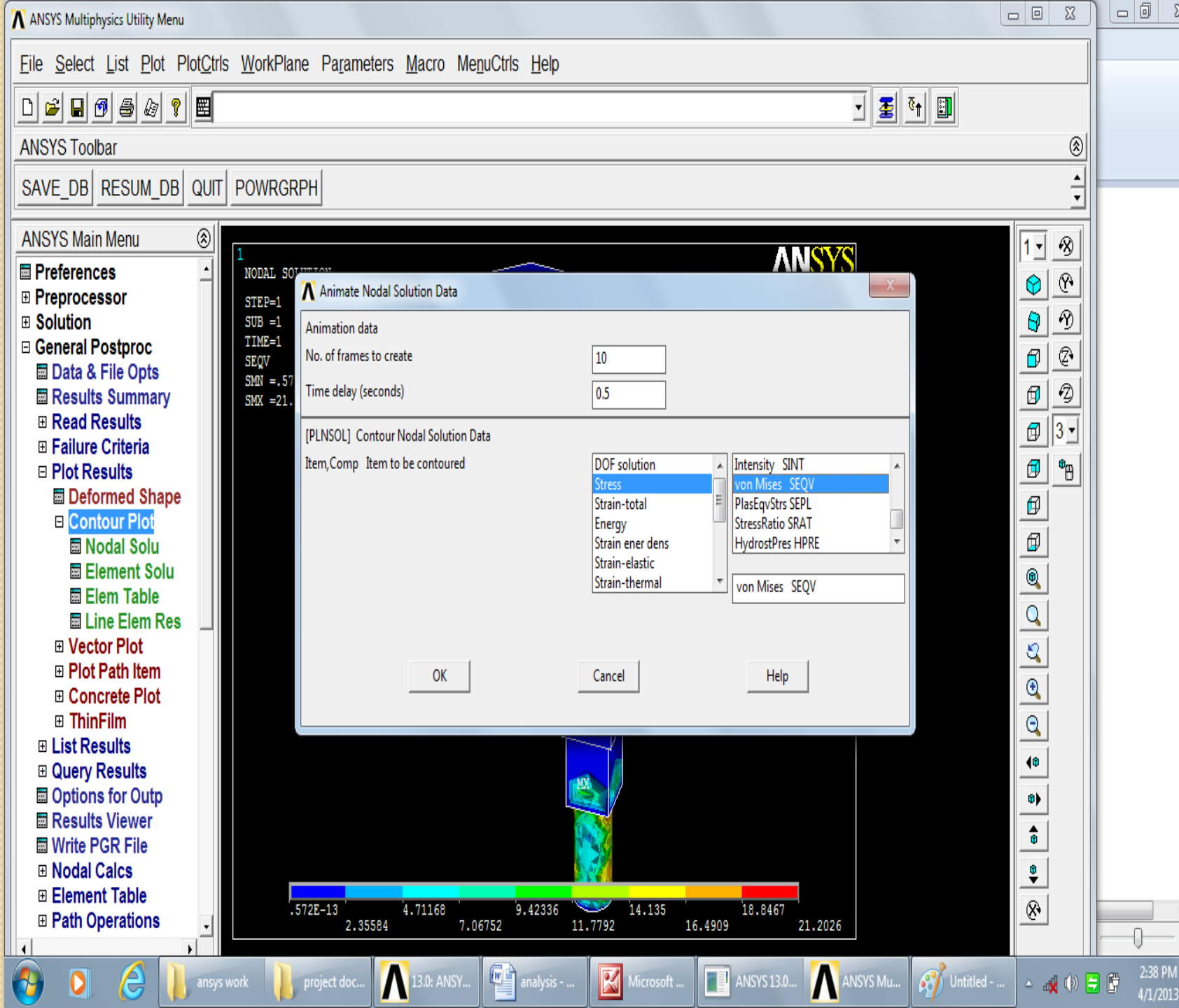
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Element Table
Path Operations
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STEP=1
SUB =1
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SMN =.57
SMX =21.
Animate Nodal Solution Data
Animation data
No. of frames to create
10
Time delay (seconds)
0.5
[PLNSOL] Contour Nodal Solution Data
Item,Comp Item to be contoured
DOF solution
Stress
Strain-total
Energy
Strain ener dens
Strain-elastic
Strain-thermal
Intensity SINT
