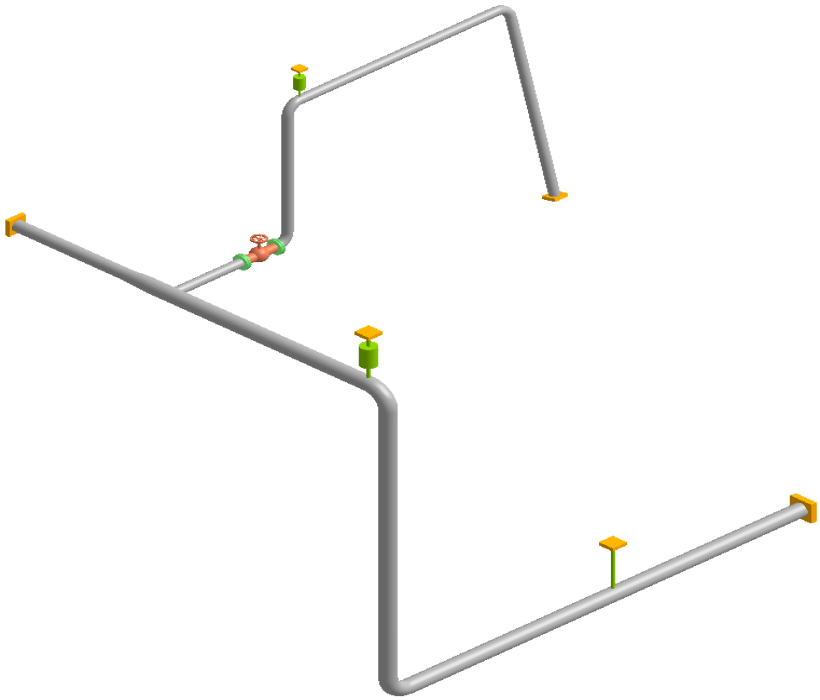
CAEPIPE™

Tutorial for Modeling and Results Review

Problem 2



SST SYSTEMS, INC.

The ***FASTEST*** Solutions for Piping Design and Analysis

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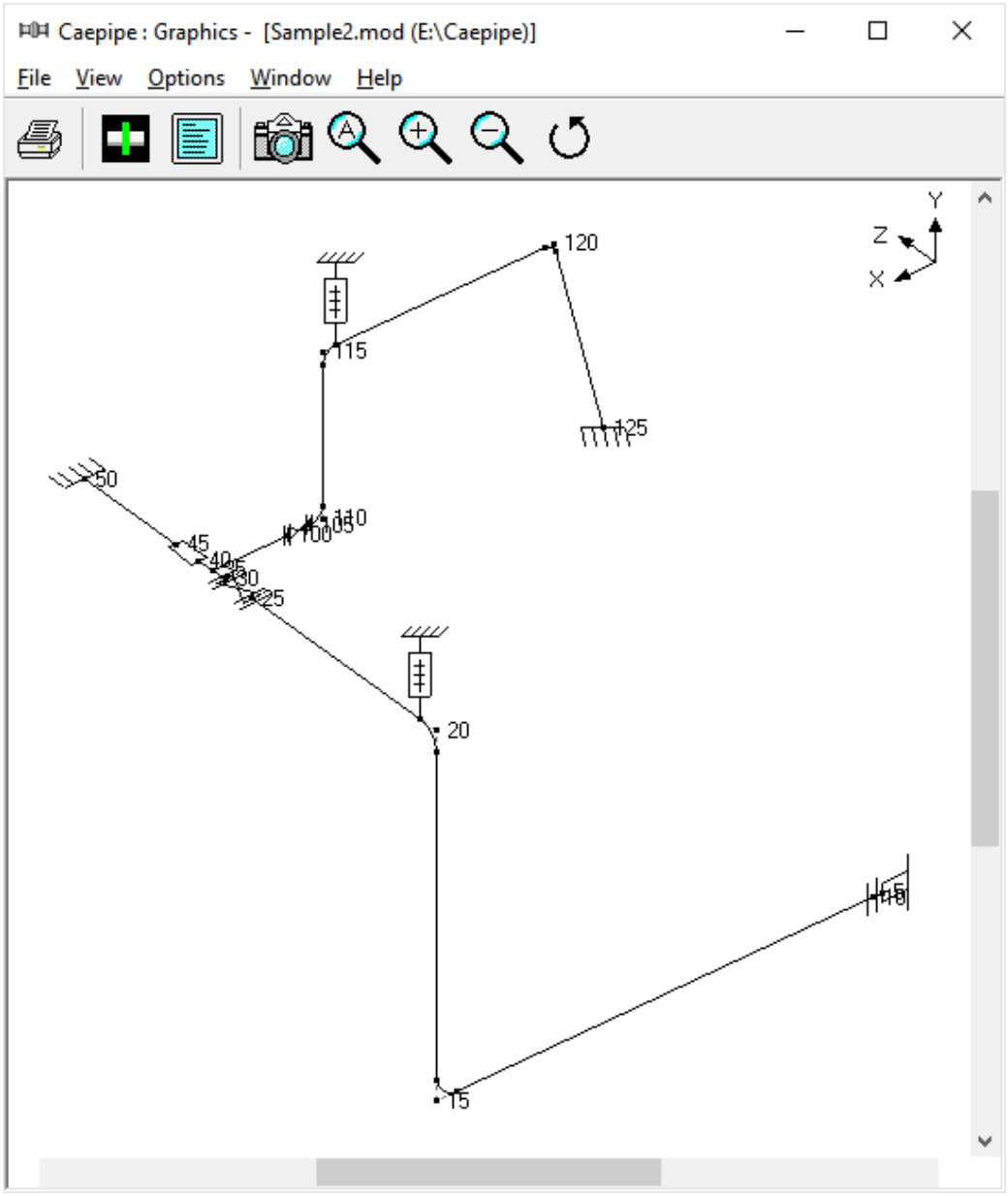
Modeling and Results Review – Problem 2

Let us model a slightly more advanced piping system now that you have familiarized yourself with the basic use of CAEPIPE via Tutorial 1. The details of the model (in SI units) are shown below:



You will learn how to:

1. Enter Title
2. Select Analysis options (piping code etc.)
3. Define Material, Section and Loads for the model
4. Input Model Layout (different loads for different segments)
5. Select Load Cases for Analysis
6. Analyze
7. View Results

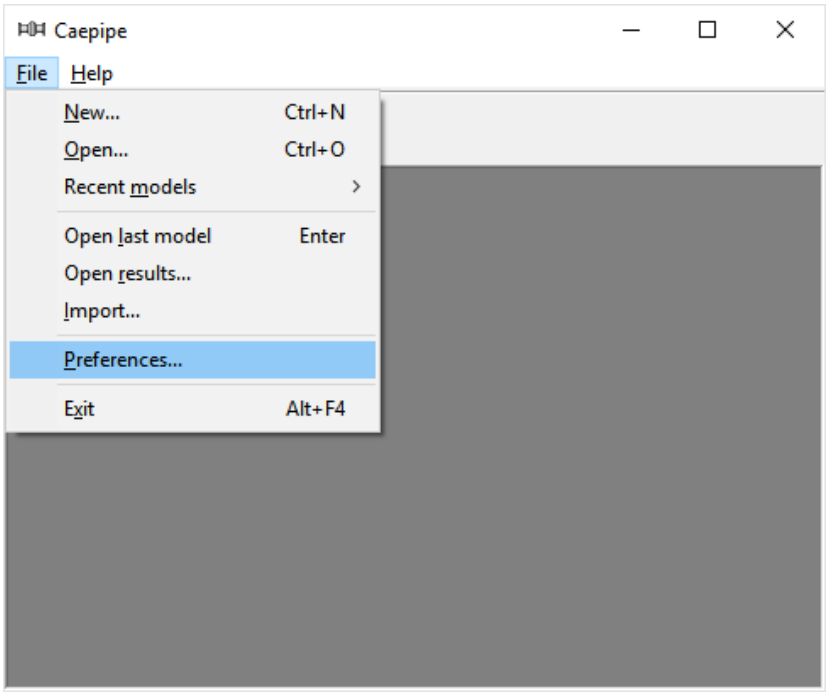
Modeling and Results Review – Problem 2

Model Description

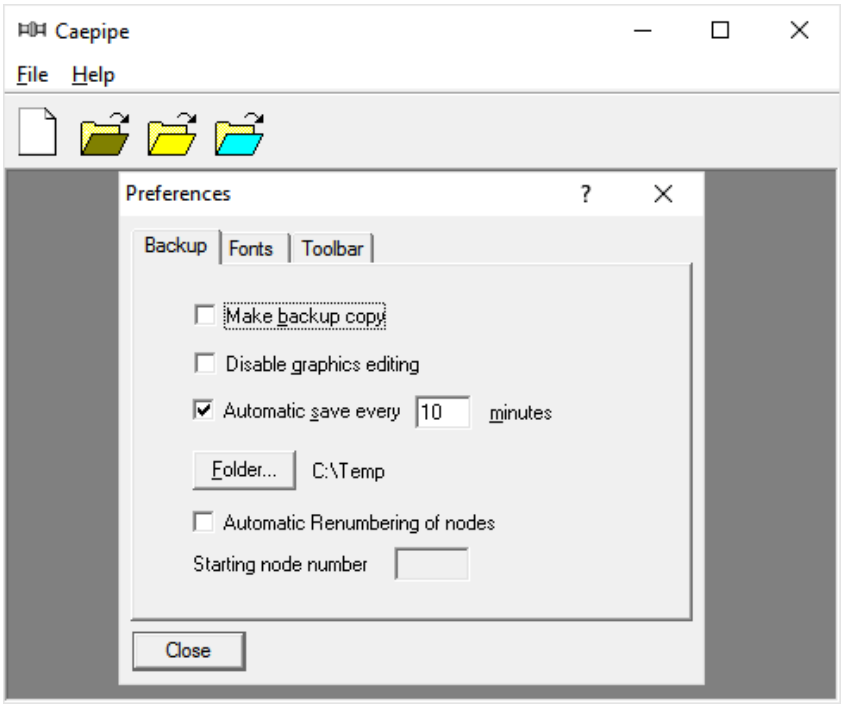
Details of the Layout, Material, Sections, Loads and Connection details are summarized for reference:

1. **Axes Chosen:** Global X = East, Global Y = Up and Global Z = South
2. **Piping Code:** ASME B31.1 (2014)
3. **Section Properties:**
    a. Main Line: 10" Schedule STD
    b. Branch Line: 6" Schedule STD
4. **Insulation throughout the Piping system**:
    a. **Density**: 176.2 kg/m3
    b. **Thickness**: 65 mm
5. **Material**: A 312 TP 316
6. **Temperature**:
    a. For Main Line and Branch Line up to Valve End Node 105: 185 Deg. C
    b. For Branch Line after Valve Node 105: 260 Deg. C
7. **Pressure**:
    a. For Main Line and Branch Line up to Valve End Node 105: 10 bar
    b. For Branch Line after Valve Node 105: 32 bar
8. **Operating Fluid and Specific Gravity**: Steam, 0.1
9. **Connection Details**:
    a. Node 5 connecting to Nozzle of a Cylindrical Vessel
    b. Node 55 connecting to Nozzle of a API 610 Horizontal Pump
10. **Wind Velocity**: 100 km/hr
11. **Static Seismic g's**: X=0.3, Y=0.2 and Z=0.3

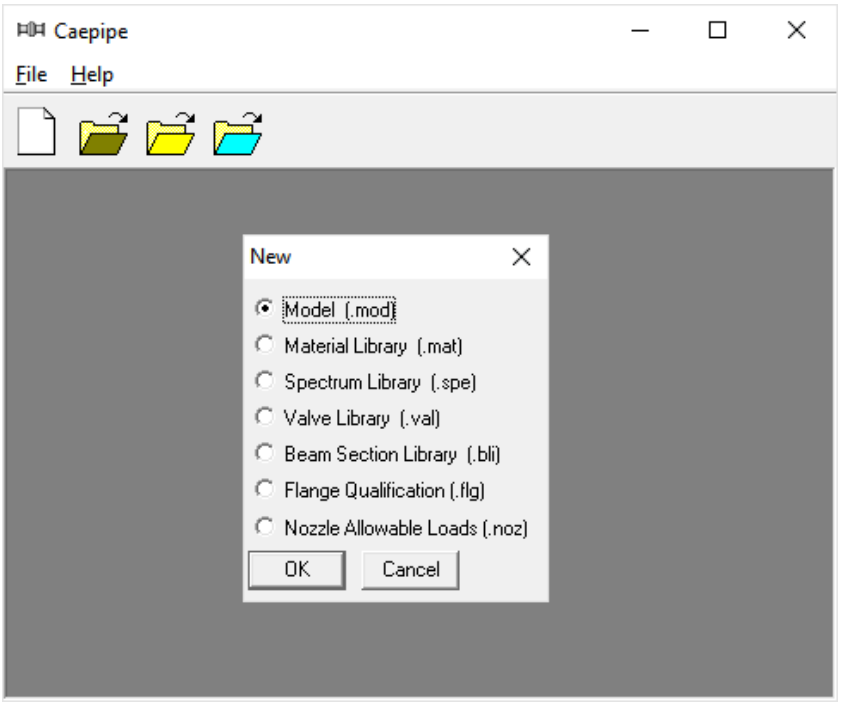
Start CAEPIPE. From the File pull down menu select Preferences.



Make sure that the Automatic save feature is enabled and the Automatic Renumbering of nodes feature is disabled.

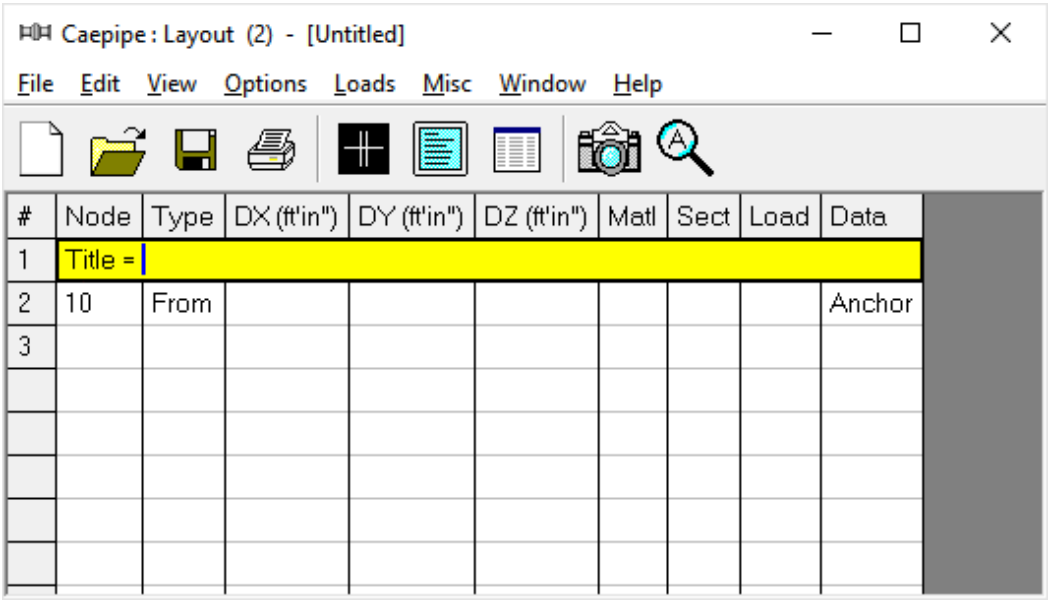


Start CAEPIPE. Then click on the New file button.

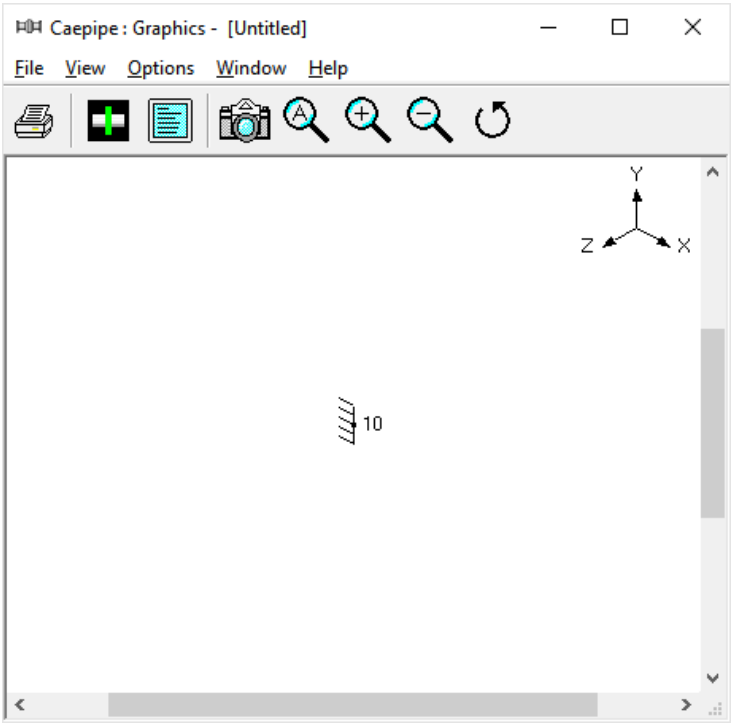


From the New file dialog, select the type of the new file as Model (.mod) file. This opens two independent windows: Layout and Graphics.

Layout window



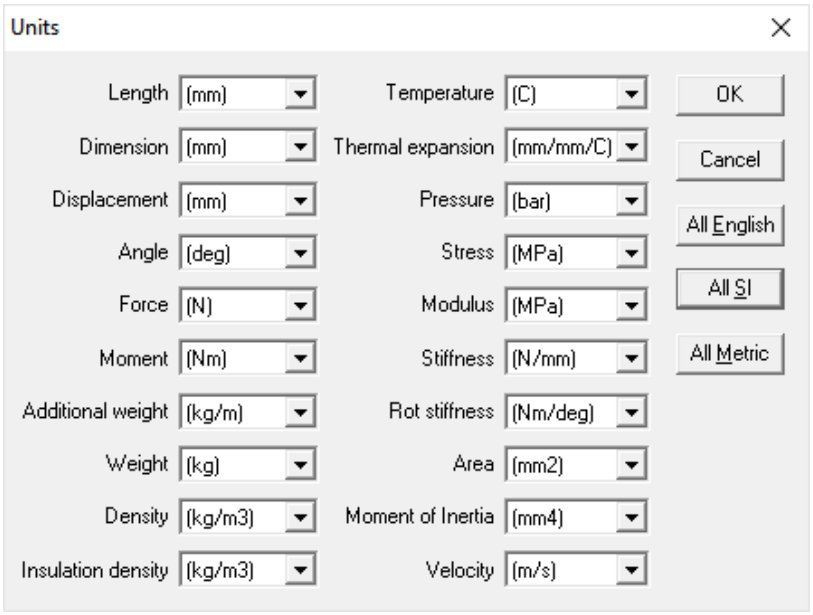
Graphics window



Adjust the size of the windows to fit your desktop such that you can view both comfortably at the same time.

Change Units

As this is an SI/Metric model, change the units appropriately. From the layout window, click on Options menu > Units (alternately, press the hotkey Ctrl+U). Click on "All SI" button followed by OK. The layout window will show the offsets (DX/DY/DZ) in mm units.

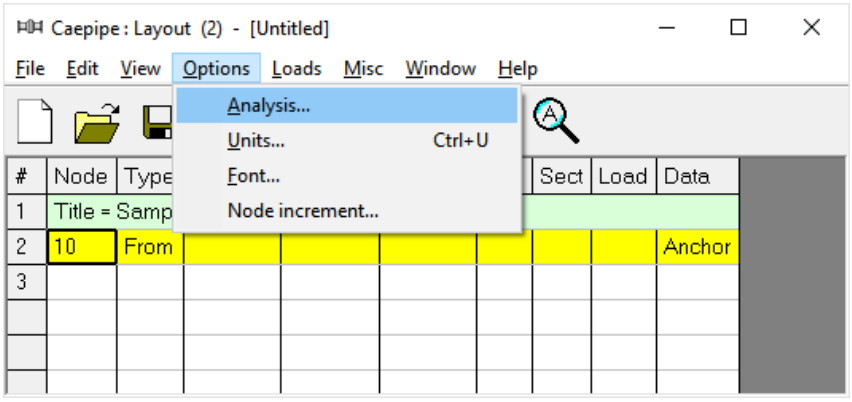


1. Enter Title

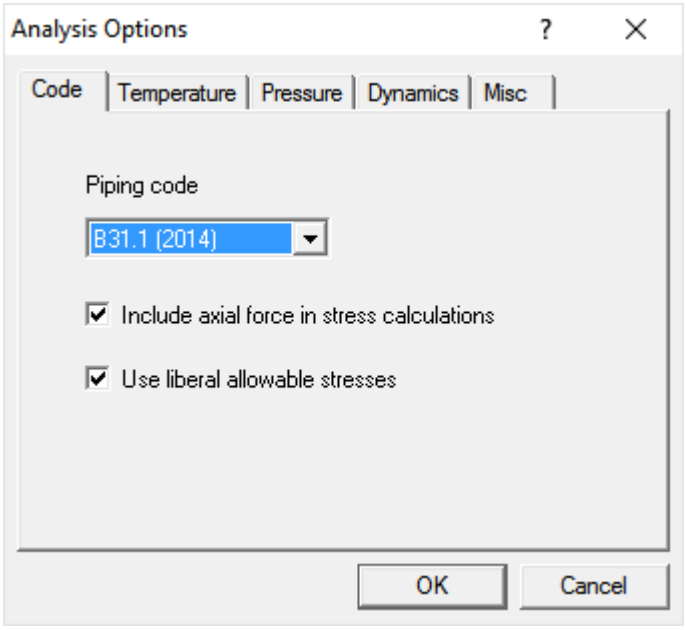
Type "Sample Problem 2" as the title in the first row that contains "Title = ". Press Enter.

2. Select Analysis options (piping code etc.)

Click on the Options menu and then select Analysis (Options > Analysis) to specify options for analysis.



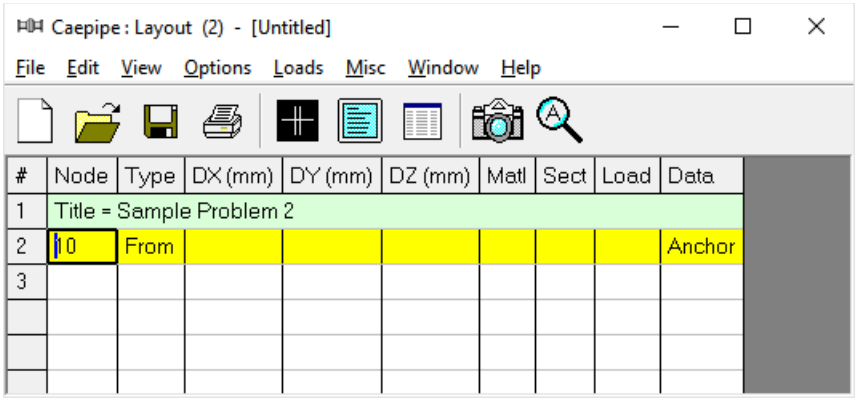
This opens the Analysis Options dialog.



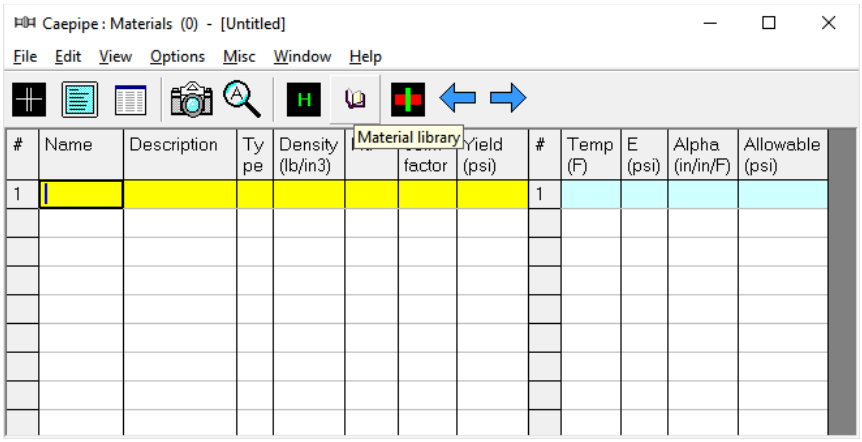
On the Code property page, select B31.1 (2014) for Piping code. Turn ON the options "Include axial force in stress calculations" as well as "Use liberal allowable stresses". Then click on OK to close Analysis Options dialog.

3. Define Material, Sections and Load

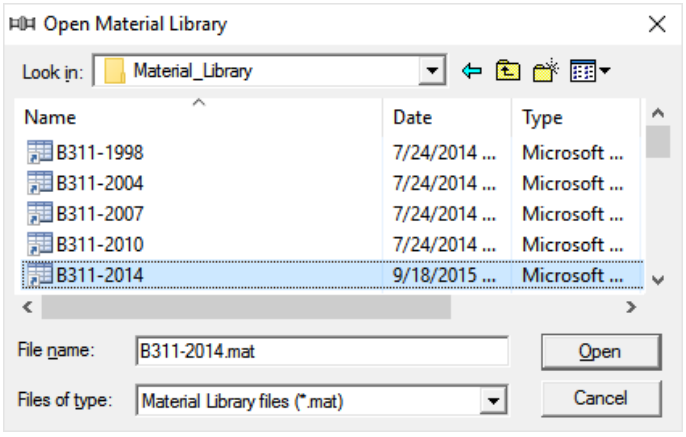
Click on "Matl" in the header in the Layout window (or press Ctrl+Shift+M)



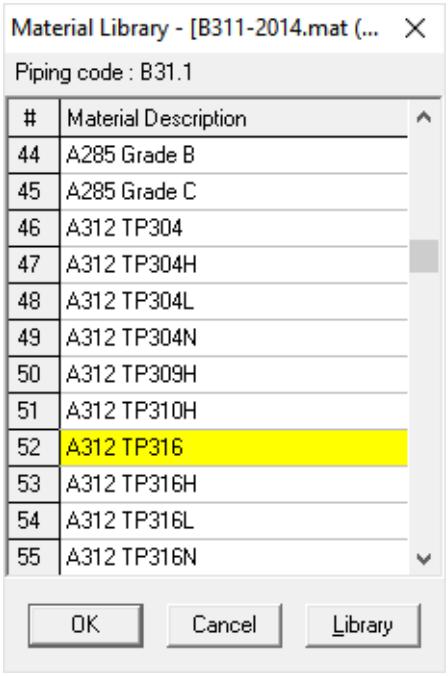
This opens up the Materials list in a separate List window. Position and resize the list window as you desire. Click on Library button on the Toolbar (or choose File > Library).



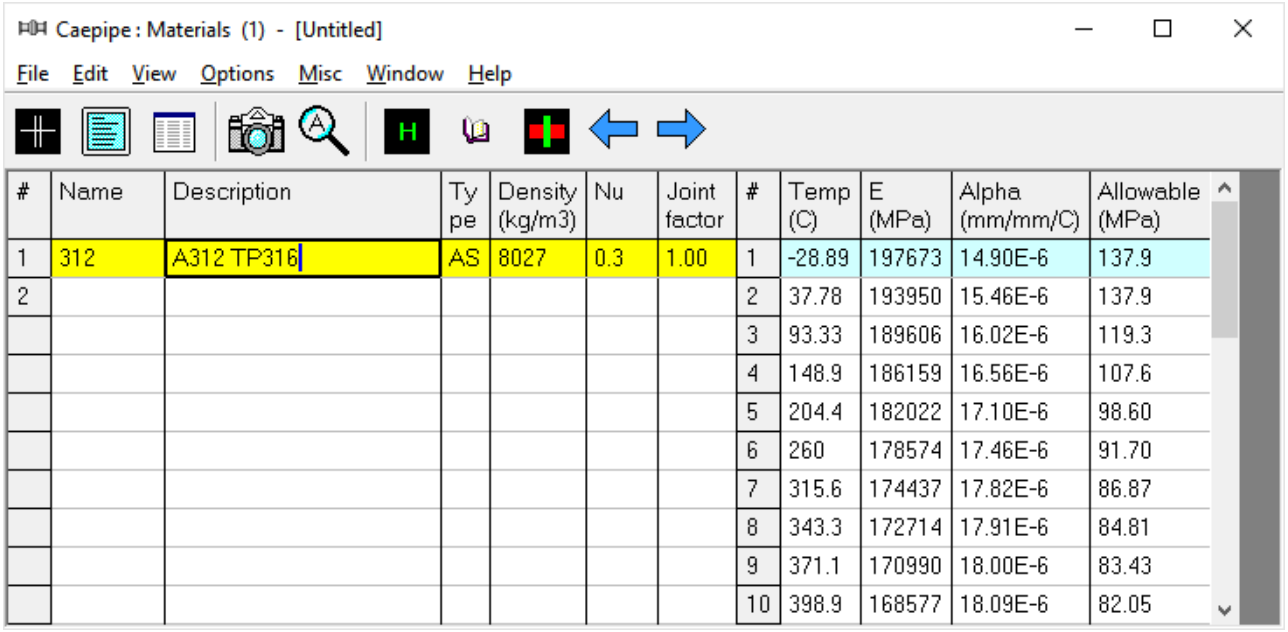
The Open Material Library dialog is shown. *If you don't see the folder, shown below,then navigate to the Material Library folder under the CAEPIPE installed folder (usually C:\CAEPIPIE\xxx, xxx = version number).*



Select B311-2014.mat as the library file by double clicking on it. The available materials in the library are shown. Scroll down to A312 TP 316. Double click on it or click on OK to select it.



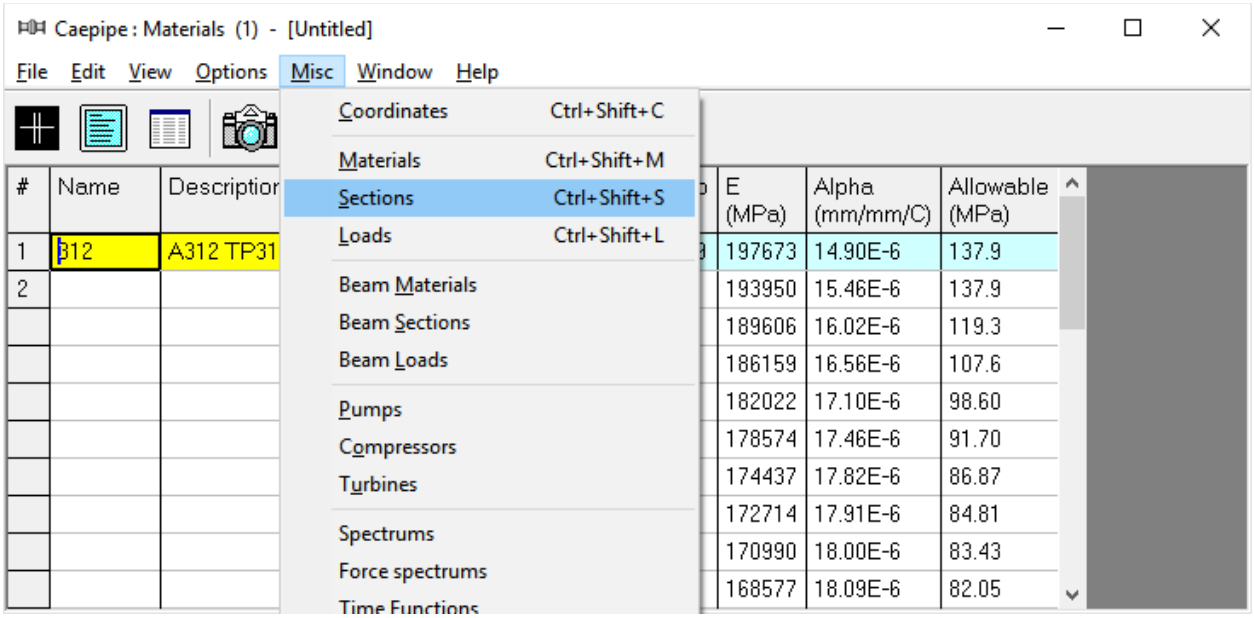
The properties for this selected material are transferred to the material in the List window. Type "312" for material name and then **press Enter**.



