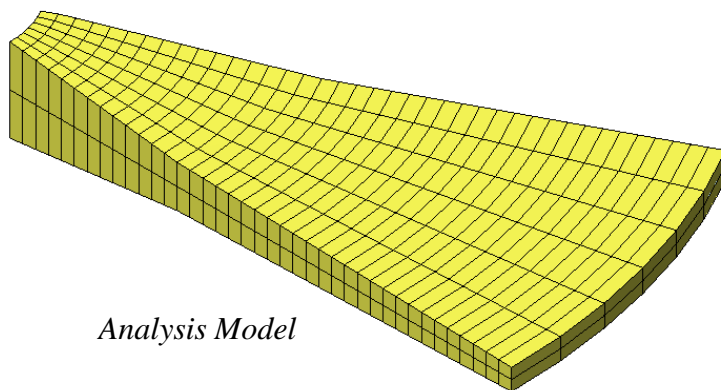
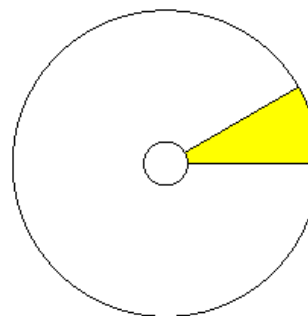


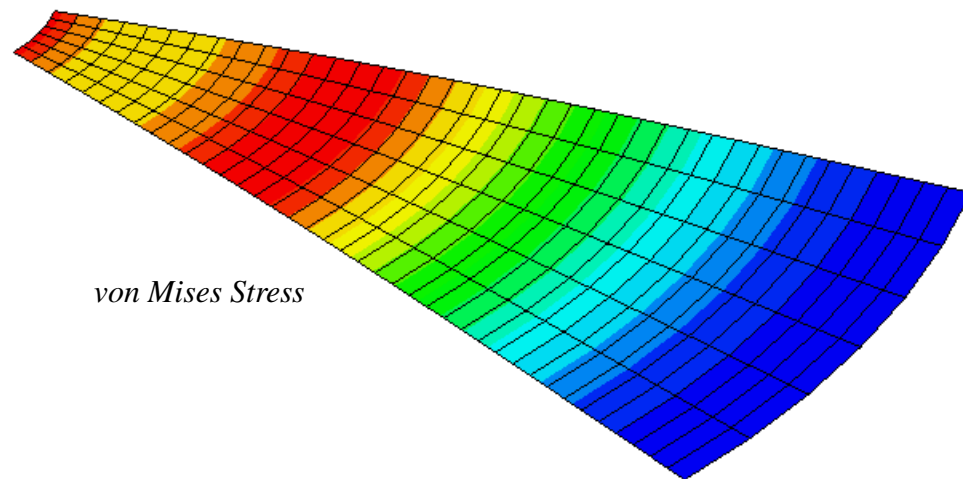
# LS-4. Tapered Plate



Analysis Model



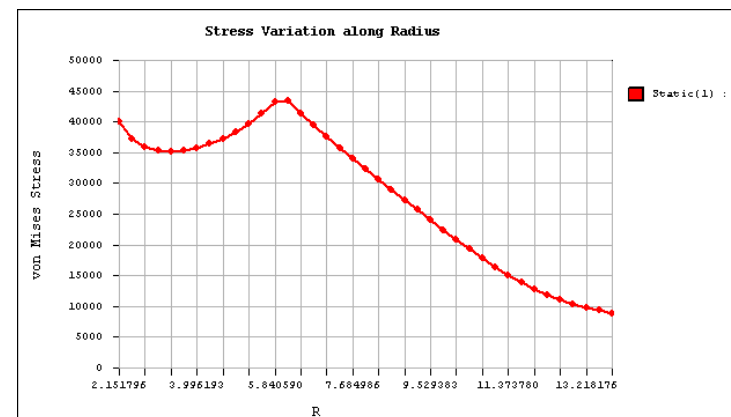
1/12 Symmetric Part



von Mises Stress

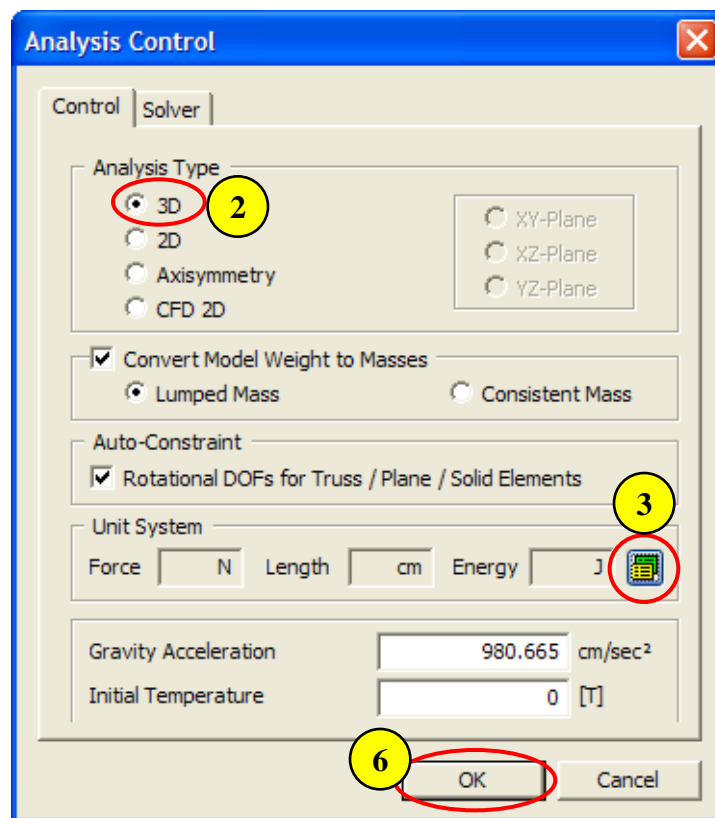
## Overview

- 3-D Linear Static Analysis
- Model
  - 1/12 (30°) Symmetric Model
  - Unit : N, cm
  - Isotropic Elastic Material
  - Plate Elements
- Load & Boundary Condition
  - Variable Pressure
  - Constraint in Nodal CSys
- Result Evaluation
  - Deformation
  - von Mises Stress
  - Result Extraction



Stress Variation Graph

# Step 1.



1. Analysis > Analysis Control – Control tab

2. Analysis Type : 3D

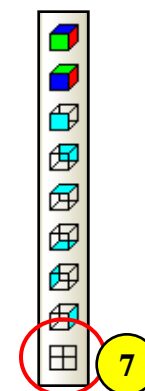
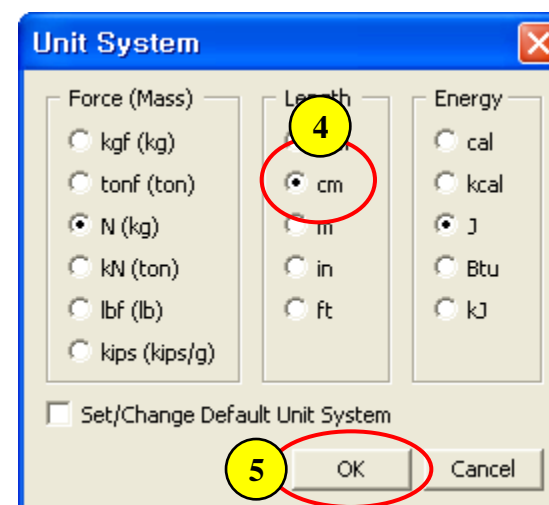
3. Click  Button (Unit System)

4. Length : cm

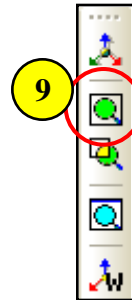
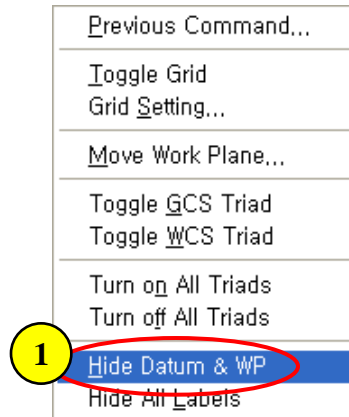
5. Click [OK] Button

6. Click [OK] Button

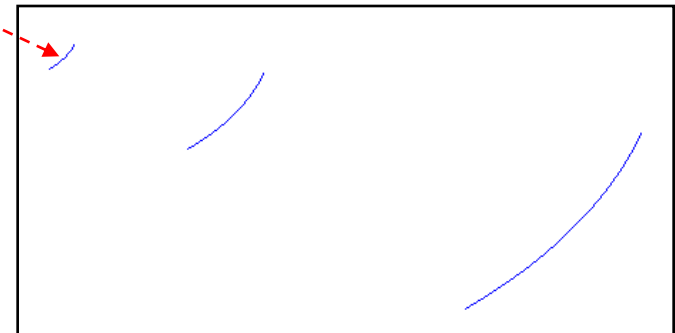
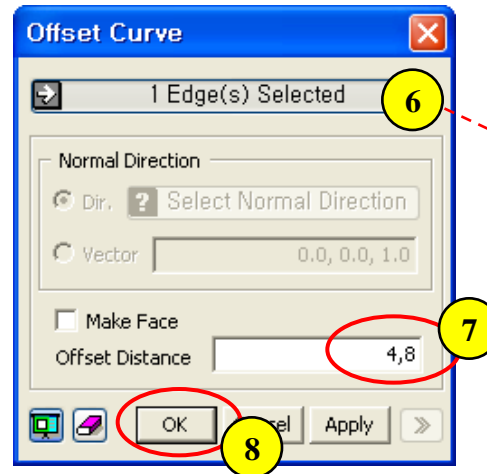
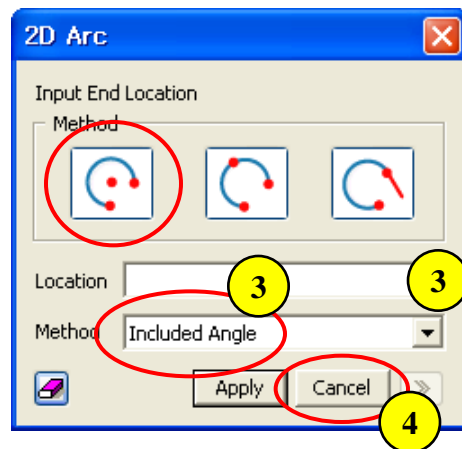
7. Click “Normal View”