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StressRatio SRAT
HydrostPres HPRE
von Mises SEQV
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Cancel
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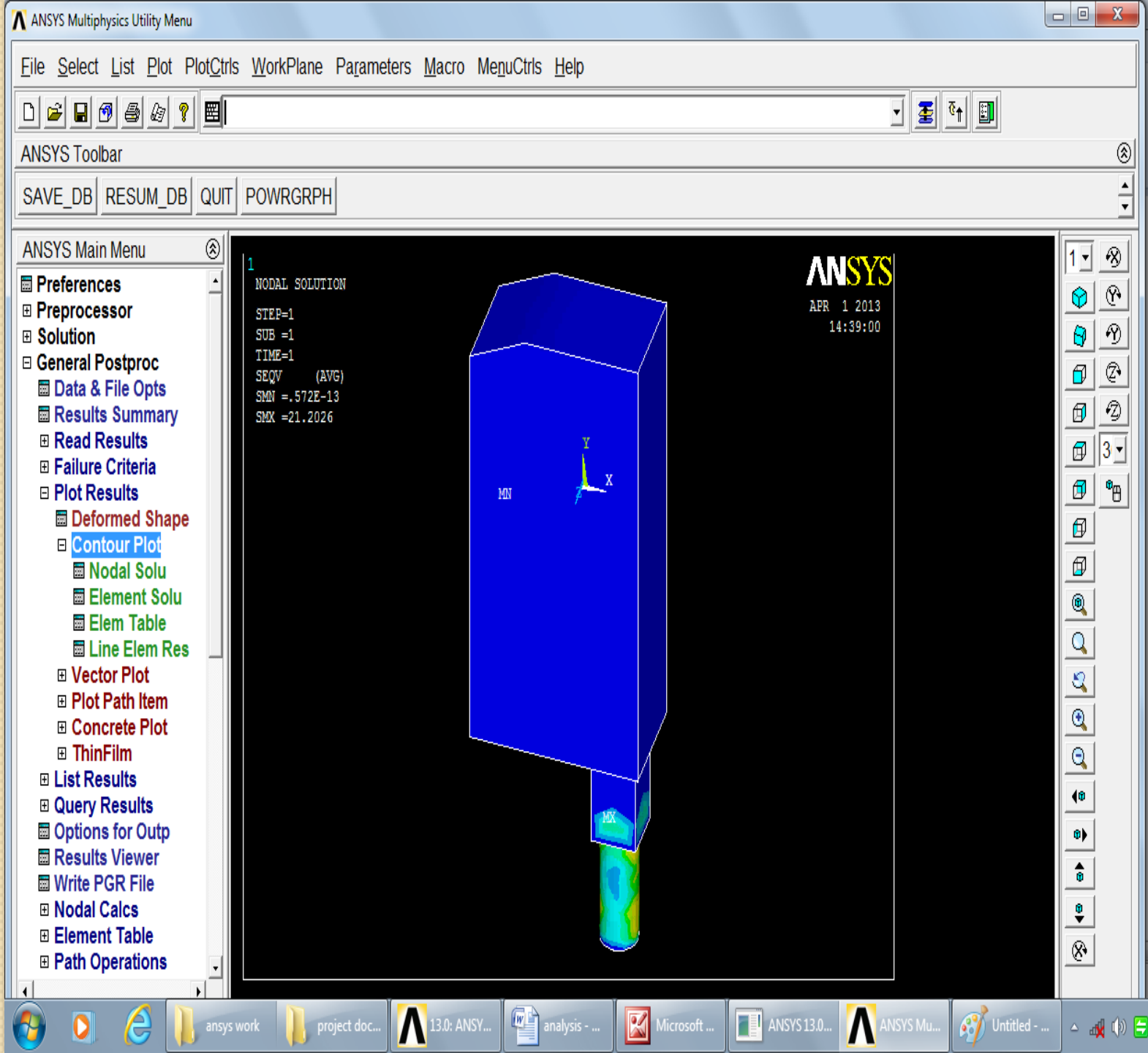
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Element Table
Path Operations
1
NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
SMN =.572E-13
SMX =21.2026
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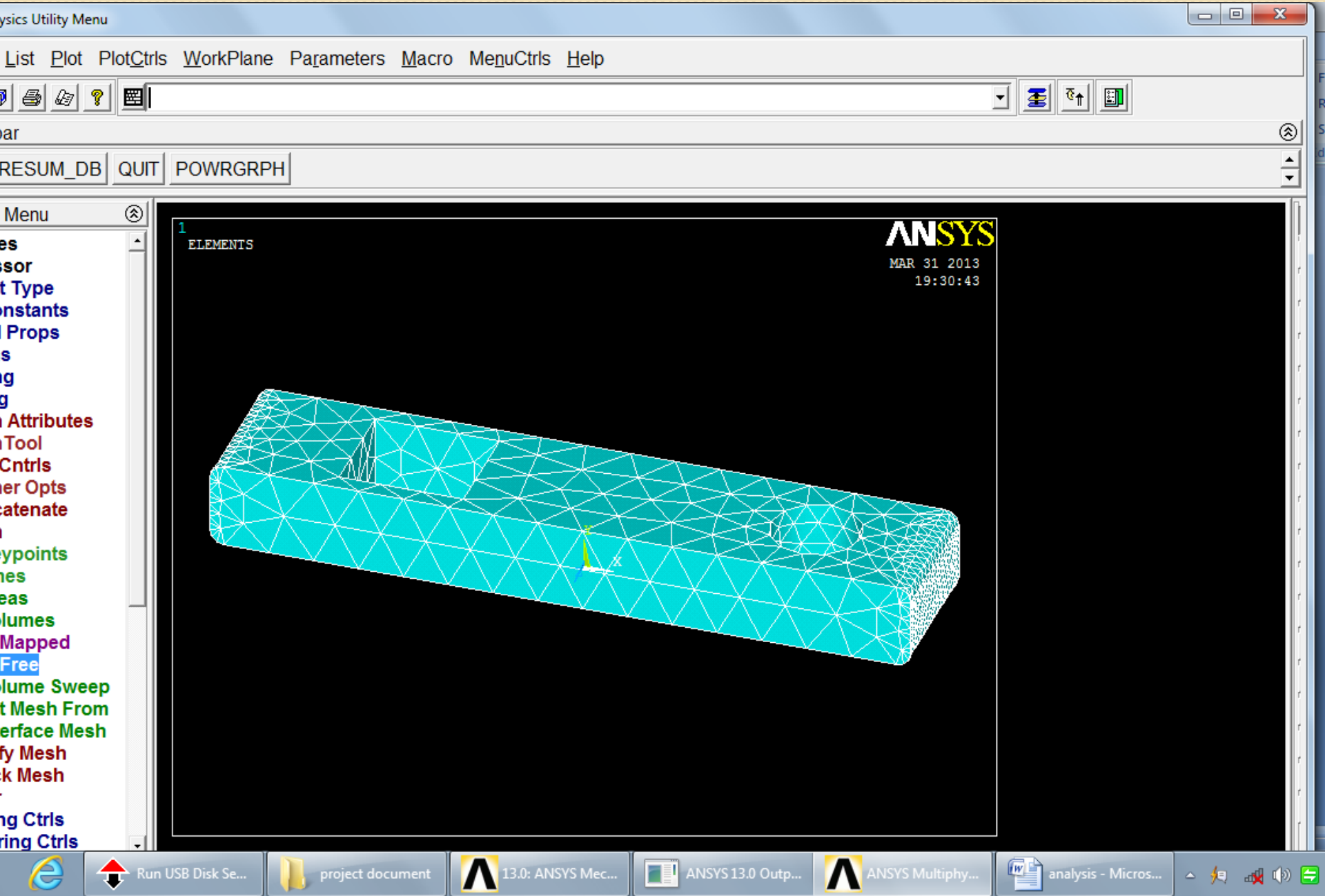
4/1/2013