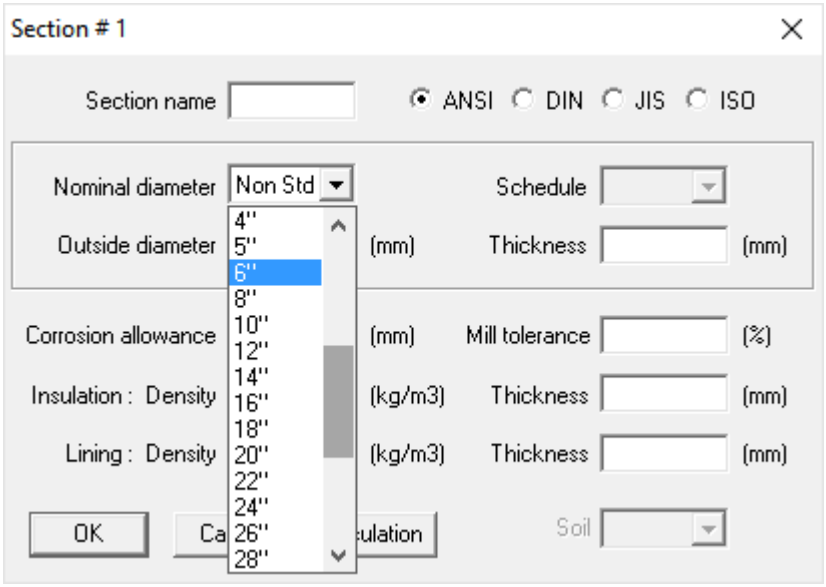
#	Name	Description	Type	Density (kg/m3)	Nu	Joint factor	#	Temp (C)	E (MPa)	Alpha (mm/mm/C)	Allowable (MPa)
1	312	A312 TP316	AS	8027	0.3	1.00	1	-28.89	197673	14.90E-6	137.9
2							2	37.78	193950	15.46E-6	137.9
							3	93.33	189606	16.02E-6	119.3
							4	148.9	186159	16.56E-6	107.6
							5	204.4	182022	17.10E-6	98.60
							6	260	178574	17.46E-6	91.70
							7	315.6	174437	17.82E-6	86.87
							8	343.3	172714	17.91E-6	84.81
							9	371.1	170990	18.00E-6	83.43
							10	398.9	168577	18.09E-6	82.05

Sections

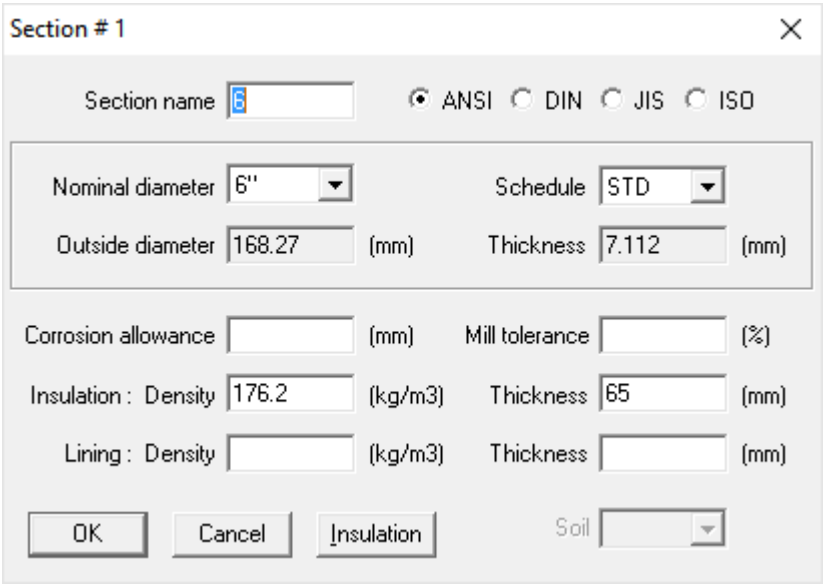
Select Sections from the Misc menu of the List window (or press Ctrl+Shift+S).



A list of Sections is shown. This system has three sections: 6", 8" and 10". To enter the first section, type '6' for Section name and press Enter. The Section Properties dialog is shown with the section name 6.



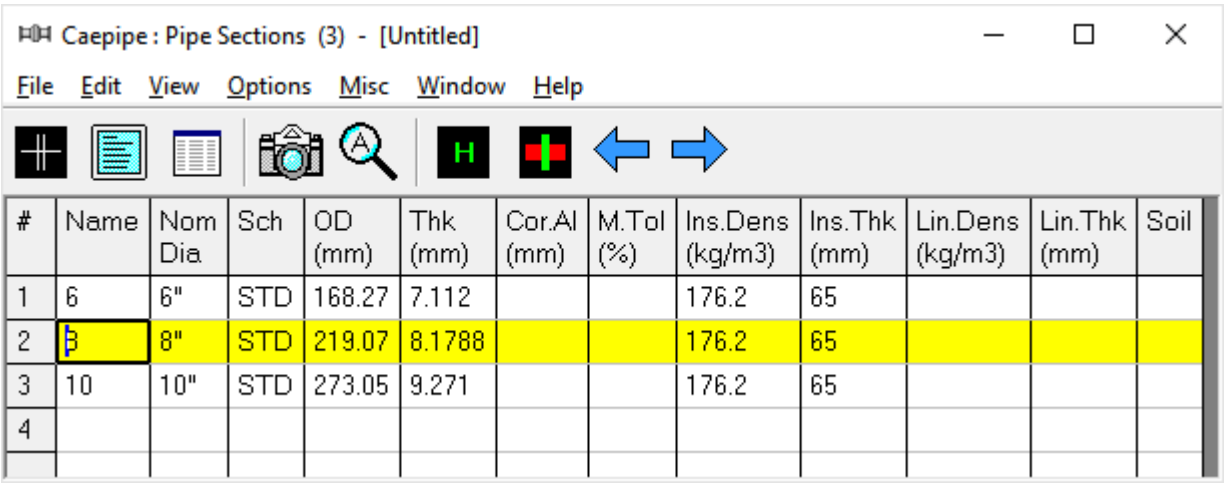
Click on the down arrow of the dropdown combo box for Nominal diameter and select 6" for Nominal diameter. Select/Enter other properties (STD thickness, Insulation density [Alt+I may be used for a list of insulation materials or you may enter your own density, in this case, 176.2 kg/cu.m] and thickness).



After entering all properties, press Enter or click on OK to enter the first section.

Now repeat the process for the 8" pipe section.

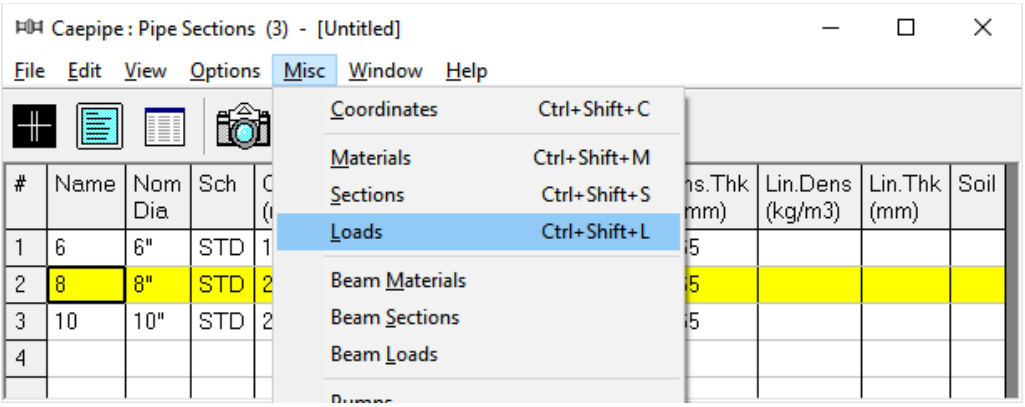
In row # 2, Type 8 for Section name and press Enter. The Section Properties dialog is shown with the section name 8. Select 8" for Nominal diameter, STD for Schedule, and same insulation properties as before for Insulation. Press Enter or click on OK to enter the second section. Do similarly for the 10" pipe section.



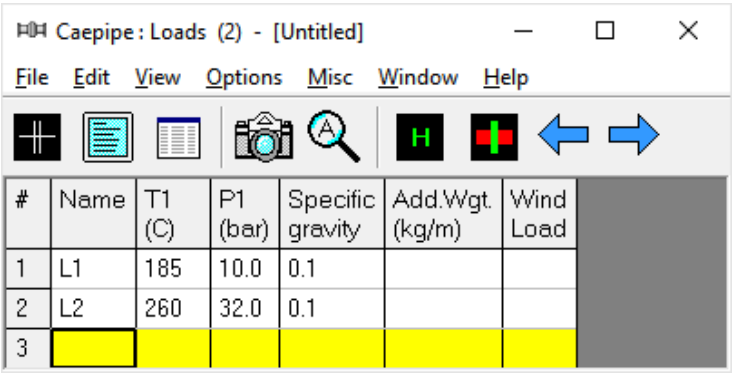
#	Name	Nom Dia	Sch	OD (mm)	Thk (mm)	Cor.Al (mm)	M.Tol (%)	Ins.Dens (kg/m3)	Ins.Thk (mm)	Lin.Dens (kg/m3)	Lin.Thk (mm)	Soil
1	6	6"	STD	168.27	7.112			176.2	65			
2	8	8"	STD	219.07	8.1788			176.2	65			
3	10	10"	STD	273.05	9.271			176.2	65			
4												

Load

Select Loads from the Misc menu (or press Ctrl+Shift+L).



The Loads list is shown. To enter the first load, Type 'L1' for Name, Tab to T1 and type 185, Tab to P1 and type 10 bar, Tab to Specific gravity and type 0.1. Then press Enter. That is it! The load is entered. (Alternately, you could have pressed Ctrl+E on the first row and typed in the same information in a dialog box). Similarly, enter the second load set "L2" {260°C, 32 bar, Sp. Gravity = 0.1}.



Click in the Layout window or press F3 to move the focus to the Layout window.

4. Input Model Layout

We are going to model the 10" main line first, followed by the 8" segment.

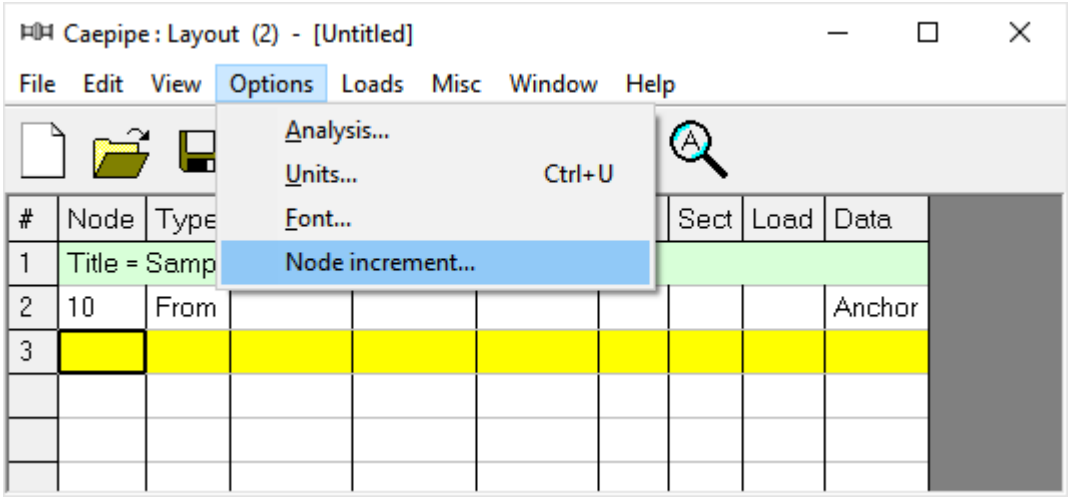
CONVENTIONS

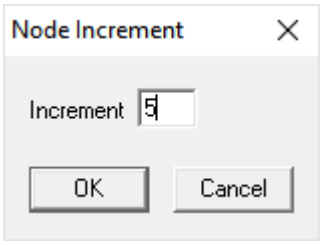
- In the following text, the word 'type' should be distinguished from the words 'Type column' or simply 'Type' (upper case 'T'). The former ('type') will mean press the keys on the keyboard. The latter word 'Type' will refer to the Type column in the Layout spreadsheet. Of course, occurrence of Type at the beginning of a sentence will mean "type" the keys.
- Also, the instruction "type B for Bend" does not necessarily mean the upper case 'B'. The lower case 'b' can also be typed.
- For items in the Data column (such as Anchor or Hanger), the cursor needs to be in the Data column. To move the cursor quickly to that column, press Ctrl+D from any column or click in the Data column. Or press the Tab key repeatedly to reach the Data column.

- As the graphics window is simultaneously updated, you should position the graphics window in such a way that you can see it along with the input window. Simultaneous feedback is one of the chief design intents in CAEPIPE.
- For mouse clicks, when you read the word "click on xxx," this means left-click on your mouse. For the context menu, if referred to, right-click.

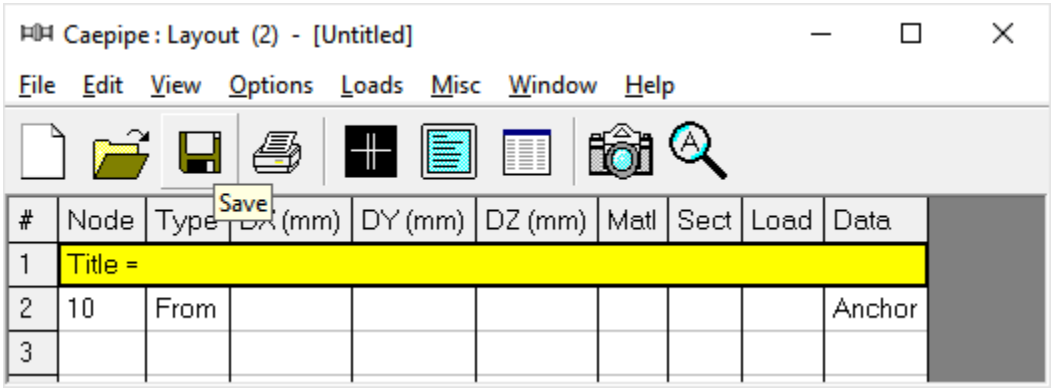
Change Node Increment

You might have noticed in the model drawing that the node numbering scheme has an increment of 5. CAEPIPE has a feature that allows you to specify a node increment. Select Options menu > Node increment…type 5 for value. Click on OK.

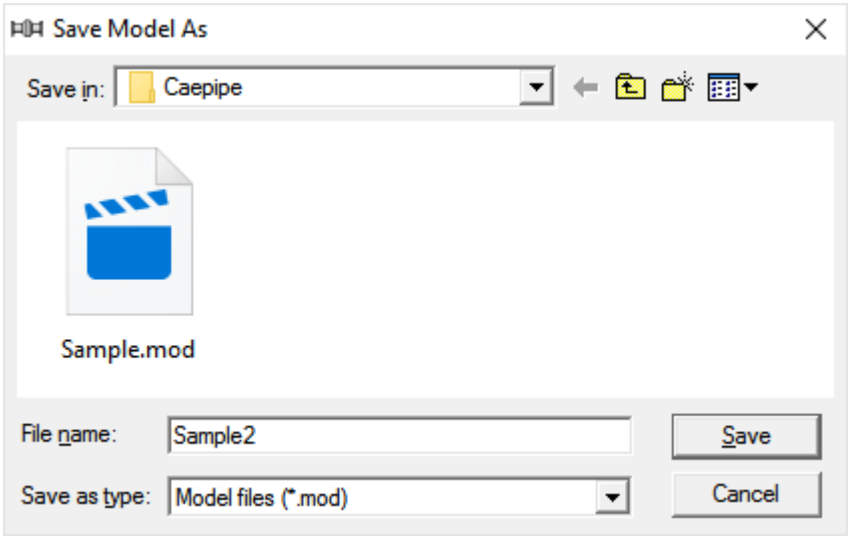




After defining the above parameters,  Save the model by clicking on the Save button.



The "Save Model As" dialog is shown.



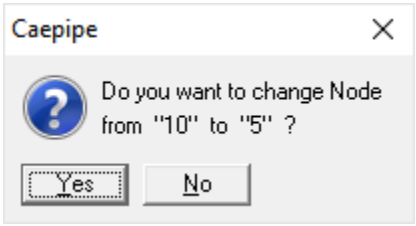
Type the File name as "Sample2" and press Enter to save the model.

First model the 10" Main line

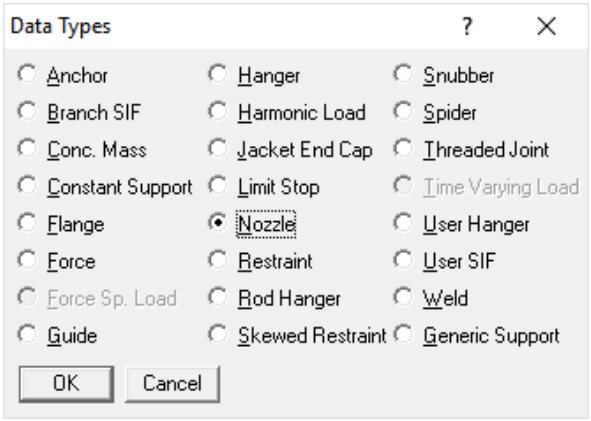
Following the Title at row #1, row #2 is already generated with Node 10 of Type "From" with an Anchor in the Data column.

Model information shows that the piping is connecting to a Nozzle of a Cylindrical Vessel with node number as 5. So, to account for the stiffness of the Nozzle protruding out of the Cylindrical Vessel, the nozzle portion is modeled as a pipe in this model. The junction of this Pipe (Nozzle) and the Shell is modeled as "Nozzle".

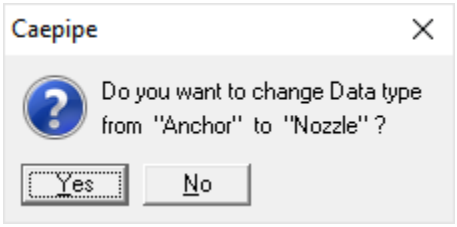
To change the Node number and to replace "Anchor" with "Nozzle", click on 10, press Backspace to erase 10, type 5. Press Tab to advance. Confirm the node number change when asked (by clicking on Yes, or simply pressing the Spacebar key on the keyboard).



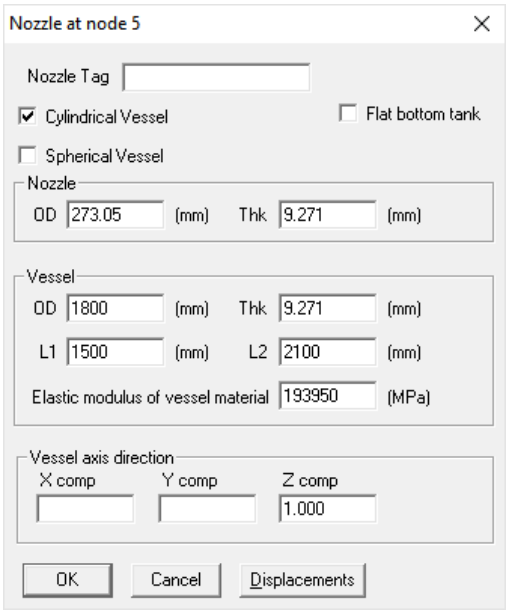
To replace the "Anchor" with "Nozzle", highlight the data type "Anchor" at row #2 using mouse left button and then click on "Data" in the header in the Layout window. From the "Data types" dialog box shown, select the new data type as "Nozzle".

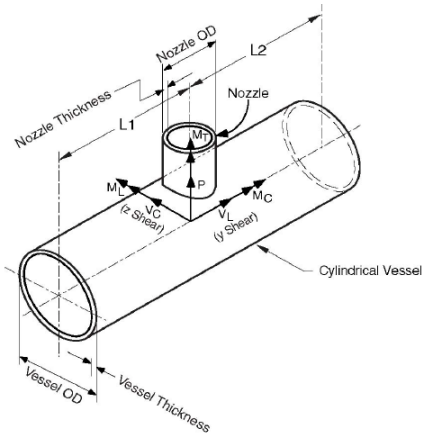


CAEPIPE will prompt as shown below. Press "Yes" to proceed.



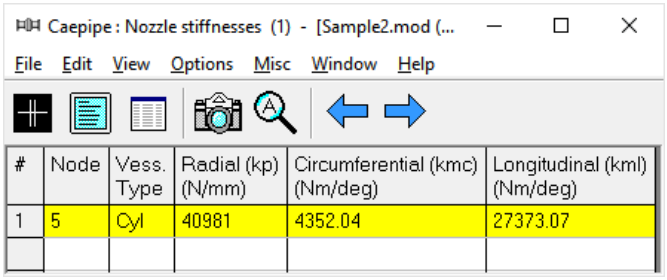
Enter the Nozzle and Vessel parameters as shown below and press "OK".





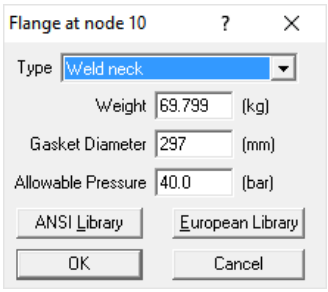
From the snap shots shown above, Lengths L1 and L2 on either side of the nozzle are the distances from the nozzle center line to the nearest location on vessel where the "ovalization deformation" of the vessel is stopped such as at a stiffener on the inner or outer surface of the vessel, or at the center of a saddle support to the vessel or at the junction to the torispherical enclosure (also called the head) or at a tube sheet inside the vessel etc.

Nozzle stiffness computed by CAEPIPE can be seen through Layout window > View > List > Nozzle Stiffnesses.



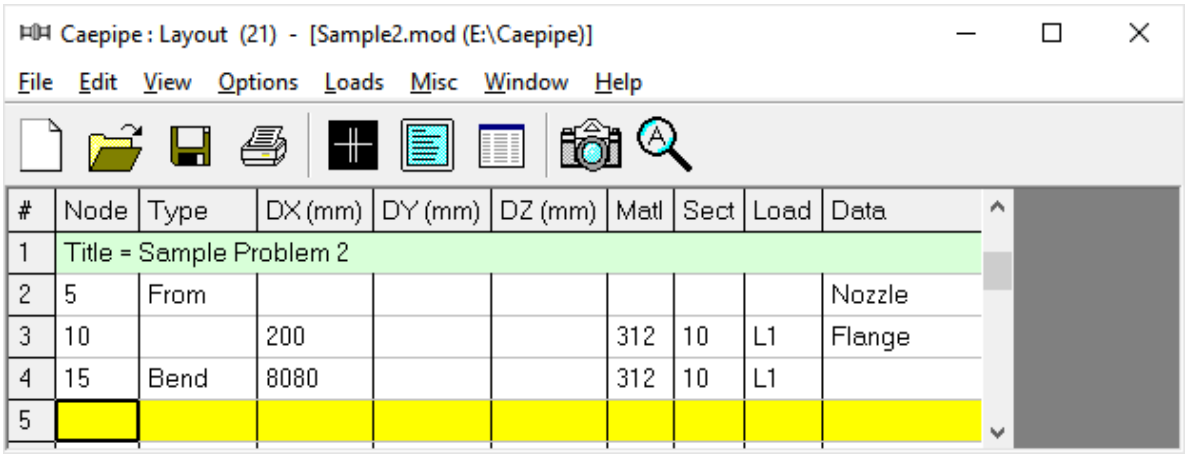
#	Node	Vess. Type	Radial (kp) (N/mm)	Circumferential (kmc) (Nm/deg)	Longitudinal (kml) (Nm/deg)
1	5	Cyl	40981	4352.04	27373.07

Now, press Enter to move the highlight to the next row (#3). Tab to the Type column. The next Node 10 is automatically assigned. Tab over to DX, type 200 (mm), Tab over to Material, press Enter to open the list of materials and select 312. Next Tab over to Section and press Enter. Select section 10 and press OK. Tab over to Load and press Enter, select L1 and click OK. Tab again to Data to input the flanges mating with the pipe and the equipment nozzle. Type "fl" to model flange and enter the data as shown below and press OK. CAEPIPE moves the highlight automatically to the next (new) row (#4).



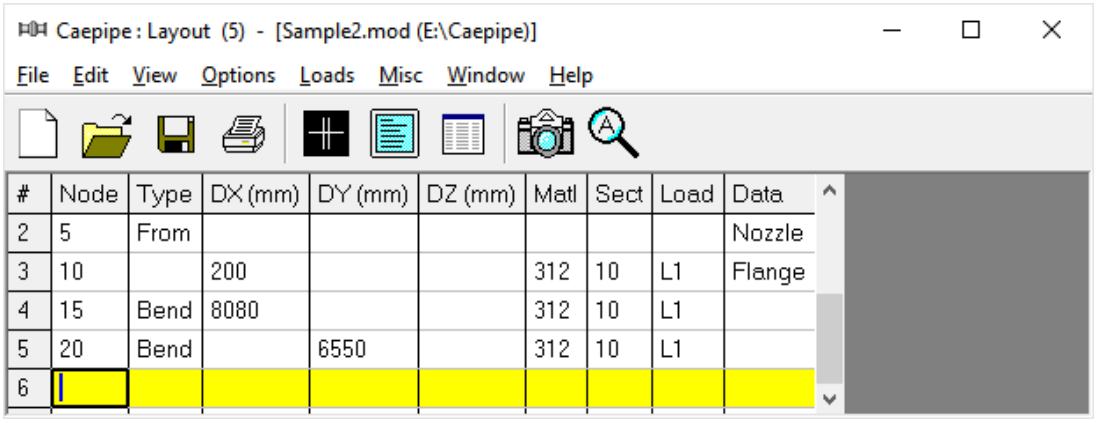
Tab to the type column. The next node 15 is automatically assigned.

Node 15 has a LR (long radius) bend (in CAEPIPE, a bend node is defined always at the tangent intersection point, being such, this node does not exist on the physical bend). Press Tab to go the Type column; type "ben" to insert a default LR bend. Tab to DX, type in 8080 (mm), press Enter. CAEPIPE automatically enters the material, section and load from the previous row and moves the highlight to the next new row.



#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
1	Title = Sample Problem 2								
2	5	From							Nozzle
3	10		200			312	10	L1	Flange
4	15	Bend	8080			312	10	L1	
5									

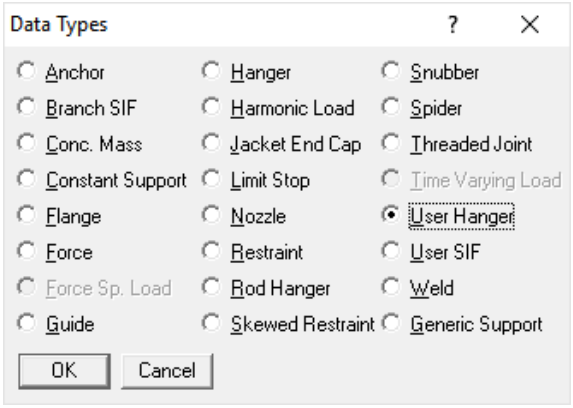
The following vertical bend (at node 20) can be modeled as before. Tab to Type (node 20 is automatically inserted), and type "ben" to insert a default LR bend, Tab again to DY, type 6550 (mm) and press Enter.



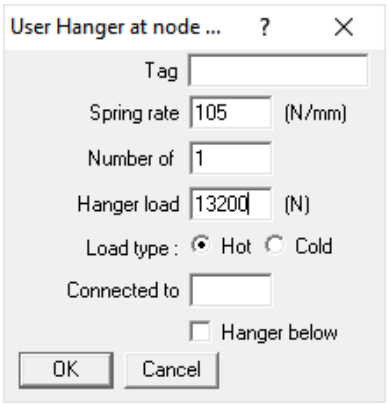
#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
2	5	From							Nozzle
3	10		200			312	10	L1	Flange
4	15	Bend	8080			312	10	L1	
5	20	Bend		6550		312	10	L1	
6									

This bend has an already existing hanger (called "User Hanger" in CAEPIPE) at the far end, referred to as node 20B, an internally generated bend node.

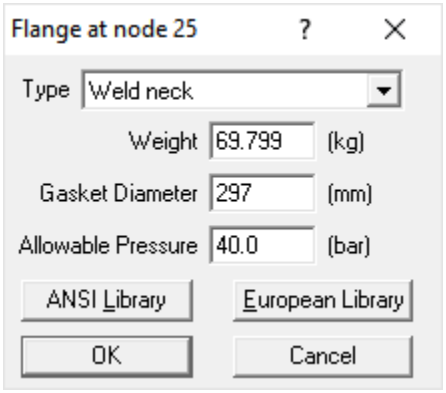
So, on the next row, type 20B, Tab to Type, press "L" for Location, which spawns the available data types you can insert at this node. Pick "User Hanger" from the dialog.



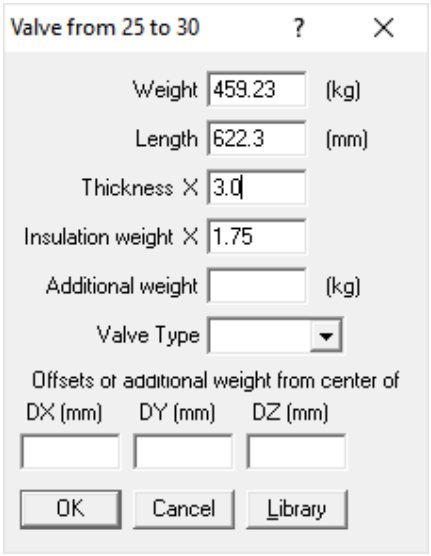
Enter its properties as shown. Click on OK.