## Step 2.

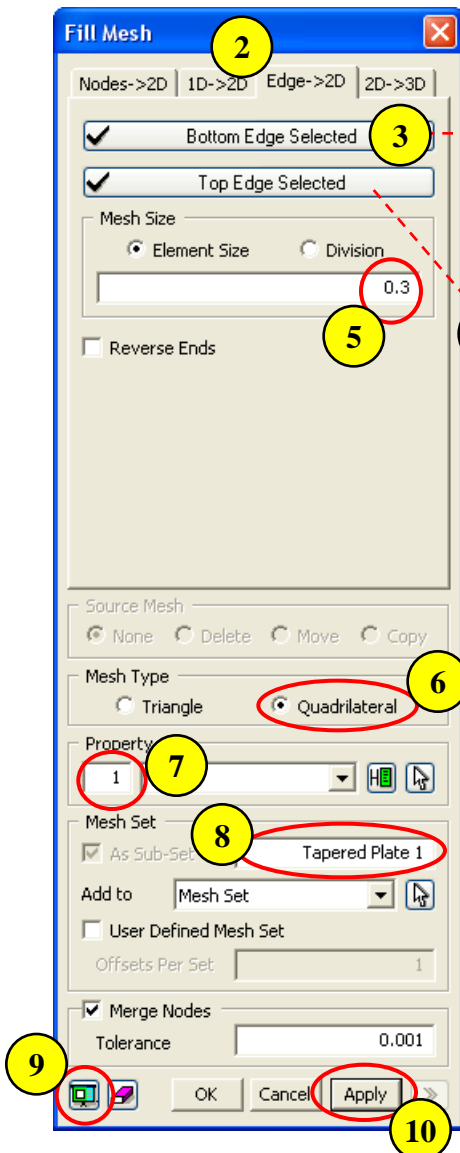


1. Click Right Mouse Button in Work Window and Select "Hide Datum & WP"
2. Geometry > Curve > Create on WP > Arc...
3. Center (0) - Start (2) <sup>Ⓢ</sup> - Included Angle (30)
4. Click [Cancel] Button <sup>Ⓢ</sup>
5. Geometry > Curve > Create 3D > Offset Curve...
6. Select Arc
7. Offset Distance : 4, 8
8. Click [OK] Button
9. Click "Zoom All"

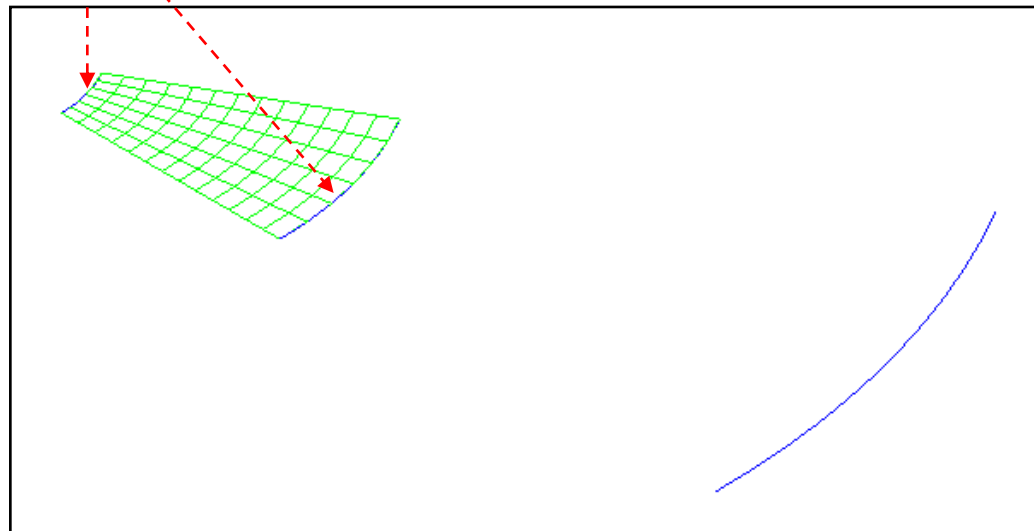


Ⓢ () : "ABS x, y", <> : "REL dx, dy"  
 (0) same as (0, 0)  
 Ⓢ [Esc] as shortcut for [Cancel].

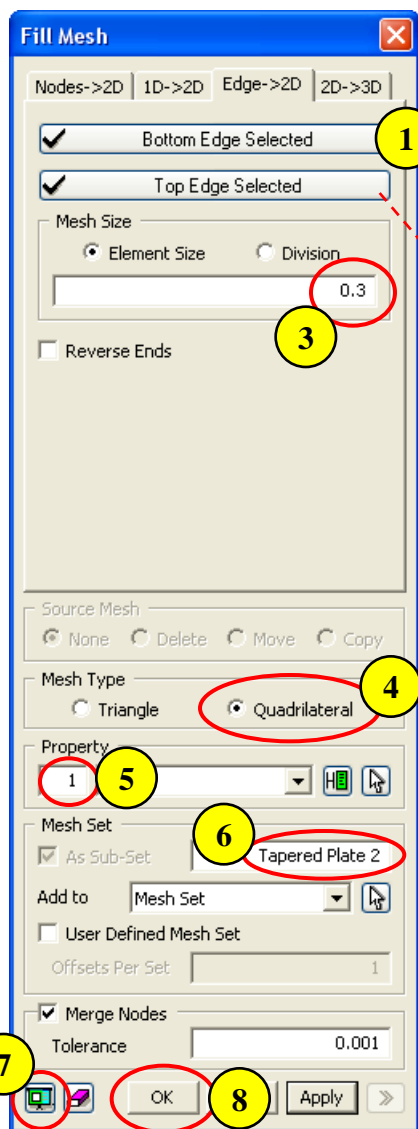
### Step 3.



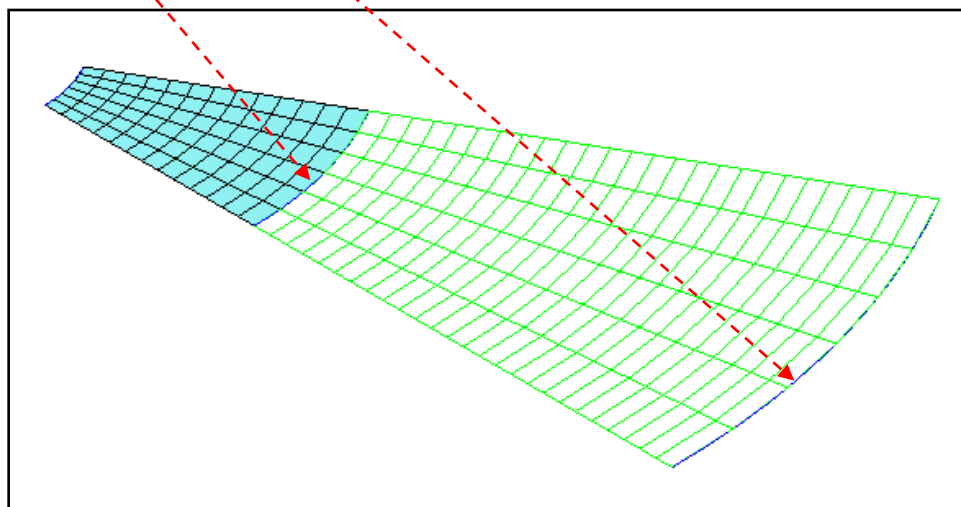
1. Mesh > Protrude Mesh > Fill...
2. Select "Edge->2D" tab
3. Select Bottom Edge
4. Select Top Edge
5. Mesh Size - Element Size : 0.3
6. Mesh Type : Quadrilateral
7. Property : 1
8. Mesh Set : Tapered Plate 1
9. Click "Preview" Button
10. Click [Apply] Button



