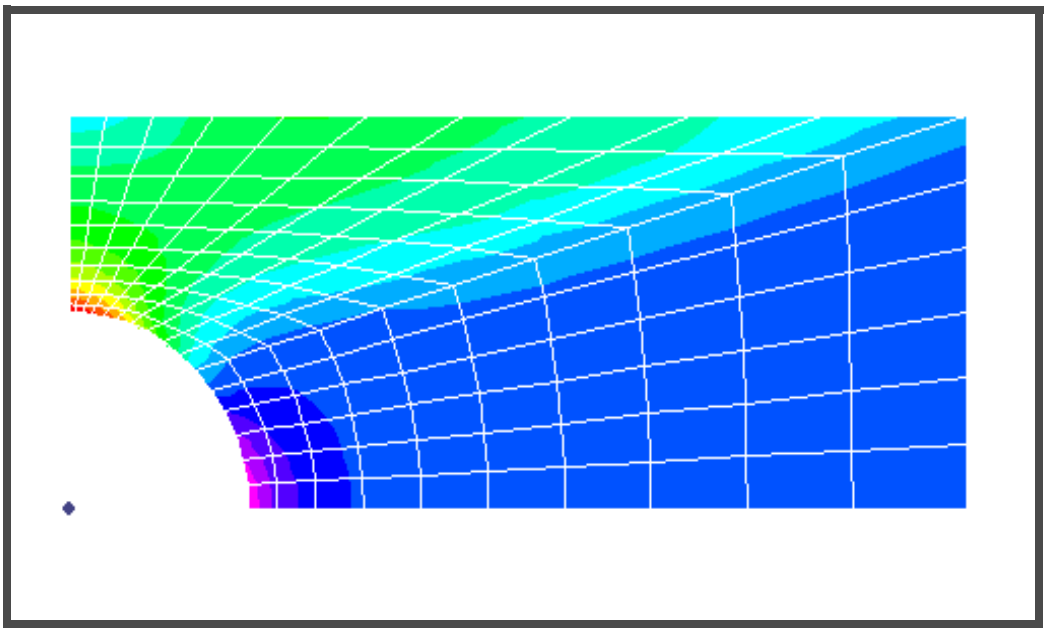
WORKSHOP 29

Advanced Results Post-Processing - Tension Coupon



Objectives:

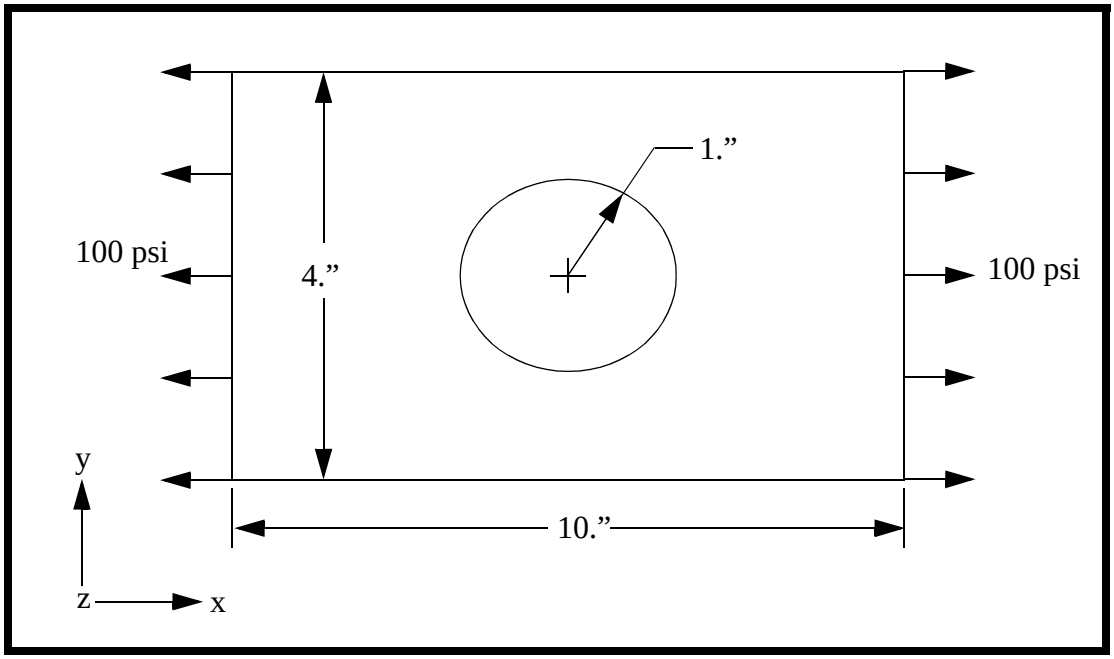
- Review and analyze the output file.
- Rerun an analysis to include element corner stresses.
- Review and analyze the output file of the new analysis.
- Compare results.