ANALYSIS OF LONG ARM



ANSYS Multiphysics Utility Menu

File Select List Plot PlotCtrls WorkPlane Parameters Macro MenuCtrls Help

ANSYS Toolbar

SAVE_DB RESUM_DB QUIT POWRGRPH

ANSYS Main Menu

- Preferences
- Preprocessor
- Solution
- General Postproc
  - Data & File Opts
  - Results Summary
  - Read Results
  - Failure Criteria
  - Plot Results
    - Deformed Shape
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      - Element Solu
      - Elem Table
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  - Results Viewer
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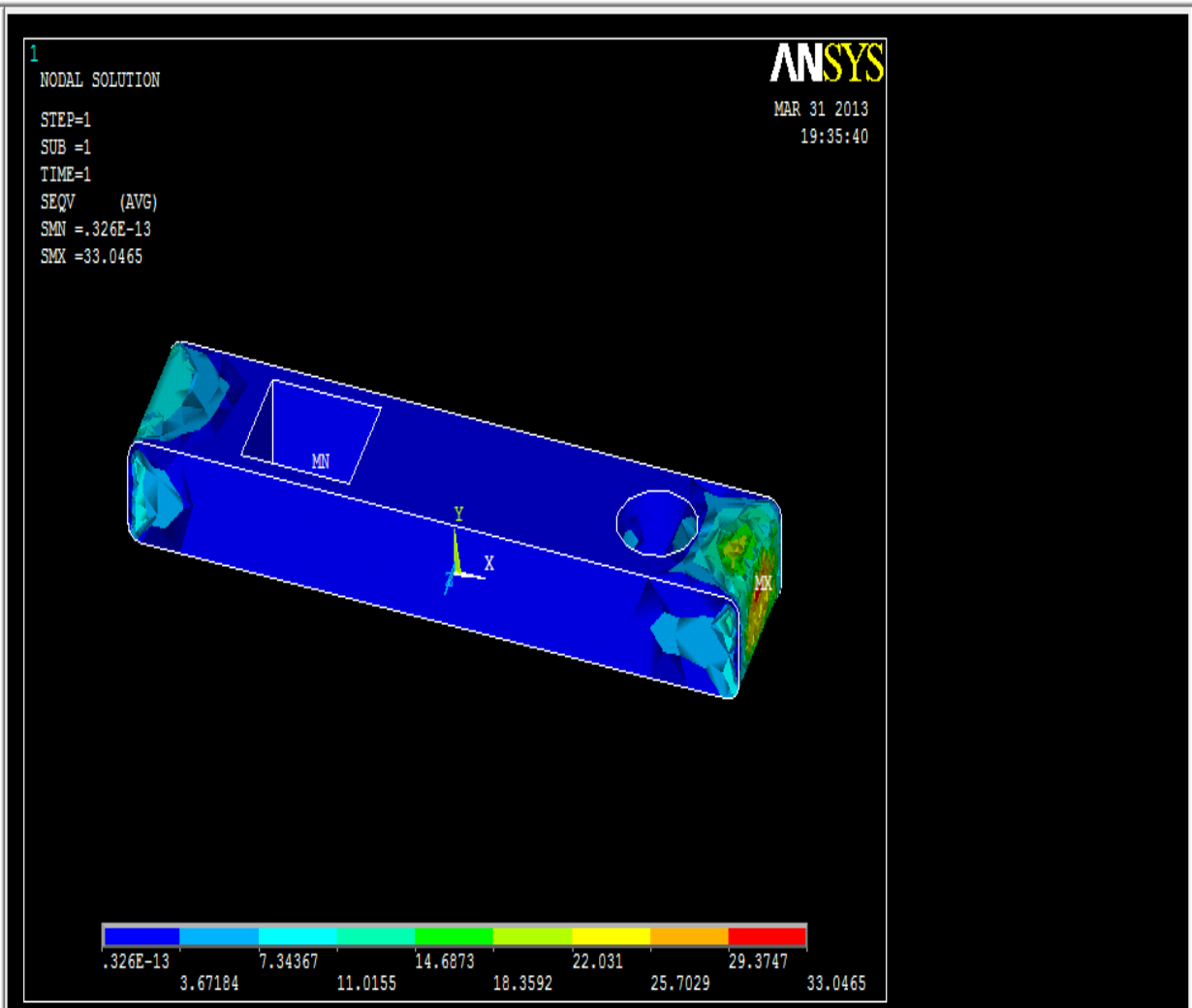
  - Nodal Calcs
  - Element Table
  - Path Operations



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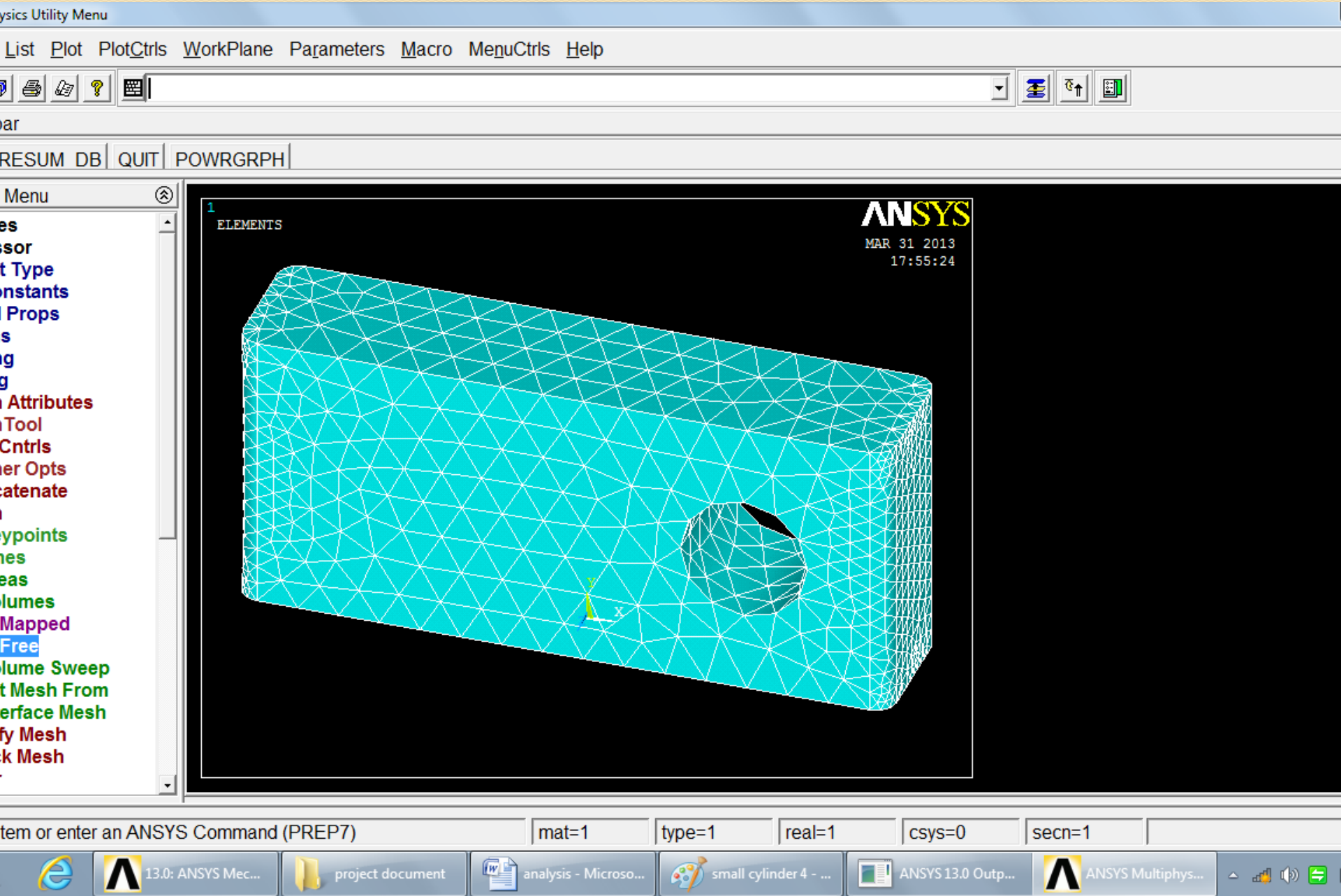
ANALYSIS OF SMALL ARM