## Step 4.



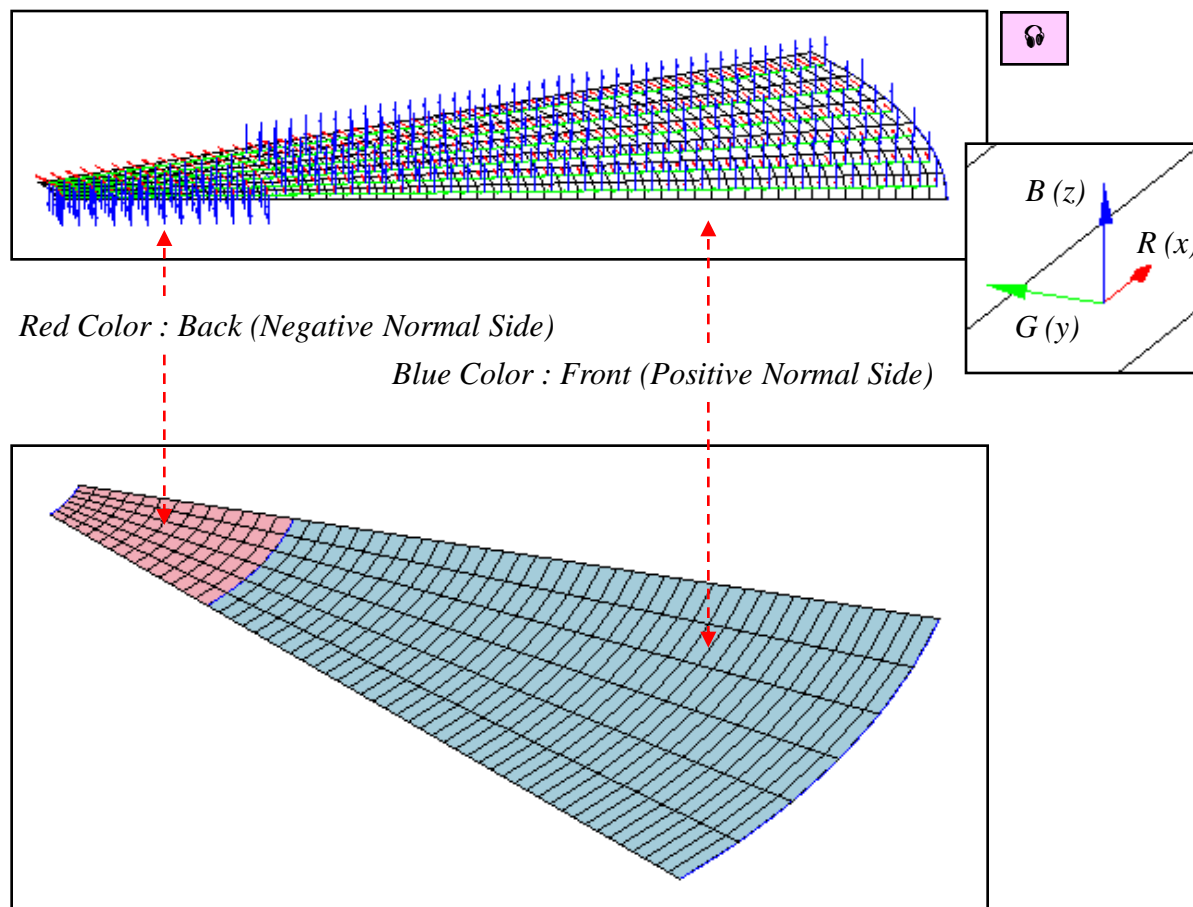
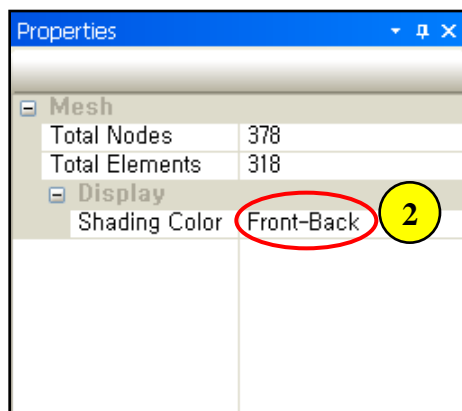
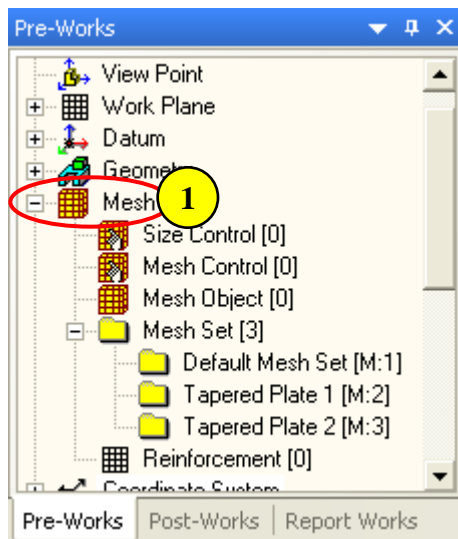
1. Select Bottom Edge
2. Select Top Edge
3. Mesh Size - Element Size : 0.3
4. Mesh Type : Quadrilateral
5. Property : 1
6. Mesh Set : Tapered Plate 2
7. Click "Preview" Button
8. Click [OK] Button



## Step 5.

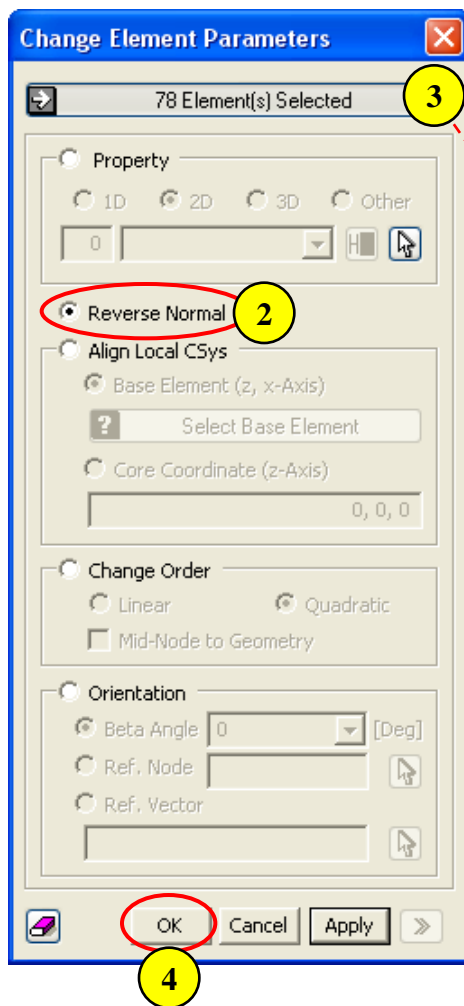
1. Pre-Works Tree : Mesh ...

2. Property Window : Display – Shading Color (Front-Back)

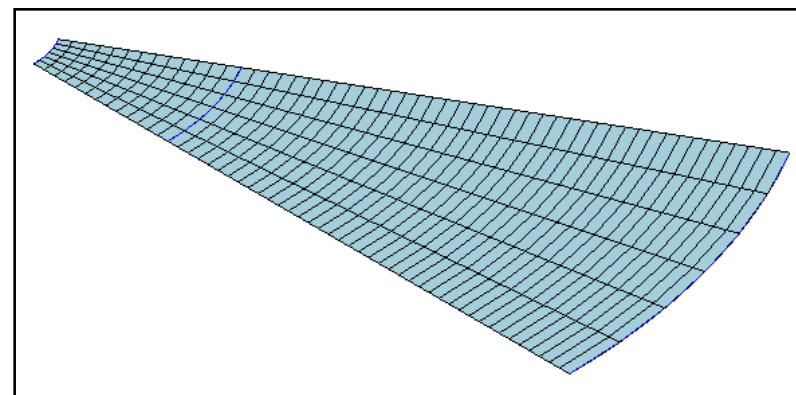
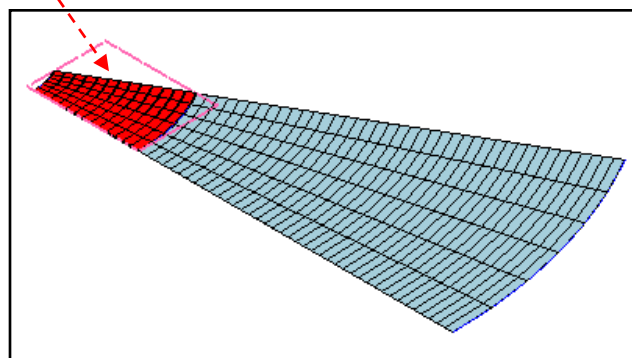


🔊 Pre-Works Tree : Mesh – Tapered Plate 1 & 2 (Context Menu: Display > Element CSys)

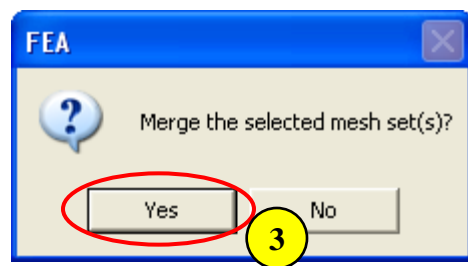
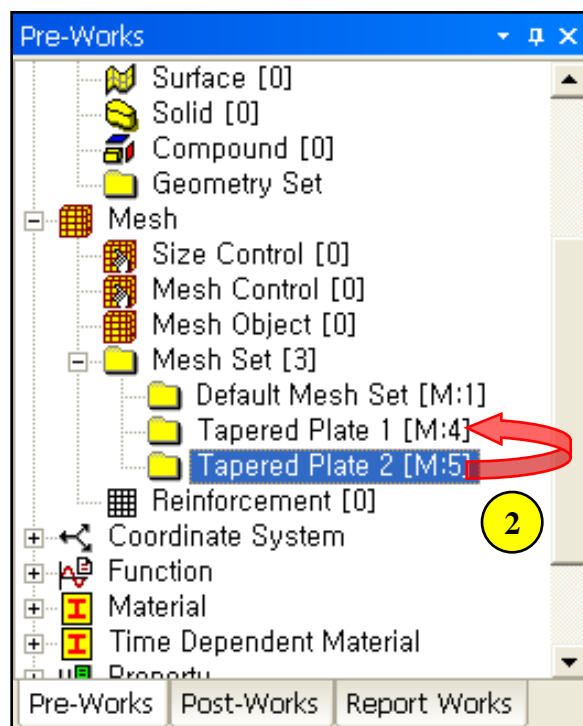
## Step 6.



1. Mesh > Element > Change Parameter...
2. Select "Reverse Normal" Option
3. Select "Tapered Plate 1" Mesh Set
4. Click [OK] Button
5. Pre-Works Tree : Mesh ...
6. Property Window : Display – Shading Color (Set Color)



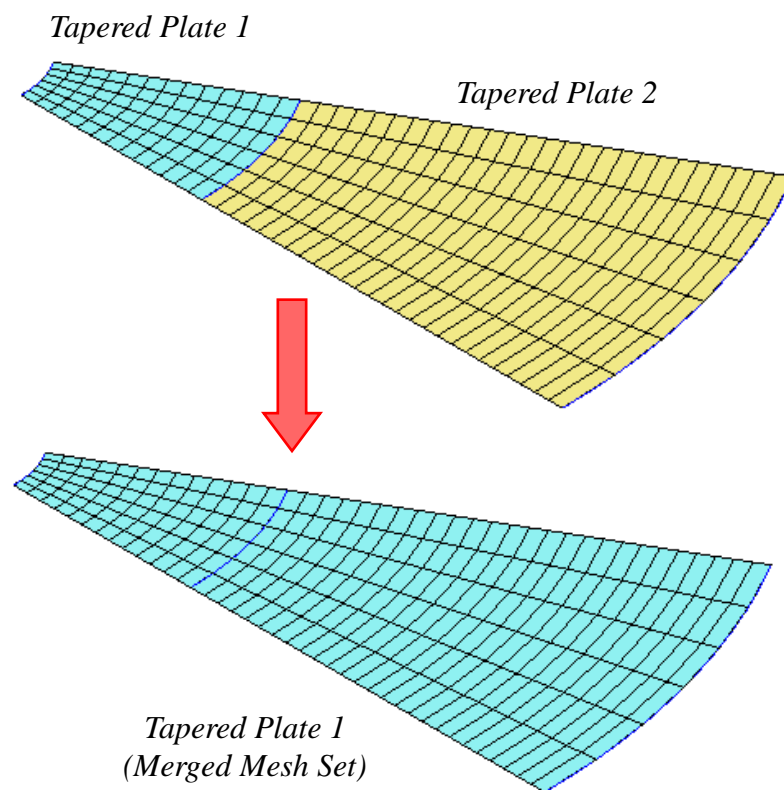
## Step 7.