Model Description:

The following exercise is a continuation of Workshop 14, Static Analysis of a Tension Coupon.

This exercise will show the users how to view the N4W output file (.f06). We will also explain how N4W interprets the results in this output file and displays them graphically. The users can also choose how the results are post-processed.

Figure 29.1 - Load Conditions



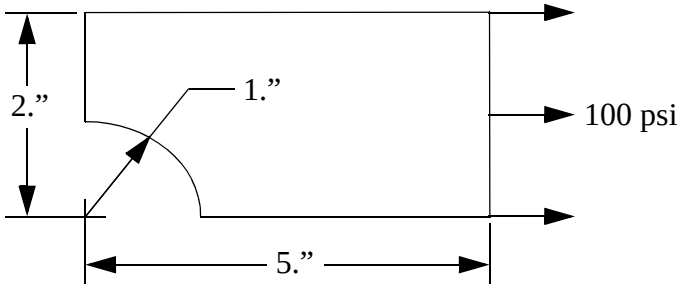
- Thickness =0.125 in.
- E = 30, 000, 000 psi
- ν = 0.3

Answer (*Theory of Elasticity,* Timoshenko & Goodier, 3rd edition, page 95):

The answer given is the maximum at two points on the plate (Where?).

- $\frac{P}{A} \text{Þ} K_f = 100.(4.3)$
- σ_{xx} **= 430 psi**

Because of symmetry, the model simplifies into the model below.



Exercise Procedure:

1. Start up MSC.Nastran for Windows V4.0 and open **tension.mod**.

   Double click on the icon labeled **MSC.Nastran for Windows V4.0.**

   On the *Open Model File* form, navigate to the directory with **tension.mod.**

   Open Model File: **tension.MOD**

   Before we get started:

   There are several options to consider when post processing results. For this workshop, we are going to investigate exactly how N4W creates contour plots, and we are going to compare these plots to the results shown in the .f06 file.

   MSC/Nastran uses the .f06 file to report the elements stresses in the element coordinate system. The values are given for the centroidal stress as well as the 4 nodal stresses for each quad element in the model. The following page shows the section of the F06 file for element 10 which connects GRIDs 10, 11, 22 and 21. It would be difficult if not impossible to search through the F06 file to find the max stress in a model, and that is why we use N4W to visualize these results by color coding the nodes.

   To create a contour plot, N4W needs only one result value at each node in the model. N4W then assigns different colors (16 colors total) to the different nodes in the model that exhibit these result values. The value assigned to each node is determined by the user, and we are going to explore these options now.

S T R E S S E S I N Q U A D R I L A T E R A L E L E M E N T S (Q U A D 4) OPTI

ELEMENT ID	GRID-ID	FIBRE DISTANCE	STRESSES IN ELEMENT COORD SYSTEM NORMAL-X	NORMAL-Y	SHEAR-XY	PRINCIPAL STRESSES (ZERO SHEAR) ANGLE	MAJOR	MINOR	
10	CEN/4	-6.250000E-02	4.043371E+02	9.168494E+00	-1.519871E+01	-2.1993	4.049208E+02	8.584793E+00	4
		6.250000E-02	4.043371E+02	9.168494E+00	-1.519871E+01	-2.1993	4.049208E+02	8.584793E+00	4
	10	-6.250000E-02	4.330060E+02	1.732091E+01	-1.519871E+01	-2.0912	4.335609E+02	1.676594E+01	
		6.250000E-02	4.330060E+02	1.732091E+01	-1.519871E+01	-2.0912	4.335609E+02	1.676594E+01	
	11	-6.250000E-02	4.313164E+02	1.768254E+01	-1.519871E+01	-2.1015	4.318741E+02	1.712483E+01	
		6.250000E-02	4.313164E+02	1.768254E+01	-1.519871E+01	-2.1015	4.318741E+02	1.712483E+01	
	22	-6.250000E-02	3.774866E+02	1.484461E+00	-1.519871E+01	-2.3110	3.780999E+02	8.711013E-01	
		6.250000E-02	3.774866E+02	1.484461E+00	-1.519871E+01	-2.3110	3.780999E+02	8.711013E-01	
	21	-6.250000E-02	3.790166E+02	1.228204E+00	-1.519871E+01	-2.3001	3.796271E+02	6.177343E-01	
		6.250000E-02	3.790166E+02	1.228204E+00	-1.519871E+01	-2.3001	3.796271E+02	6.177343E-01	