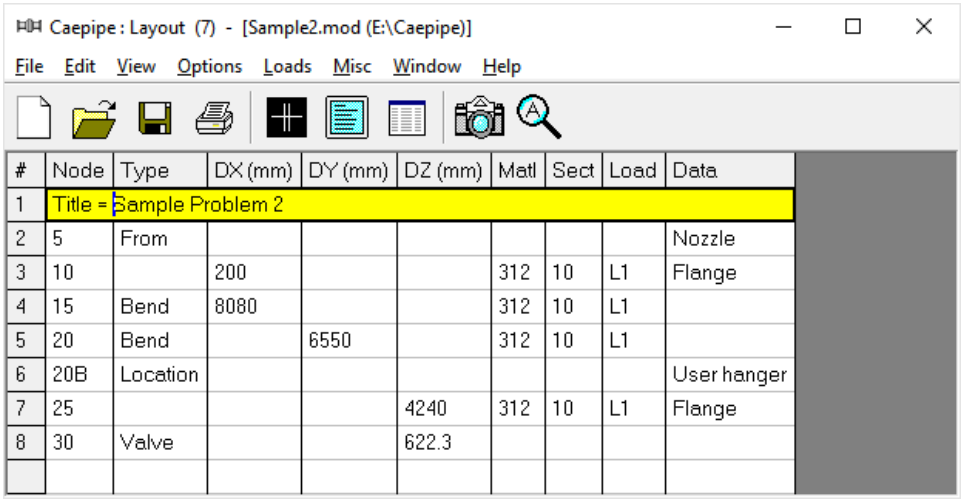


Next, the line moves in the Z direction to the flange node 25. Pressing Tab on the new row generates node 25 for you. Tab to DZ, type 4240, (click in Data column) or press Ctrl+D to move cursor to Data column. Type "fl" to open the Flange Data type dialog. Enter the details shown below and press OK.



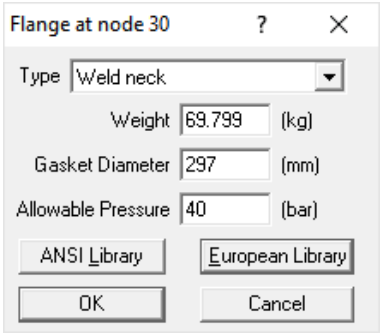
A valve is placed next from Node 25 to Node 30, where another mating flange is located. Pressing Tab on the new row generates node 30. Press Tab to go the Type column; type "v" to insert a "Valve" and enter the data as shown below and press OK.



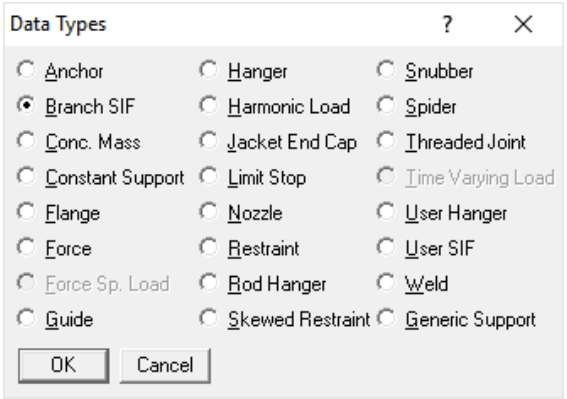


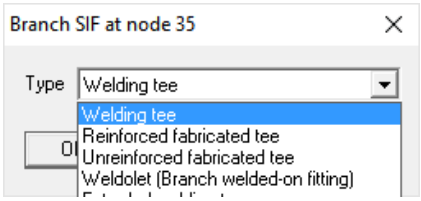
#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
1	Title = Sample Problem 2								
2	5	From							Nozzle
3	10		200			312	10	L1	Flange
4	15	Bend	8080			312	10	L1	
5	20	Bend		6550		312	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3				

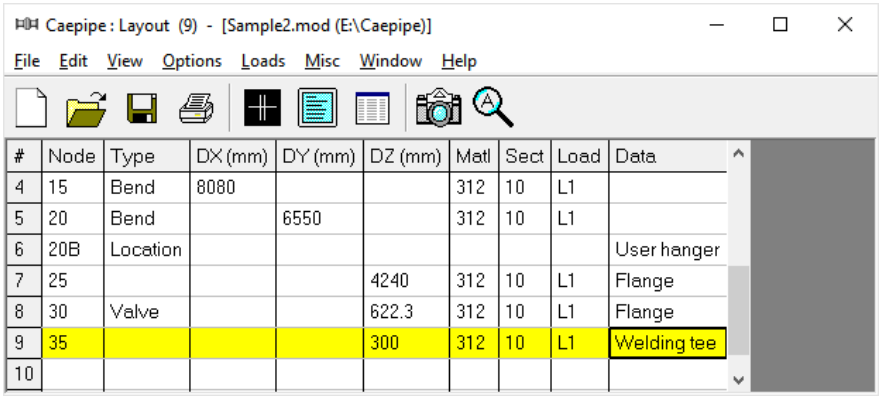
Tab to Data and type “fl” to enter a “flange”. Type “fl” to open the Flange Data type dialog. Enter the details shown below and press OK.



Next model a pipe element till node 35 (welding tee). Press Tab for node 35, Tab to DZ, type 300, (click in Data column) or press Ctrl+D to move cursor to Data column. Type “br” (or right-click in Data, select Branch SIF) to open the Tee types Data type dialog. Select Welding Tee from the dropdown box. Click on OK (or press Enter).



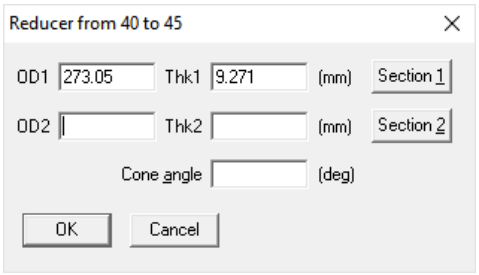




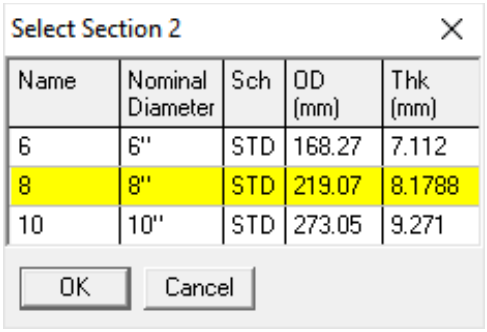
#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
4	15	Bend	8080			312	10	L1	
5	20	Bend		6550		312	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10									

Next model a pipe element till node 40. Press Tab for node 40, Tab to DZ, type 300 and press Enter.

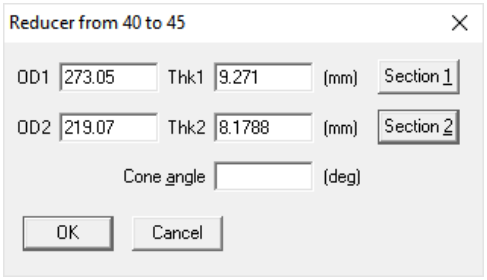
The next element is a 10x8 concentric reducer. Here is how to model it. Tab for the next node # (45), type "red" for Reducer in the Type column. CAEPIPE displays the Reducer dialog with the current section properties.



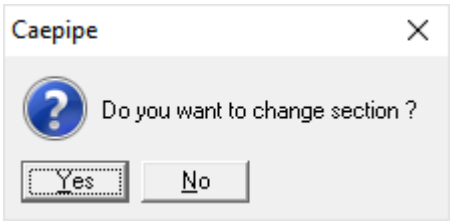
Click on "Section 2" button to select the following section, in this case, the 8" section. After placing the highlight on the 8" section, press Enter (or click on OK).

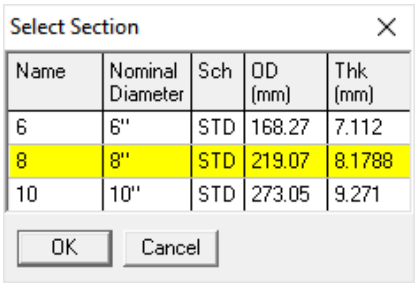


You are back at the Reducer dialog.

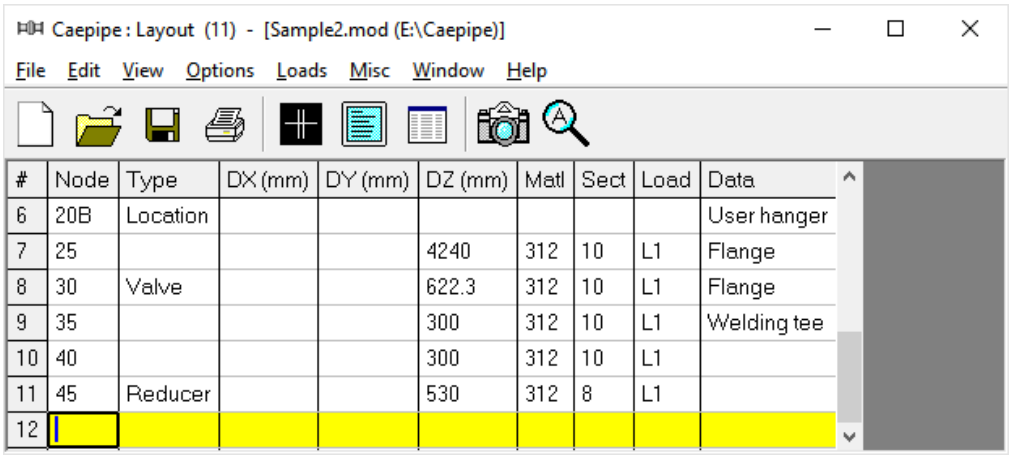


Click on OK to finish inserting the reducer. On the layout screen, type 530 for DZ and press Enter, at which point CAEPIPE wants you to confirm the section change. Click on Yes.

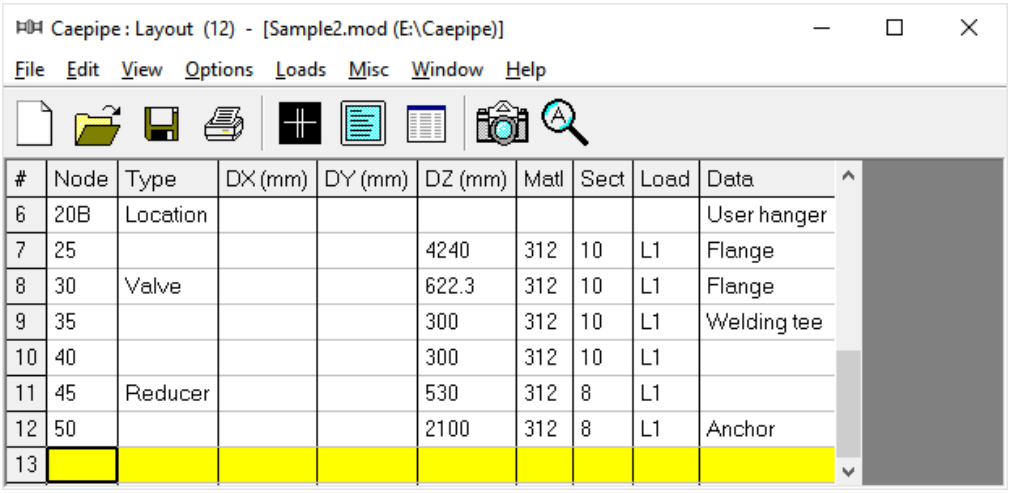




Then select 8 as the new section from here on. Press Enter to move to next row.

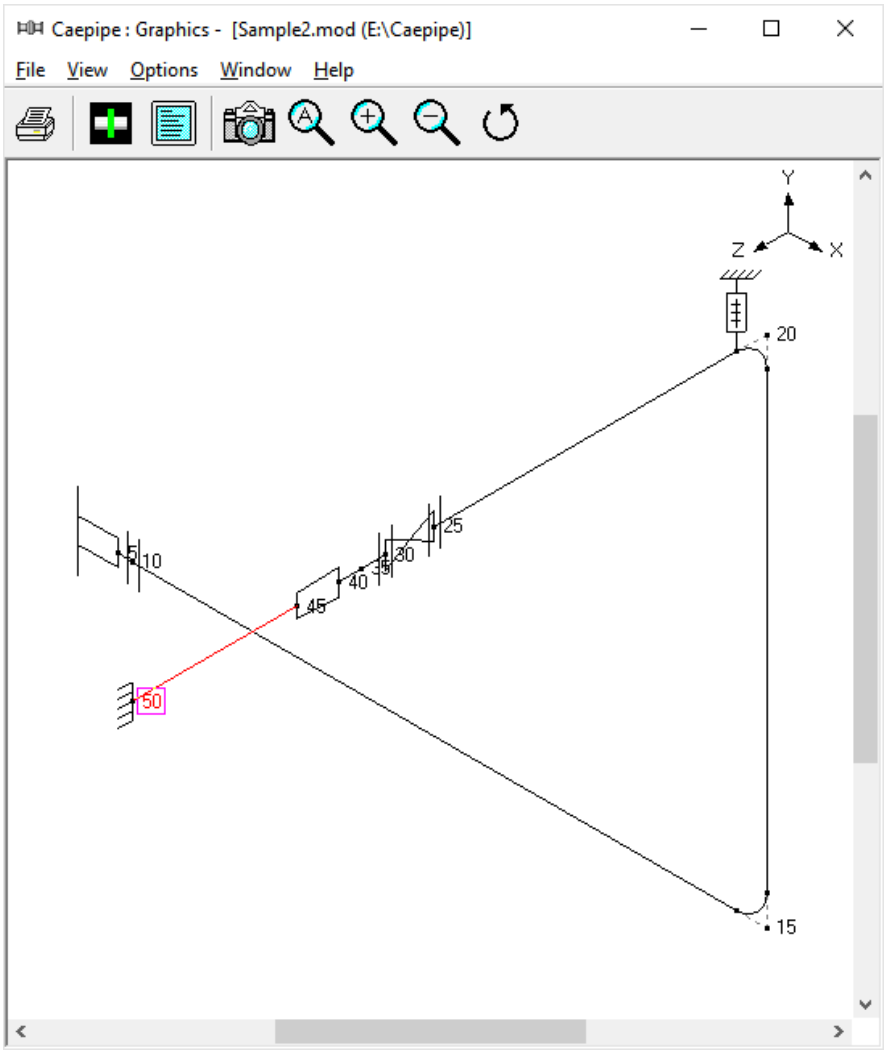


The last element here is an 8" pipe that ends at node 50. As before, press Tab for 50, type 2100 for length in the same direction. Press Ctrl+D to go to Data and press A to insert a rigid anchor (note that CAEPIPE inserts the correct old material, new section and old load for this row).

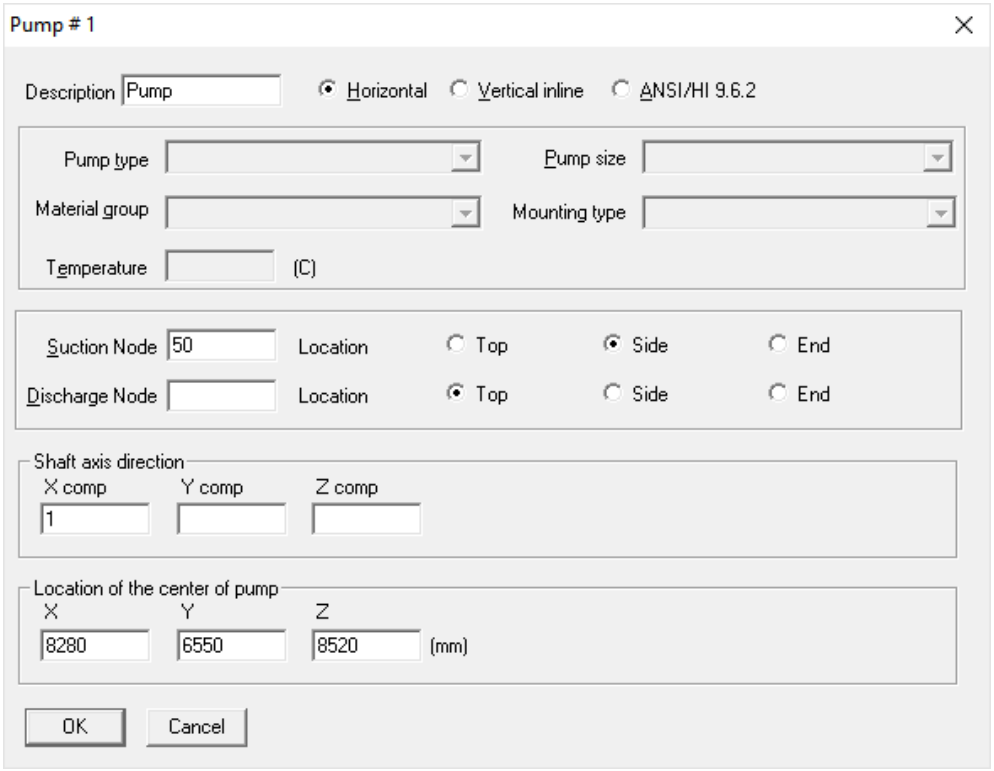


#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13									

 Click on the Zoom All button (or press Ctrl+A) to view the header line fully in the graphics window.

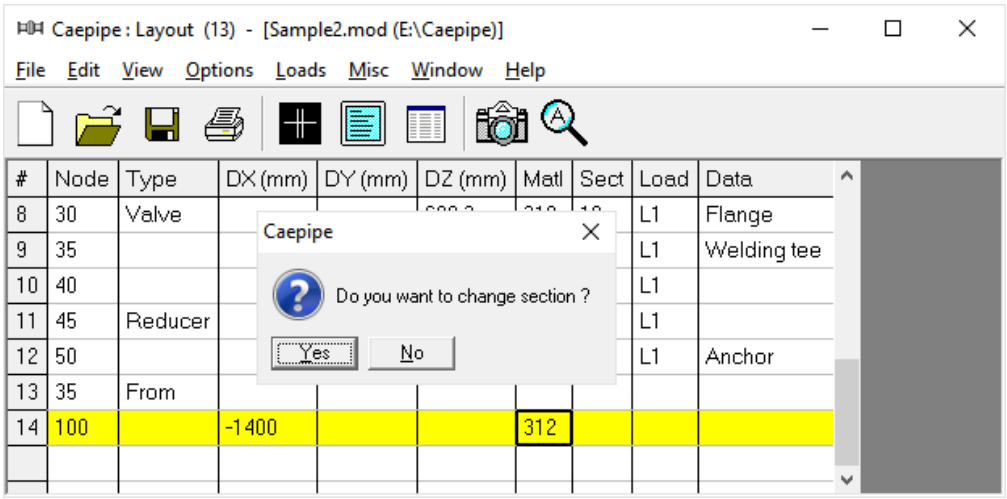


Node 50 is connecting to a Side Suction Nozzle of an API 610 Horizontal Pump. To model this, select the option "Pumps" through Layout Window > Misc. Double click on an empty row and enter the values as shown below. Once modeled, CAEPIPE will automatically perform the Pump Qualification and shows the report in Results.

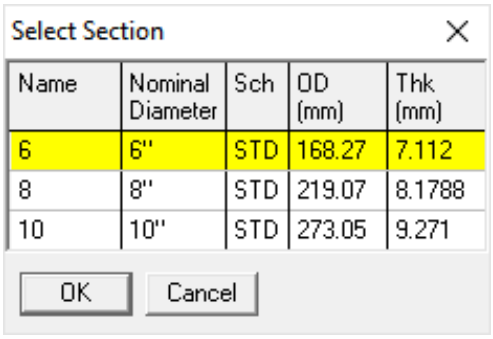


Now the 6" branch

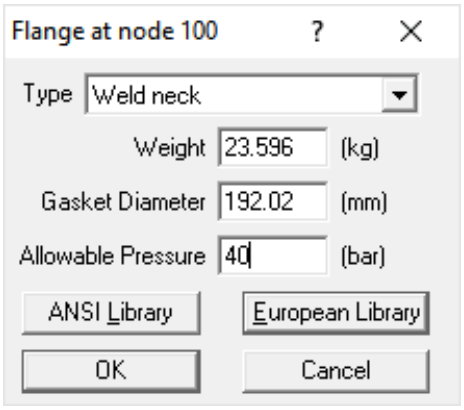
On the next row (#13), type 35 for Node, Tab to the Type column, type 'f' (for "From", since we are beginning a new branch from an existing Node 35), press Enter. In the next row (#14), type "100" in the Node column to clearly identify the new branch. Tab to DX and enter –1400. CAEPIPE inserts the previous material, and automatically detects the new branch and asks if you want to change section.



Since we want to change the section to 6, click on Yes. This opens the Section selection dialog.

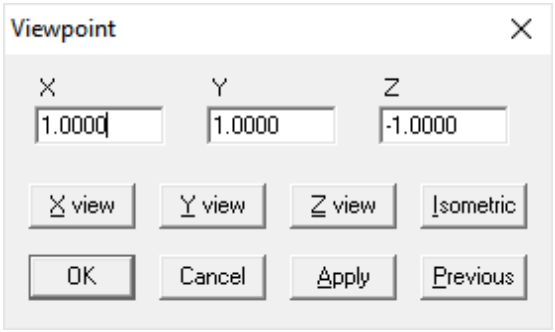


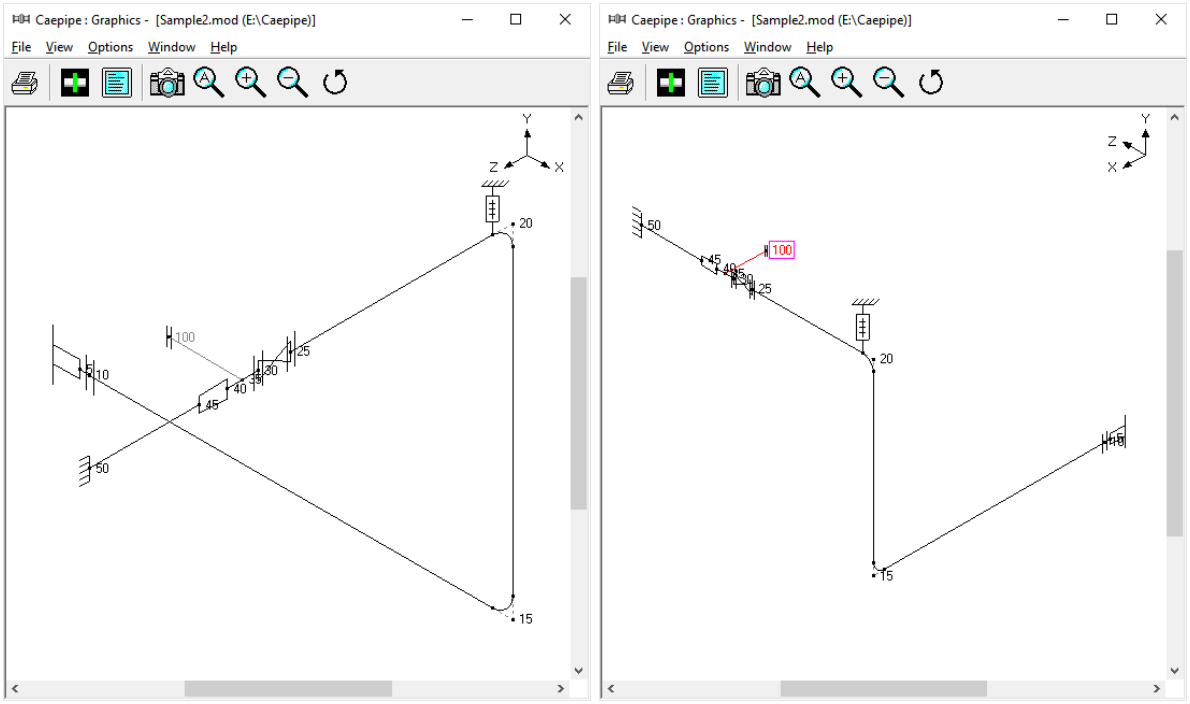
Select the 6" section by double clicking on it. The section (6) is entered in the Section column in the Layout window. The load is again automatically inserted from the previous load. Lastly, type "fl" in the Data column and hit enter to create a mating Flange. This will bring up the Flange type dialog box.



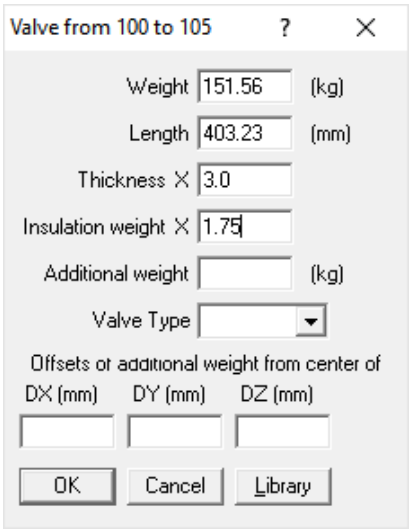
Type in 23.596 for Weight, 192.02 for Gasket Diameter, 40 for Allowable Pressure and click Ok.

The graphics window will look like this. For better view, rotate the model by clicking the icon  and scrolling the horizontal scroll bar towards left using the mouse left button or through keyboard left arrow key. Alternatively, you can specify the viewpoint as shown below by selecting the icon  from the graphics frame.



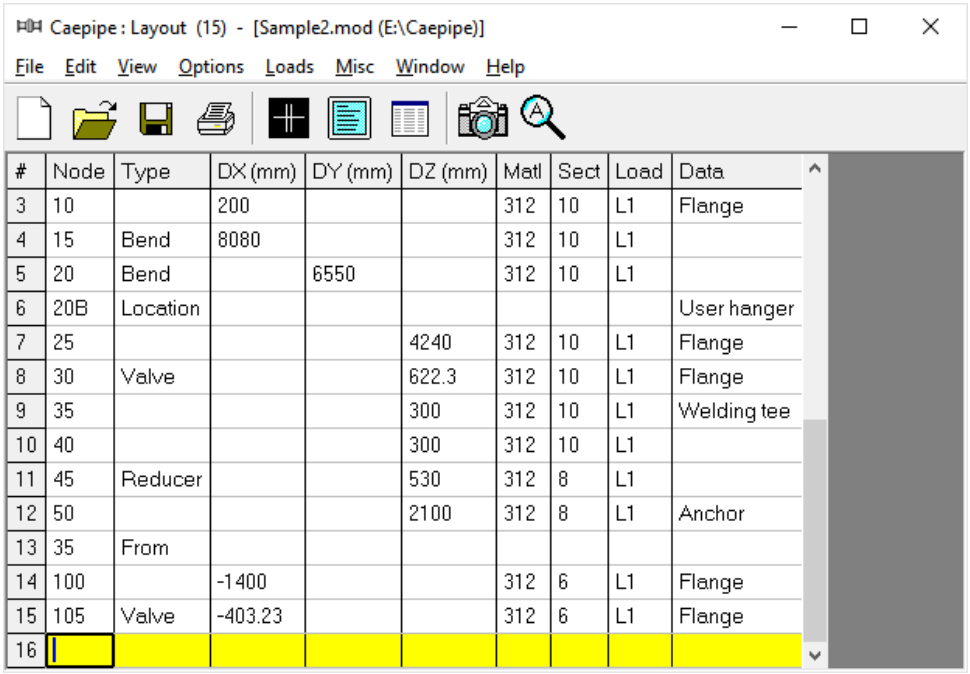


In the next row (#15), Tab to the Type column. The next Node 105 is automatically assigned. In the Type column, type 'v' (for Valve). This brings up the Valve dialog box.



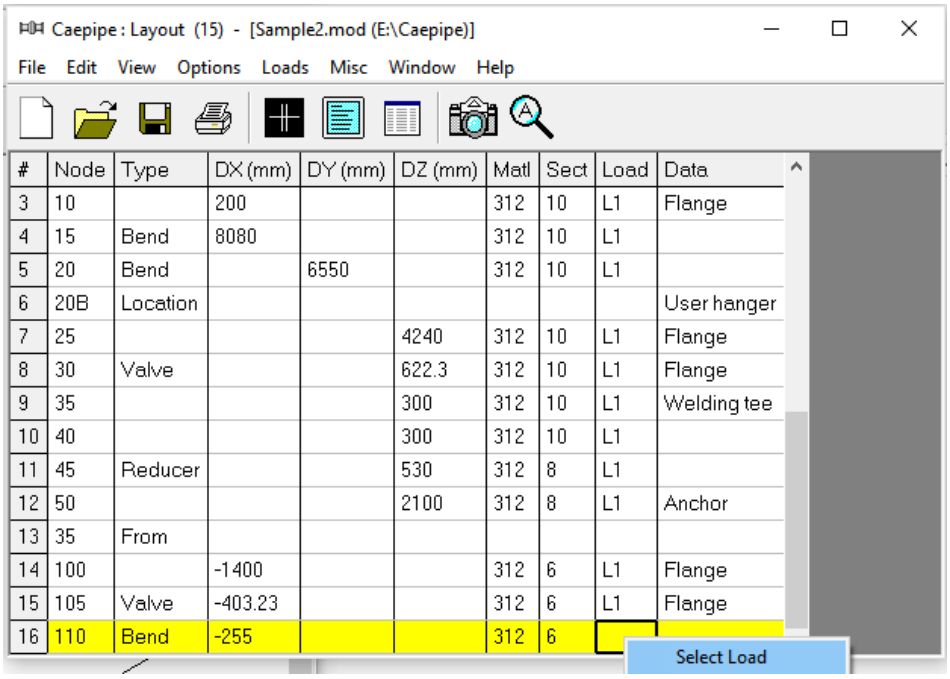
In the Valve dialog box, type 151.56 for Weight, 403.23 for Length, 3.00 for Thickness, and 1.75 for Insulation weight. Then press Enter or click on OK to input the valve. Press Enter again. You will see that the DX, Material, Section and Load information is automatically input in the Layout window.

You can now copy the flange along with data from Node 100 and paste it at Node 105. To perform this, highlight row # 14 and press Ctrl+C. Then move the cursor to data column of row #15 and press Ctrl+V to paste the flange. Press Enter to move to the next row.



#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
3	10		200			312	10	L1	Flange
4	15	Bend	8080			312	10	L1	
5	20	Bend		6550		312	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13	35	From							
14	100		-1400			312	6	L1	Flange
15	105	Valve	-403.23			312	6	L1	Flange
16									

In the next row (#16), Tab to the Type column, type "b" to create a Long Radius Bend and then Tab to the DX column. The default LR Bend is automatically input when you Tab over. In the DX column type –255 and hit Enter. The Material, Section and Load information and is automatically input. As the Temperature and Pressure is changing from this element, change the Load from L1 to L2 by right clicking on the "L1" in the Load field.



#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
3	10		200			312	10	L1	Flange
4	15	Bend	8080			312	10	L1	
5	20	Bend		6550		312	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13	35	From							
14	100		-1400			312	6	L1	Flange
15	105	Valve	-403.23			312	6	L1	Flange
16	110	Bend	-255			312	6		

This will bring up a small Context menu from which you will choose Select Load. This will bring up the Select Load window. Highlight L2 and click Ok. Press Enter to complete inputting Node 110 at row (#16).