ANSYS Multiphysics Utility Menu

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ANSYS Toolbar

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ANSYS Main Menu

- Preferences
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- Solution
- General Postproc
  - Data & File Opts
  - Results Summary
  - Read Results
  - Failure Criteria
  - Plot Results
    - Deformed Shape
    - Contour Plot
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    - Vector Plot
    - Plot Path Item
    - Concrete Plot
    - ThinFilm
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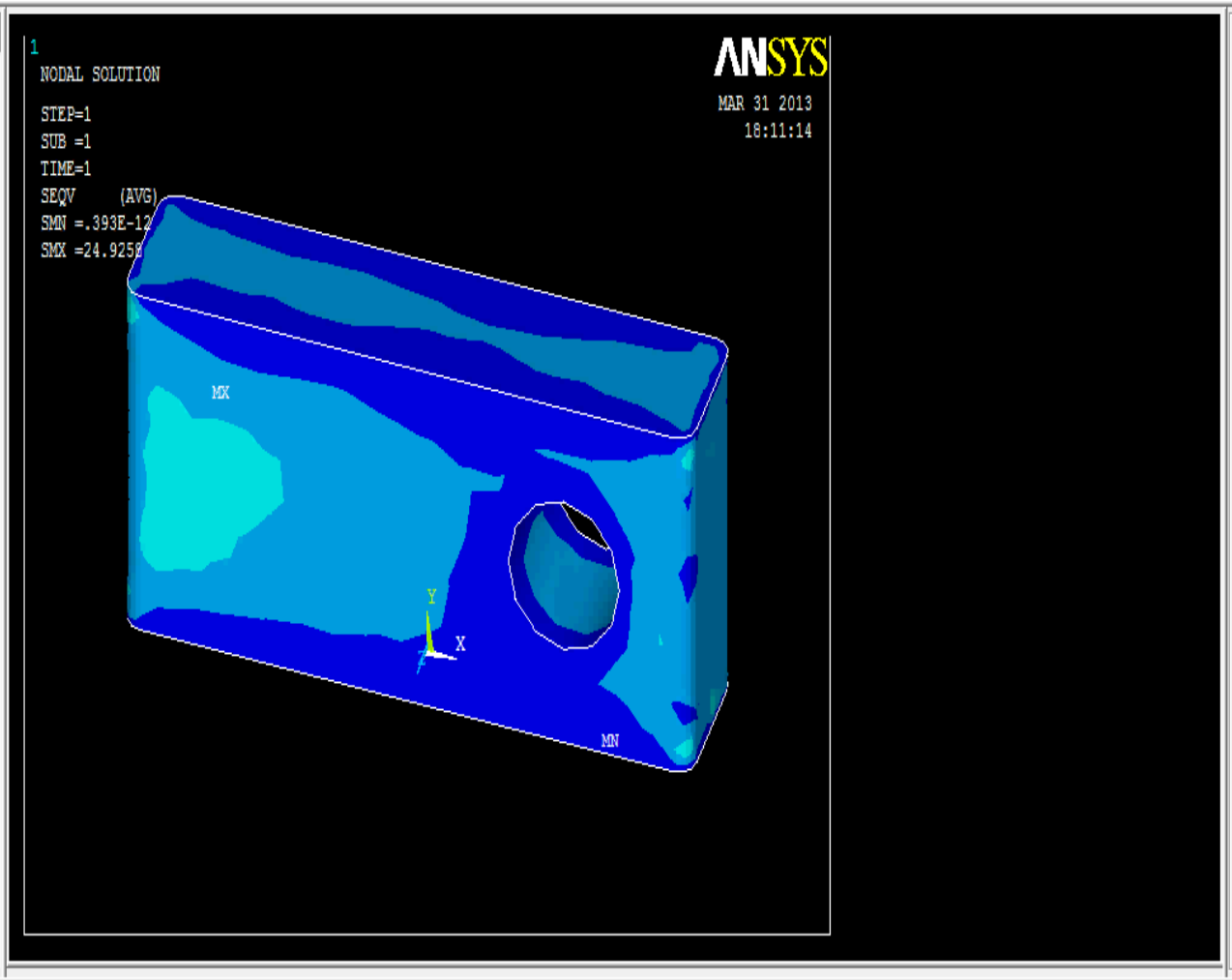
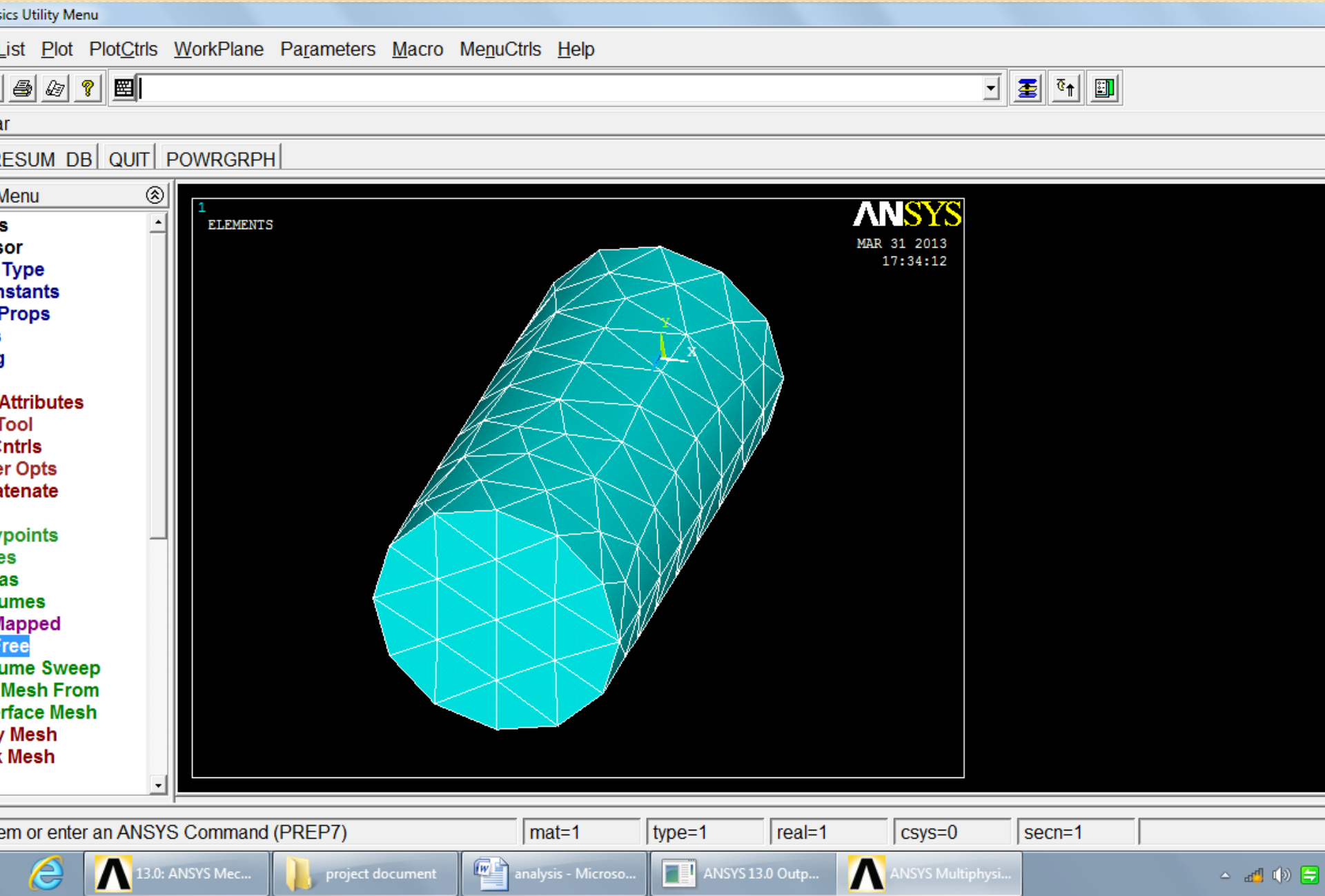
  - Query Results
  - Options for Outp
  - Results Viewer
  - Write PGR File
  - Nodal Calcs