2. Create contour plots of centroidal values averaged at nodes.

   In this contour plot, we will use the centroidal value for each element, and we will assign this value to the four nodes of the elements. When an element shares a node with another element, then the nodal value will be averaged.

   View/Select... **<F5>**

   Contour Style: ● **Contour**

   Deformed and Contour Data...

   Output Set: **1..MSC/NASTRAN Case 1**

   Output Vectors/Contour: **7020..Plate Top X Normal Stress**

   Contour Options...

   Data Conversion: ● **Average**

   ☐ **Use Corner Data**

   OK

   OK

   OK

   Zoom in to the corner where the maximum stress occurs with the Zoom toolbar button.

    **Zoom**

   Turn off all geometry and then turn on the element and node labels.

   View/Options... **<F6>**

   Quick Options...

   All Entities Off

   ☒ **Node**

   ☒ **Elements**

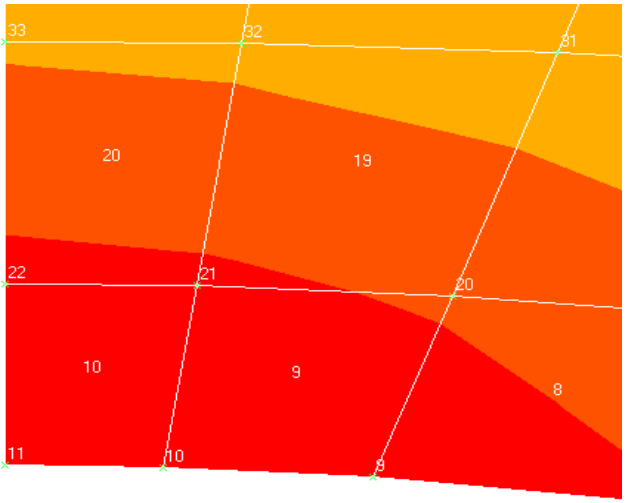
   Labels On

   Done

OK

Your display should look something similar to this.

Figure 29.2 - Stress Concentration location



At the lower right corner of your N4W window, change the entity select from **Off** to **Element**.

Now you can pick the desire elements and obtain information of the nodal stress.

3. Compare the results to your .f06 file.

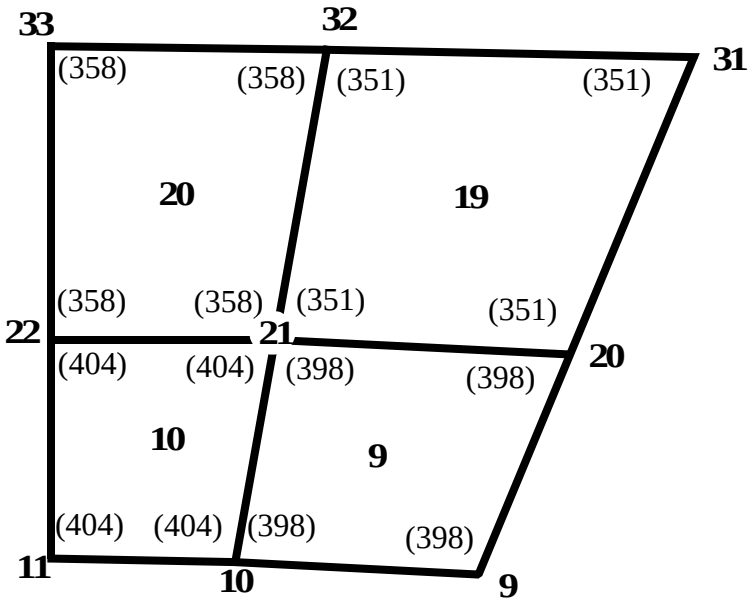
   Notice that in the pop up window for element 10 the Plate Top X Normal Stress = 404.3371 is exactly the same value in the .f06 file for CEN/4 Normal-X.