1. Pre-Works Tree : Mesh...

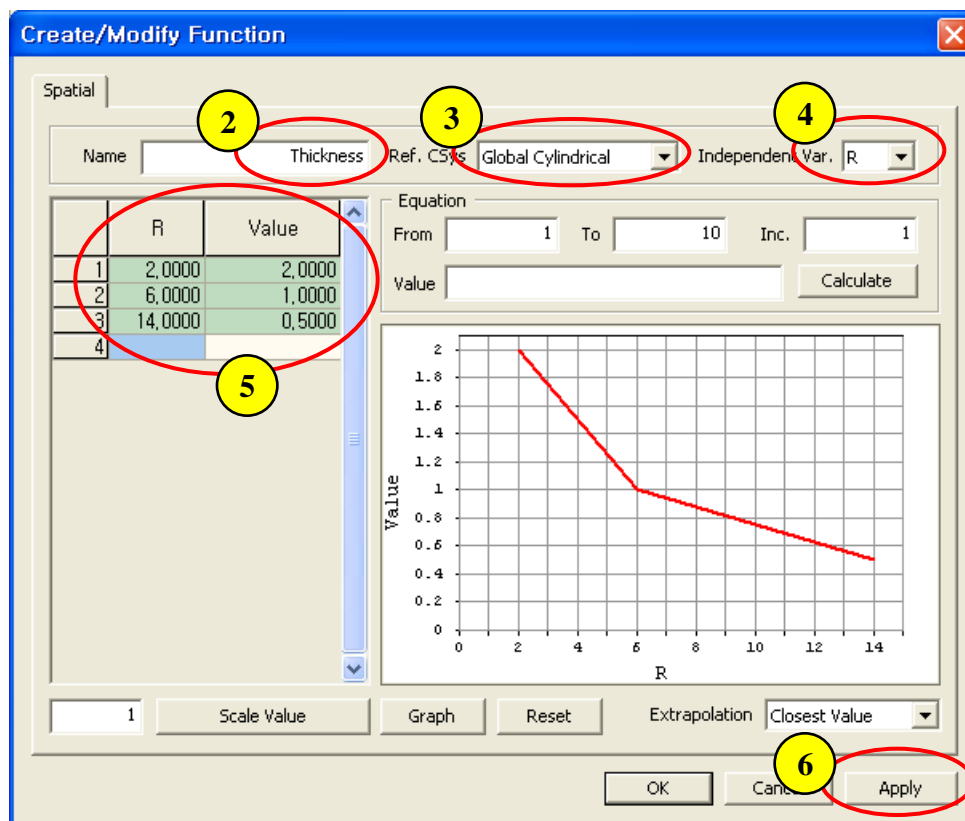
2. Drag & Drop "Tapered Plate 2" to "Tapered Plate 1"

3. Click [Yes] Button





## Step 8.



1. Analysis > General Function...

2. Name : Thickness

3. Ref. CSys : Global Cylindrical

4. Independent Var. : R

5. Enter (2, 2), (6, 1), (14, 0.5)

6. Click [Apply] Button

## Step 9.

**Create/Modify Function**

Spatial

Name: **Pressure** Ref. CSys: Global Cylindrical Independent Var.: R

	R	Value
1	2,0000	0,0000
2	3,0000	2,0000
3	4,0000	8,0000
4	5,0000	18,0000
5	6,0000	32,0000
6	7,0000	50,0000
7	8,0000	72,0000
8	9,0000	98,0000
9	10,0000	128,0000
10	11,0000	162,0000
11	12,0000	200,0000
12	13,0000	242,0000
13	14,0000	288,0000
14		

Equation

From: 2 To: 14 Inc.: 1

Value:  $2*(r-2)*(r-2)$  Calculate

Graph

Reset

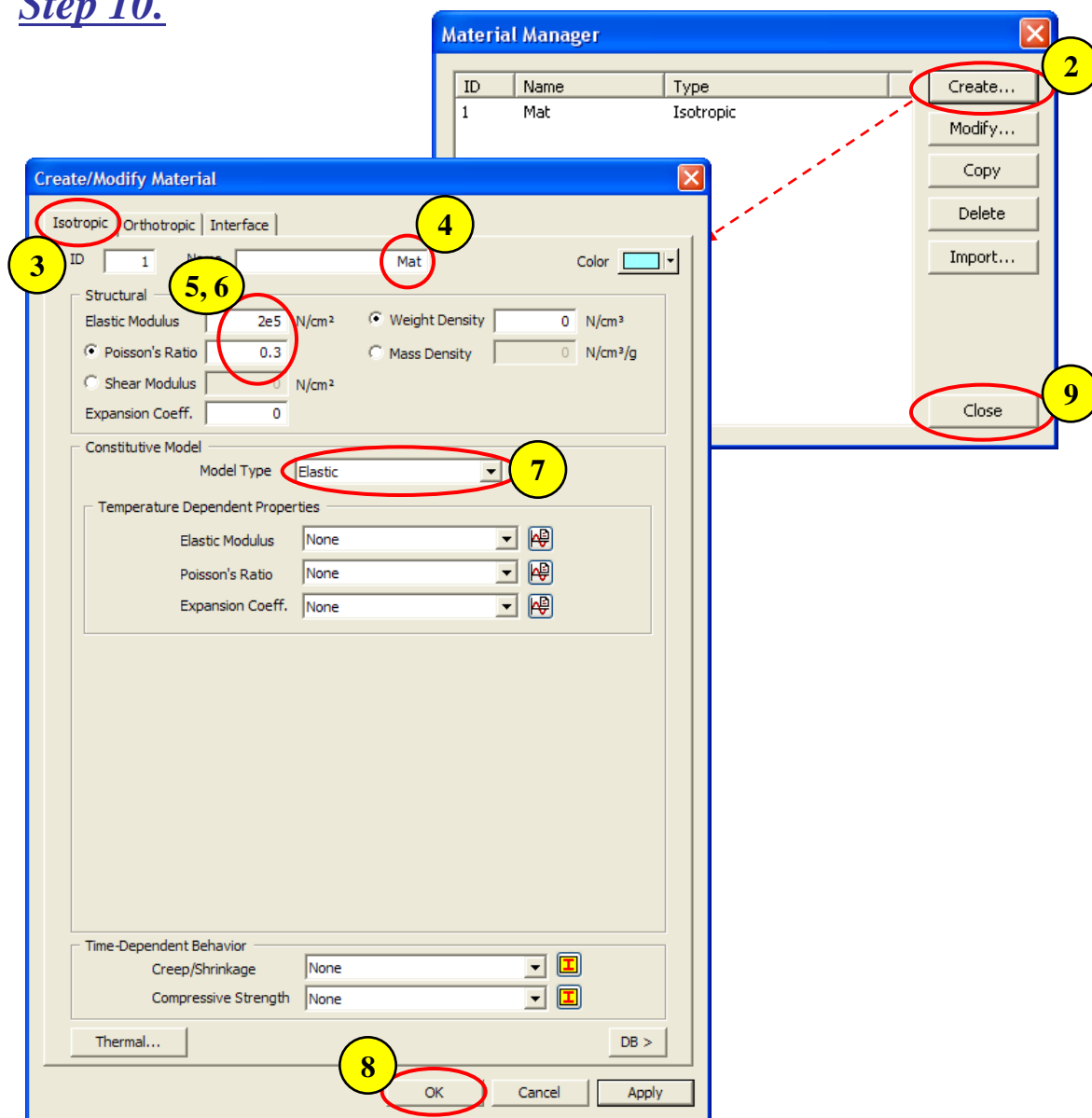
Extrapolation: Closest Value

Scale Value: 1

OK Cancel Apply

1. Name : Pressure
2. Ref. CSys : Global Cylindrical
3. Independent Var. : R
4. From : 2 , To : 14 , Inc. : 1  
Value :  $2*(r-2)*(r-2)$
5. Click [Calculate] Button
6. Click [OK] Button