Select Load

Name	T1 (C)	P1 (bar)	Specific gravity	Addialog.Wgt. (kg/m)	Wind Load
L1	185	10.0			
L2	260	32.0			

OK Cancel

In the next row (#17), create another Long Radius Bend just like the one in row (#17), except change the DX -255 to DY 2950 and press Enter.

Your Layout window should look like this.

Caepipe : Layout (17) - [Sample2.mod (E:\Caepipe)]

File Edit View Options Loads Misc Window Help

#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
5	20	Bend		6550		312	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13	35	From							
14	100		-1400			312	6	L1	Flange
15	105	Valve	-403.23			312	6	L1	Flange
16	110	Bend	-255			312	6	L2	
17	115	Bend		2950		312	6	L2	
18									

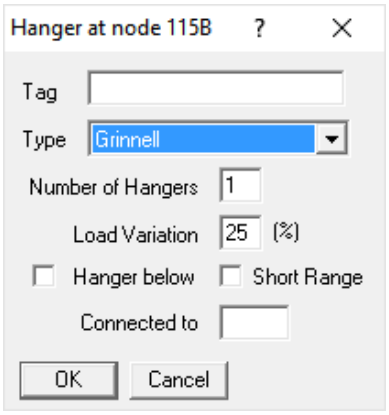
Start the next row (#18) by typing 115B in the Node column. Tab to the Type column and type "L" to specify a Location type. This will automatically open the Data Types dialog box. Select Hanger.

Data Types

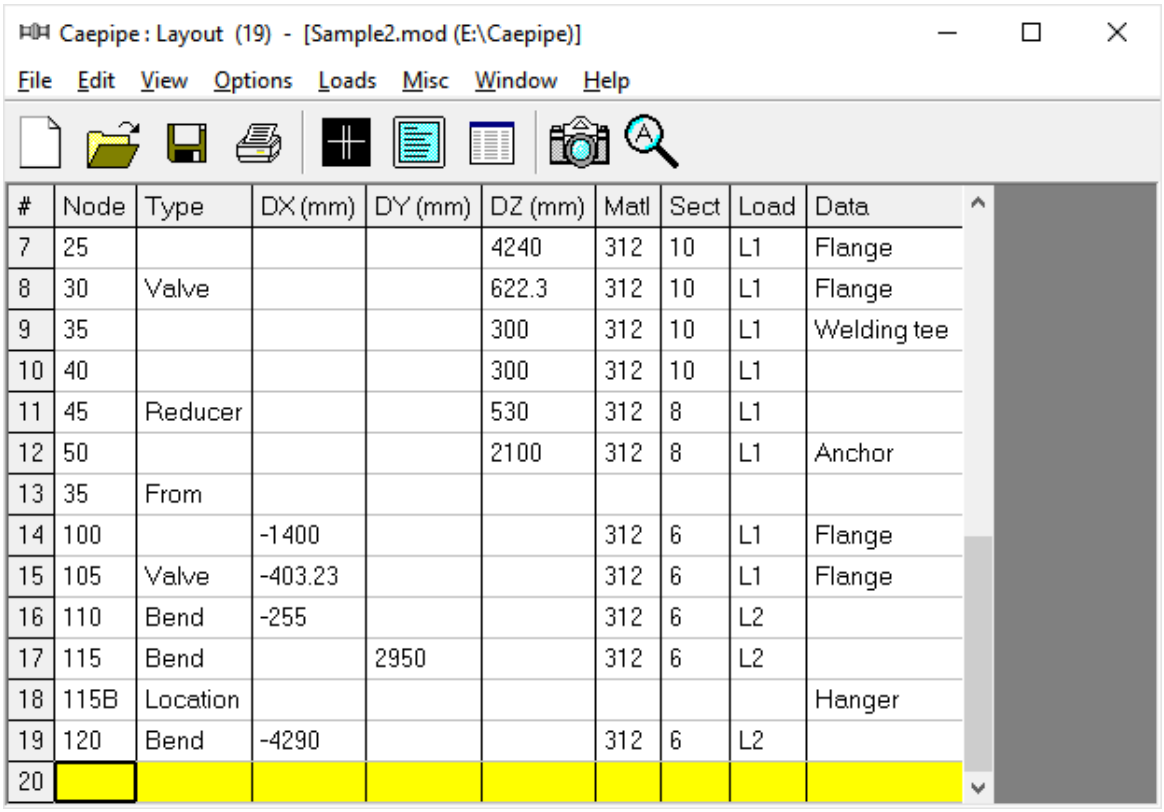
Anchor	Hanger	Snubber
Branch SIF	Harmonic Load	Spider
Conc. Mass	Jacket End Cap	Threaded Joint
Constant Support	Limit Stop	Time Varying Load
Flange	Nozzle	User Hanger
Force	Restraint	User SIF
Force Sp. Load	Rod Hanger	Weld
Guide	Skewed Restraint	Generic Support

OK Cancel

Another dialog box will appear with specific Hanger type input options. Keep the default settings and click OK.



In Node 120 on the next row (#19), Tab to the Type column and input a default LR Bend by typing "b". Tab to the DX column and input –4290 and press Enter.



#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13	35	From							
14	100		-1400			312	6	L1	Flange
15	105	Valve	-403.23			312	6	L1	Flange
16	110	Bend	-255			312	6	L2	
17	115	Bend		2950		312	6	L2	
18	115B	Location							Hanger
19	120	Bend	-4290			312	6	L2	
20									

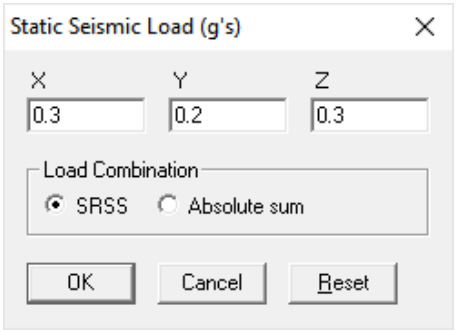
On the next row (#20), Tab over to the DX column and input -910, then in DY input –3660. Create an Anchor in the Data column by either pressing Ctrl+D or Tabbing to the Data column and typing "a". Press Enter and you are done with Layout window input.

Caepipe : Layout (20) - [Sample2.mod (E:\Caepipe)]

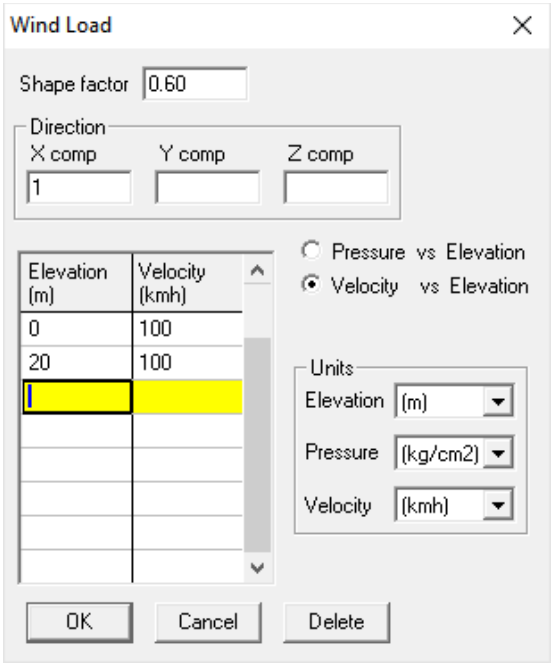
File Edit View Options Loads Misc Window Help

#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
1	Title = Sample Problem 2								
2	5	From							Nozzle
3	10		200			312	10	L1	Flange
4	15	Bend	8080			312	10	L1	
5	20	Bend		6550		312	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13	35	From							
14	100		-1400			312	6	L1	Flange
15	105	Valve	-403.23			312	6	L1	Flange
16	110	Bend	-255			312	6	L2	
17	115	Bend		2950		312	6	L2	
18	115B	Location							Hanger
19	120	Bend	-4290			312	6	L2	
20	125		-910	-3660		312	6	L2	Anchor
21									

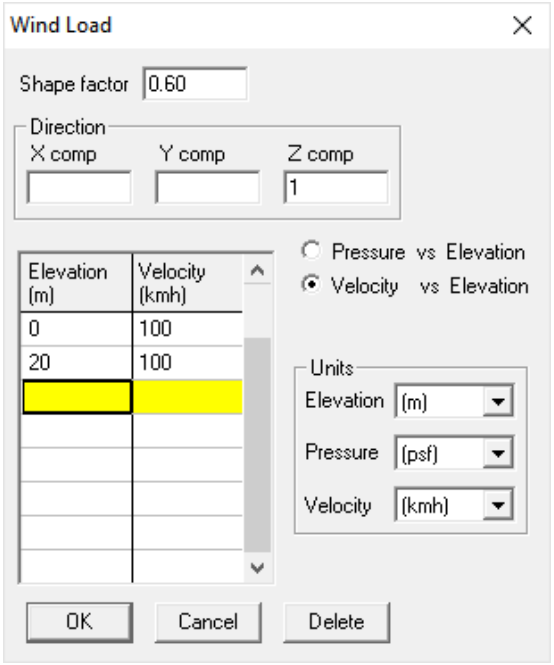
Define "Static seismic" through Layout Window > Loads > Static Seismic. Enter the value as show below.



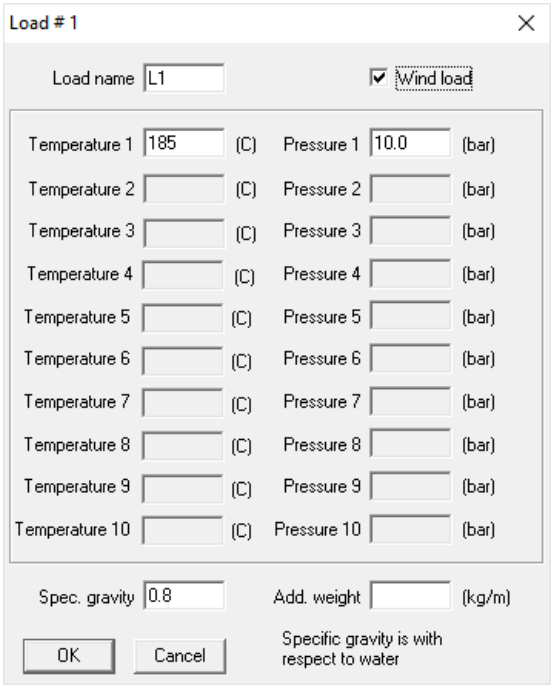
Let us define "Wind Load" profile in +X direction through Layout Window > Loads > Wind 1 and enter the data as shown below and press OK. The maximum elevation of 20m is chosen so that the entire piping system experiences the wind loads.



Similarly, define "Wind Load" profile in +Z direction through Layout Window > Loads > Wind 2 and enter the data as shown below and press OK.



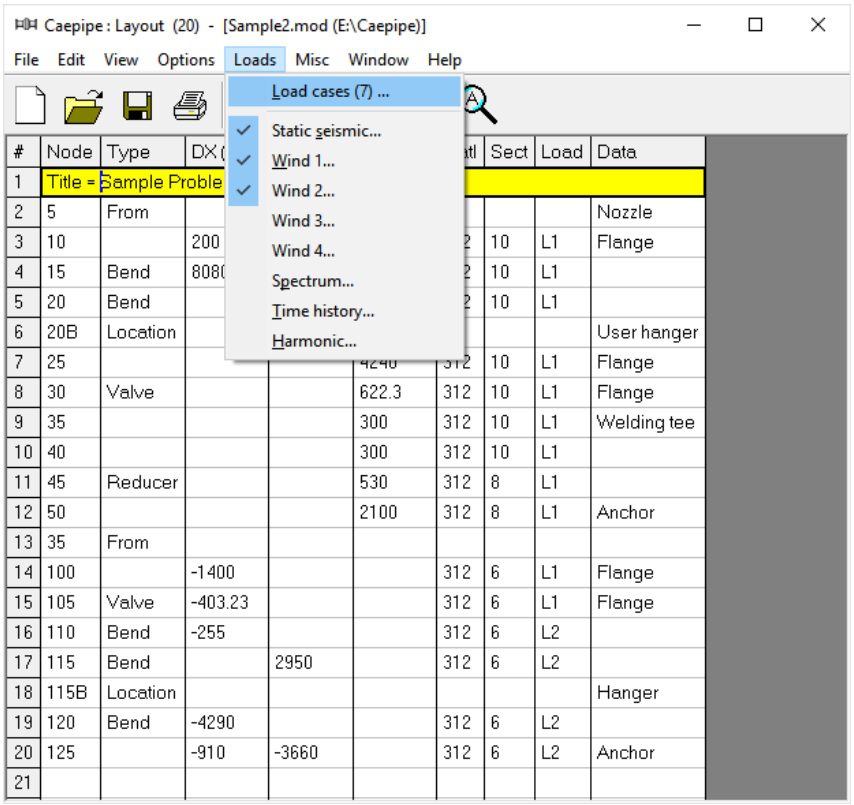
Assign the Wind Loads defined above to the stress layout through Layout window > Misc > Loads and then double on the Loads "L1" and select the check box "Wind load" as shown below.



Similarly, select the check box "Wind load" for "L2".

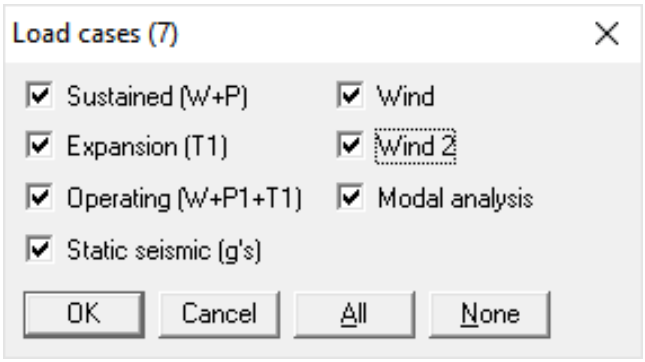
5. Select Load Cases for Analysis

Select Loads cases from the Loads menu.



#	Node	Type	DX				Sect	Load	Data
1	Title = Sample Proble								
2	5	From							Nozzle
3	10		200			2	10	L1	Flange
4	15	Bend	808(			2	10	L1	
5	20	Bend				2	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13	35	From							
14	100		-1400			312	6	L1	Flange
15	105	Valve	-403.23			312	6	L1	Flange
16	110	Bend	-255			312	6	L2	
17	115	Bend		2950		312	6	L2	
18	115B	Location							Hanger
19	120	Bend	-4290			312	6	L2	
20	125		-910	-3660		312	6	L2	Anchor
21									

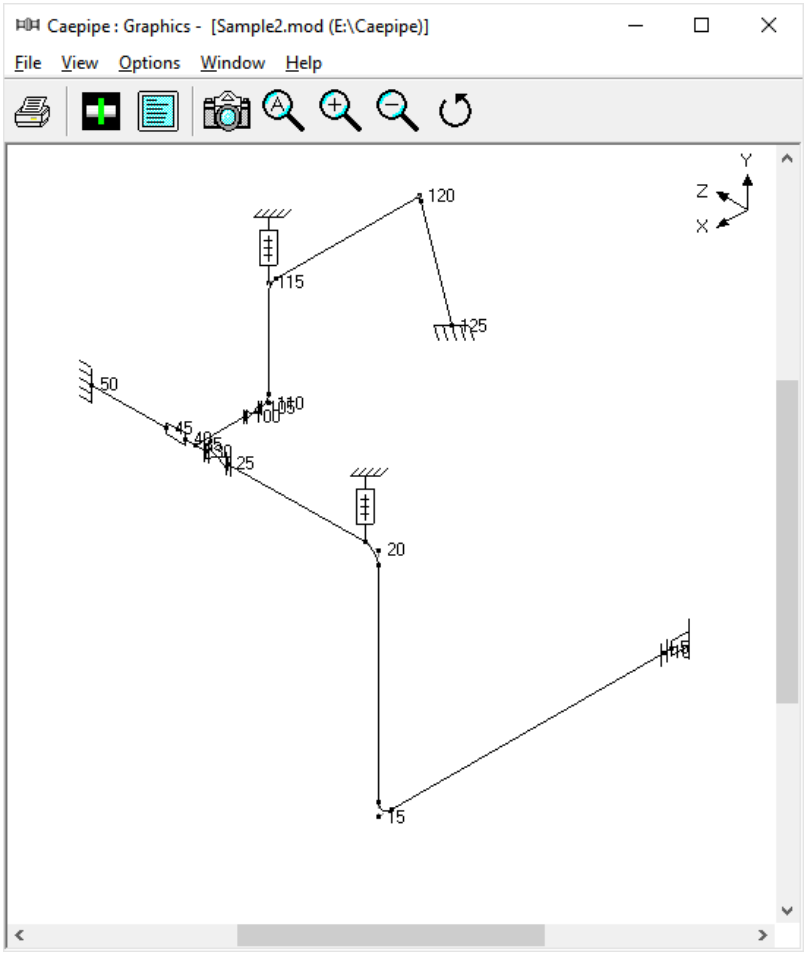
The Load cases dialog is shown.

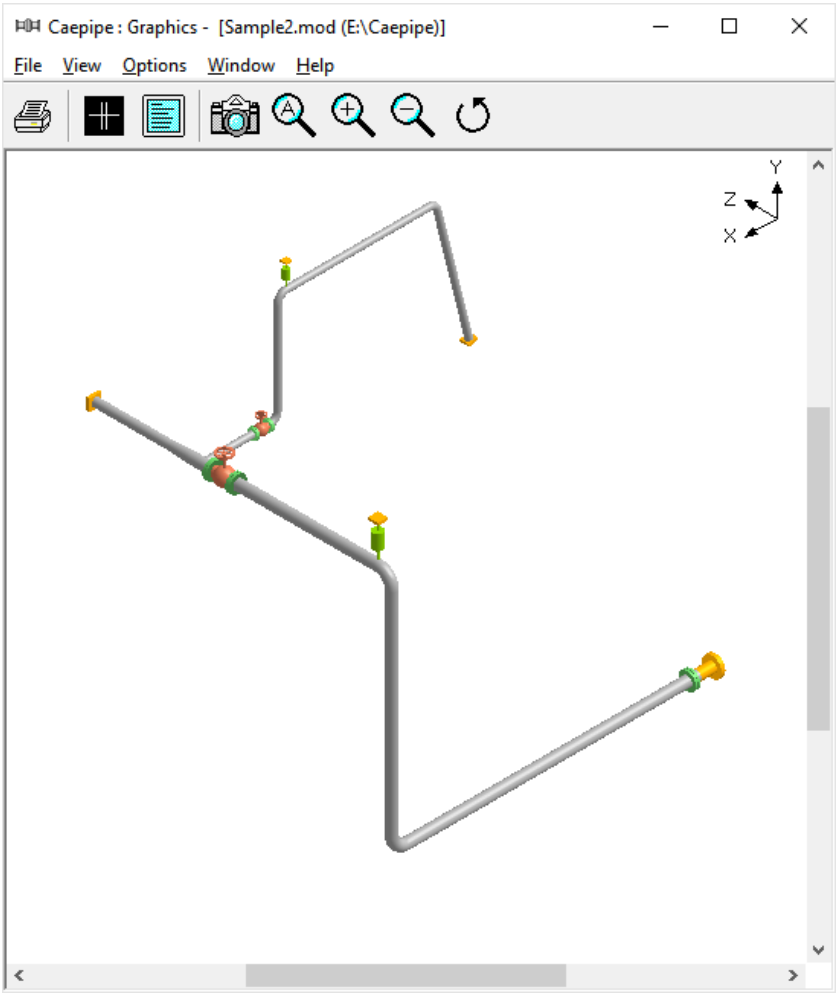


By default, Sustained (W+P), Expansion (T1) and Operating (W+P1+T1) load cases are already selected. Add Static Seismic (g's), Wind, Wind 2, and the Modal analysis Load cases by clicking on the checkbox next to it and press OK to return to the Layout window. The model input is now complete.

Click on the Zoom All button (or press Ctrl+A) to show the whole model in the graphics window.

To see a 3D rendered view of the model, click on the Render button (or press Ctrl+R) in the graphics window.

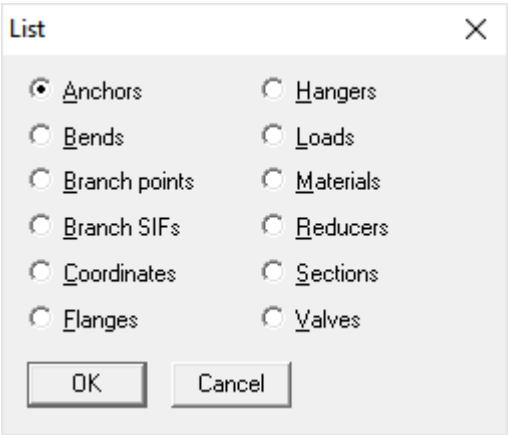




To return to the non rendered view, click on the Do not render button (or press Ctrl+R).

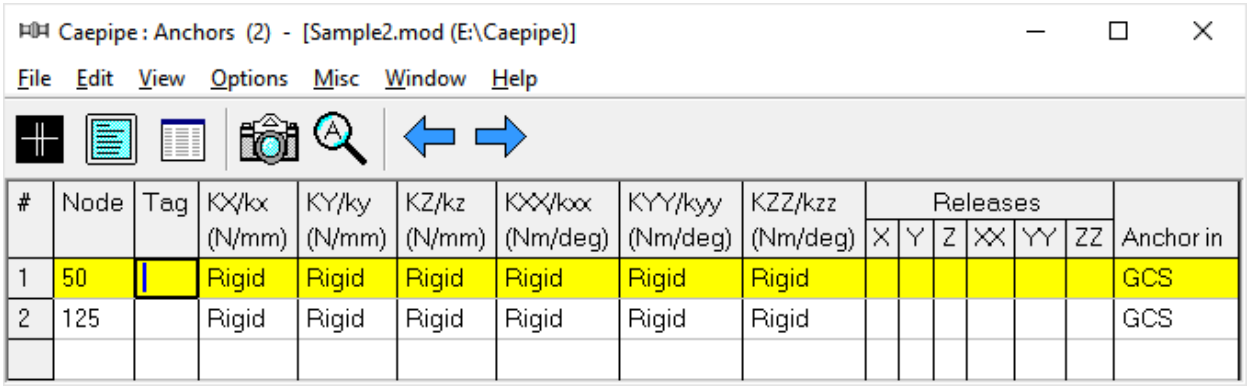
List

One of the useful features of CAEPIPE is the ability to show a list of all like items such as anchors, bends etc. in a separate List window. Click on the List button (or press Ctrl+L) to show the list dialog.



Click on an item of interest to show the list for that item.

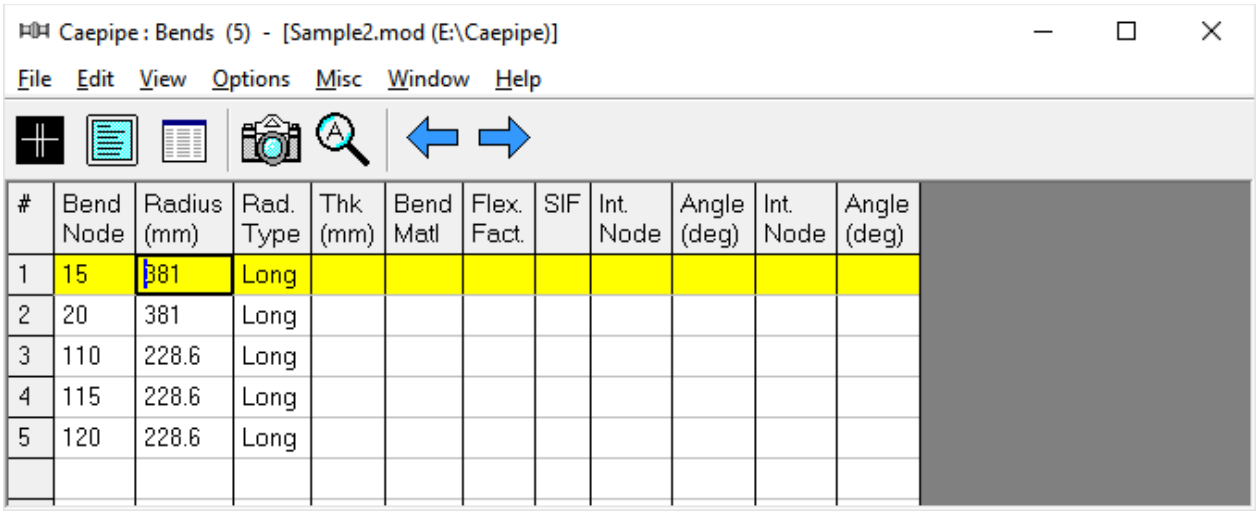
A list of all the anchors present in this sample model is shown below:



#	Node	Tag	KX/kx (N/mm)	KY/ky (N/mm)	KZ/kz (N/mm)	KXX/kxx (Nm/deg)	KYY/kyy (Nm/deg)	KZZ/kzz (Nm/deg)	Releases						Anchor in
									X	Y	Z	XX	YY	ZZ	
1	50		Rigid	Rigid	Rigid	Rigid	Rigid	Rigid							GCS
2	125		Rigid	Rigid	Rigid	Rigid	Rigid	Rigid							GCS

The highlighted item can be edited directly in the List window (in most cases) or in a dialog by pressing Ctrl+E. The items can be deleted by pressing Ctrl+X. The item is also highlighted in the graphics window by flashing and with a box around the node number.

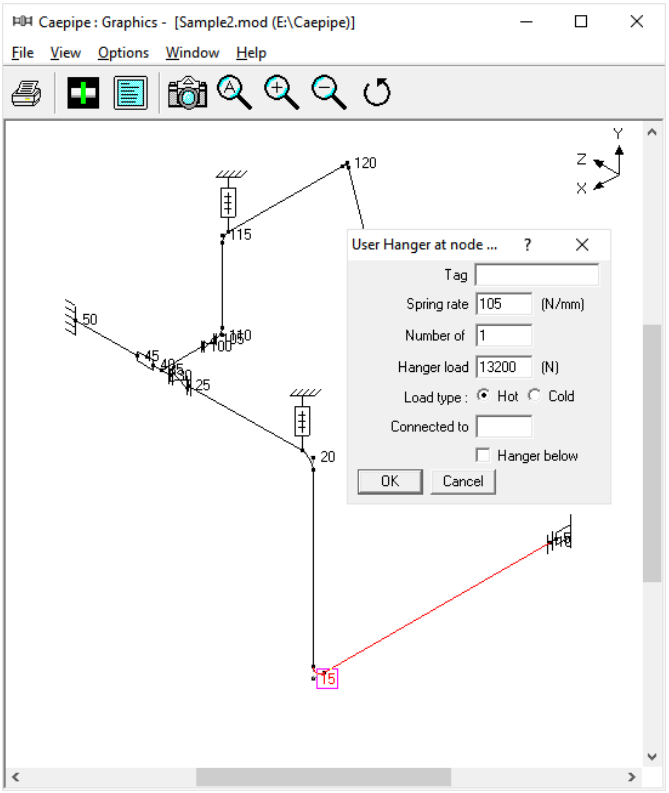
A list of all the bends in the sample model is shown below:



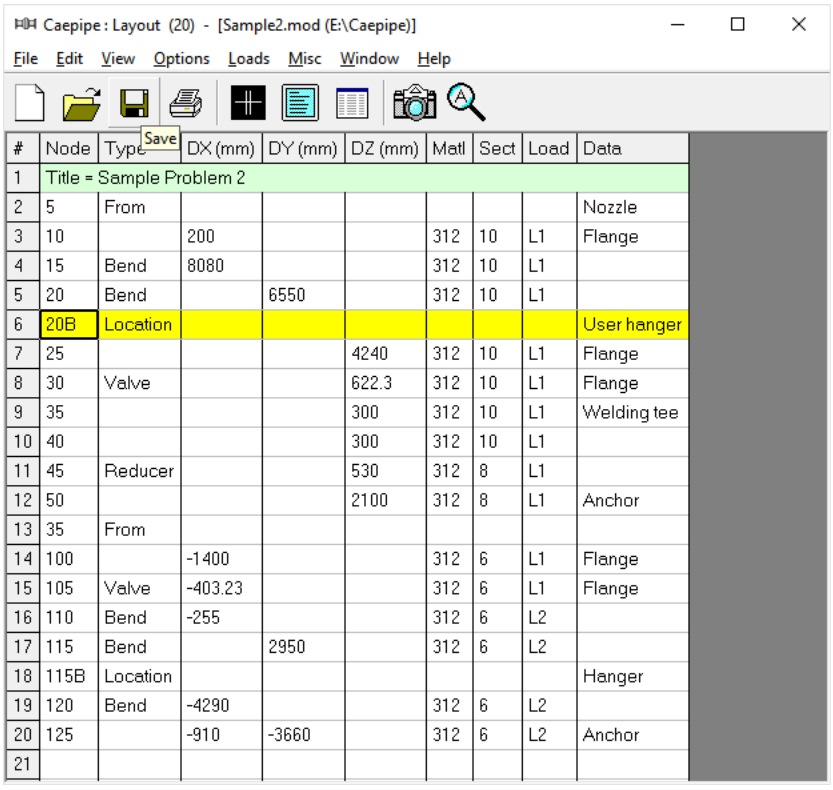
#	Bend Node	Radius (mm)	Rad. Type	Thk (mm)	Bend Matl	Flex. Fact.	SIF	Int. Node	Angle (deg)	Int. Node	Angle (deg)
1	15	381	Long								
2	20	381	Long								
3	110	228.6	Long								
4	115	228.6	Long								
5	120	228.6	Long								

Editing in the Graphics Window

Another useful feature is the ability to edit an item in the graphics window. When an item such as a Hanger is clicked in the graphics window, a dialog box for that item is opened, where it can be modified.



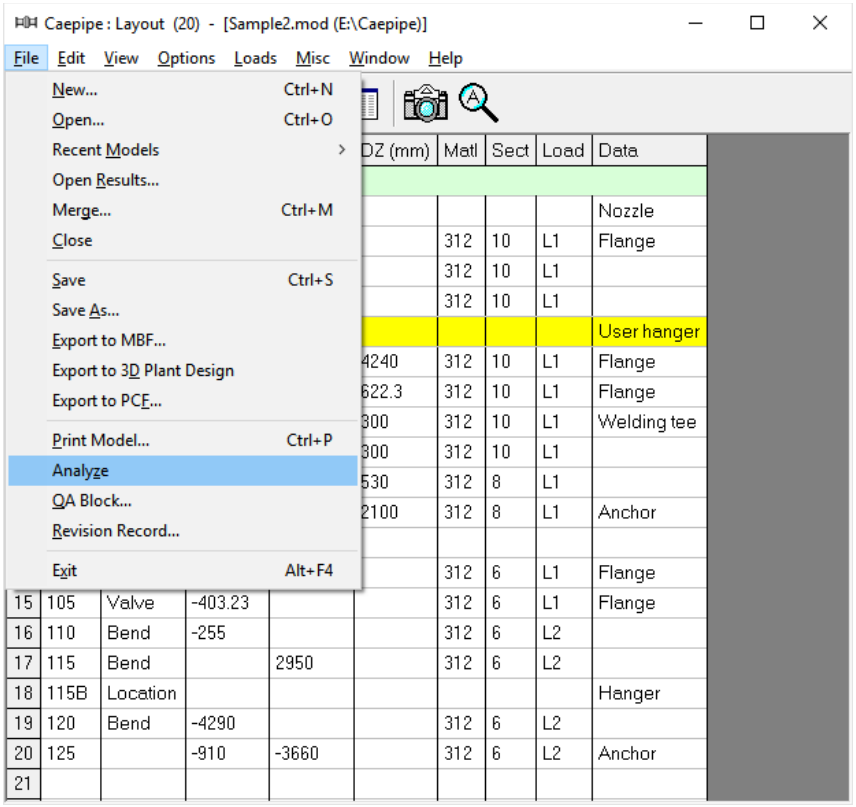
Save the model by clicking on the Save button.