   Also notice that the nodal results in the pop up window for the individual nodes are averaged with the adjacent elements' centroidal values.

4. Analyze the average nodal stresses.

   From the .f06 file, you will find that the Stresses in the Element Coordinate System for the Normal-X direction is approximately **404** for **element 10**. N4W will assign this value to the four nodes of element 10: Node 10, 11, 21, and 22. This also applies to element 9, 19, and 20 along with their respective nodes. The figure below shows all the nodal stress values assigned by N4W.

Figure 29.3 - Nodal Stresses (not using corner data)



From the above figure, you will see that both node 10 and 22 have two nodal stress values assigned to them while node 21 has four. Since we have set up N4W to not use corner data, element 10 assigned a value of 404 to node 22, while element 20 assigned 358 to node 22. Therefore, the average stresses at node 22 will be the average of the two values.

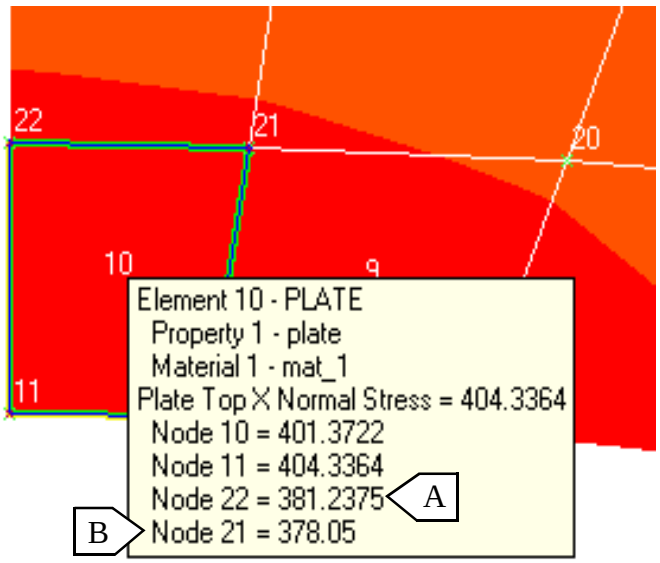
σ_{xx} = (358 + 404) / 2 = <u>381 (at node 22).</u> Refer to Figure 29.4 Arrow A to verify this answer.

This calculation also applies for other nodes. Another example would be node 21.

σ_{xx} = (358 + 404 + 398 + 351) / 4 = <u>378 (at node 21)</u>. Refer to Figure 27.4 Arrow B to verify this answer.

Drag your cursor over to element 10 and outline it. Detailed information of element 10 will appear. The nodal stresses should match our calculation. Your display should be similar to the following:

Figure 29.4 - Average Nodal Stresses for element 10 (not using corner data



5. Create contour plot of maximum centroidal value at nodes.

   There are actually two places where we can change the averaging. First, we will show you how to set the max value as we did in the previous step.

   View/Select... <F5>

   Contour Style: ● **Contour**

   Deformed and Contour Data...

   Output Set: **1..MSC.Nastran Case 1**

   Output Vectors/Contour: **7020..Plate Top X Normal Stress**

   Contour Options...

   Data Conversion: ● **Max Value**

   ☐ **Use Corner Data**

   OK

   OK

   OK

A user can also change the averaging in the View/Options form.

View/Options... <F6>

Category:	● **PostProcessing**
Options:	**Contour/Criteria Style**
Data Conversion:	**3..Max Value, Skip Corner**