Pick a menu item or enter an ANSYS Command (POST1) | mat=1 | type=1 | real=1 | csys=0 | secn=1

13.0: ANSYS Mec... | project document | analysis - Microso... | s cyl 4 - Paint | ANSYS 13.0 Outp... | ANSYS Multiphys... | 6:11 PM 3/31/2013

ANALYSIS OF LARGE CYLINDER



ANSYS Multiphysics Utility Menu

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ANSYS Toolbar

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ANSYS Main Menu

- Preferences
- Preprocessor
- Solution
- General Postproc
  - Data & File Opts
  - Results Summary
  - Read Results
  - Failure Criteria
  - Plot Results
    - Deformed Shape
    - Contour Plot
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    - Plot Path Item
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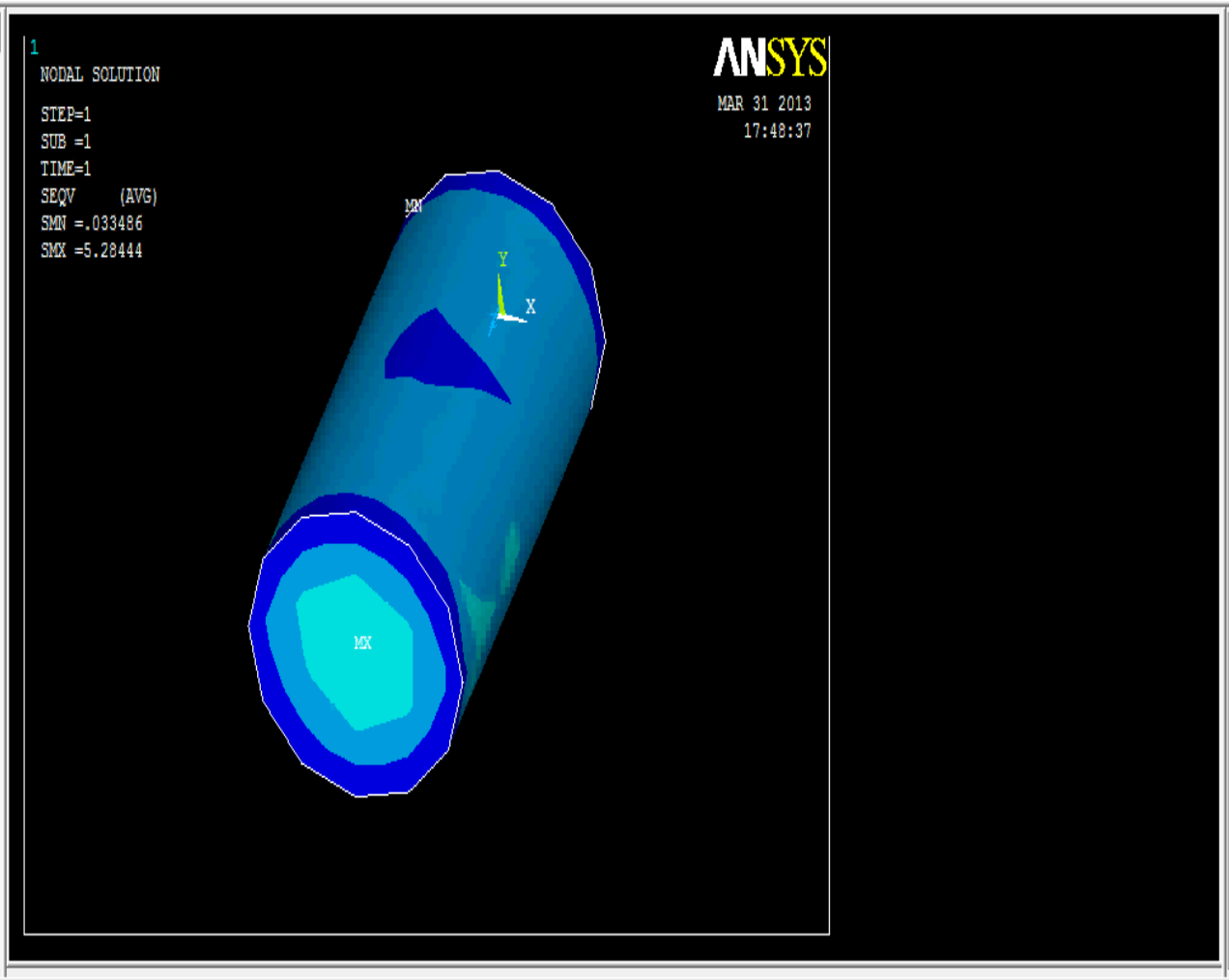
  - Options for Outp
  - Results Viewer
  - Write PGR File
  - Nodal Calcs