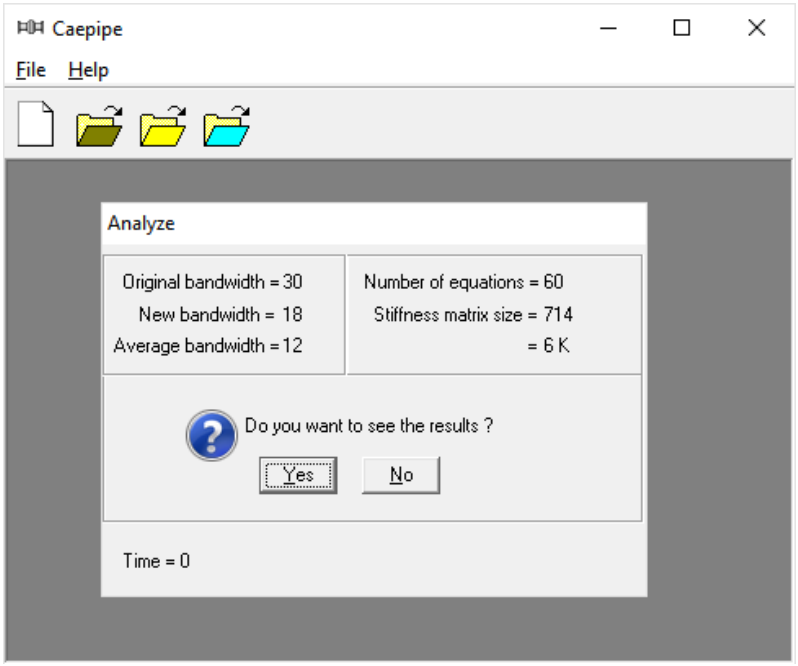
#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
1	Title = Sample Problem 2								
2	5	From							Nozzle
3	10		200			312	10	L1	Flange
4	15	Bend	8080			312	10	L1	
5	20	Bend		6550		312	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13	35	From							
14	100		-1400			312	6	L1	Flange
15	105	Valve	-403.23			312	6	L1	Flange
16	110	Bend	-255			312	6	L2	
17	115	Bend		2950		312	6	L2	
18	115B	Location							Hanger
19	120	Bend	-4290			312	6	L2	
20	125		-910	-3660		312	6	L2	Anchor
21									

6. Analyze

Click on Analyze under the File menu.

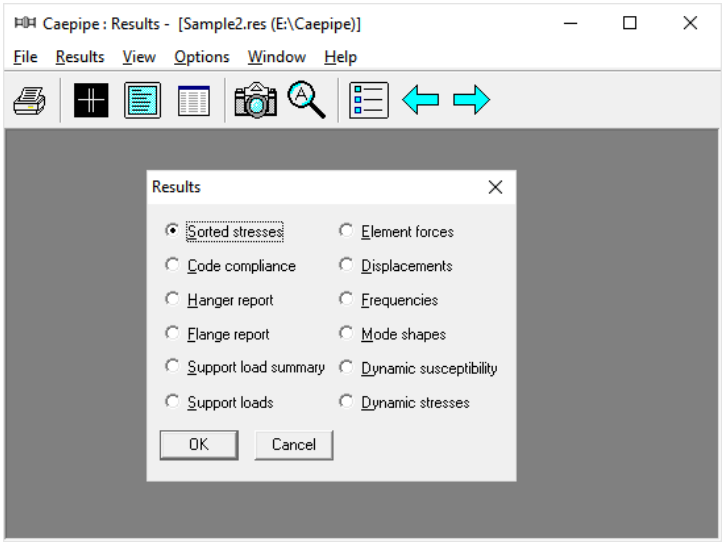


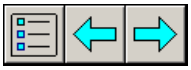
After the analysis, you are asked if you want to see the results. Select Yes.



7. View Results

After finishing the analysis and choosing to see the results or by opening the results file (.res), the results window is displayed. The Results dialog is opened automatically.



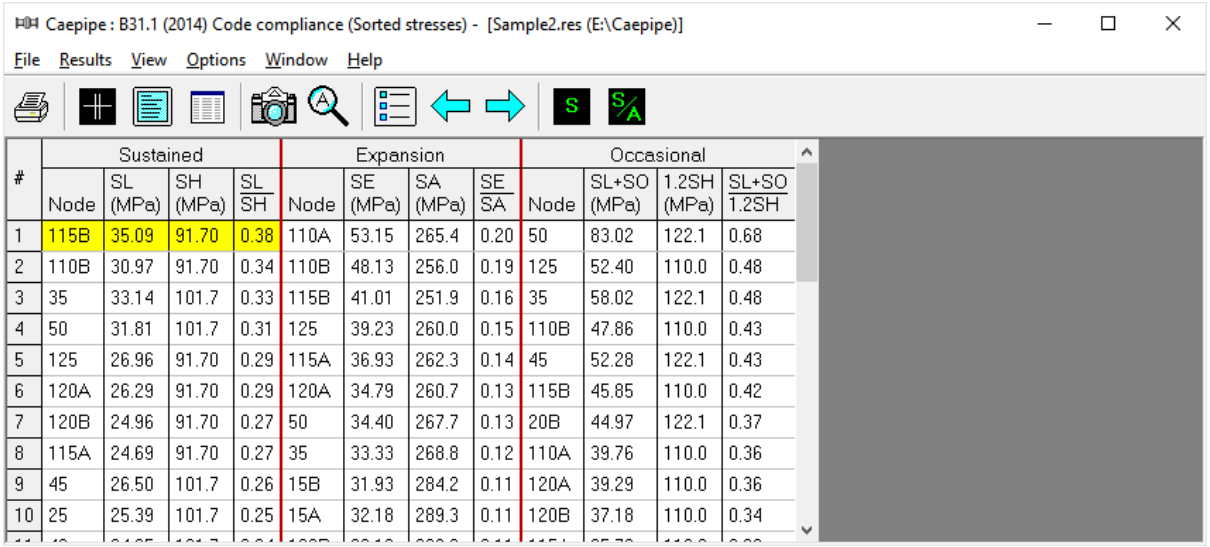


Select an item of interest by clicking on it. When you are viewing the results, use Tab (or Next Result button) to view the next result and Shift+Tab (or Previous Result button) to view the previous result. The Results dialog can be brought up by clicking on the Results button (or press Ctrl+R).

While viewing the results, the model data can also be simultaneously viewed in separate Layout and List windows. These are now "read only" windows, i.e. the model data can not be modified while viewing the results. Some of the results from the sample problem are shown below:

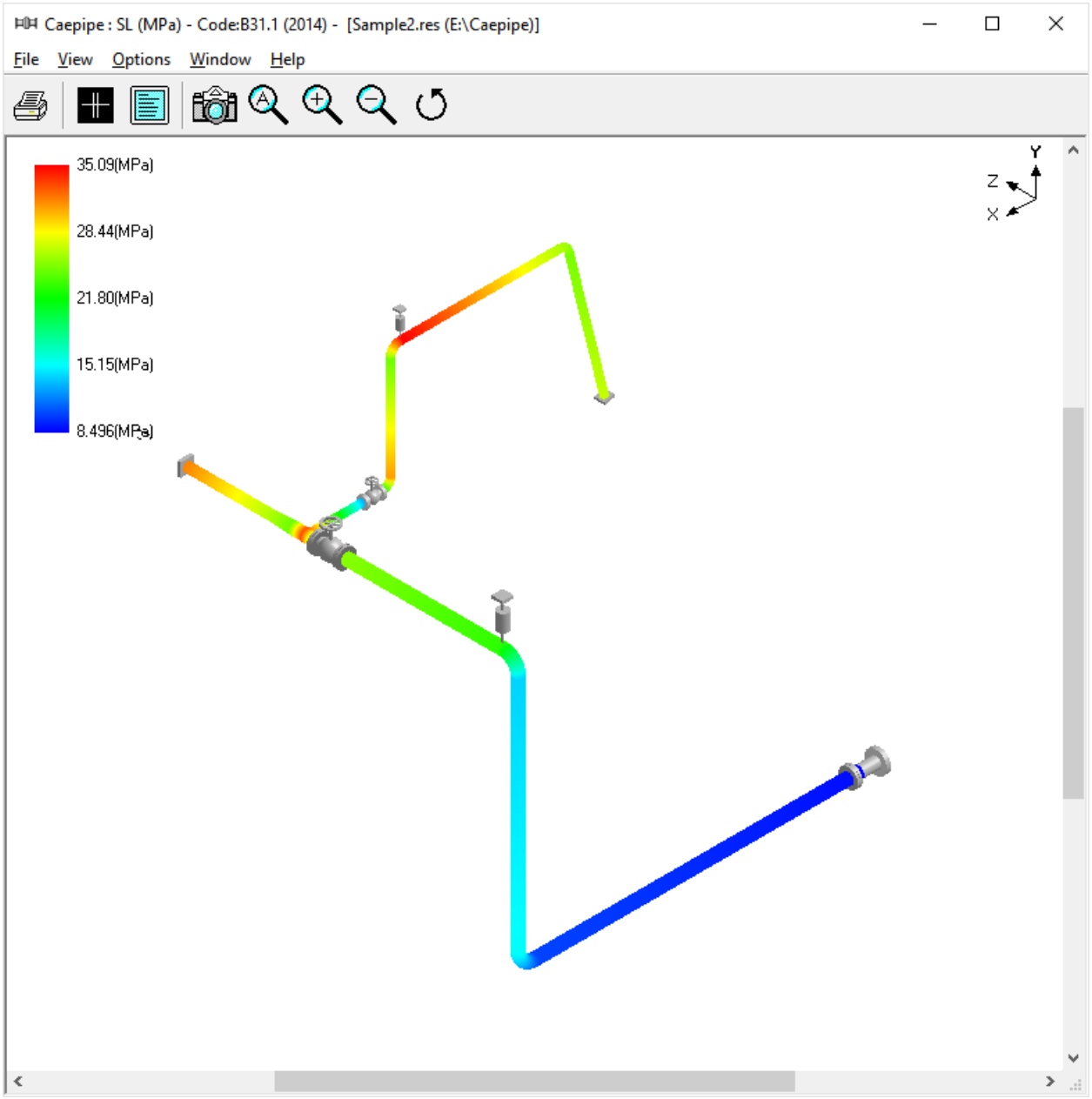
Sorted Stresses

The computed stresses (sustained, expansion and occasional) are sorted in descending order by stress ratios.



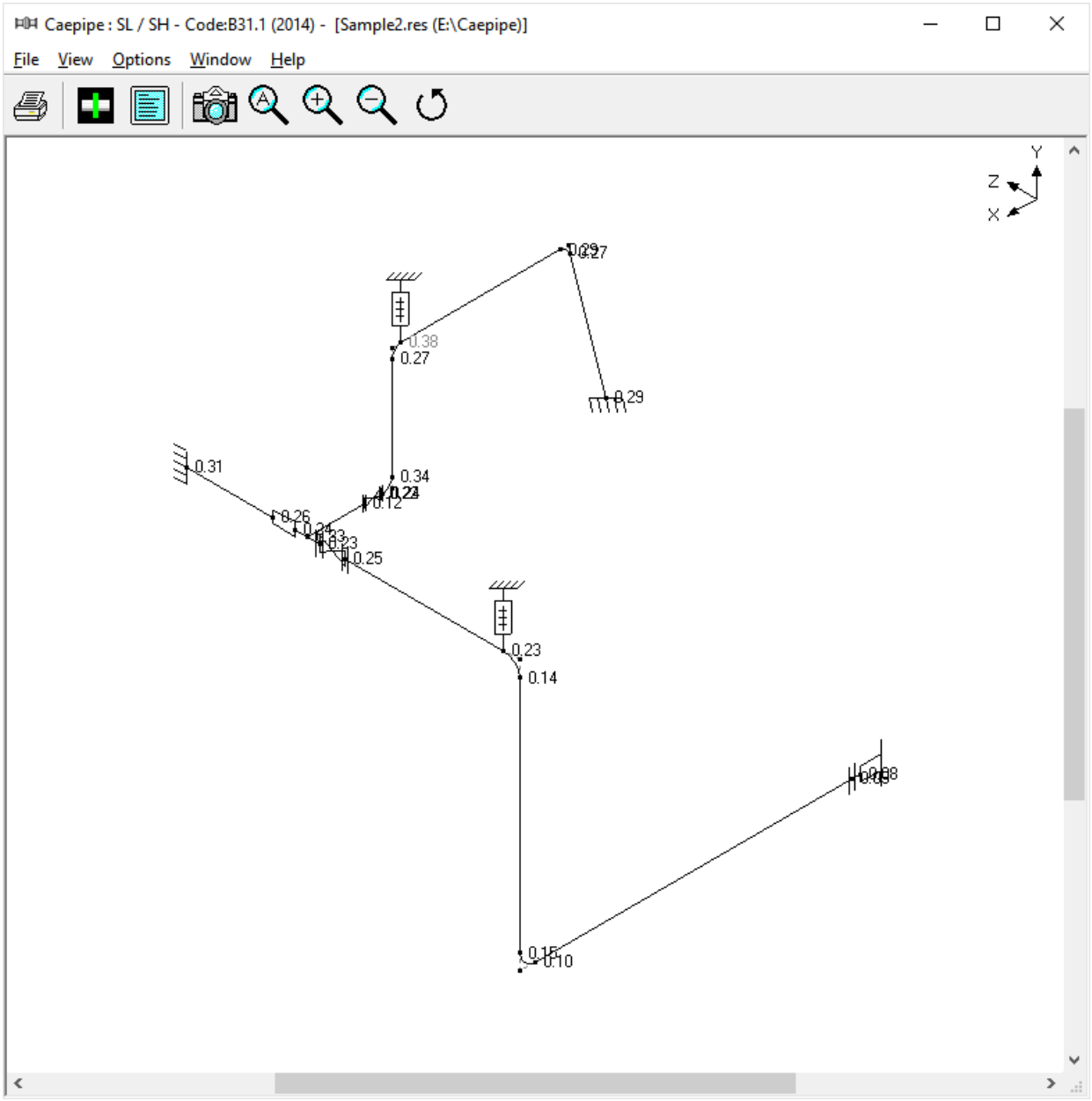
#	Sustained				Expansion				Occasional			
	Node	SL (MPa)	SH (MPa)	SL/SH	Node	SE (MPa)	SA (MPa)	SE/SA	Node	SL+SO (MPa)	1.2SH (MPa)	SL+SO/1.2SH
1	115B	35.09	91.70	0.38	110A	53.15	265.4	0.20	50	83.02	122.1	0.68
2	110B	30.97	91.70	0.34	110B	48.13	256.0	0.19	125	52.40	110.0	0.48
3	35	33.14	101.7	0.33	115B	41.01	251.9	0.16	35	58.02	122.1	0.48
4	50	31.81	101.7	0.31	125	39.23	260.0	0.15	110B	47.86	110.0	0.43
5	125	26.96	91.70	0.29	115A	36.93	262.3	0.14	45	52.28	122.1	0.43
6	120A	26.29	91.70	0.29	120A	34.79	260.7	0.13	115B	45.85	110.0	0.42
7	120B	24.96	91.70	0.27	50	34.40	267.7	0.13	20B	44.97	122.1	0.37
8	115A	24.69	91.70	0.27	35	33.33	268.8	0.12	110A	39.76	110.0	0.36
9	45	26.50	101.7	0.26	15B	31.93	284.2	0.11	120A	39.29	110.0	0.36
10	25	25.39	101.7	0.25	15A	32.18	289.3	0.11	120B	37.18	110.0	0.34

Color coded stresses may be rendered in the graphics window by pressing the Show stresses button (or choose View > Show Stresses). The stresses in the highlighted columns (the bar highlights three columns simultaneously) are displayed in the graphics window. Use the left and right arrow keys to change the highlighted columns or click in a particular column.

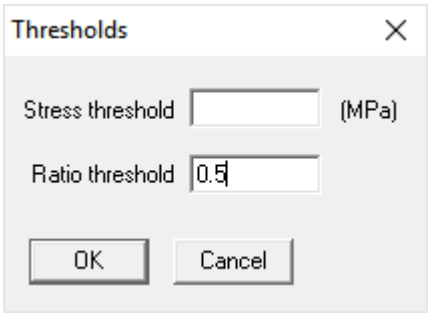


The stress ratios may similarly be rendered by using the Show stress ratios button (or choose View > Show Stress Ratios).

Instead of rendering color coded stresses/ratios, the values of stresses/stress ratios may be plotted by using the menu: View > No color coding and pressing the icon S or S/A.

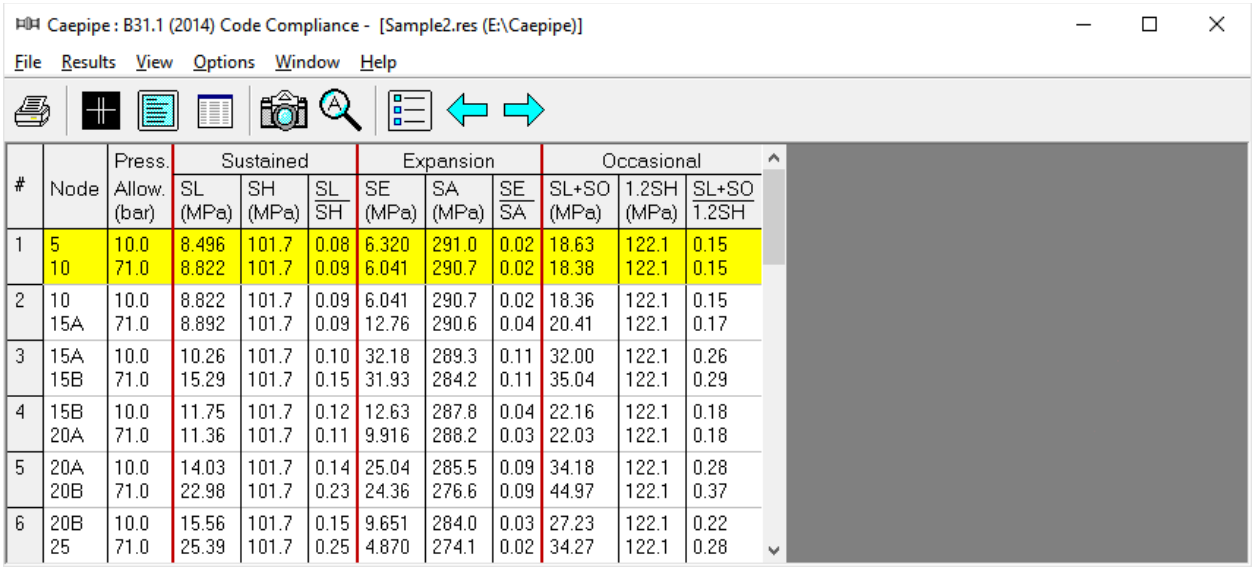


While plotting stresses or stress ratios, thresholds may be specified from the graphics window (choose View > Thresholds). Only the stresses or stress ratios exceeding the thresholds are plotted.



Code compliance

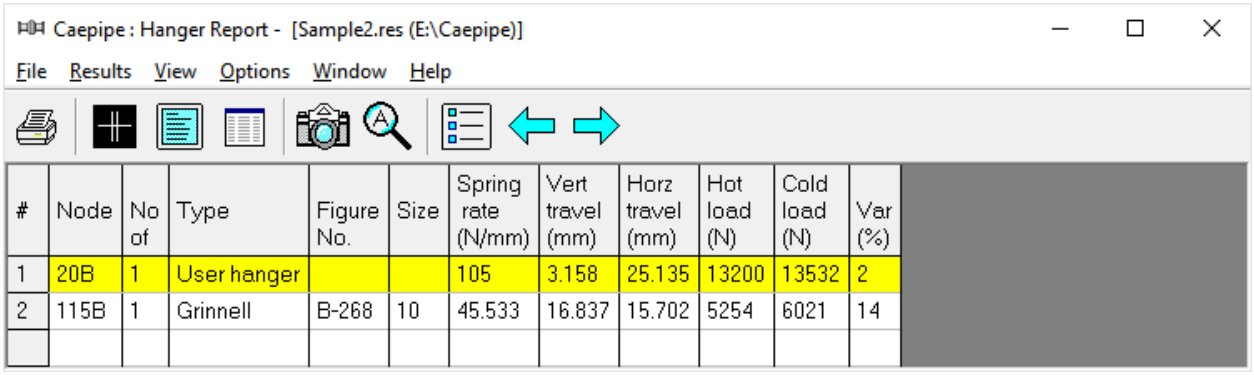
The element stresses calculated according to the piping code are shown under code compliance.



#	Node	Press. Allow. (bar)	Sustained SL (MPa)	Sustained SH (MPa)	Sustained SL/SH	Expansion SE (MPa)	Expansion SA (MPa)	Expansion SE/SA	Occasional SL+SO (MPa)	Occasional 1.2SH (MPa)	Occasional SL+SO/1.2SH
1	5	10.0	8.496	101.7	0.08	6.320	291.0	0.02	18.63	122.1	0.15
	10	71.0	8.822	101.7	0.09	6.041	290.7	0.02	18.38	122.1	0.15
2	10	10.0	8.822	101.7	0.09	6.041	290.7	0.02	18.36	122.1	0.15
	15A	71.0	8.892	101.7	0.09	12.76	290.6	0.04	20.41	122.1	0.17
3	15A	10.0	10.26	101.7	0.10	32.18	289.3	0.11	32.00	122.1	0.26
	15B	71.0	15.29	101.7	0.15	31.93	284.2	0.11	35.04	122.1	0.29
4	15B	10.0	11.75	101.7	0.12	12.63	287.8	0.04	22.16	122.1	0.18
	20A	71.0	11.36	101.7	0.11	9.916	288.2	0.03	22.03	122.1	0.18
5	20A	10.0	14.03	101.7	0.14	25.04	285.5	0.09	34.18	122.1	0.28
	20B	71.0	22.98	101.7	0.23	24.36	276.6	0.09	44.97	122.1	0.37
6	20B	10.0	15.56	101.7	0.15	9.651	284.0	0.03	27.23	122.1	0.22
	25	71.0	25.39	101.7	0.25	4.870	274.1	0.02	34.27	122.1	0.28

Hanger report

The hanger report is shown below.



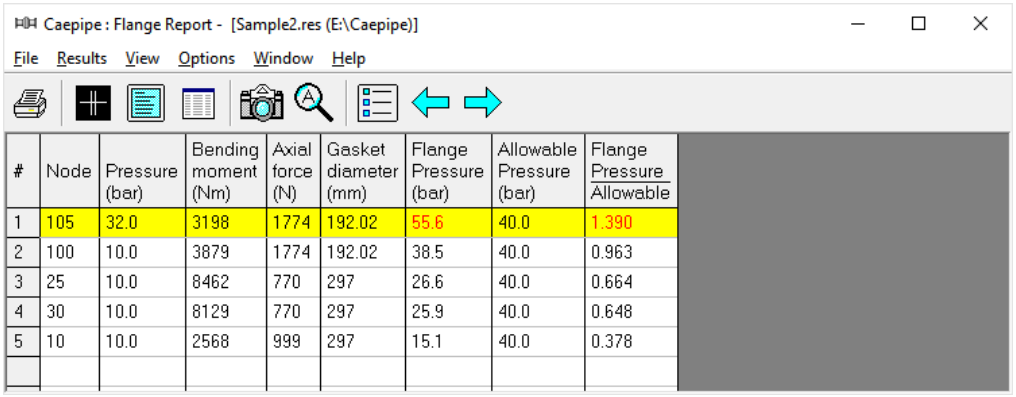
#	Node	No of	Type	Figure No.	Size	Spring rate (N/mm)	Vert travel (mm)	Horz travel (mm)	Hot load (N)	Cold load (N)	Var (%)
1	20B	1	User hanger			105	3.158	25.135	13200	13532	2
2	115B	1	Grinnell	B-268	10	45.533	16.837	15.702	5254	6021	14

The "No of" field shows the number of hangers required at the indicated location. The Figure No. and Size refer to the manufacturer's catalog. The vertical travel is the vertical deflection at the hanger location for the first operating load case. Similarly, the horizontal travel is the resultant horizontal deflection at the hanger location for the first operating case. The hot load is the hanger load for the operating condition and the cold load is the hanger load at zero deflection.

Variability(%) = (Spring rate × Hanger travel / Hot load) × 100

Flange Report

CAEPIPE lists every flange in a model in the flange report. The "Flange Pressure" is an equivalent pressure calculated from the actual pressure in the piping element, the bending moment and the axial force on the flange from the first operating case (W+P1+T1).



#	Node	Pressure (bar)	Bending moment (Nm)	Axial force (N)	Gasket diameter (mm)	Flange Pressure (bar)	Allowable Pressure (bar)	Flange Pressure / Allowable
1	105	32.0	3198	1774	192.02	55.6	40.0	1.390
2	100	10.0	3879	1774	192.02	38.5	40.0	0.963
3	25	10.0	8462	770	297	26.6	40.0	0.664
4	30	10.0	8129	770	297	25.9	40.0	0.648
5	10	10.0	2568	999	297	15.1	40.0	0.378

The Flange report in the CAEPIPE results window shows the loads at each flange location for the operating case (W+P1+T1).

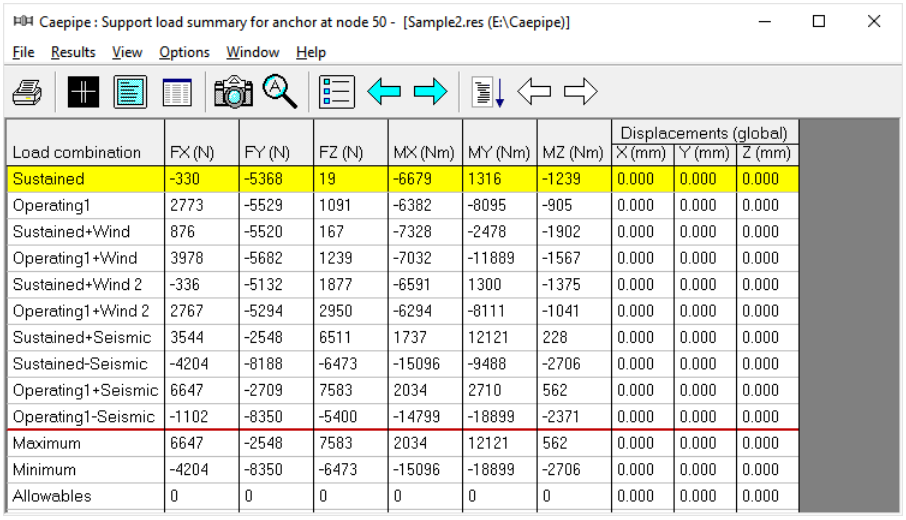
The "equivalent" flange pressure is the sum of three terms from the flange equation as shown in Flange Report section above. The last column shows a ratio of this equivalent flange pressure to a user-input allowable pressure. This ratio is flagged in red when more than 1.0.

Support load summary

Support load summary for each support is created by considering all the load cases and appropriate combinations and then showing the maximum and minimum loads.

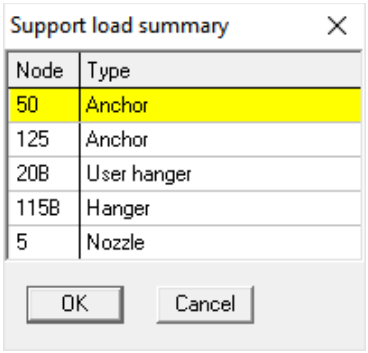
Note: Allowable loads at equipment nozzle can be calculated using the module "Nozzle Allowable loads" available in CAEPIPE through Main Frame > New > Nozzle Allowable Loads.

The allowable loads thus calculated can then be entered as "User Allowables" in CAEPIPE Stress Model through Layout window > Misc. See the CAEPIPE tutorial titled "*Tutorial on Qualification of Nozzles to Equipment using CAEPIPE*" for more details.



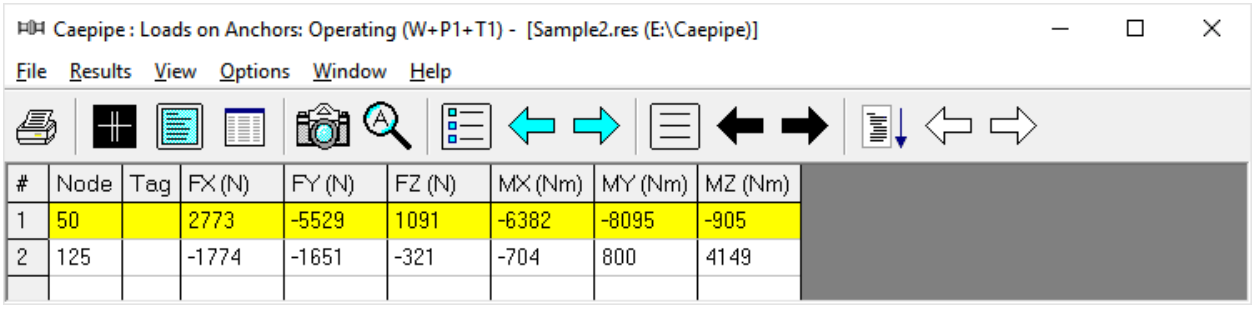
Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	Displacements (global) X (mm)	Y (mm)	Z (mm)
Sustained	-330	-5368	19	-6679	1316	-1239	0.000	0.000	0.000
Operating1	2773	-5529	1091	-6382	-8095	-905	0.000	0.000	0.000
Sustained+Wind	876	-5520	167	-7328	-2478	-1902	0.000	0.000	0.000
Operating1+Wind	3978	-5682	1239	-7032	-11889	-1567	0.000	0.000	0.000
Sustained+Wind 2	-336	-5132	1877	-6591	1300	-1375	0.000	0.000	0.000
Operating1+Wind 2	2767	-5294	2950	-6294	-8111	-1041	0.000	0.000	0.000
Sustained+Seismic	3544	-2548	6511	1737	12121	228	0.000	0.000	0.000
Sustained-Seismic	-4204	-8188	-6473	-15096	-9488	-2706	0.000	0.000	0.000
Operating1+Seismic	6647	-2709	7583	2034	2710	562	0.000	0.000	0.000
Operating1-Seismic	-1102	-8350	-5400	-14799	-18899	-2371	0.000	0.000	0.000
Maximum	6647	-2548	7583	2034	12121	562	0.000	0.000	0.000
Minimum	-4204	-8350	-6473	-15096	-18899	-2706	0.000	0.000	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Use the Other supports button (F6), Next support button (Ctrl+Right arrow) or Previous support button (Ctrl+Left arrow) to see loads on other supports (e.g. other anchors, hangers etc.).