## Step 10.



1. Analysis > Material ...

2. Click [Create] Button

3. Select "Isotropic" tab

4. ID : 1 , Name : Mat

5. Elastic Modulus : 2e5 N/cm²

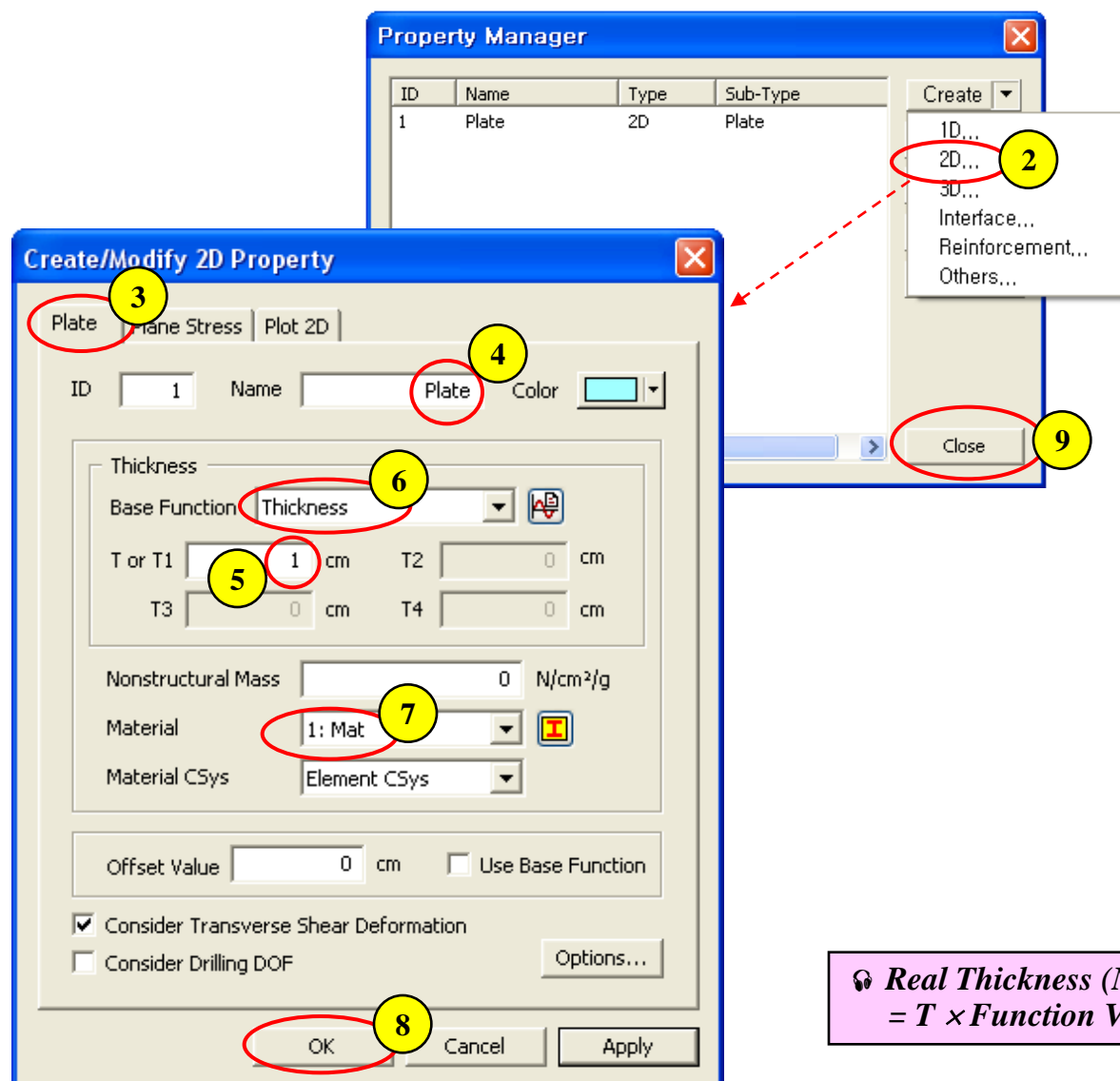
6. Poisson's Ratio : 0.3

7. Model Type : Elastic

8. Click [OK] Button

9. Click [Close] Button

## Step 11.



1. Analysis > Property ...

2. Create 2D...

3. Select "Plate" tab

4. ID : 1 , Name : Plate

5. T or T1 : 1

6. Base Function : Thickness

7. Material : 1: Mat

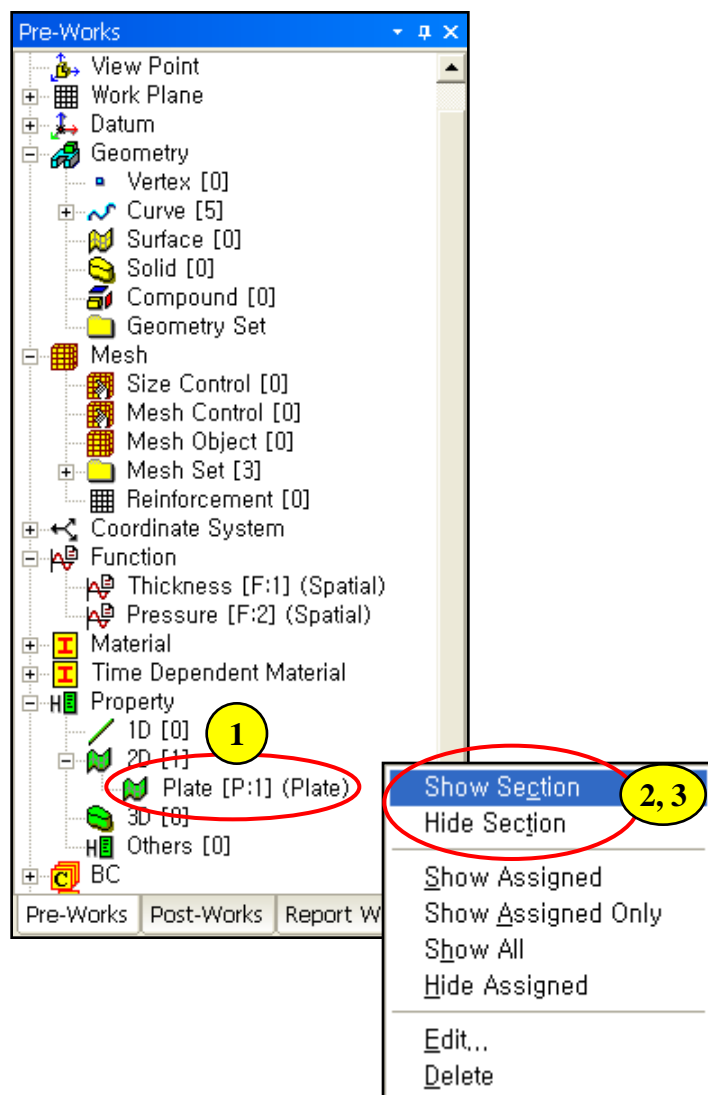
8. Click [OK] Button

9. Click [Close] Button

**Real Thickness (Nodal Thickness)**  

$$= T \times \text{Function Value Evaluated at Nodal Coordinate}$$

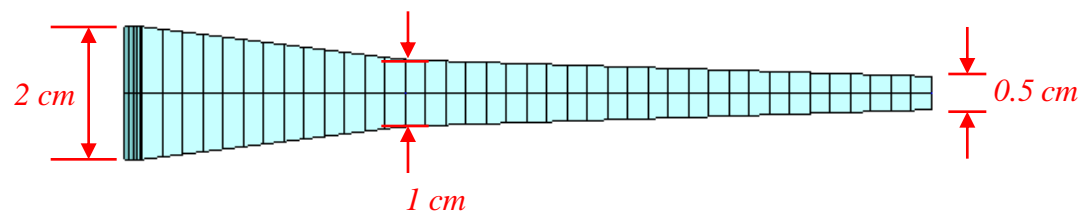
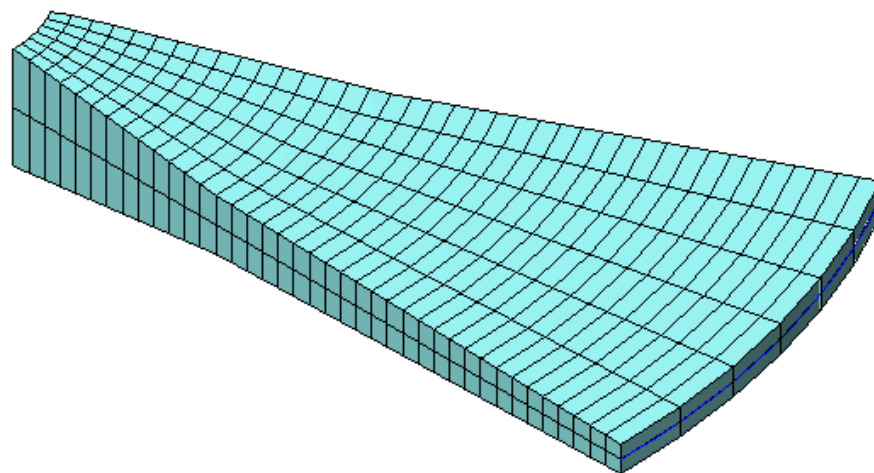
## Step 12.



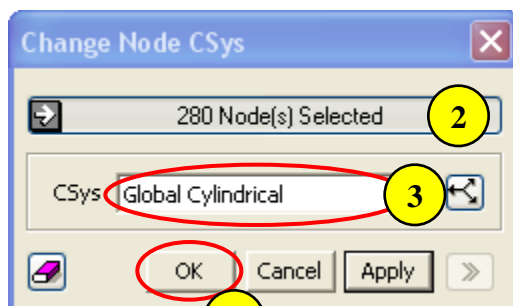
1. Pre-Works Tree : Property - 2D - Plate [P:1]

2. Click Right Mouse Button and Select "Show Section"

3. Select "Hide Section"



## Step 13.



1. Mesh > Node > Change CSys...

2. Select  "Displayed" 

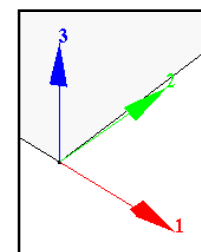
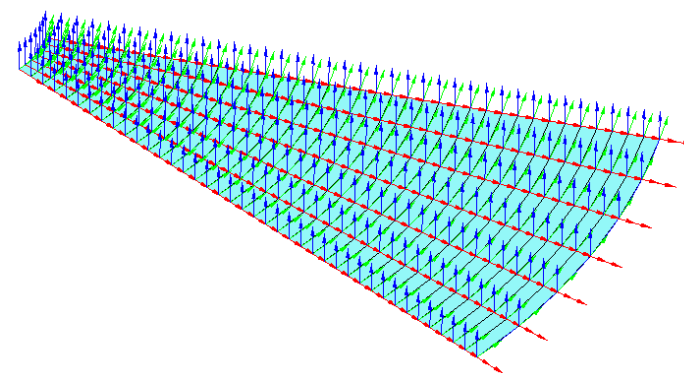
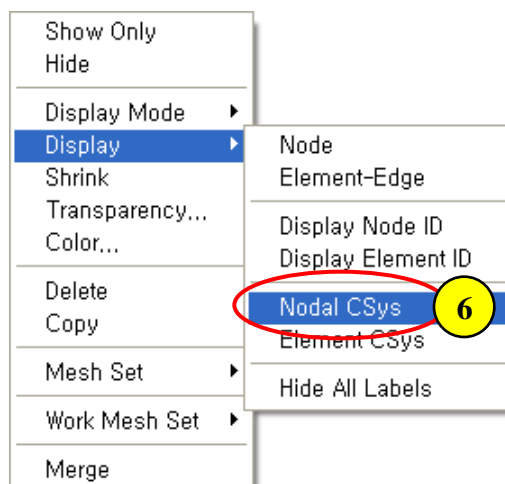
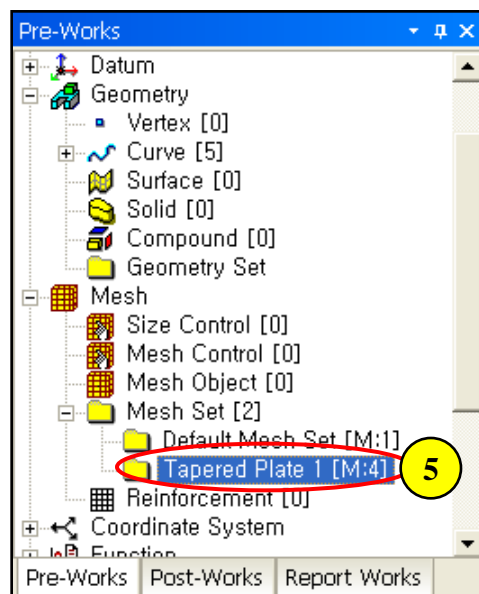
3. CSys : Global Cylindrical