OK

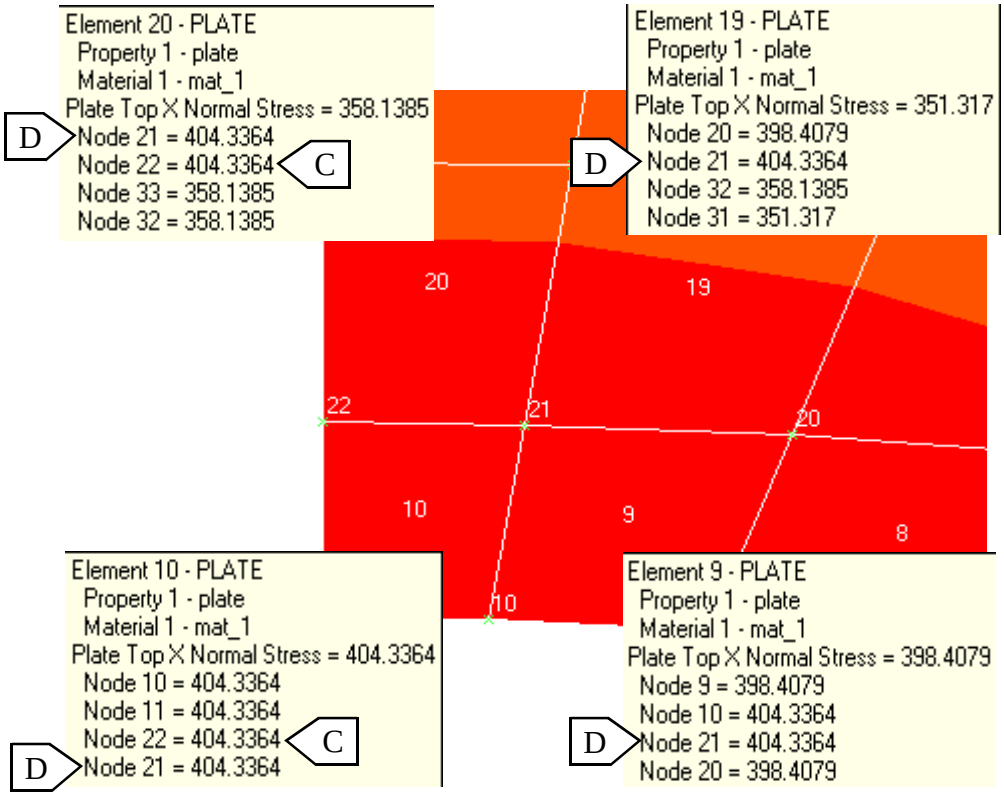
Now, instead of averaging the values assigned to a node, N4W will select the maximum value assigned to a particular node.

For Example, element 10 assigned a value of 404 to node 22, while element 20 assigned 358 to node 22. Since 404 is the greater of the two, N4W assigns this value to node 22. Refer to **Arrow C** in Figure 29.5.

Another example is node 21, which has four values assigned by four elements. Again, the greatest value will be assigned to the node. In this case, among 398, 404, 351, and 358, N4W chose 404 assigned by element 10. Refer to **Arrow D** in Figure 29.5.

Drag your cursor and outline element 9, 10, 19, or 20, you will get an information box similar to the following diagram:

Figure 29.5 - Maximum Nodal Stresses (not using corner data)



6. Create contour plot of average calculated nodal values.

   If you would like to visualize the MSC.Nastran calculated corner values (nodal values) in N4W, follow these steps.

   The nodal values are more conservative, but they are not necessarily more accurate. The nodal values are calculated in MSC.Nastran using the element shape functions, and if you have elements with bad aspect ratios or bad skew angles, the nodal results could potentially be overly conservative.

   Switch the Data Conversion to Average, and this time do not use Skip Corner. Average alone will automatically use the nodal data from MSC.Nastran.

   View/Options... <F6>

   Options: **Contour/Criteria Style**

   Data Conversion: **0..Average**

   OK

   To view the X Normal Stress Fringe Plot, select the following:

   View/Select... <F5>

   Contour Style: ● **Contour**

   Deformed and Contour Data...