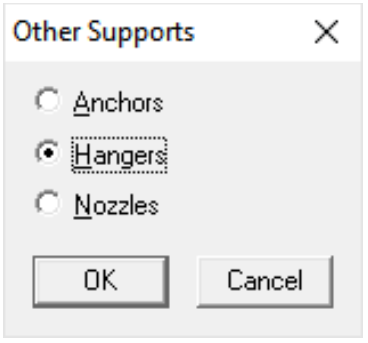
Support loads

Support loads are the loads acting on all the supports of each support type for a specific loading case. The loads on anchors for the Operating case are shown below.

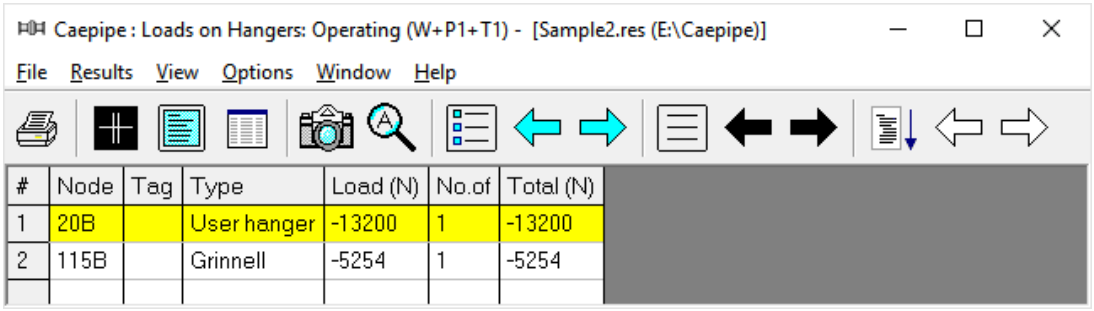


Use the Load cases button, Next load case button(Right arrow) or Previous load case button (Left arrow) to see loads for different load cases(e.g. Sustained, Expansion etc.).

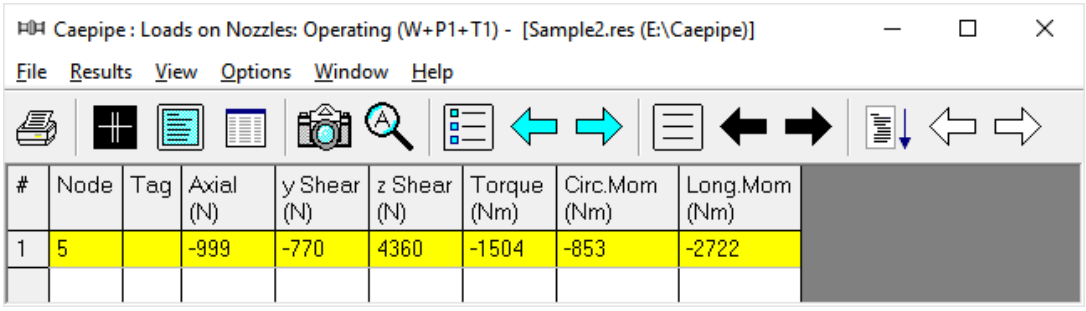
Use the Other supports button (F6), Next support button(Ctrl+Right arrow) or Previous support button (Ctrl+Left arrow) to see loads on supports of different types (e.g. other anchors, hangers etc.).



The loads on hangers and nozzle (i.e. the loads acting at the hanger locations imposed by the piping system) for the Operating case are shown below.



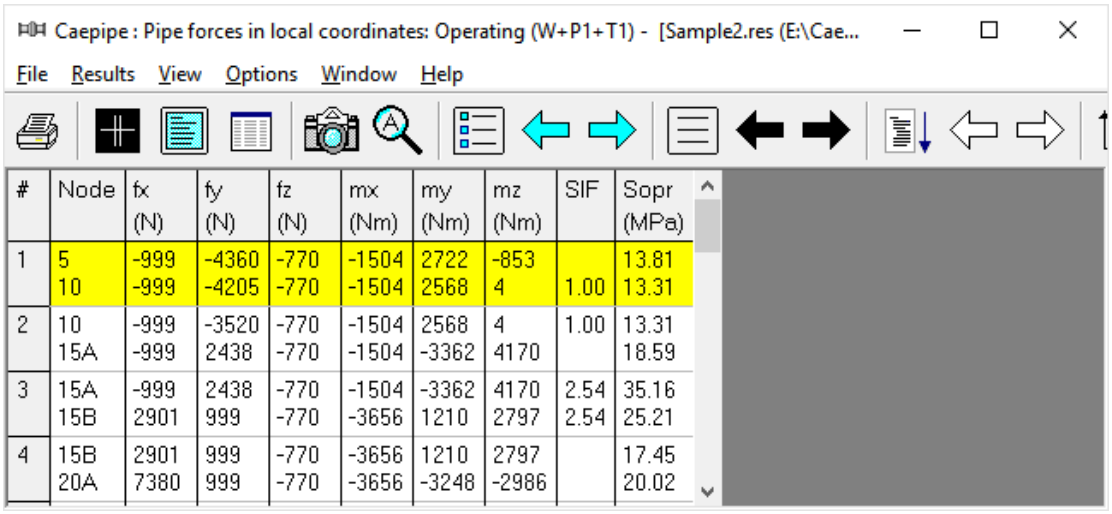
#	Node	Tag	Type	Load (N)	No.of	Total (N)
1	20B		User hanger	-13200	1	-13200
2	115B		Grinnell	-5254	1	-5254



#	Node	Tag	Axial (N)	y Shear (N)	z Shear (N)	Torque (Nm)	Circ.Mom (Nm)	Long.Mom (Nm)
1	5		-999	-770	4360	-1504	-853	-2722

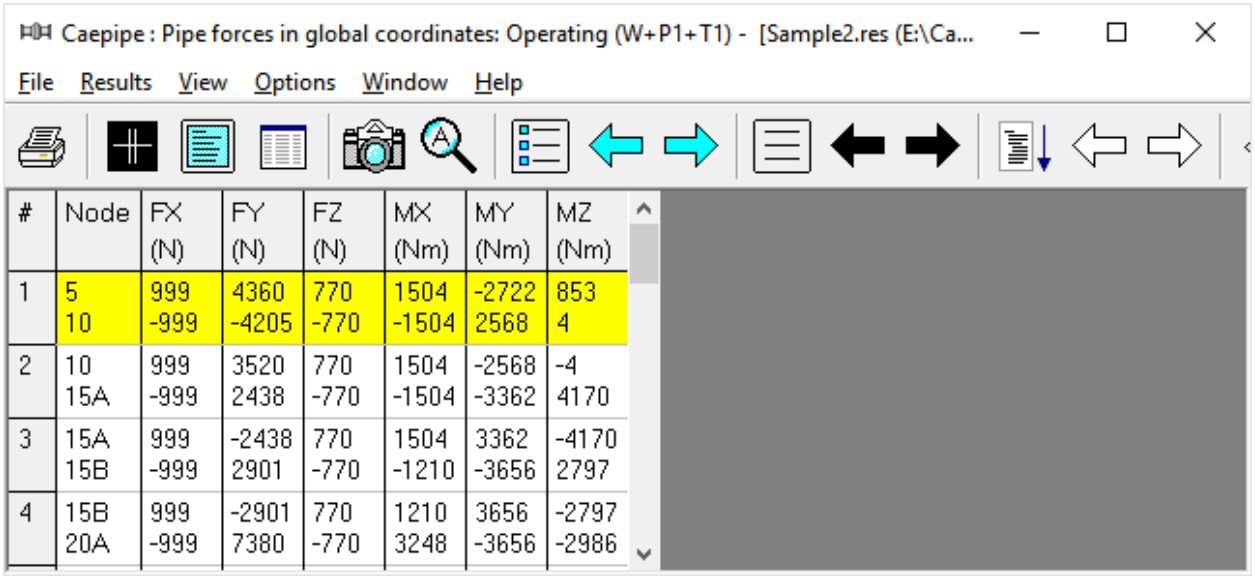
Element Forces

The element forces in local and global coordinates are shown. For pipe (also bend and reducer) element forces in local coordinates, the stress intensification factors (SIFs) and stresses are also shown.



#	Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	Sopr (MPa)
1	5 10	-999 -999	-4360 -4205	-770 -770	-1504 -1504	2722 2568	-853 4	1.00	13.81 13.31
2	10 15A	-999 -999	-3520 2438	-770 -770	-1504 -1504	2568 -3362	4 4170	1.00	13.31 18.59
3	15A 15B	-999 2901	2438 999	-770 -770	-1504 -3656	-3362 1210	4170 2797	2.54 2.54	35.16 25.21
4	15B 20A	2901 7380	999 999	-770 -770	-3656 -3656	1210 -3248	2797 -2986		17.45 20.02

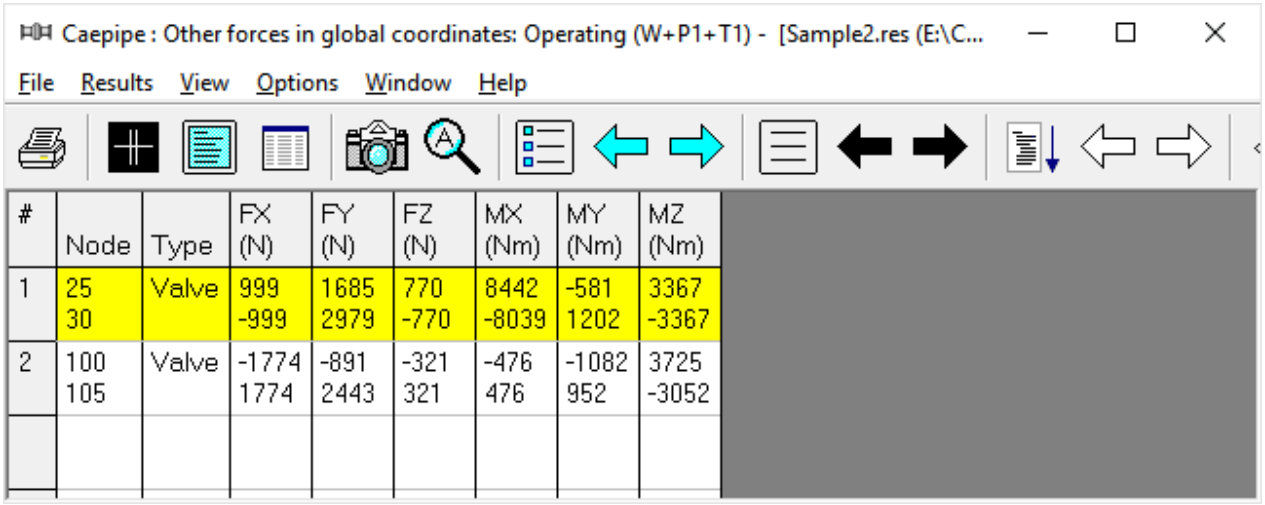
Use the Global forces button (F7) to see the element forces in global coordinates.



#	Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
1	5 10	999 -999	4360 -4205	770 -770	1504 -1504	-2722 2568	853 4
2	10 15A	999 -999	3520 2438	770 -770	1504 -1504	-2568 -3362	-4 4170
3	15A 15B	999 -999	-2438 2901	770 -770	1504 -1210	3362 -3656	-4170 2797
4	15B 20A	999 -999	-2901 7380	770 -770	1210 3248	3656 -3656	-2797 -2986


Use the Local forces button (F7) to see the element forces in local coordinates again.


Use the Other forces button (F6), Next force button (Ctrl+Right arrow) or Previous force button (Ctrl+Left arrow) to see other element forces(e.g. valves, bellows etc.).



#	Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
1	25 30	Valve	999 -999	1685 2979	770 -770	8442 -8039	-581 1202	3367 -3367
2	100 105	Valve	-1774 1774	-891 2443	-321 321	-476 476	-1082 952	3725 -3052

Displacements

The nodal displacements are shown.

Caepipe : Displacements: Operating (W+P1+T1) - [Sample2.res (E:\Caepipe)]

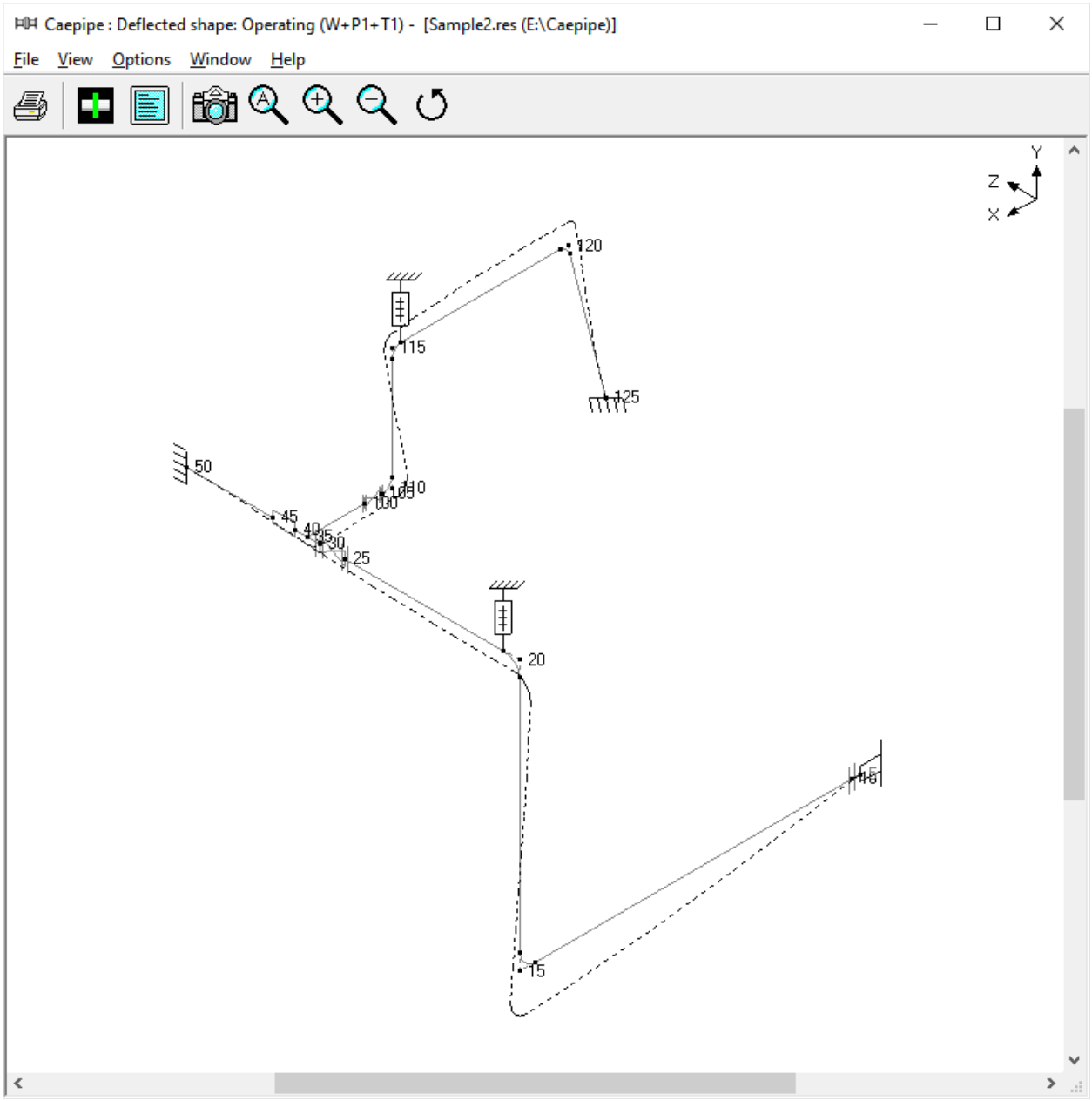
File Results View Options Window Help

#	Node	Displacements (global)					
		X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
1	5	-0.024	0.000	0.000	0.0000	0.0995	-0.1960
2	10	0.533	-0.688	-0.352	-0.0017	0.1018	-0.1963
3	15A	21.978	-15.229	-15.393	-0.0679	0.0883	0.0036
4	15B	22.688	-13.955	-16.274	-0.0645	0.0535	0.0749
5	20A	13.980	2.191	-22.450	-0.0386	-0.0673	0.0725
6	20B	13.074	3.158	-21.467	0.0553	-0.0914	0.0536
7	25	5.769	-0.926	-10.718	0.0223	-0.1142	-0.0206
8	30	4.531	-1.134	-8.993	0.0160	-0.1136	-0.0238
9	35	3.939	-1.187	-8.157	0.0062	-0.1118	-0.0296
10	40	3.352	-1.191	-7.322	-0.0028	-0.1113	-0.0281

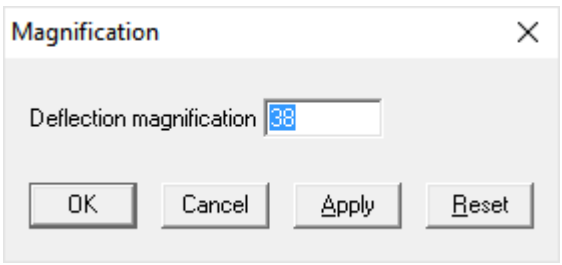
Use the Load cases button, Next load case button (Right arrow) or Previous load case button (Left arrow) to see displacements for different load cases (for example, Sustained, Expansion etc.).

Use the Deflected shape button (or View > Show deflected shape) to plot the deflected shape in the graphics window.

Use the Animated deflected shape button (or View > Show animated deflected shape) to plot the animated deflected shape in the graphics window.

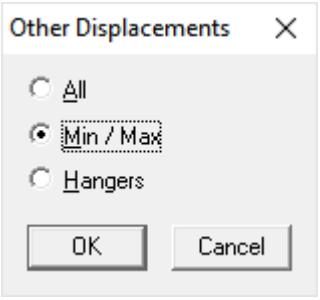


Choose View > Magnification to change the magnification of the deflected shape.

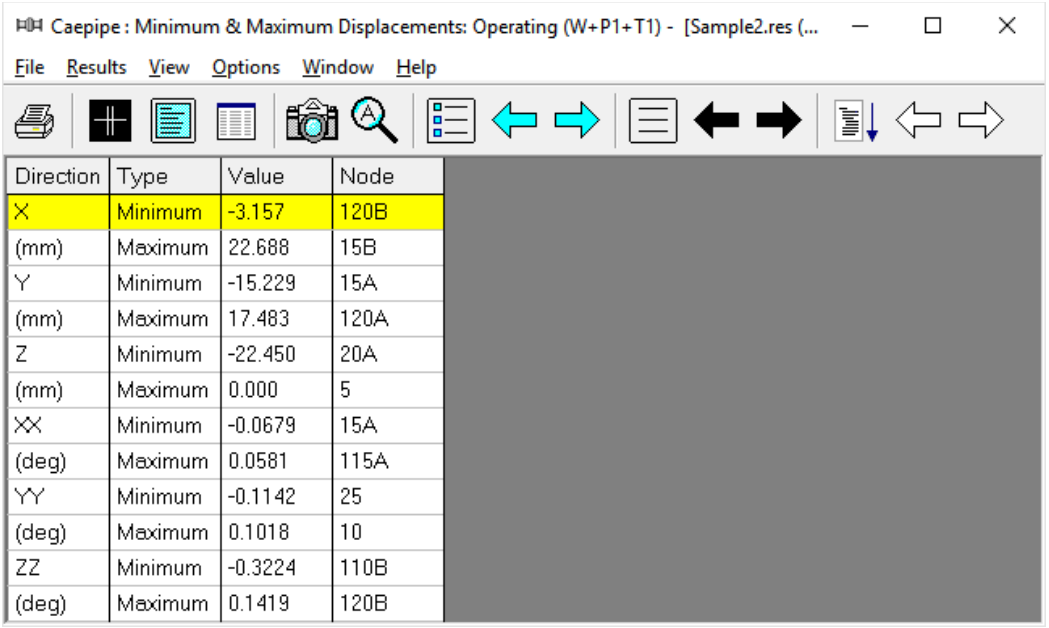


The reset button is used to calculate a default magnification factor which scales the maximum deflection to about 5% of the width of the graphics window.

Use the Other displacements button (F6), Next displacement button (Ctrl+Right arrow) or Previous displacement button (Ctrl+Left arrow) to see other displacements (e.g. Min/Max, displacements at hangers, flex joints, limit stops etc.).

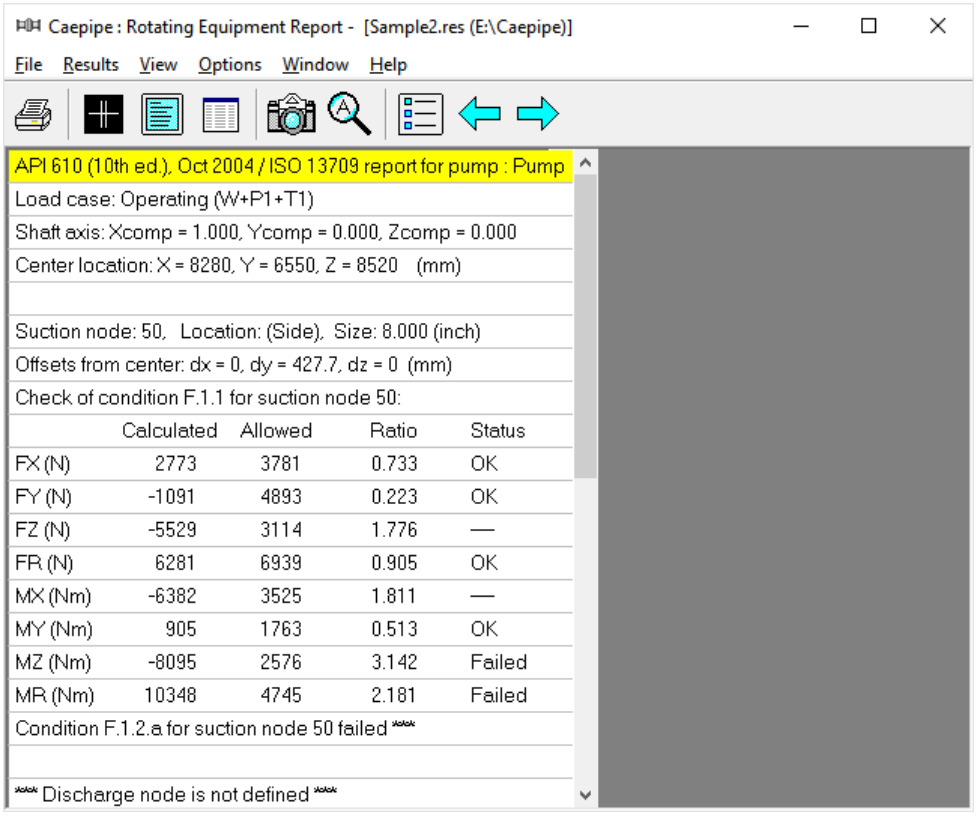


The minimum and maximum displacements for each of the directions and the corresponding nodes are shown below.



Direction	Type	Value	Node
X	Minimum	-3.157	120B
(mm)	Maximum	22.688	15B
Y	Minimum	-15.229	15A
(mm)	Maximum	17.483	120A
Z	Minimum	-22.450	20A
(mm)	Maximum	0.000	5
XX	Minimum	-0.0679	15A
(deg)	Maximum	0.0581	115A
YY	Minimum	-0.1142	25
(deg)	Maximum	0.1018	10
ZZ	Minimum	-0.3224	110B
(deg)	Maximum	0.1419	120B

The Pump qualification report (Rotating Equipment report) is shown below.



Caepipe : Rotating Equipment Report - [Sample2.res (E:\Caepipe)]

File Results View Options Window Help

API 610 (10th ed.), Oct 2004 / ISO 13709 report for pump : Pump

Load case: Operating (W+P1+T1)

Shaft axis: Xcomp = 1.000, Ycomp = 0.000, Zcomp = 0.000

Center location: X = 8280, Y = 6550, Z = 8520 (mm)

Suction node: 50, Location: (Side), Size: 8.000 (inch)

Offsets from center: dx = 0, dy = 427.7, dz = 0 (mm)

Check of condition F.1.1 for suction node 50:

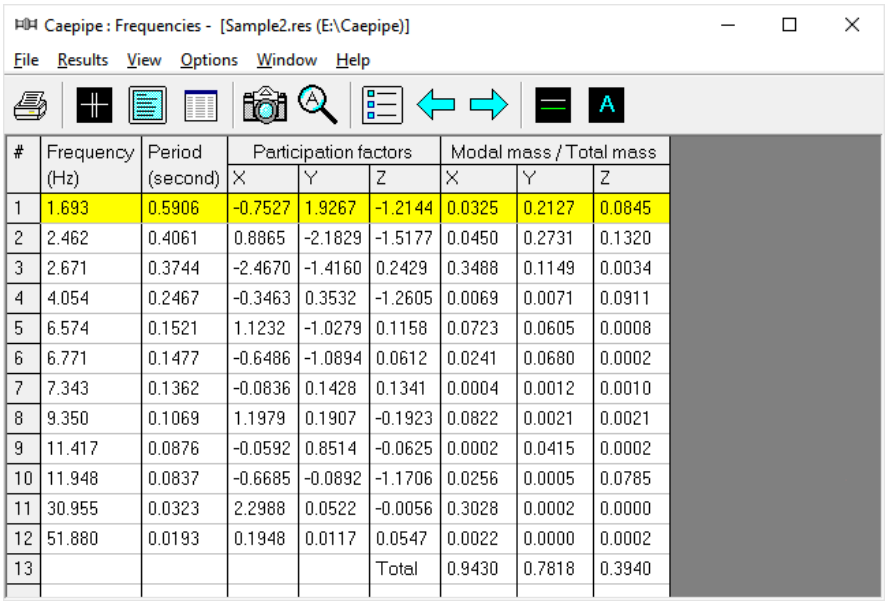
	Calculated	Allowed	Ratio	Status
FX (N)	2773	3781	0.733	OK
FY (N)	-1091	4893	0.223	OK
FZ (N)	-5529	3114	1.776	—
FR (N)	6281	6939	0.905	OK
MX (Nm)	-6382	3525	1.811	—
MY (Nm)	905	1763	0.513	OK
MZ (Nm)	-8095	2576	3.142	Failed
MR (Nm)	10348	4745	2.181	Failed

Condition F.1.2.a for suction node 50 failed ***

*** Discharge node is not defined ***

Frequencies

A list of natural frequencies, periods, modal participation factors and modal mass fractions is shown next. You can show each frequency's mode shape graphically or animate it by clicking on Show mode shape or Show animated mode shape button in the toolbar.

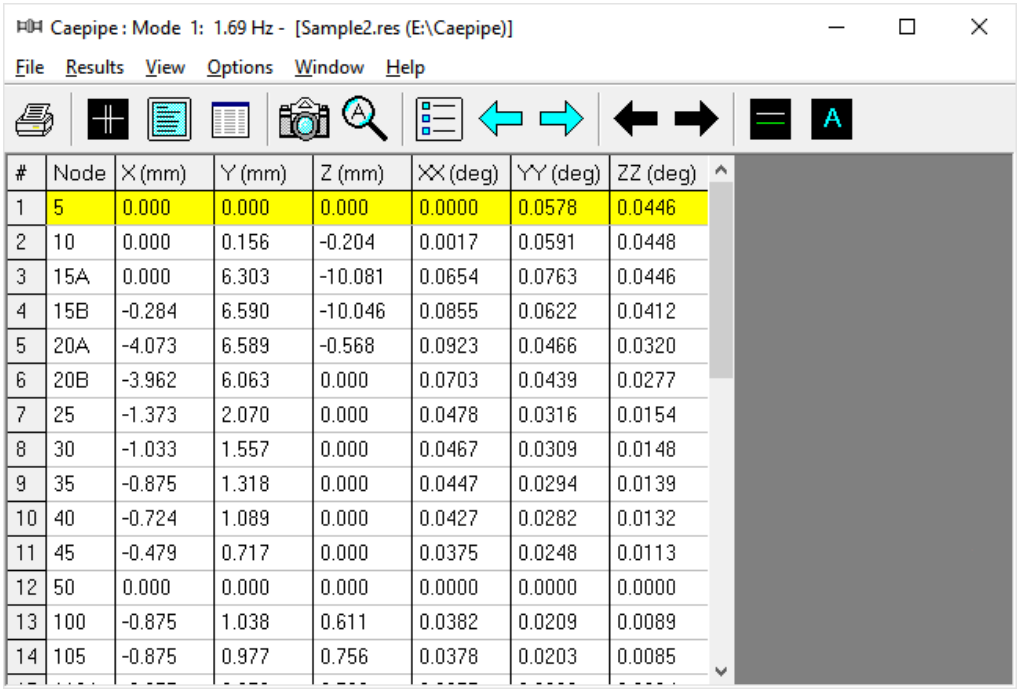


Caepipe : Frequencies - [Sample2.res (E:\Caepipe)]

File Results View Options Window Help

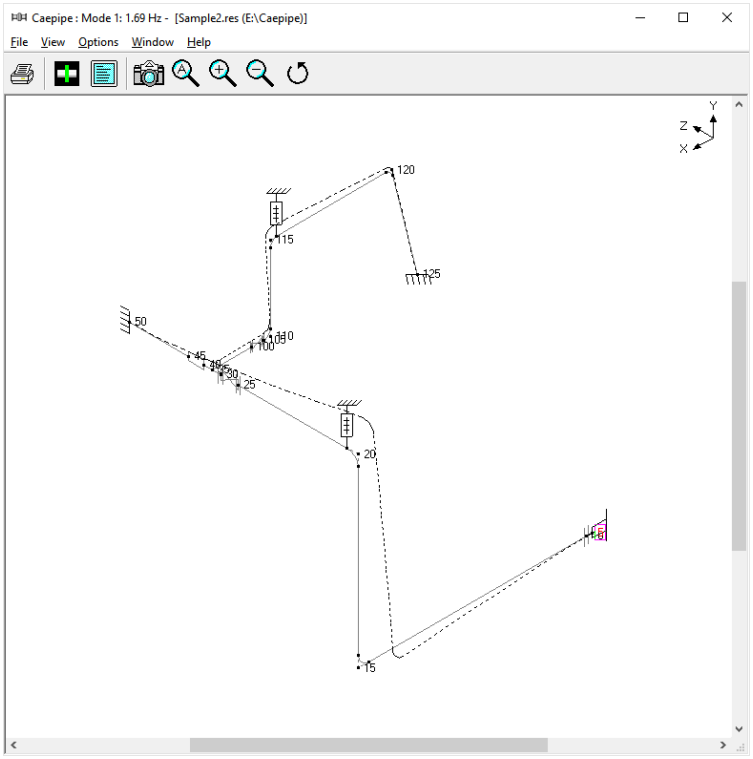
#	Frequency (Hz)	Period (second)	Participation factors			Modal mass / Total mass		
			X	Y	Z	X	Y	Z
1	1.693	0.5906	-0.7527	1.9267	-1.2144	0.0325	0.2127	0.0845
2	2.462	0.4061	0.8865	-2.1829	-1.5177	0.0450	0.2731	0.1320
3	2.671	0.3744	-2.4670	-1.4160	0.2429	0.3488	0.1149	0.0034
4	4.054	0.2467	-0.3463	0.3532	-1.2605	0.0069	0.0071	0.0911
5	6.574	0.1521	1.1232	-1.0279	0.1158	0.0723	0.0605	0.0008
6	6.771	0.1477	-0.6486	-1.0894	0.0612	0.0241	0.0680	0.0002
7	7.343	0.1362	-0.0836	0.1428	0.1341	0.0004	0.0012	0.0010
8	9.350	0.1069	1.1979	0.1907	-0.1923	0.0822	0.0021	0.0021
9	11.417	0.0876	-0.0592	0.8514	-0.0625	0.0002	0.0415	0.0002
10	11.948	0.0837	-0.6685	-0.0892	-1.1706	0.0256	0.0005	0.0785
11	30.955	0.0323	2.2988	0.0522	-0.0056	0.3028	0.0002	0.0000
12	51.880	0.0193	0.1948	0.0117	0.0547	0.0022	0.0000	0.0002
13					Total	0.9430	0.7818	0.3940

Each frequency's mode shape detail is shown in the next window. As in the earlier window, you can show graphically the mode shape or animate it by clicking on the appropriate button.