4. Click [OK] Button


5. Pre-Works : Mesh - Mesh Set - Tapered Plate 1

6. Click Right Mouse Button and Select "Display > Nodal CSys"

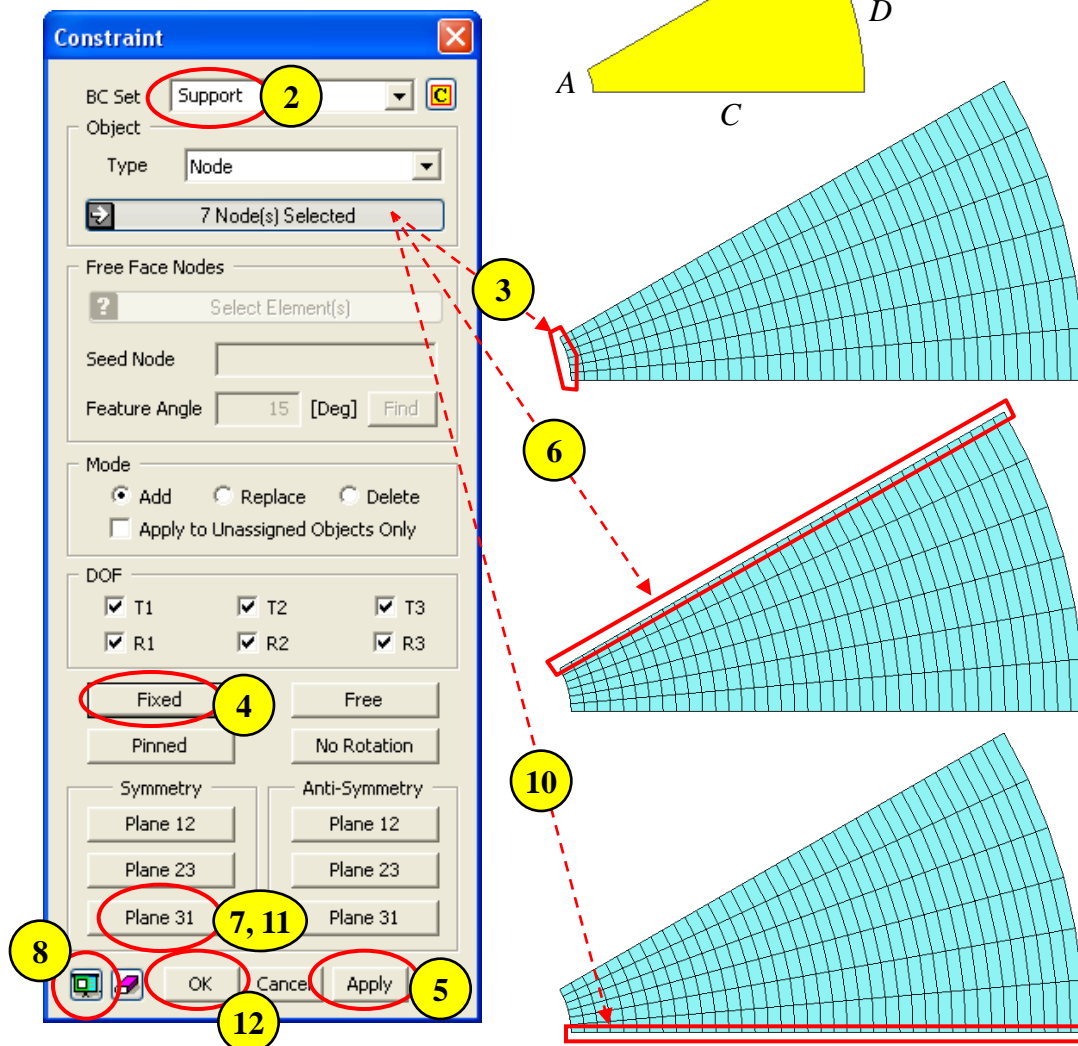
7. Repeat <6> to Hide Nodal CSys



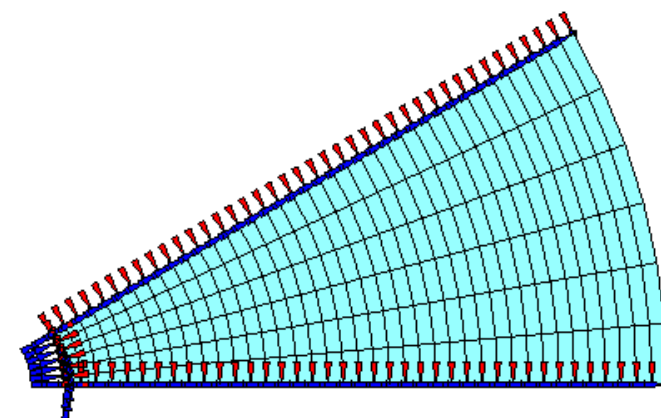
	Color	Rect. CSys	Cyln. CSys
1	R	X	R
2	G	Y	$\theta$
3	B	Z	T

 "Ctrl+A" as shortcut for "Select Displayed".

## Step 14.

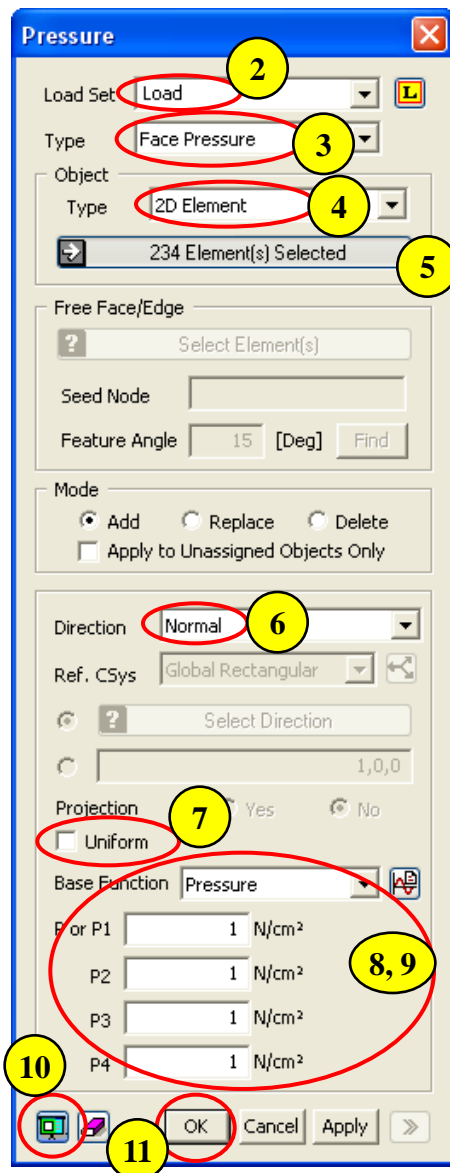


1. Analysis > BC > Constraint...
2. BC Set : Support
3. Select 7 Nodes (Side A) <sup>Ⓐ</sup>
4. Click [Fixed] Button
5. Click [Apply] Button
6. Select 40 Nodes (Side B)
7. Click "Symmetry" - [Plane 31] Button
8. Click "Preview" Button
9. Click [Apply] Button
10. Select 40 Nodes (Side C)
11. Click "Symmetry" - [Plane 31] Button
12. Click [OK] Button

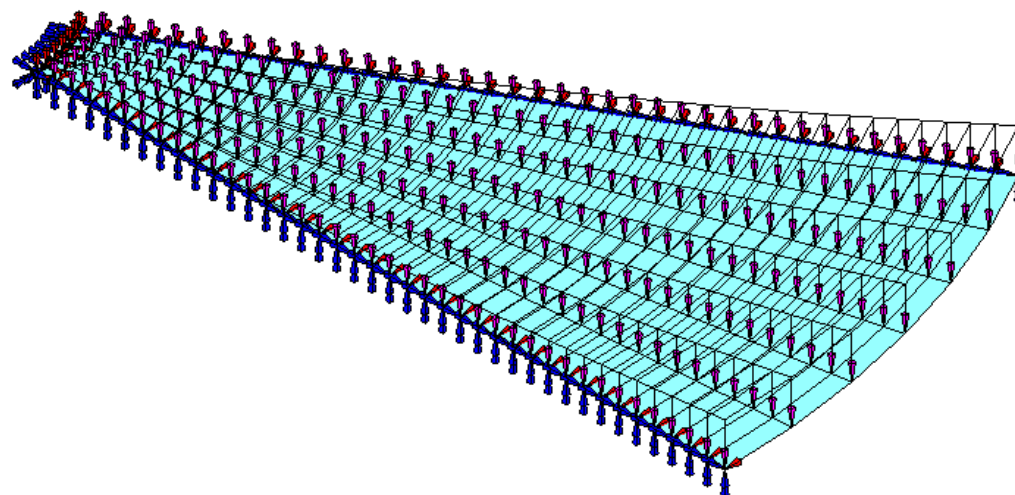


Use "Polygon" Selection.