   Output Set: **2..MSC.Nastran Case 1**

   Output Vectors/Contour: **7020..Plate Top X Normal Stress**

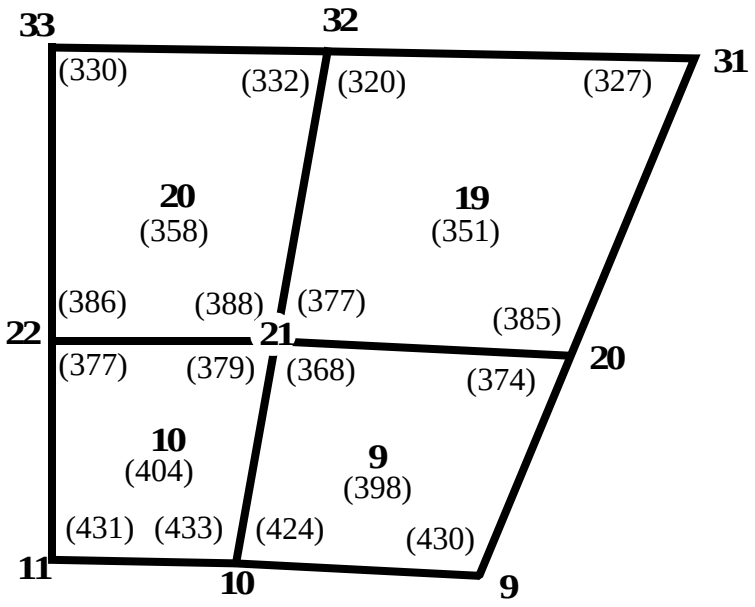
   OK

   OK

   Refer back to the .f06, and compare these results with the N4W display in the next few steps.

   From the .f06 file, you will find that the Stresses in the Element Coordinate System for the Normal-X direction is still approximately **404** for **element 10**. However, this is the centroidal value. Below the CEN/4 values you will see four other sets of numbers each corresponding to the four nodes of element 10. These nodal stress values are extrapolated from the centroidal value according to the shape function of the element. The figure below shows all the nodal stress values assigned by N4W.

Figure 27.5 - Extrapolated Nodal Stresses (using corner data)



The nodal stress calculation, with averaging.

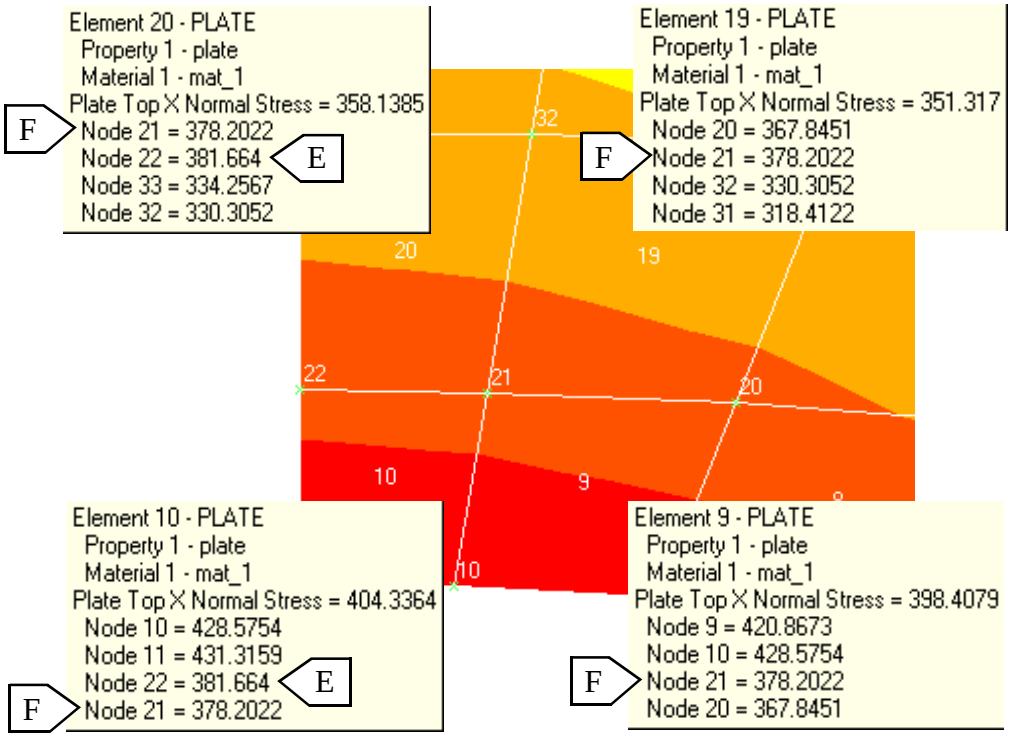
σ_{xx} **= (386 + 377) / 2 =** **<u>381.5 (at node 22)</u>.** Refer to Figure 29.6 Arrow E to verify this answer.