#	Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
1	5	0.000	0.000	0.000	0.0000	0.0578	0.0446
2	10	0.000	0.156	-0.204	0.0017	0.0591	0.0448
3	15A	0.000	6.303	-10.081	0.0654	0.0763	0.0446
4	15B	-0.284	6.590	-10.046	0.0855	0.0622	0.0412
5	20A	-4.073	6.589	-0.568	0.0923	0.0466	0.0320
6	20B	-3.962	6.063	0.000	0.0703	0.0439	0.0277
7	25	-1.373	2.070	0.000	0.0478	0.0316	0.0154
8	30	-1.033	1.557	0.000	0.0467	0.0309	0.0148
9	35	-0.875	1.318	0.000	0.0447	0.0294	0.0139
10	40	-0.724	1.089	0.000	0.0427	0.0282	0.0132
11	45	-0.479	0.717	0.000	0.0375	0.0248	0.0113
12	50	0.000	0.000	0.000	0.0000	0.0000	0.0000
13	100	-0.875	1.038	0.611	0.0382	0.0209	0.0089
14	105	-0.875	0.977	0.756	0.0378	0.0203	0.0085

The graphic window will show the mode shape as thus.

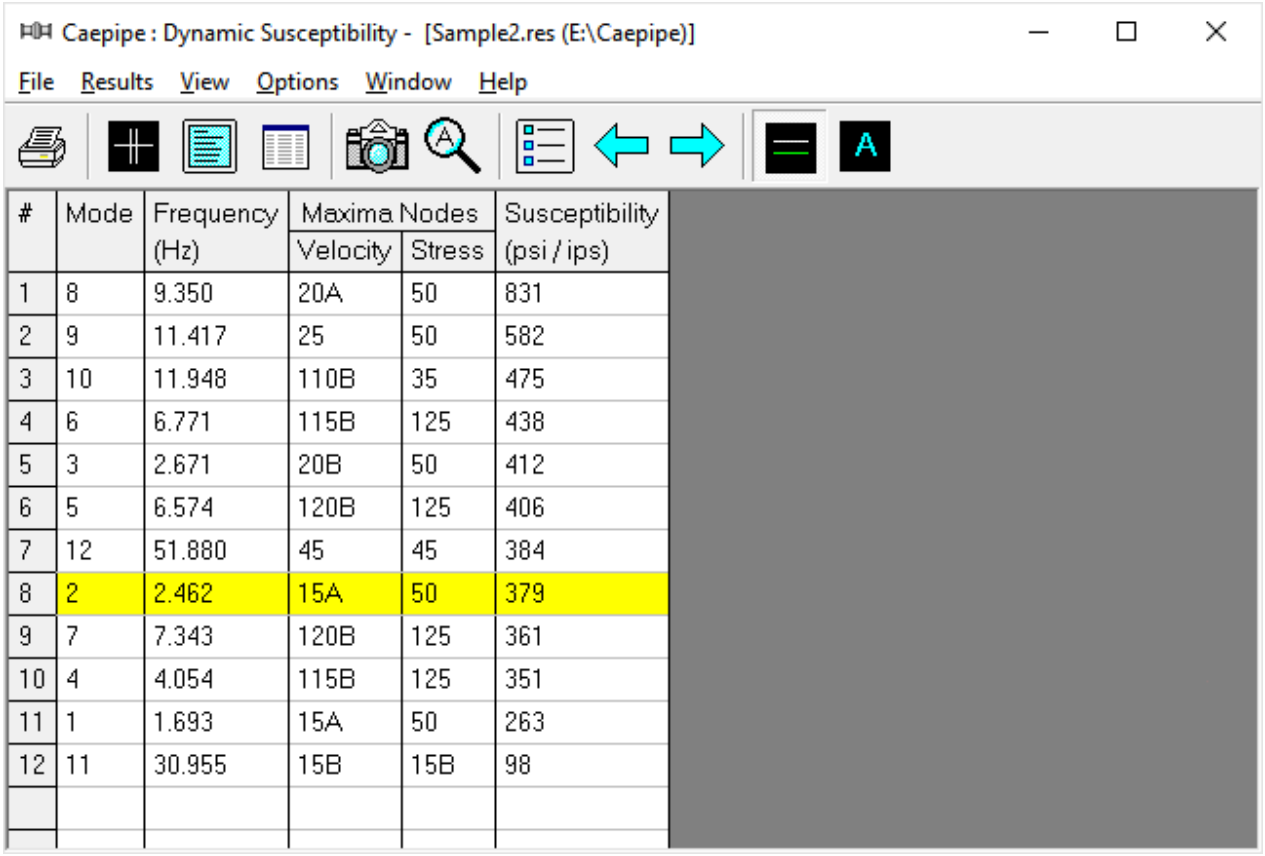


 Use the black arrow buttons to cycle through the different Modes.

Dynamic Susceptibility

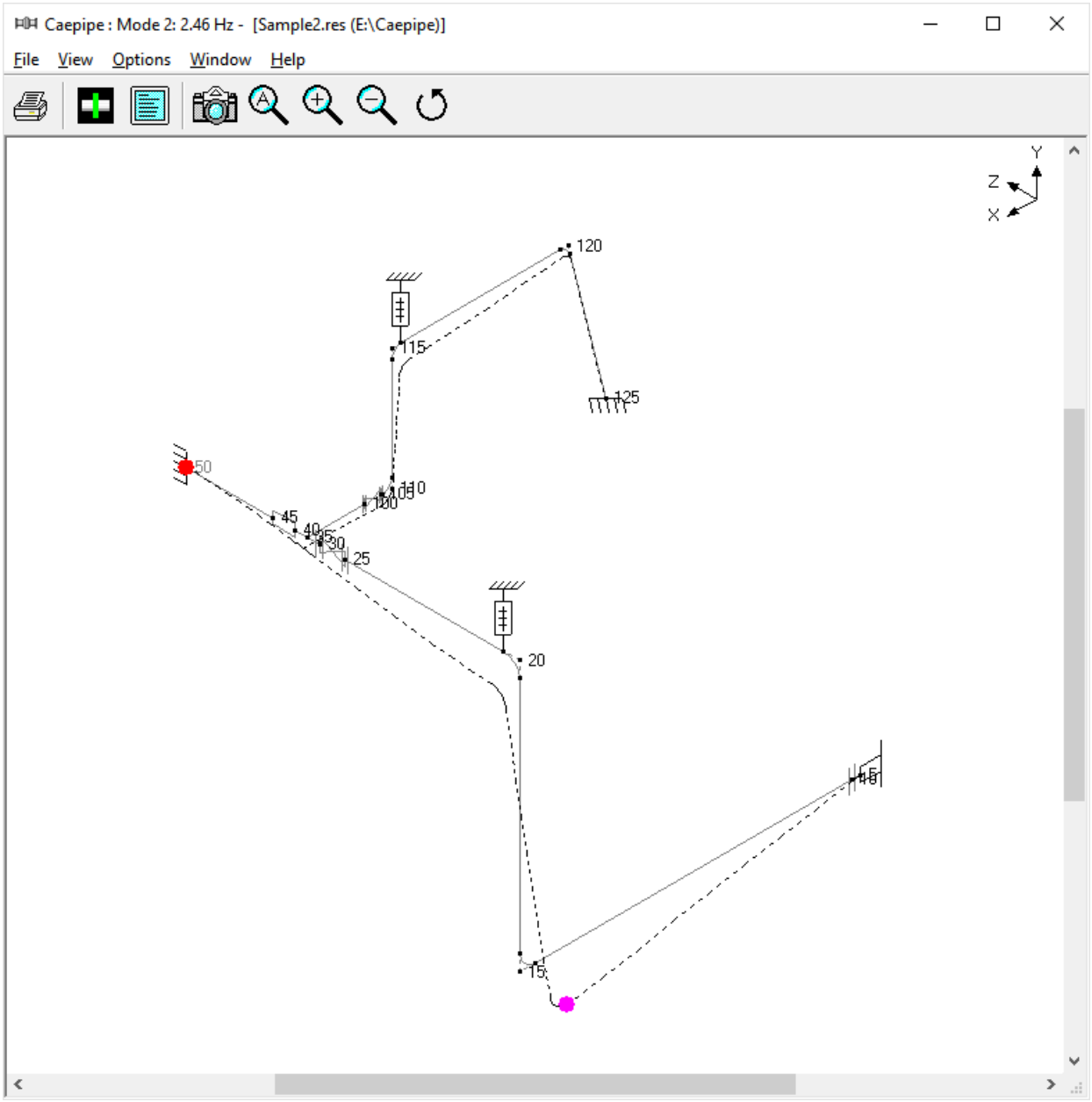
Note: *Dynamic Susceptibility is NOT available for Evaluation Version of CAEPIPE. For FULL version of CAEPIPE, this feature can be turned ON by setting an environment variable "HARTLEN" that needs to be declared under My Computer or This PC Icon > Mouse Right Click > Properties > Advanced System Settings > Environmental Variable with its Value set to (YES). Refer to CAEPIPE User's Manual for more details.*

The stress / velocity method, implemented in CAEPIPE as the "Dynamic Susceptibility" feature, provides quantified insights into the stress versus vibration characteristics of the system layout per se.

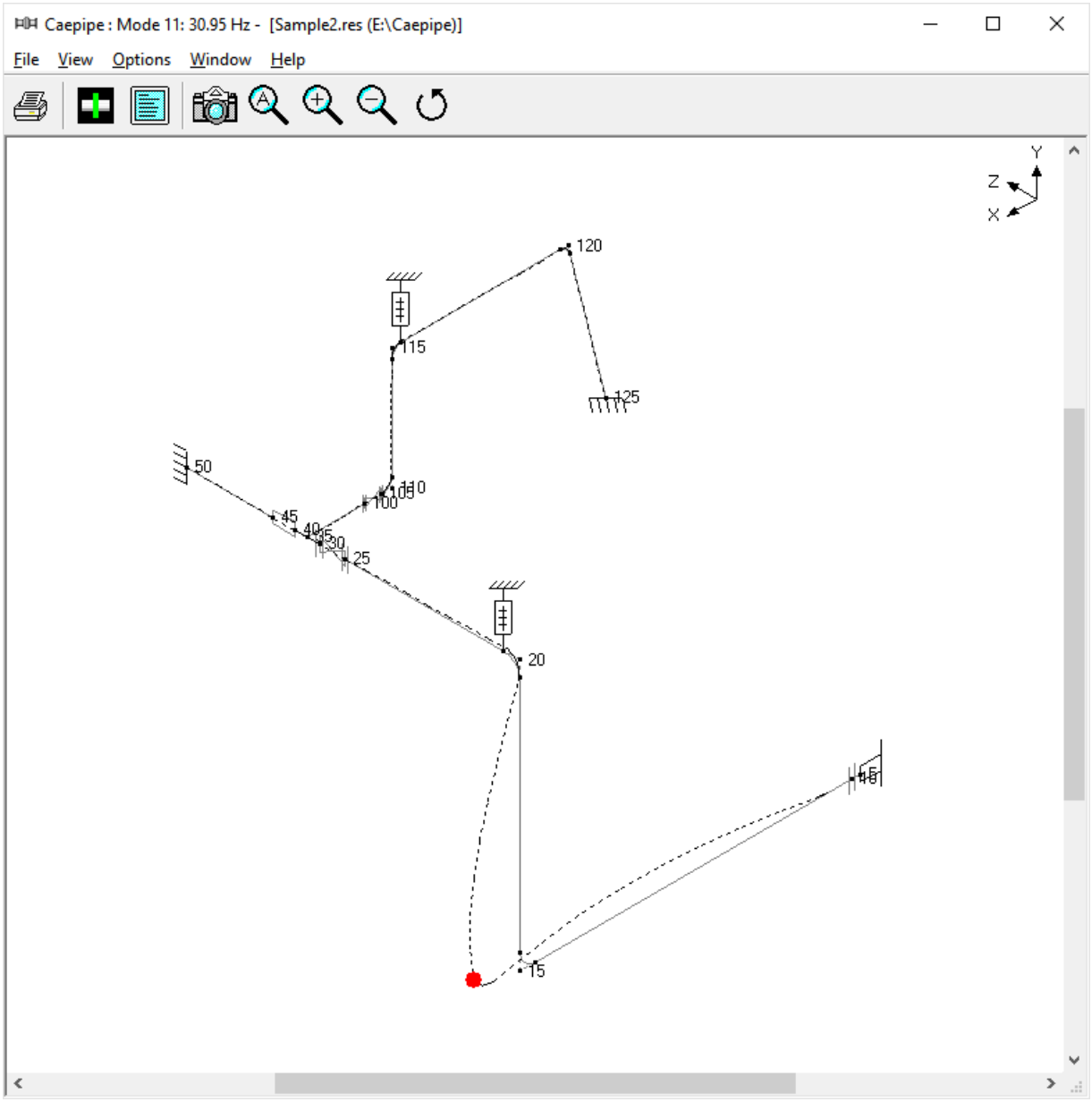


#	Mode	Frequency (Hz)	Maxima Nodes		Susceptibility (psi / ips)
			Velocity	Stress	
1	8	9.350	20A	50	831
2	9	11.417	25	50	582
3	10	11.948	110B	35	475
4	6	6.771	115B	125	438
5	3	2.671	20B	50	412
6	5	6.574	120B	125	406
7	12	51.880	45	45	384
8	2	2.462	15A	50	379
9	7	7.343	120B	125	361
10	4	4.054	115B	125	351
11	1	1.693	15A	50	263
12	11	30.955	15B	15B	98

Pressing the Animated mode shape button (or View > Show animated mode shape) for Mode 2, for example, shows the maximum dynamic bending stress at the Anchor Node 50 (RED dot) and the maximum velocity at the Bend Node 15A (PINK dot).



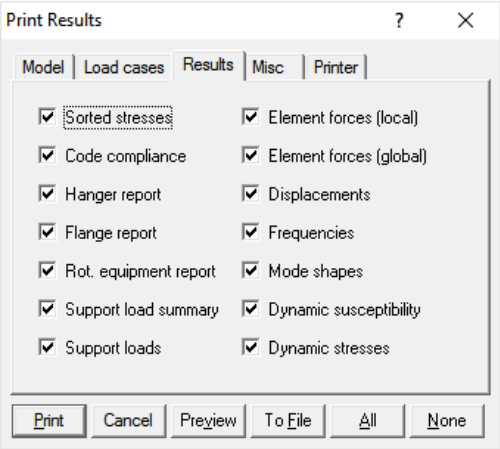
In case the maximum dynamic bending stress and the maximum velocity occur at the same node for a specific mode, then the RED and PINK dots overlap with each other and only the RED dot is seen for that mode. See the Animated mode shape shown below for mode 11 as an example.



The dynamic susceptibility module *does not apply directly to meeting code or other formal stress analysis requirements.* However, it is an incisive analytical tool to help the designer understand the stress / vibration relationship, assess the situation and to decide how to modify the design if necessary to possibly reduce the susceptibility to vibration. It can be used for design, planning acceptance tests, troubleshooting and correction.

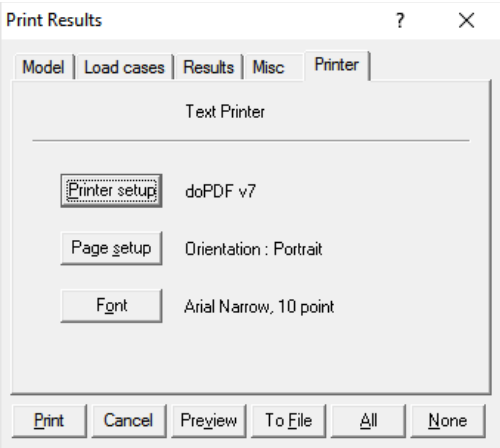
Print

To print results and model data, click on the Print button (or press Ctrl+P). In the Print Results dialog, the items to print can be selected in the property pages.



You can also be print to a text file by using the To File button. A preview of the printed output can be seen by using the Preview button.

The printing options such as choice of printer, margins, portrait or landscape and font can be set on the Printer tab.



The sample problem report is shown next. Observe that for sorted stresses and code compliance, when the stress ratio exceeds 1.00, the stress and the stress ratio are shown in white letters on black background.

This is the end of the tutorial. If you have questions or comments, please email them to: support@sstusa.com

Quality Assurance Block

Caepipe

Version 7.60

Client :

Project :

File Number :

Report Number :

Model Name : Sample2

Title : Sample Problem 2

Analyzed : Mon Sep 12 11:47:34 2016

Prepared by : _____ Date:

Checked by : _____ Date:

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Analysis Options

Code : Piping code = B31.1 (2014)
Include axial force in stress calculations
Use liberal allowable stresses

Temperature : Reference temperature = 21.11 (C)
Number of thermal cycles = 7000
Number of thermal loads = 1
Thermal = Operating - Sustained
Use modulus at reference temperature

Pressure : Pressure stress = PD / 4t
Peak pressure factor = 1.00
Include Bourdon effect
Use pressure correction for bends

Dynamics : Cut off frequency = 33 Hz
Number of modes = 20
Include missing mass correction
Do not use friction in dynamic analysis

Misc. : Include hanger stiffness
Vertical direction = Y

Layout (20)

#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Matl	Sect	Load	Data
1	Title = Sample Problem 2								
2	5	From							Nozzle
3	10		200			312	10	L1	Flange
4	15	Bend	8080			312	10	L1	
5	20	Bend		6550		312	10	L1	
6	20B	Location							User hanger
7	25				4240	312	10	L1	Flange
8	30	Valve			622.3	312	10	L1	Flange
9	35				300	312	10	L1	Welding tee
10	40				300	312	10	L1	
11	45	Reducer			530	312	8	L1	
12	50				2100	312	8	L1	Anchor
13	35	From							
14	100		-1400			312	6	L1	Flange
15	105	Valve	-403.23			312	6	L1	Flange
16	110	Bend	-255			312	6	L2	
17	115	Bend		2950		312	6	L2	
18	115B	Location							Hanger
19	120	Bend	-4290			312	6	L2	
20	125		-910	-3660		312	6	L2	Anchor

Anchors (2)

Node	Tag	KX/kx (N/mm)	KY/ky (N/mm)	KZ/kz (N/mm)	KXX/kxx (Nm/deg)	KYY/kyy (Nm/deg)	KZZ/kzz (Nm/deg)	Releases						Anchor in Pipe
								X	Y	Z	XX	YY	ZZ	
50		Rigid	Rigid	Rigid	Rigid	Rigid	Rigid							GCS
125		Rigid	Rigid	Rigid	Rigid	Rigid	Rigid							GCS

Bends (5)

Bend Node	Radius (mm)	Rad. Type	Thk (mm)	Bend Matl	Flex. Fact.	SIF	Int. Node	Angle (deg)	Int. Node	Angle (deg)
15	381	Long								
20	381	Long								
110	228.6	Long								
115	228.6	Long								
120	228.6	Long								

Branch SIFs (1)

Node	Type
35	Welding tee

Flanges (5)

Node	Type	Weight (kg)	Gasket Dia (mm)	Allow Pres (bar)
10	Weld neck	69.799	297	40.0
25	Weld neck	69.799	297	40.0
30	Weld neck	69.799	297	40.0
100	Weld neck	23.596	192.02	40.0
105	Weld neck	23.596	192.02	40.0

Hangers (2)

Node	Tag	Type	No of	Load var%	Short range	Spring rate (N/mm)	Load (N)	Load Type	CNode
20B		User hanger	1			105	13200	Hot	
115B		Grinnell	1	25					

Nozzles (1)

Node	Tag	Vess. Type	Rnf Pad	Nozzle OD/R	Nozzle Thk	Vessel OD/R	Vessel Thk	L1 (mm)	L2 (mm)	Modulus (MPa)	Vessel axis direction X comp	Y comp	Z comp
5		Cyl		273.05	9.271	1800	9.271	1500	2100	193950			1.000

Nozzle stiffnesses (1)

Node	Vess. Type	Radial (kp) (N/mm)	Circumferential (kmc) (Nm/deg)	Longitudinal (kml) (Nm/deg)
5	Cyl	40981	4352.04	27373.07

Pump: Pump

Type = Horizontal Suct. Node: 50 Suct. Loc: Side Shaft axis direction:1.000, 0.000, 0.000,
Location of center: 8280, 6550, 8520 (mm)

Reducers (1)

From	To	OD1 (mm)	Thk1 (mm)	OD2 (mm)	Thk2 (mm)	Cone angle (deg)
40	45	273.05	9.271	219.07	8.1788	

Valves (2)

From	To	Weight (kg)	Length (mm)	Thick X	Insul Wgt X	Add.Wgt (kg)	Offsets of Add.Wgt DX (mm)	DY (mm)	DZ (mm)
25	30	459.23	622.3	3.00	1.75				
100	105	151.56	403.23	3.00	1.75				

Coordinates (26)

Node	X (mm)	Y (mm)	Z (mm)
5	0	0	0
10	200	0	0
15A	7899	0	0
15	8280	0	0
15B	8280	381	0
20A	8280	6169	0
20	8280	6550	0
20B	8280	6550	381
25	8280	6550	4240
30	8280	6550	4862.3
35	8280	6550	5162.3
40	8280	6550	5462.3
45	8280	6550	5992.3
50	8280	6550	8092.3
100	6880	6550	5162.3
105	6476.77	6550	5162.3

Coordinates (26)

Node	X (mm)	Y (mm)	Z (mm)
110A	6450.37	6550	5162.3
110	6221.77	6550	5162.3
110B	6221.77	6778.6	5162.3
115A	6221.77	9271.4	5162.3
115	6221.77	9500	5162.3
115B	5993.17	9500	5162.3
120A	2110.49	9500	5162.3
120	1931.77	9500	5162.3
120B	1888.65	9326.56	5162.3
125	1021.77	5840	5162.3

Pipe material 312: A312 TP316

Density = 8027 (kg/m3), Nu = 0.300, Joint factor = 1.00, Type = AS

Temp (C)	E (MPa)	Alpha (mm/mm/C)	Allowable (MPa)
-28.89	197673	14.90E-6	137.9
37.78	193950	15.46E-6	137.9
93.33	189606	16.02E-6	119.3
148.9	186159	16.56E-6	107.6
204.4	182022	17.10E-6	98.60
260	178574	17.46E-6	91.70
315.6	174437	17.82E-6	86.87
343.3	172714	17.91E-6	84.81
371.1	170990	18.00E-6	83.43
398.9	168577	18.09E-6	82.05
426.7	166164	18.18E-6	81.36
454.4	164095	18.27E-6	79.98
482.2	162027	18.36E-6	79.29
510	159614	18.45E-6	78.60
537.8	157201	18.54E-6	77.91
565.6	154443	18.81E-6	77.22
593.3	151685	18.72E-6	76.53
621.1	149272	18.90E-6	67.57
648.9	146169	19.08E-6	51.02

Pipe Sections (3)

Name	Nom Dia	Sch	OD (mm)	Thk (mm)	Cor.Al (mm)	M.Tol (%)	Ins.Dens (kg/m3)	Ins.Thk (mm)	Lin.Dens (kg/m3)	Lin.Thk (mm)	Soil
6	6"	STD	168.27	7.112			176.2	65			
8	8"	STD	219.07	8.1788			176.2	65			
10	10"	STD	273.05	9.271			176.2	65			

Loads

Static seismic load: X = 0.30, Y = 0.20, Z = 0.30 (g's)
Seismic load combination = Square Root of Sum of Squares

Wind load 1

Shape factor = 0.60
Wind direction: X comp = 1.000, Y comp = 0.000, Z comp = 0.000

Elevation (m)	Velocity (kmh)
0	100
20	100

Wind load 2

Shape factor = 0.60
Wind direction: X comp = 0.000, Y comp = 0.000, Z comp = 1.000

Elevation (m)	Velocity (kmh)
0	100
20	100

Pipe Loads (2)

Name	T1 (C)	P1 (bar)	Specific gravity	Add.Wgt. (kg/m)	Wind Load
L1	185	10.0	0.1		Y
L2	260	32.0	0.1		Y

B31.1 (2014) Code compliance (Sorted stresses)

Sustained				Expansion				Occasional			
Node	SL (MPa)	SH (MPa)	SL / SH	Node	SE (MPa)	SA (MPa)	SE / SA	Node	SL+SO (MPa)	1.2SH (MPa)	SL+SO / 1.2SH
115B	35.09	91.70	0.38	110A	53.15	265.4	0.20	50	83.02	122.1	0.68
110B	30.97	91.70	0.34	110B	48.13	256.0	0.19	125	52.40	110.0	0.48
35	33.14	101.7	0.33	115B	41.01	251.9	0.16	35	58.02	122.1	0.48
50	31.81	101.7	0.31	125	39.23	260.0	0.15	110B	47.86	110.0	0.43
125	26.96	91.70	0.29	115A	36.93	262.3	0.14	45	52.28	122.1	0.43
120A	26.29	91.70	0.29	120A	34.79	260.7	0.13	115B	45.85	110.0	0.42
120B	24.96	91.70	0.27	50	34.40	267.7	0.13	20B	44.97	122.1	0.37
115A	24.69	91.70	0.27	35	33.33	268.8	0.12	110A	39.76	110.0	0.36
45	26.50	101.7	0.26	15B	31.93	284.2	0.11	120A	39.29	110.0	0.36
25	25.39	101.7	0.25	15A	32.18	289.3	0.11	120B	37.18	110.0	0.34
40	24.65	101.7	0.24	120B	29.10	262.0	0.11	115A	35.78	110.0	0.33
110A	21.59	91.70	0.24	105	24.73	266.9	0.09	15B	35.04	122.1	0.29
30	23.82	101.7	0.23	20B	24.36	276.6	0.09	105	31.30	110.0	0.28
20B	22.98	101.7	0.23	20A	25.04	285.5	0.09	25	34.27	122.1	0.28
105	20.09	91.70	0.22	100	23.02	287.1	0.08	20A	34.18	122.1	0.28
15B	15.29	101.7	0.15	45	21.86	273.0	0.08	40	33.84	122.1	0.28
20A	14.03	101.7	0.14	40	6.189	274.9	0.02	30	32.81	122.1	0.27
100	12.39	101.7	0.12	5	6.320	291.0	0.02	15A	32.00	122.1	0.26
15A	10.26	101.7	0.10	10	6.041	290.7	0.02	100	24.27	122.1	0.20
10	8.822	101.7	0.09	30	5.582	275.7	0.02	5	18.63	122.1	0.15
5	8.496	101.7	0.08	25	4.870	274.1	0.02	10	18.38	122.1	0.15

B31.1 (2014) Code Compliance

	Press.	Sustained			Expansion			Occasional		
Node	Allow. (bar)	SL (MPa)	SH (MPa)	SL / SH	SE (MPa)	SA (MPa)	SE / SA	SL+SO (MPa)	1.2SH (MPa)	SL+SO / 1.2SH
5	10.0	8.496	101.7	0.08	6.320	291.0	0.02	18.63	122.1	0.15
10	71.0	8.822	101.7	0.09	6.041	290.7	0.02	18.38	122.1	0.15
10	10.0	8.822	101.7	0.09	6.041	290.7	0.02	18.36	122.1	0.15
15A	71.0	8.892	101.7	0.09	12.76	290.6	0.04	20.41	122.1	0.17
15A	10.0	10.26	101.7	0.10	32.18	289.3	0.11	32.00	122.1	0.26
15B	71.0	15.29	101.7	0.15	31.93	284.2	0.11	35.04	122.1	0.29
15B	10.0	11.75	101.7	0.12	12.63	287.8	0.04	22.16	122.1	0.18
20A	71.0	11.36	101.7	0.11	9.916	288.2	0.03	22.03	122.1	0.18
20A	10.0	14.03	101.7	0.14	25.04	285.5	0.09	34.18	122.1	0.28
20B	71.0	22.98	101.7	0.23	24.36	276.6	0.09	44.97	122.1	0.37
20B	10.0	15.56	101.7	0.15	9.651	284.0	0.03	27.23	122.1	0.22
25	71.0	25.39	101.7	0.25	4.870	274.1	0.02	34.27	122.1	0.28
30	10.0	23.82	101.7	0.23	5.582	275.7	0.02	32.81	122.1	0.27
35	71.0	33.14	101.7	0.33	14.89	266.4	0.06	50.26	122.1	0.41
35	10.0	32.98	101.7	0.32	4.692	266.5	0.02	42.14	122.1	0.35
40	71.0	18.89	101.7	0.19	3.164	280.6	0.01	25.27	122.1	0.21
40	10.0	24.65	101.7	0.24	6.189	274.9	0.02	33.84	122.1	0.28
45		26.50	101.7	0.26	21.86	273.0	0.08	52.28	122.1	0.43