## Step 15.

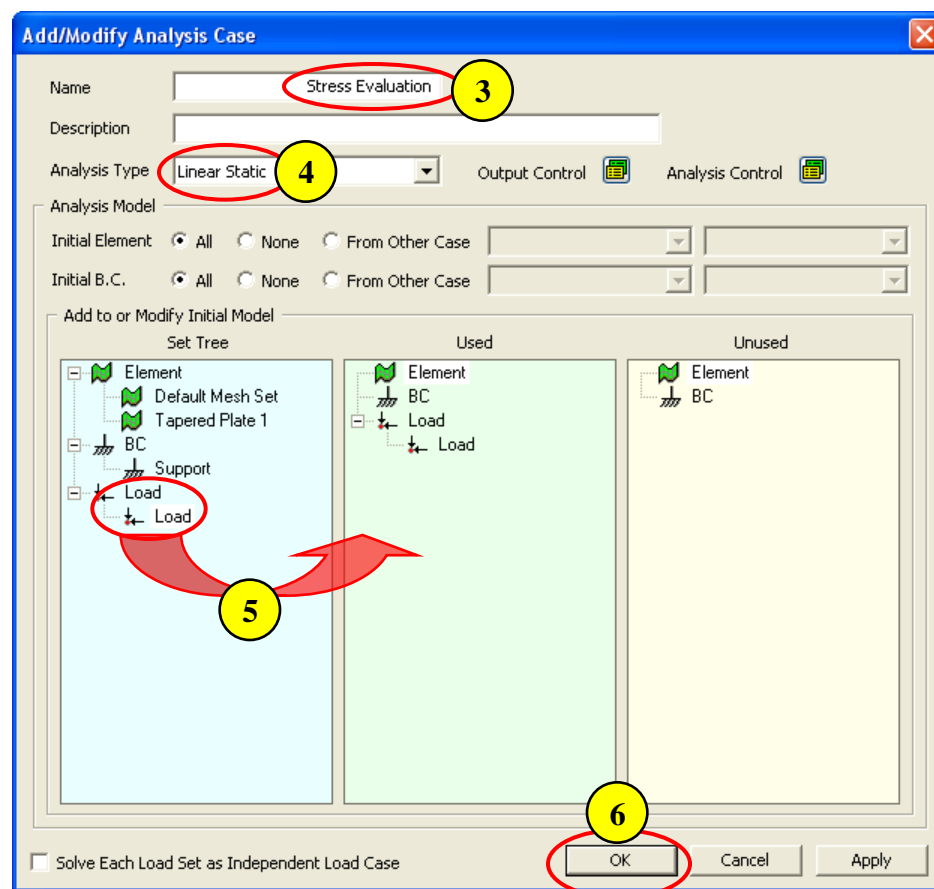
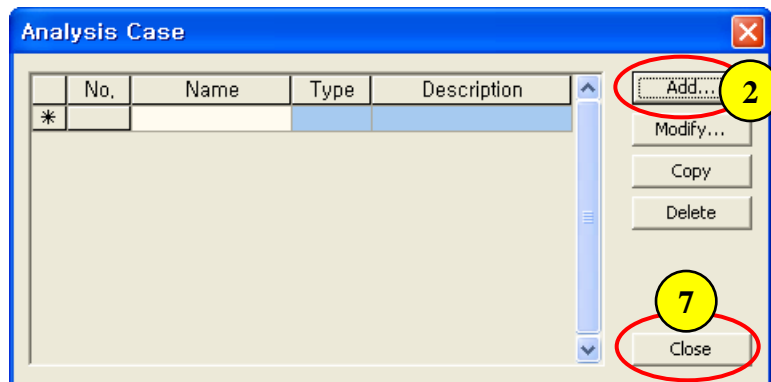


1. Analysis > Load > Pressure...
2. Load Set : Load
3. Type : Face Pressure
4. Object Type : 2D Element
5. Select "Displayed"
6. Direction : Normal
7. Check off "Uniform"
8. Base Function : Pressure
9. P1~P4 : 1
10. Click "Preview" Button
11. Click [OK] Button





## Step 16.



1. Analysis > Analysis Case ...

2. Click [Add] Button

3. Name : Stress Evaluation

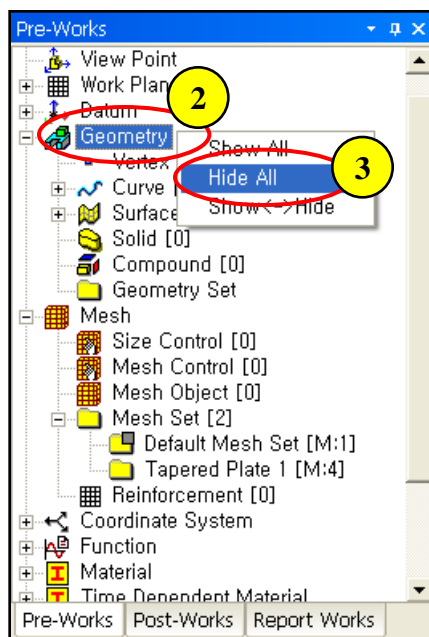
4. Analysis Type : Linear Static

5. Drag & Drop "Load" to "Used" Window

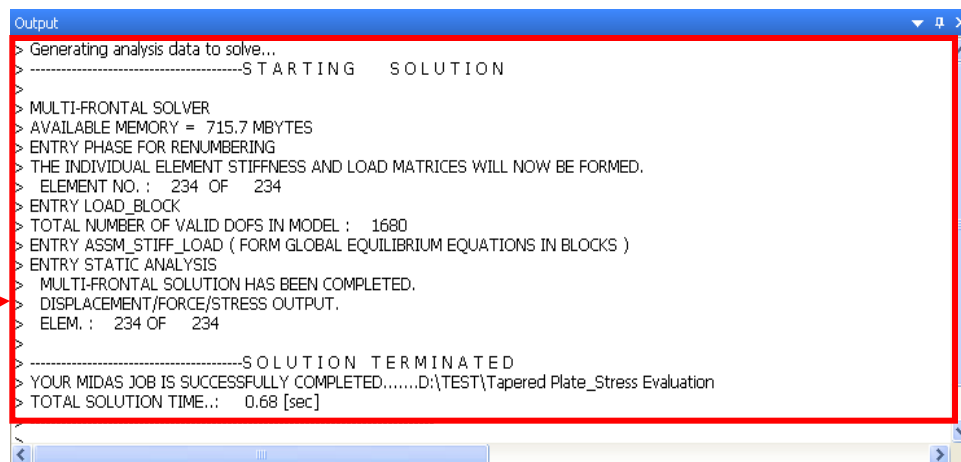
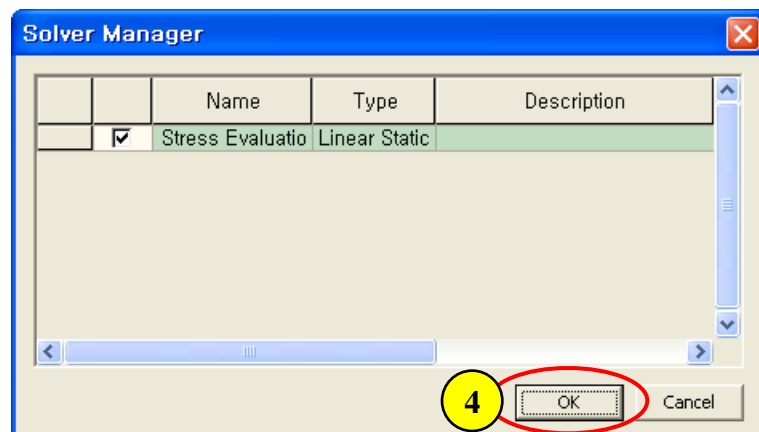
6. Click [OK] Button

7. Click [Close] Button

## Step 17.

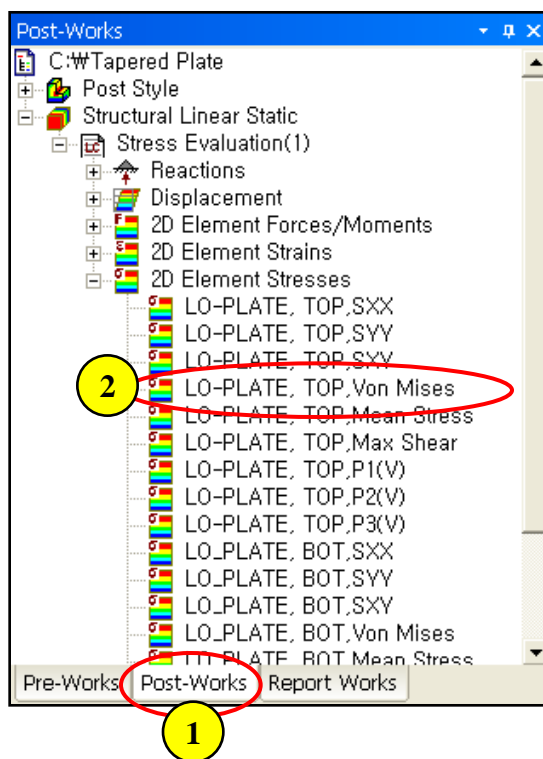


1. File > Save... (Tapered Plate.feb)
2. Pre-Works Tree : Geometry ...
3. Click Right Mouse Button and Select "Hide All"
4. Analysis > Solve ...
5. Click [OK] Button

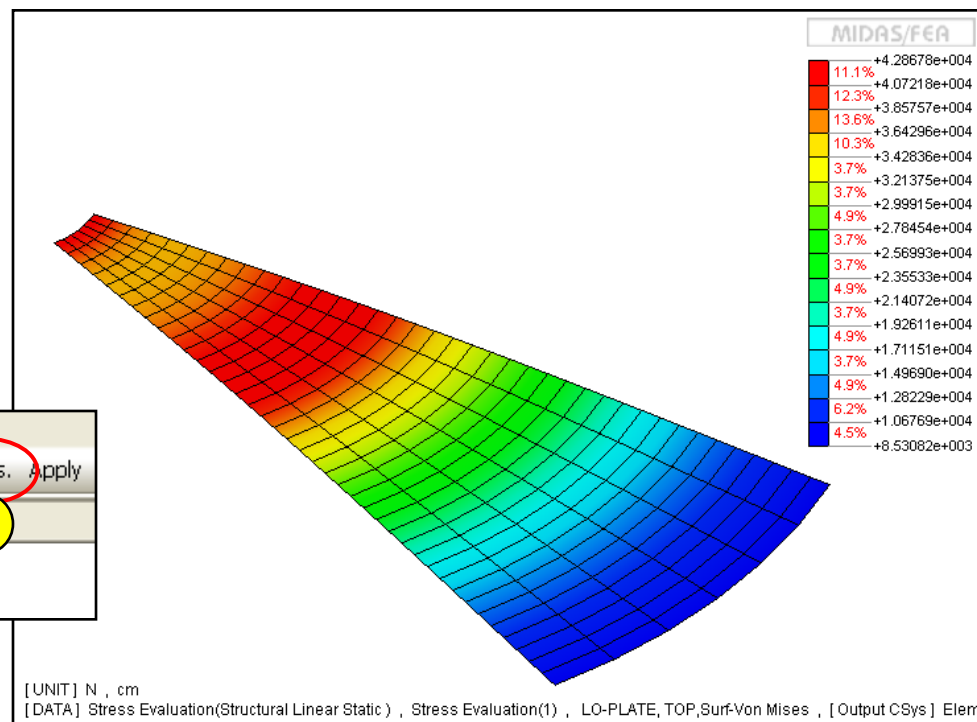
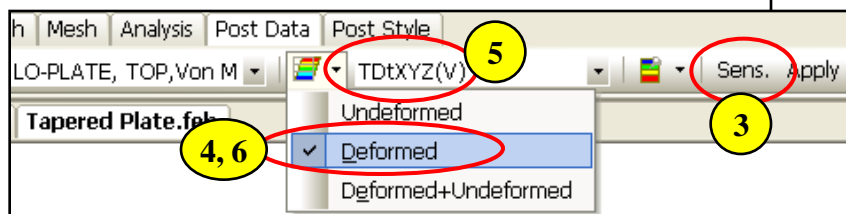