Pick a menu item or enter an ANSYS Command (POST1) | mat=1 | type=1 | real=1 | csys=0 | secn=1

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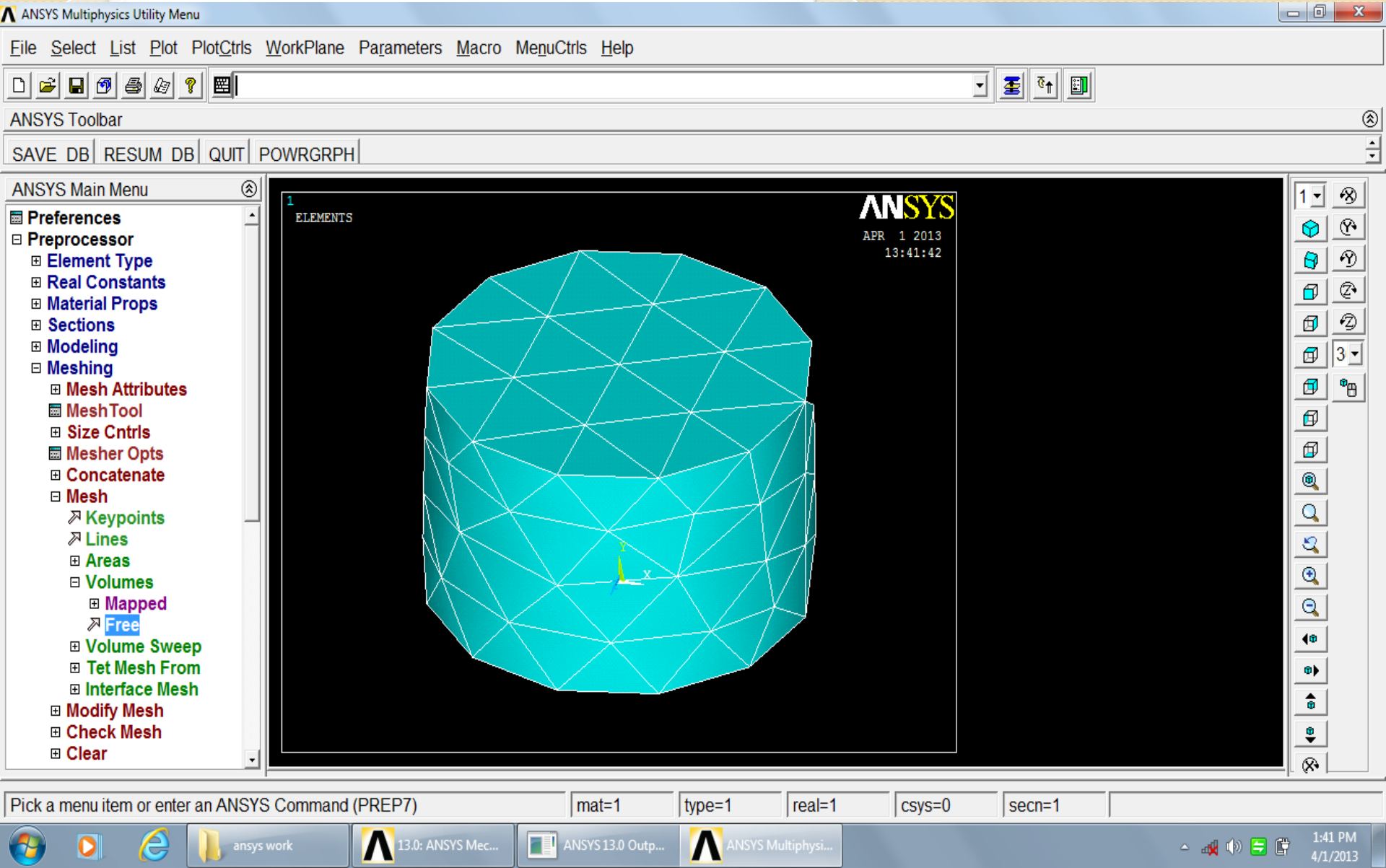
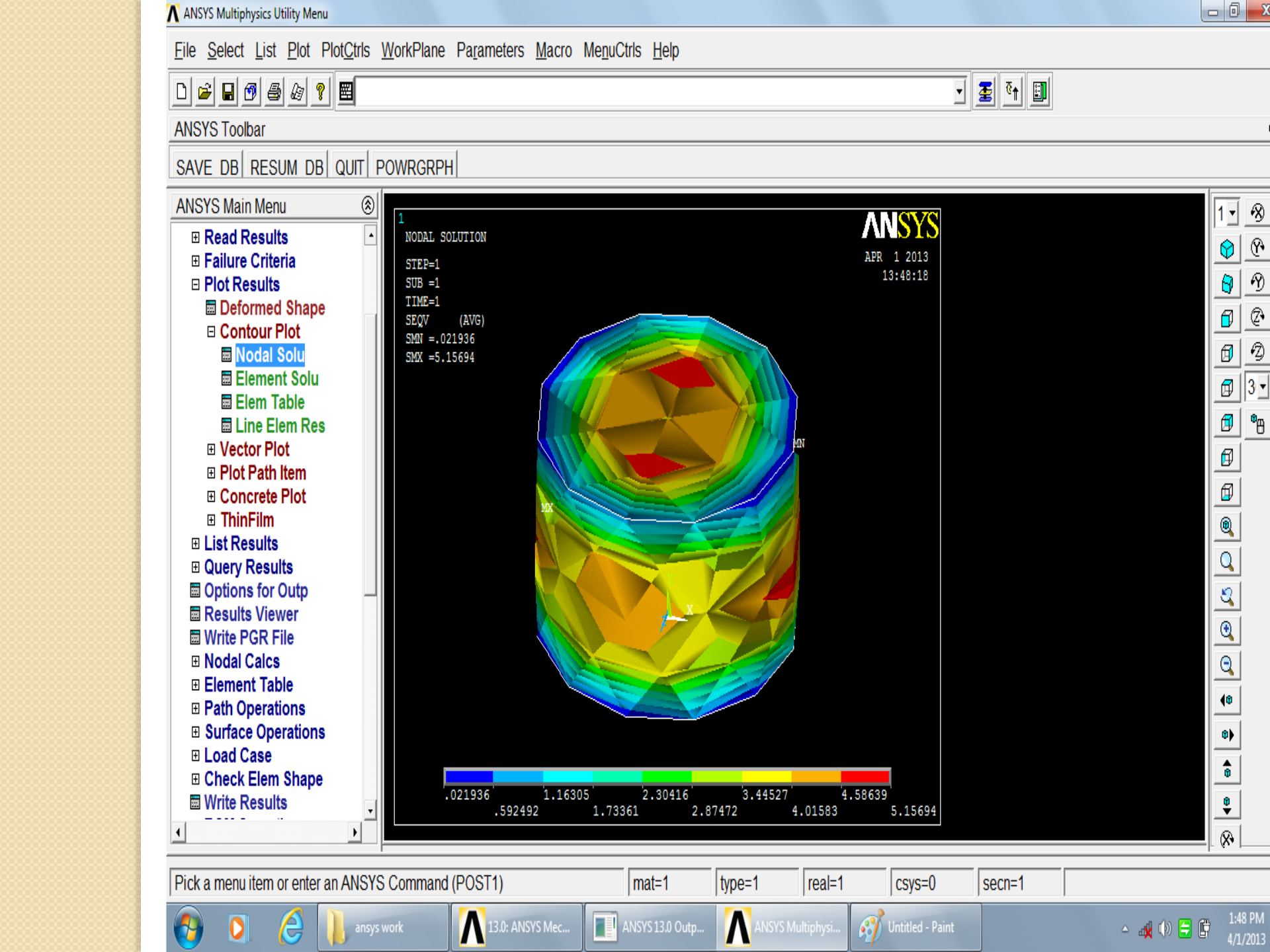
ANALYSIS OF SMALL CYLINDER