This calculation also applies for other nodes. Another example would be node 21.

σ_{xx} **= (388 + 379 + 368 + 377) / 4 =** **<u>378 (at node 21)</u>**. Refer to Figure 27.6 Arrow F to verify this answer.7

Move the cursor and outline element 9, 10, 19, or 20 to check the nodal stresses. Your Average Nodal Stresses should be as follow:

Figure 29.6 - Extrapolated Average Nodal Stresses (using corner data)



7. Create contour plot of maximum calculated nodal values.

Again, we may want to visualize the max stress at a particular node. This would be the most conservative number available.

View/Options... <F6>

Options: **Contour/Criteria Style**

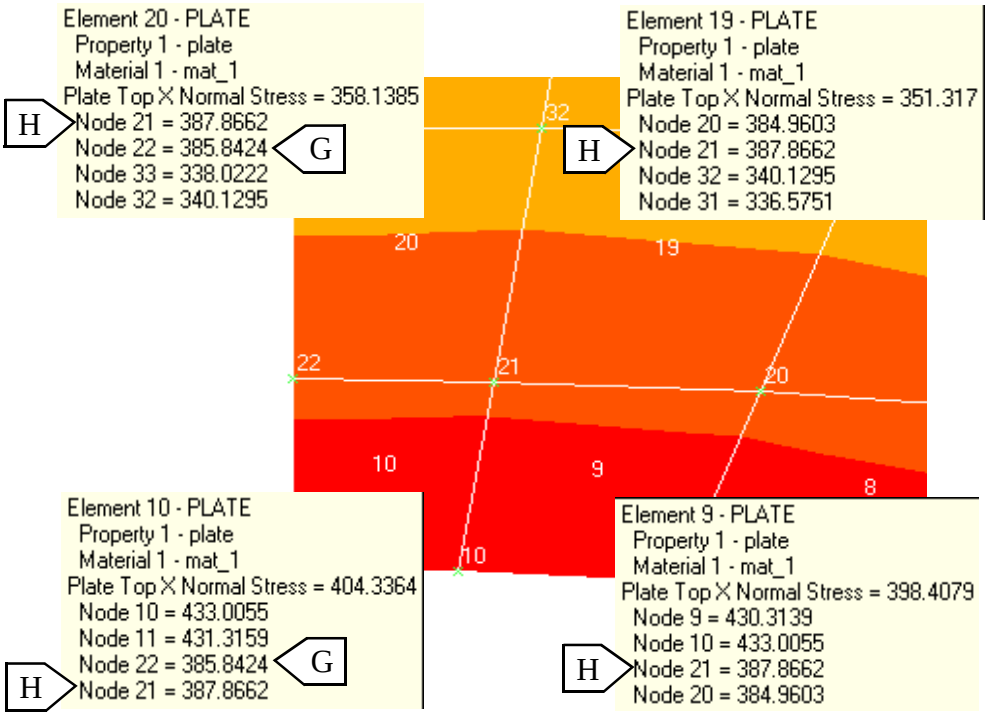
Data Conversion: **1..Maximum Value**

OK

For Example, element 10 calculated a value of 377 at node 22, while element 20 calculated 386 at node 22. Since 386 is the greater of the two, N4W assigns this value to node 22. Refer to **Arrow G** in Figure 29.7.

Another example is node 21 which has four calculated values from the four attached elements. Again, the greatest value will be assigned to the node. In this case, among 368, 379, 377, and 388, N4W selected 388 calculated by element 20. Refer to **Arrow H** in Figure 29.7.

Figure 29.7 - Extrapolated Maximum Nodal Stresses



The maximum values calculated in the previous steps could also be considered for the minimum value. This would be important if you were displaying compressive stresses which will have negative values. Instead of choosing the max option when changing the Data Conversion, use the min option.

In summary, there are 4 options when generating contour plots.

Contour Plot Format	Value Assigned to Node
Average Centroidal	Average of all calculated elements' centroidal values
Max/Min Centroidal	Max/Min of all calculated elements' centroidal values
Average Nodal	Average of all calculated elements' nodal values
Max/Min Nodal	Max/Min of all calculated elements' nodal values

Note: Max/Min Nodal will give the most conservative values.

This concludes the exercise.

File/Save

File/Exit