<Output Window> Analysis Procedure and Messages

## Step 18.

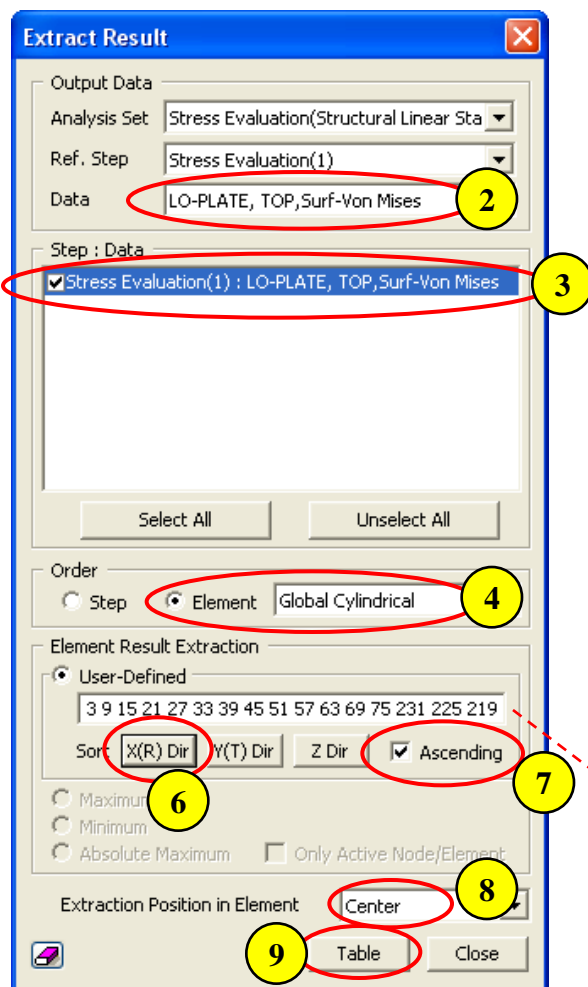


1. Post-Works Tree : Stress Evaluation (Structural Linear Static) > Stress Evaluation (1) > 2D Element Stresses
2. Double Click “LO-PLATE,TOP,Von Mises”
3. Click “Sens.” Button
4. Select “Deformed” for Mesh Shape at “Post Data” Toolbar
5. Select “TDtXYZ(V)” for Deformation Data
6. Select “Undeformed” for Mesh Shape at “Post Data” Toolbar

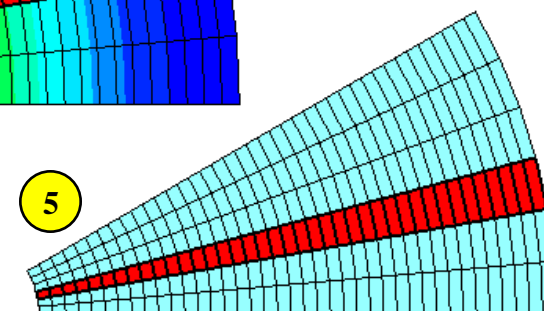
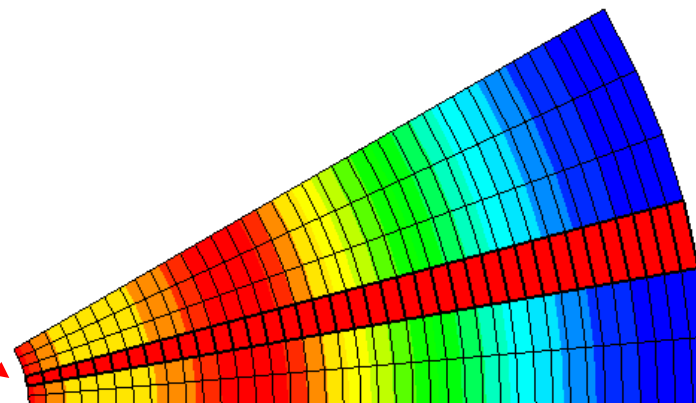


“Sensitive Update” Button

## Step 19.



1. Post > Extract Result...
2. Data : LO-PLATE, TOP, Surf-Von Mises
3. Check on "Stress Evaluation(1):LO-PLATE,BOT, Surf-Von Mises" at "Step : Data"
4. Order : Element – Global Cylindrical
5. Select 39 Elements (Red Colored Elements in Figure) ⑤
6. Click [X Dir] Button ⑥
7. Check on "Ascending"
8. Extraction Position in Element : Center
9. Click [Table] Button



⑥ Use "Polyline" Selection.  
⑥ "R Direction" in Cylindrical CSys

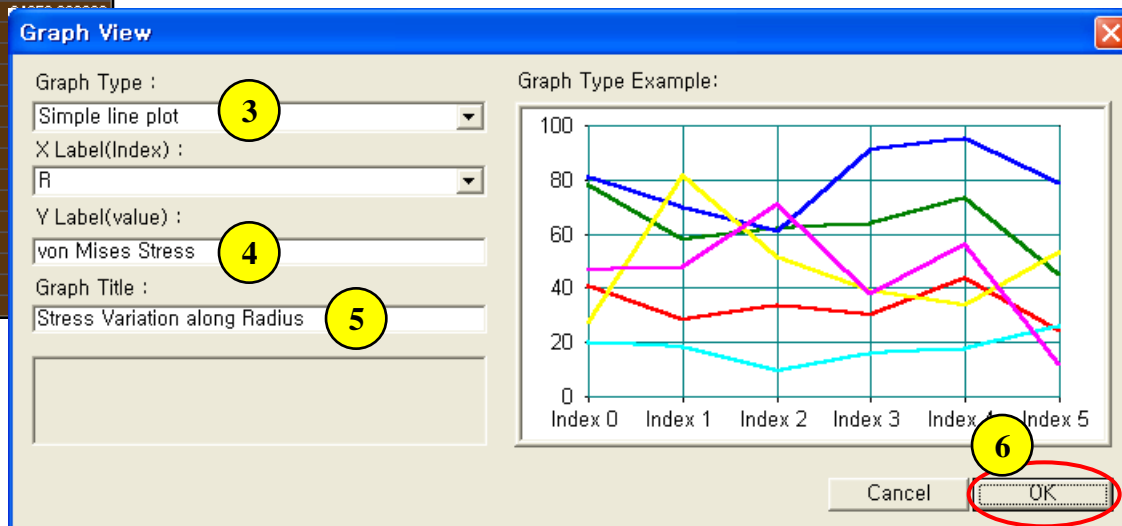
## Step 20.

No	Element	R	T	Z	Stress Evaluation(1)
1	3	2,151795	12,500000	0,000000	40020,800000
2	9	2,459196	12,500000	0,000000	37243,000000
3	15	2,766595	12,500000	0,000000	35886,700000
4	21	3,073995	12,500000	0,000000	35301,600000
5	27	3,381394	12,500000	0,000000	35177,000000
6	33	3,688793	12,500000	0,000000	35362,100000
7	39	3,996193	12,500000	0,000000	35785,900000
8	45	4,303592	12,500000	0,000000	36420,400000
9	51	4,610992	12,500000	0,000000	37263,500000
10	57	4,918391	12,500000	0,000000	38331,500000
11	63	5,225791	12,500000	0,000000	39656,600000
12	69	5,533190	12,500000	0,000000	41287,900000
13	75	5,840590	12,500000	0,000000	43295,900000
14	231	6,147989	12,500000	0,000000	43422,900000
15	225	6,455389	12,500000	0,000000	41344,500000
16	219	6,762788	12,500000	0,000000	39394,400000
17	213	7,070187	12,500000	0,000000	37537,600000
18	207	7,377587	12,500000	0,000000	35748,300000
19	201	7,684986	12,500000	0,000000	34007,500000
20	195	7,992386	12,500000	0,000000	32301,200000
21	189	8,299785	12,500000	0,000000	30619,600000
22	183	8,607185	12,500000	0,000000	28956,300000
23	177	8,914584	12,500000	0,000000	27307,500000
24	171	9,221984	12,500000	0,000000	25672,300000
25	165	9,529383	12,500000	0,000000	24156,300000
26	159	9,836783	12,500000	0,000000	22640,300000
27	153	10,144182	12,500000	0,000000	21124,300000
28	147	10,451582	12,500000	0,000000	19608,300000
29	141	10,758981	12,500000	0,000000	18092,300000
30	135	11,066381	12,500000	0,000000	16576,300000
31	129	11,373780	12,500000	0,000000	15060,300000
32	123	11,681180	12,500000	0,000000	13544,300000
33	117	11,988579	12,500000	0,000000	12028,300000
34	111	12,295979	12,500000	0,000000	10512,300000
35	105	12,603378	12,500000	0,000000	8996,300000
36	99	12,910777	12,500000	0,000000	7480,300000
37	93	13,218176	12,500000	0,000000	5964,300000
38	87	13,525576	12,500000	0,000000	4448,300000
39	81	13,832975	12,500000	0,000000	2932,300000

Copy Ctrl+C  
Find... Ctrl+F  
Sorting...  
Style...  
Graph...

1. Click Two Column Headers "R" and "Stress Evaluation(1)"
2. Click Right Mouse Button and Select "Graph"
3. Graph Type : Simple Line Plot
4. Y Label(value): von Mises Stress
5. Graph Title : Stress Variation along Radius
6. Click [OK] Button

MS-Excel Compatible table



## Step 21.



1. Draw Interesting Area by Dragging Mouse (Black Box in table)
2. Click Mouse Right Button and Select “Zoom Out All”
3. Close Graph and table by Clicking [X] Button
4. Close “Extract Result” Dialog by Clicking [Close] Button
5. Click “Initial Post Style” at “Post Style” Toolbar