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Path Operations
Surface Operations
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NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
SMN =.021936
SMX =5.15694
ANSYS
APR 1 2013
13:48:18
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.021936
.592492
1.16305
1.73361
2.30416
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3.44527
4.01583
4.58639
5.15694
Pick a menu item or enter an ANSYS Command (POST1)
mat=1
type=1
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csys=0
secn=1
ansys work
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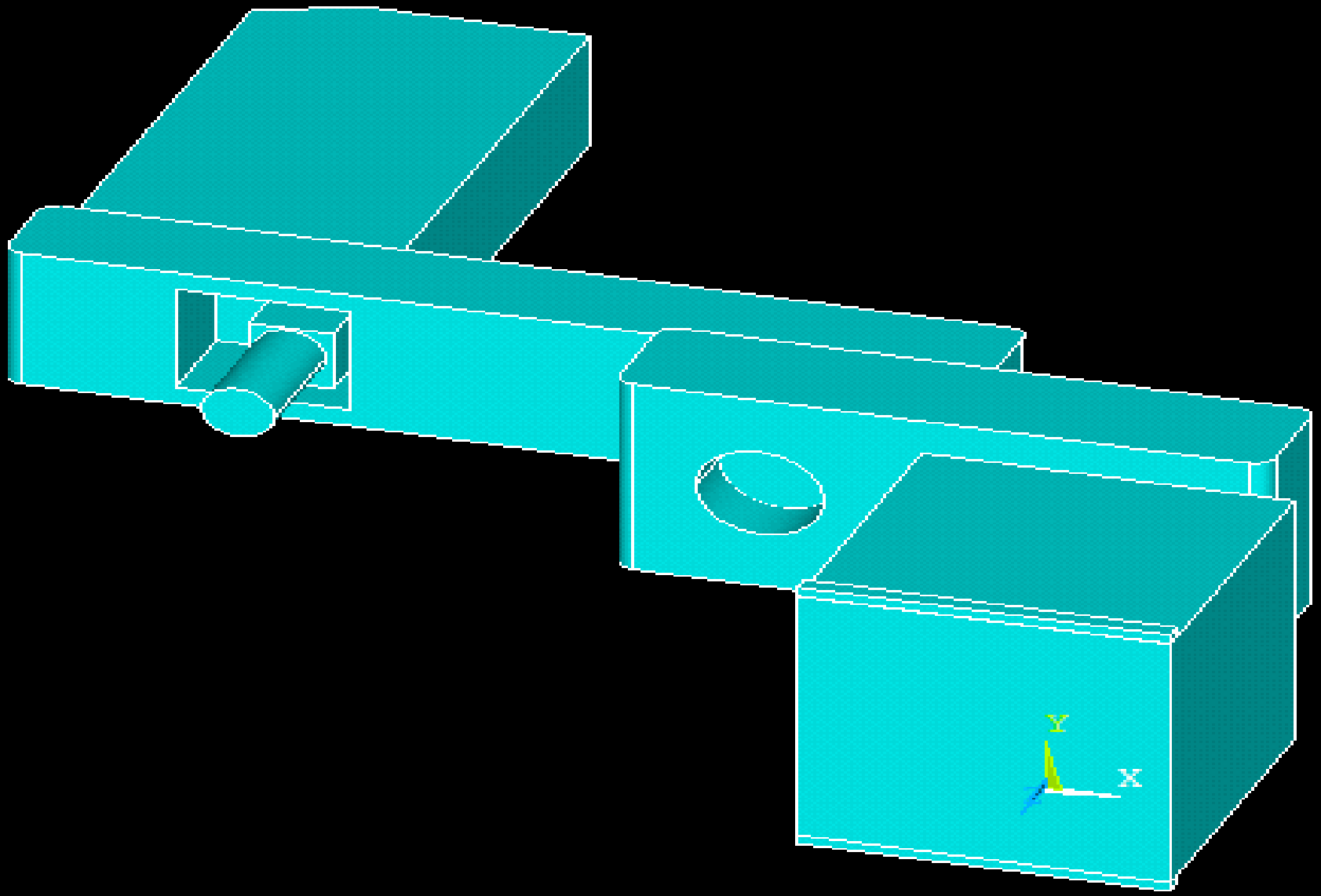
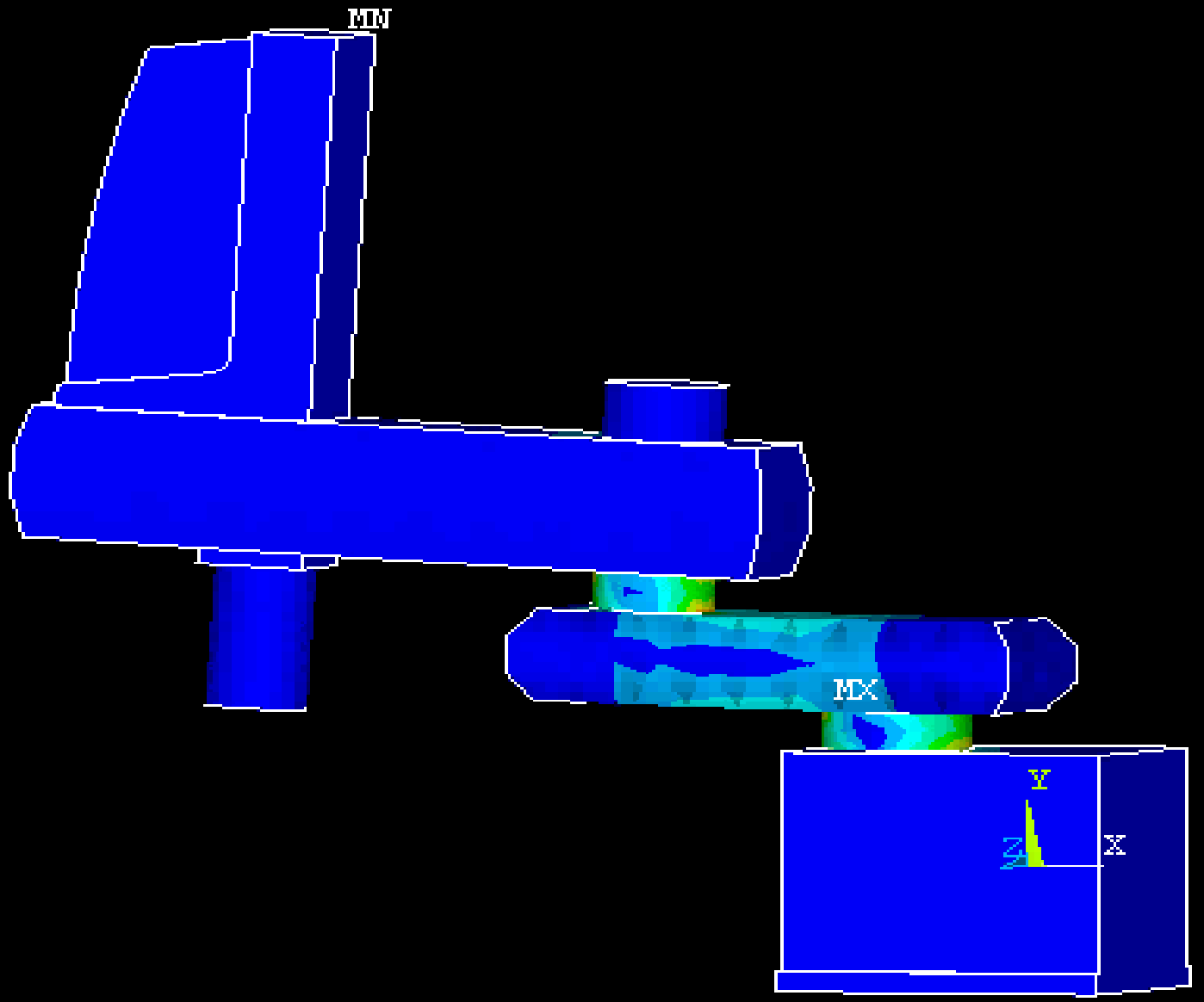
ANALYSIS OF FULL ARM




MN
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Conclusion

Kinematics model developed describes the spatial position of joints and links, and position & orientation of the end-effectors. It gives the relations between the position & orientation of the end-effectors & spatial position of joint-links. Using method of Jacobeans actuation torque is computed in designing the drives of the actual robot. It is believed that systematic methodology proposed for computation & software developed will be helpful for practical designers.

Conclusion (contd….)

Program developed in MAT-LAB gives actual movement of arm in forward and inverse position which will not disturbed the equilibrium of robot.

The maximum payload for this robotic arm is 196 N (20 kg). If we apply this load to full arm, it deflects but does not break. So design is safe for given maximum pay load.

If we apply the same load to individual parts, they also deflects but do not break. So design is safe for given maximum pay load.

References

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THANKS……..