B31.1 (2014) Code Compliance

Node	Press. Allow. (bar)	Sustained SL (MPa)	Sustained SH (MPa)	Sustained SL/SH	Expansion SE (MPa)	Expansion SA (MPa)	Expansion SE/SA	Occasional SL+SO (MPa)	Occasional 1.2SH (MPa)	Occasional SL+SO/1.2SH
45	10.0	19.90	101.7	0.20	11.03	279.6	0.04	37.47	122.1	0.31
50	78.3	31.81	101.7	0.31	34.40	267.7	0.13	83.02	122.1	0.68
35	10.0	30.78	101.7	0.30	33.33	268.8	0.12	58.02	122.1	0.48
100	89.0	12.39	101.7	0.12	23.02	287.1	0.08	24.27	122.1	0.20
105	32.0	20.09	91.70	0.22	24.73	266.9	0.09	31.30	110.0	0.28
110A	80.2	20.59	91.70	0.22	24.84	266.4	0.09	31.78	110.0	0.29
110A	32.0	21.59	91.70	0.24	53.15	265.4	0.20	39.76	110.0	0.36
110B	80.2	30.97	91.70	0.34	48.13	256.0	0.19	47.86	110.0	0.43
110B	32.0	26.72	91.70	0.29	22.34	260.3	0.09	37.15	110.0	0.34
115A	80.2	22.96	91.70	0.25	17.17	264.0	0.07	29.82	110.0	0.27
115A	32.0	24.69	91.70	0.27	36.93	262.3	0.14	35.78	110.0	0.33
115B	80.2	35.09	91.70	0.38	41.01	251.9	0.16	45.85	110.0	0.42
115B	32.0	28.91	91.70	0.32	19.24	258.1	0.07	35.57	110.0	0.32
120A	80.2	23.48	91.70	0.26	16.37	263.5	0.06	31.58	110.0	0.29
120A	32.0	26.29	91.70	0.29	34.79	260.7	0.13	39.29	110.0	0.36
120B	80.2	24.96	91.70	0.27	29.10	262.0	0.11	37.18	110.0	0.34
120B	32.0	22.61	91.70	0.25	13.50	264.4	0.05	30.19	110.0	0.27
125	80.2	26.96	91.70	0.29	39.23	260.0	0.15	52.40	110.0	0.48

Hanger Report

Node	No of	Type	Figure No.	Size	Spring rate (N/mm)	Vert travel (mm)	Horz travel (mm)	Hot load (N)	Cold load (N)	Var (%)
20B	1	User hanger			105	3.158	25.135	13200	13532	2
115B	1	Grinnell	B-268	10	45.533	16.837	15.702	5254	6021	14

Flange report

Node	Pressure (bar)	Bending moment (Nm)	Axial force (N)	Gasket diameter (mm)	Flange Pressure (bar)	Allowable Pressure (bar)	Flange Pressure/Allowable
105	32.0	3198	1774	192.02	55.6	40.0	1.390
100	10.0	3879	1774	192.02	38.5	40.0	0.963
25	10.0	8462	770	297	26.6	40.0	0.664
30	10.0	8129	770	297	25.9	40.0	0.648
10	10.0	2568	999	297	15.1	40.0	0.378

API 610 (11th ed.), Sep 2010 / ISO 13709 report for pump : Pump

Load case: Operating (W+P1+T1)
Shaft axis: Xcomp = 1.000, Ycomp = 0.000, Zcomp = 0.000
Center location: X = 8280, Y = 6550, Z = 8520 (mm)

Suction node: 50, Location: (Side), Size: 8.000 (inch)
Offsets from center: dx = 0, dy = 427.7, dz = 0 (mm)

Check of condition F.1.1 for suction node 50:

	Calculated	Allowed	Ratio	Status
FX (N)	2773	3781	0.733	OK
FY (N)	-1091	4893	0.223	OK
FZ (N)	-5529	3114	1.776	----
FR (N)	6281	6939	0.905	OK
MX (Nm)	-6382	3525	1.811	----
MY (Nm)	905	1763	0.513	OK
MZ (Nm)	-8095	2576	3.142	Failed
MR (Nm)	10348	4745	2.181	Failed

Condition F.1.2.a for suction node 50 failed ***

*** Discharge node is not defined ***

Support load summary for anchor at node 50

Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	Displacements (global) X (mm)	Y (mm)	Z (mm)
Sustained	-330	-5368	19	-6679	1316	-1239	0.000	0.000	0.000
Operating1	2773	-5529	1091	-6382	-8095	-905	0.000	0.000	0.000
Sustained+Wind	876	-5520	167	-7328	-2478	-1902	0.000	0.000	0.000
Operating1+Wind	3978	-5682	1239	-7032	-11889	-1567	0.000	0.000	0.000
Sustained+Wind 2	-336	-5132	1877	-6591	1300	-1375	0.000	0.000	0.000
Operating1+Wind 2	2767	-5294	2950	-6294	-8111	-1041	0.000	0.000	0.000
Sustained+Seismic	3544	-2548	6511	1737	12121	228	0.000	0.000	0.000
Sustained-Seismic	-4204	-8188	-6473	-15096	-9488	-2706	0.000	0.000	0.000
Operating1+Seismic	6647	-2709	7583	2034	2710	562	0.000	0.000	0.000
Operating1-Seismic	-1102	-8350	-5400	-14799	-18899	-2371	0.000	0.000	0.000
Maximum	6647	-2548	7583	2034	12121	562	0.000	0.000	0.000
Minimum	-4204	-8350	-6473	-15096	-18899	-2706	0.000	0.000	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Support load summary for anchor at node 125

Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	Displacements (global) X (mm)	Y (mm)	Z (mm)
Sustained	230	-1727	28	45	-39	-1179	0.000	0.000	0.000
Operating1	-1774	-1651	-321	-704	800	4149	0.000	0.000	0.000
Sustained+Wind	821	-1714	-64	-183	124	-2172	0.000	0.000	0.000
Operating1+Wind	-1182	-1637	-412	-932	963	3157	0.000	0.000	0.000
Sustained+Wind 2	240	-1723	698	1797	-463	-1199	0.000	0.000	0.000
Operating1+Wind 2	-1764	-1646	350	1049	376	4129	0.000	0.000	0.000
Sustained+Seismic	1504	-1105	826	2162	694	1524	0.000	0.000	0.000
Sustained-Seismic	-1045	-2349	-771	-2073	-773	-3882	0.000	0.000	0.000
Operating1+Seismic	-499	-1029	477	1414	1533	6852	0.000	0.000	0.000
Operating1-Seismic	-3048	-2272	-1120	-2822	66	1447	0.000	0.000	0.000
Maximum	1504	-1029	826	2162	1533	6852	0.000	0.000	0.000
Minimum	-3048	-2349	-1120	-2822	-773	-3882	0.000	0.000	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Support load summary for hanger at node 20B

Load combination	Load (N)	Displacements (global) X (mm)	Y (mm)	Z (mm)
Sustained	-13283	-2.816	2.368	0.000
Operating1	-13200	13.074	3.158	-21.467
Sustained+Wind	-13442	4.505	0.857	0.000
Operating1+Wind	-13359	20.396	1.647	-21.467
Sustained+Wind 2	-13490	-2.030	0.396	0.008
Operating1+Wind 2	-13407	13.861	1.186	-21.459
Sustained+Seismic	-11735	14.472	17.113	0.024
Sustained-Seismic	-14831	-20.105	-12.377	-0.024
Operating1+Seismic	-11652	30.363	17.902	-21.443
Operating1-Seismic	-14748	-4.214	-11.587	-21.491
Maximum	-11652	30.363	17.902	0.024
Minimum	-14831	-20.105	-12.377	-21.491

Support load summary for hanger at node 115B

Load combination	Load (N)	Displacements (global) X (mm)	Y (mm)	Z (mm)
Sustained	-5949	1.454	1.562	0.166
Operating1	-5254	13.734	16.837	-7.611
Sustained+Wind	-5948	2.981	1.595	-1.166
Operating1+Wind	-5252	15.260	16.870	-8.944

Support load summary for hanger at node 115B

Load combination	Load (N)	Displacements (global) X (mm)	Y (mm)	Z (mm)
Sustained+Wind 2	-5948	1.482	1.591	4.848
Operating1+Wind 2	-5253	13.761	16.866	-2.930
Sustained+Seismic	-5757	5.590	5.785	7.278
Sustained-Seismic	-6142	-2.681	-2.662	-6.945
Operating1+Seismic	-5062	17.869	21.061	-0.500
Operating1-Seismic	-5446	9.598	12.613	-14.723
Maximum	-5062	17.869	21.061	7.278
Minimum	-6142	-2.681	-2.662	-14.723

Support load summary for nozzle at node 5

Load combination	Radial (P) (N)	y Shear (VL) (N)	z Shear (VC) (N)	Torque (MT) (Nm)	Circ.Mom (MC) (Nm)	Long.Mom (ML) (Nm)	Displacements (global) X (mm)	Y (mm)	Z (mm)
Sustained	100	-47	3666	319	-214	-392	0.000	0.000	0.000
Operating1	-999	-770	4360	-1504	-853	-2722	-0.024	0.000	0.000
Sustained+Wind	944	-103	3459	5	-215	-208	0.023	0.000	0.000
Operating1+Wind	-155	-827	4153	-1818	-854	-2538	-0.004	0.000	0.000
Sustained+Wind 2	96	898	3700	-1440	-288	1547	0.000	0.000	0.000
Operating1+Wind 2	-1003	174	4394	-3263	-927	-783	-0.024	0.000	0.000
Sustained+Seismic	3956	1717	4798	3227	326	3285	0.097	0.000	0.000
Sustained-Seismic	-3755	-1811	2534	-2588	-753	-4068	-0.092	0.000	0.000
Operating1+Seismic	2856	994	5492	1404	-313	954	0.070	0.000	0.000
Operating1-Seismic	-4855	-2534	3227	-4411	-1392	-6399	-0.118	0.000	0.000
Maximum	3956	1717	5492	3227	326	3285	0.097	0.000	0.000
Minimum	-4855	-2534	2534	-4411	-1392	-6399	-0.118	0.000	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Loads on Anchors: Sustained (W+P)

Node	Tag	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
50		-330	-5368	19	-6679	1316	-1239
125		230	-1727	28	45	-39	-1179

Loads on Hangers: Sustained (W+P)

Node	Tag	Type	Load (N)	No.of	Total (N)
20B		User hanger	-13283	1	-13283
115B		Grinnell	-5949	1	-5949

Loads on Nozzles: Sustained (W+P)

Node	Tag	Axial (N)	y Shear (N)	z Shear (N)	Torque (Nm)	Circ.Mom (Nm)	Long.Mom (Nm)
5		100	-47	3666	319	-214	-392

Pipe forces in local coordinates: Sustained (W+P)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	SL (MPa)
5	100	-3666	-47	319	392	-214		8.496
10	100	-3511	-47	319	383	504	1.00	8.822
10	100	-2827	-47	319	383	504	1.00	8.822
15A	100	3132	-47	319	23	-670		8.892
15A	100	3132	-47	319	23	-670	2.54	10.26
15B	3595	-100	-47	5	-337	-1889	2.54	15.29
15B	3595	-100	-47	5	-337	-1889		11.75
20A	8074	-100	-47	5	-608	-1310		11.36
20A	8074	-47	100	5	-1310	608	2.54	14.03
20B	-47	-8537	100	-1272	33	3814	2.54	22.98
20B	-47	-4746	-100	-1272	-33	-3814		15.56
25	-47	-1759	-100	-1272	-419	8737	1.00	25.39

Pipe forces in local coordinates: Sustained (W+P)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	SL (MPa)
30	-47	4274	-100	-1272	-482	7954	1.00	23.82
35	-47	4506	-100	-1272	-512	6637	2.49	33.14
35	-19	3613	-330	1239	-350	6612	2.49	32.98
40	-19	3845	-330	1239	-449	5494		18.89
40	-19	3845	-330	1239	-449	5494	2.00	24.65
45	-19	4196	-330	1239	-624	3363	2.00	26.50
45	-19	4196	-330	1239	-624	3363		19.90
50	-19	5368	-330	1239	-1316	-6679		31.81
35	230	894	28	25	-162	2511	2.49	30.78
100	230	1432	28	25	-123	883	1.00	12.39
105	230	3446	28	25	-112	-100	1.00	20.09
110A	230	3456	28	25	-111	-191		20.59
110A	230	3456	28	25	-111	-191	2.17	21.59
110B	3594	-230	28	-105	-19	-940	2.17	30.97
110B	3594	230	-28	-105	19	940		26.72
115A	4551	230	-28	-105	-50	368		22.96
115A	4551	230	-28	-105	-50	368	2.17	24.69
115B	230	-4689	-28	-56	98	1376	2.17	35.09
115B	230	-1260	28	-56	-98	-1376		28.91
120A	230	231	28	-56	9	623		23.48
120A	230	-231	-28	-56	-9	-623	2.17	26.29
120B	-282	-307	-28	-27	47	-521	2.17	24.96
120B	-282	307	28	-27	-47	521		22.61
125	-1621	640	28	-27	53	-1179		26.96

Other forces in local coordinates: Sustained (W+P)

Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
25	Valve	-47	-1075	-100	-1272	-419	8737
30		-47	3590	-100	-1272	-482	7954
100	Valve	230	1663	28	25	-123	883
105		230	3215	28	25	-112	-100

Pipe forces in global coordinates: Sustained (W+P)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
5	-100	3666	47	-319	-392	214
10	100	-3511	-47	319	383	504
10	-100	2827	47	-319	-383	-504
15A	100	3132	-47	319	23	-670
15A	-100	-3132	47	-319	-23	670
15B	100	3595	-47	337	5	-1889
15B	-100	-3595	47	-337	-5	1889
20A	100	8074	-47	608	5	-1310
20A	-100	-8074	47	-608	-5	1310
20B	100	8537	-47	3814	-33	-1272
20B	-100	4746	47	-3814	33	1272
25	100	-1759	-47	-8737	-419	-1272
30	-100	-4274	47	7954	482	1272
35	100	4506	-47	-6637	-512	-1272
35	-330	-3613	19	6612	350	-1239
40	330	3845	-19	-5494	-449	1239
40	-330	-3845	19	5494	449	-1239
45	330	4196	-19	-3363	-624	1239
45	-330	-4196	19	3363	624	-1239
50	330	5368	-19	6679	-1316	1239
35	230	-894	28	25	162	2511
100	-230	1432	-28	-25	-123	-883

Pipe forces in global coordinates: Sustained (W+P)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
105	230	-3446	28	25	112	-100
110A	-230	3456	-28	-25	-111	191
110A	230	-3456	28	25	111	-191
110B	-230	3594	-28	-19	-105	940
110B	230	-3594	28	19	105	-940
115A	-230	4551	-28	50	-105	368
115A	230	-4551	28	-50	105	-368
115B	-230	4689	-28	56	-98	1376
115B	230	1260	28	-56	98	-1376
120A	-230	231	-28	56	9	-623
120A	230	-231	28	-56	-9	623
120B	-230	347	-28	52	15	-521
120B	230	-347	28	-52	-15	521
125	-230	1727	-28	-45	39	1179

Other forces in global coordinates: Sustained (W+P)

Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
25	Valve	-100	1075	47	8737	419	1272
30		100	3590	-47	-7954	-482	-1272
100	Valve	230	-1663	28	25	123	883
105		-230	3215	-28	-25	-112	100

Displacements: Sustained (W+P)

	Displacements (global)					
Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.000	0.000	0.000	0.0000	0.0143	-0.0491
10	0.000	-0.174	-0.051	0.0004	0.0147	-0.0490
15A	0.003	2.189	-2.618	0.0144	0.0215	0.0775
15B	-0.401	2.651	-2.650	0.0184	0.0199	0.0472
20A	-2.992	2.674	-0.248	0.0304	0.0200	0.0066
20B	-2.816	2.368	0.000	0.0673	0.0270	-0.0091
25	-1.087	-1.451	0.000	0.0093	0.0232	-0.0372
30	-0.837	-1.517	0.000	0.0030	0.0229	-0.0384
35	-0.719	-1.502	0.000	-0.0066	0.0222	-0.0406
40	-0.604	-1.442	0.000	-0.0146	0.0217	-0.0384
45	-0.411	-1.222	0.000	-0.0297	0.0199	-0.0330
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	-0.720	0.373	0.478	-0.0078	0.0172	-0.1024
105	-0.720	1.102	0.598	-0.0079	0.0169	-0.1035
110A	-0.720	1.150	0.606	-0.0079	0.0168	-0.1035
110B	-0.389	1.528	0.628	-0.0102	0.0128	-0.0646
115A	1.397	1.543	0.190	-0.0092	0.0043	-0.0237
115B	1.454	1.562	0.166	-0.0089	0.0016	0.0173
120A	1.453	-0.377	0.064	-0.0017	-0.0028	0.0070
120B	1.418	-0.358	0.056	-0.0005	-0.0032	-0.0207
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Loads on Anchors: Expansion (T1)

Node	Tag	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
50		3103	-161	1072	297	-9411	334
125		-2003	76	-349	-749	839	5329

Loads on Hangers: Expansion (T1)

Node	Tag	Type	Load (N)	No.of	Total (N)
20B		User hanger	83	1	83
115B		Grinnell	696	1	696

Loads on Nozzles: Expansion (T1)

Node	Tag	Axial (N)	y Shear (N)	z Shear (N)	Torque (Nm)	Circ.Mom (Nm)	Long.Mom (Nm)
5		-1099	-724	694	-1823	-639	-2330

Pipe forces in local coordinates: Expansion (T1)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	SE (MPa)
5	-1099	-694	-724	-1823	2330	-639		6.320
10	-1099	-694	-724	-1823	2186	-500	1.00	6.041
10	-1099	-694	-724	-1823	2186	-500	1.00	6.041
15A	-1099	-694	-724	-1823	-3385	4840		12.76
15A	-1099	-694	-724	-1823	-3385	4840	2.54	32.18
15B	-694	1099	-724	-3661	1547	4686	2.54	31.93
15B	-694	1099	-724	-3661	1547	4686		12.63
20A	-694	1099	-724	-3661	-2641	-1676		9.916
20A	-694	-724	-1099	-3661	-1676	2641	2.54	25.04
20B	-724	694	-1099	-2095	3242	2652	2.54	24.36
20B	-724	-611	1099	-2095	-3242	-2652		9.651
25	-724	-611	1099	-2095	1000	-295	1.00	4.870
30	-724	-611	1099	-2095	1684	85	1.00	5.582
35	-724	-611	1099	-2095	2014	268	2.49	14.89
35	-1072	161	3103	-334	320	769	2.49	4.692
40	-1072	161	3103	-334	1251	721		3.164
40	-1072	161	3103	-334	1251	721	2.00	6.189
45	-1072	161	3103	-334	2896	635	2.00	21.86
45	-1072	161	3103	-334	2896	635		11.03
50	-1072	161	3103	-334	9411	297		34.40
35	-2003	-772	-349	-501	1693	1761	2.49	33.33
100	-2003	-772	-349	-501	1205	2841	1.00	23.02
105	-2003	-772	-349	-501	1064	3153	1.00	24.73
110A	-2003	-772	-349	-501	1055	3173		24.84
110A	-2003	-772	-349	-501	1055	3173	2.17	53.15
110B	-772	2003	-349	975	421	2892	2.17	48.13
110B	-772	-2003	349	975	-421	-2892		22.34
115A	-772	-2003	349	975	448	2102		17.17
115A	-772	-2003	349	975	448	2102	2.17	36.93
115B	-2003	772	349	528	-895	2384	2.17	41.01
115B	-2003	-76	-349	528	895	-2384		19.24
120A	-2003	-76	-349	528	-459	-2087		16.37
120A	-2003	76	349	528	459	2087	2.17	34.79
120B	-409	1963	349	633	-324	1723	2.17	29.10
120B	-409	-1963	-349	633	324	-1723		13.50
125	-409	-1963	-349	633	-929	5329		39.23

Other forces in local coordinates: Expansion (T1)

Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
25	Valve	-724	-611	1099	-2095	1000	-295
30		-724	-611	1099	-2095	1684	85
100	Valve	-2003	-772	-349	-501	1205	2841
105		-2003	-772	-349	-501	1064	3153

Pipe forces in global coordinates: Expansion (T1)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
5	1099	694	724	1823	-2330	639
10	-1099	-694	-724	-1823	2186	-500
10	1099	694	724	1823	-2186	500
15A	-1099	-694	-724	-1823	-3385	4840
15A	1099	694	724	1823	3385	-4840
15B	-1099	-694	-724	-1547	-3661	4686

Pipe forces in global coordinates: Expansion (T1)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
15B	1099	694	724	1547	3661	-4686
20A	-1099	-694	-724	2641	-3661	-1676
20A	1099	694	724	-2641	3661	1676
20B	-1099	-694	-724	2652	-3242	-2095
20B	1099	611	724	-2652	3242	2095
25	-1099	-611	-724	295	1000	-2095
30	1099	611	724	85	-1684	2095
35	-1099	-611	-724	-268	2014	-2095
35	3103	-161	1072	769	-320	334
40	-3103	161	-1072	-721	1251	-334
40	3103	-161	1072	721	-1251	334
45	-3103	161	-1072	-635	2896	-334
45	3103	-161	1072	635	-2896	334
50	-3103	161	-1072	-297	9411	-334
35	-2003	772	-349	-501	-1693	1761
100	2003	-772	349	501	1205	-2841
105	-2003	772	-349	-501	-1064	3153
110A	2003	-772	349	501	1055	-3173
110A	-2003	772	-349	-501	-1055	3173
110B	2003	-772	349	421	975	-2892
110B	-2003	772	-349	-421	-975	2892
115A	2003	-772	349	-448	975	2102
115A	-2003	772	-349	448	-975	-2102
115B	2003	-772	349	-528	895	2384
115B	-2003	76	-349	528	-895	-2384
120A	2003	-76	349	-528	-459	2087
120A	-2003	76	-349	528	459	-2087
120B	2003	-76	349	-468	-536	1723
120B	-2003	76	-349	468	536	-1723
125	2003	-76	349	749	-839	-5329

Other forces in global coordinates: Expansion (T1)

Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
25	Valve	1099	611	724	-295	-1000	2095
30		-1099	-611	-724	-85	1684	-2095
100	Valve	-2003	772	-349	-501	-1205	2841
105		2003	-772	349	501	1064	-3153

Displacements: Expansion (T1)

	Displacements (global)					
Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	-0.027	0.000	0.000	0.0000	0.0851	-0.1468
10	0.530	-0.514	-0.301	-0.0021	0.0871	-0.1473
15A	21.975	-17.418	-12.775	-0.0823	0.0668	-0.0739
15B	23.089	-16.606	-13.625	-0.0828	0.0337	0.0277
20A	16.972	-0.483	-22.202	-0.0689	-0.0874	0.0660
20B	15.891	0.790	-21.467	-0.0120	-0.1184	0.0627
25	6.856	0.525	-10.718	0.0130	-0.1374	0.0165
30	5.368	0.383	-8.993	0.0131	-0.1364	0.0145
35	4.658	0.315	-8.157	0.0128	-0.1340	0.0109
40	3.956	0.250	-7.322	0.0118	-0.1330	0.0104
45	2.747	0.152	-5.846	0.0095	-0.1259	0.0089
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	0.766	0.950	-10.771	0.0357	-0.0831	-0.0699
105	-0.351	1.468	-11.345	0.0374	-0.0802	-0.0777

Displacements: Expansion (T1)

Node	Displacements (global) X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
110A	-0.462	1.504	-11.382	0.0378	-0.0795	-0.0798
110B	-0.636	3.039	-11.395	0.0681	-0.0377	-0.2579
115A	12.290	13.527	-8.245	0.0673	0.0417	-0.2826
115B	12.280	15.275	-7.778	0.0642	0.0666	-0.1495
120A	-4.048	17.860	-1.789	-0.0027	0.0879	0.0683
120B	-4.575	16.715	-1.455	-0.0085	0.0786	0.1626
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Loads on Anchors: Operating (W+P1+T1)

Node	Tag	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
50		2773	-5529	1091	-6382	-8095	-905
125		-1774	-1651	-321	-704	800	4149

Loads on Hangers: Operating (W+P1+T1)

Node	Tag	Type	Load (N)	No.of	Total (N)
20B		User hanger	-13200	1	-13200
115B		Grinnell	-5254	1	-5254

Loads on Nozzles: Operating (W+P1+T1)

Node	Tag	Axial (N)	y Shear (N)	z Shear (N)	Torque (Nm)	Circ.Mom (Nm)	Long.Mom (Nm)
5		-999	-770	4360	-1504	-853	-2722

Pipe forces in local coordinates: Operating (W+P1+T1)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	Sopr (MPa)
5	-999	-4360	-770	-1504	2722	-853		13.81
10	-999	-4205	-770	-1504	2568	4	1.00	13.31
10	-999	-3520	-770	-1504	2568	4	1.00	13.31
15A	-999	2438	-770	-1504	-3362	4170		18.59
15A	-999	2438	-770	-1504	-3362	4170	2.54	35.16
15B	2901	999	-770	-3656	1210	2797	2.54	25.21
15B	2901	999	-770	-3656	1210	2797		17.45
20A	7380	999	-770	-3656	-3248	-2986		20.02
20A	7380	-770	-999	-3656	-2986	3248	2.54	32.38
20B	-770	-7844	-999	-3367	3275	6466	2.54	45.45
20B	-770	-5356	999	-3367	-3275	-6466		23.57
25	-770	-2370	999	-3367	581	8442	1.00	25.85
30	-770	3664	999	-3367	1202	8039	1.00	25.22
35	-770	3896	999	-3367	1502	6905	2.49	43.76
35	-1091	3774	2773	905	-30	7381	2.49	44.70
40	-1091	4006	2773	905	802	6214		20.14
40	-1091	4006	2773	905	802	6214	2.00	32.86
45	-1091	4357	2773	905	2272	3998	2.00	40.05
45	-1091	4357	2773	905	2272	3998		23.51
50	-1091	5529	2773	905	8095	-6382		44.06
35	-1774	122	-321	-476	1532	4272	2.49	65.11
100	-1774	660	-321	-476	1082	3725	1.00	33.49
105	-1774	2674	-321	-476	952	3052	1.00	41.66
110A	-1774	2684	-321	-476	944	2982		41.16
110A	-1774	2684	-321	-476	944	2982	2.17	67.20
110B	2822	1774	-321	870	402	1951	2.17	51.33
110B	2822	-1774	321	870	-402	-1951		35.33
115A	3779	-1774	321	870	398	2470		39.01
115A	3779	-1774	321	870	398	2470	2.17	59.39
115B	-1774	-3917	321	472	-797	3759	2.17	78.31
115B	-1774	-1337	-321	472	797	-3759		46.25
120A	-1774	154	-321	472	-450	-1464		29.95

Pipe forces in local coordinates: Operating (W+P1+T1)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	Sopr (MPa)
120A	-1774	-154	321	472	450	1464	2.17	42.50
120B	-691	1656	321	606	-278	1202	2.17	38.41
120B	-691	-1656	-321	606	278	-1202		28.61
125	-2030	-1323	-321	606	-876	4149		49.14

Other forces in local coordinates: Operating (W+P1+T1)

Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
25	Valve	-770	-1685	999	-3367	581	8442
30		-770	2979	999	-3367	1202	8039
100	Valve	-1774	891	-321	-476	1082	3725
105		-1774	2443	-321	-476	952	3052

Pipe forces in global coordinates: Operating (W+P1+T1)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
5	999	4360	770	1504	-2722	853
10	-999	-4205	-770	-1504	2568	4
10	999	3520	770	1504	-2568	-4
15A	-999	2438	-770	-1504	-3362	4170
15A	999	-2438	770	1504	3362	-4170
15B	-999	2901	-770	-1210	-3656	2797
15B	999	-2901	770	1210	3656	-2797
20A	-999	7380	-770	3248	-3656	-2986
20A	999	-7380	770	-3248	3656	2986
20B	-999	7844	-770	6466	-3275	-3367
20B	999	5356	770	-6466	3275	3367
25	-999	-2370	-770	-8442	581	-3367
30	999	-3664	770	8039	-1202	3367
35	-999	3896	-770	-6905	1502	-3367
35	2773	-3774	1091	7381	30	-905
40	-2773	4006	-1091	-6214	802	905
40	2773	-4006	1091	6214	-802	-905
45	-2773	4357	-1091	-3998	2272	905
45	2773	-4357	1091	3998	-2272	-905
50	-2773	5529	-1091	6382	8095	905
35	-1774	-122	-321	-476	-1532	4272
100	1774	660	321	476	1082	-3725
105	-1774	-2674	-321	-476	-952	3052
110A	1774	2684	321	476	944	-2982
110A	-1774	-2684	-321	-476	-944	2982
110B	1774	2822	321	402	870	-1951
110B	-1774	-2822	-321	-402	-870	1951
115A	1774	3779	321	-398	870	2470
115A	-1774	-3779	-321	398	-870	-2470
115B	1774	3917	321	-472	797	3759
115B	-1774	1337	-321	472	-797	-3759
120A	1774	154	321	-472	-450	1464
120A	-1774	-154	-321	472	450	-1464
120B	1774	271	321	-416	-521	1202
120B	-1774	-271	-321	416	521	-1202
125	1774	1651	321	704	-800	-4149

Other forces in global coordinates: Operating (W+P1+T1)

Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
25	Valve	999	1685	770	8442	-581	3367
30		-999	2979	-770	-8039	1202	-3367

Other forces in global coordinates: Operating (W+P1+T1)

Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
100	Valve	-1774	-891	-321	-476	-1082	3725
105		1774	2443	321	476	952	-3052

Displacements: Operating (W+P1+T1)

	Displacements (global)					
Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	-0.024	0.000	0.000	0.0000	0.0995	-0.1960
10	0.533	-0.688	-0.352	-0.0017	0.1018	-0.1963
15A	21.978	-15.229	-15.393	-0.0679	0.0883	0.0036
15B	22.688	-13.955	-16.274	-0.0645	0.0535	0.0749
20A	13.980	2.191	-22.450	-0.0386	-0.0673	0.0725
20B	13.074	3.158	-21.467	0.0553	-0.0914	0.0536
25	5.769	-0.926	-10.718	0.0223	-0.1142	-0.0206
30	4.531	-1.134	-8.993	0.0160	-0.1136	-0.0238
35	3.939	-1.187	-8.157	0.0062	-0.1118	-0.0296
40	3.352	-1.191	-7.322	-0.0028	-0.1113	-0.0281
45	2.337	-1.070	-5.846	-0.0202	-0.1061	-0.0241
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	0.046	1.323	-10.293	0.0279	-0.0659	-0.1723
105	-1.071	2.570	-10.747	0.0295	-0.0633	-0.1812
110A	-1.182	2.654	-10.776	0.0299	-0.0626	-0.1832
110B	-1.025	4.567	-10.767	0.0580	-0.0249	-0.3224
115A	13.686	15.069	-8.055	0.0581	0.0459	-0.3062
115B	13.734	16.837	-7.611	0.0554	0.0682	-0.1322
120A	-2.596	17.483	-1.724	-0.0044	0.0851	0.0753
120B	-3.157	16.357	-1.398	-0.0090	0.0755	0.1419
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Loads on Anchors: Seismic (g)

Node	Tag	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
50		3874	2820	6492	8417	10805	1467
125		1274	622	798	2118	734	2703

Loads on Hangers: Seismic (g)

Node	Tag	Type	Load (N)	No.of	Total (N)
20B		User hanger	1548	1	1548
115B		Grinnell	192	1	192

Loads on Nozzles: Seismic (g)

Node	Tag	Axial (N)	y Shear (N)	z Shear (N)	Torque (Nm)	Circ.Mom (Nm)	Long.Mom (Nm)
5		3856	1764	1132	2908	539	3676

Pipe forces in local coordinates: Seismic (g)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	SL+SO (MPa)
5	3856	1132	1764	2908	3676	539		18.63
10	3809	1105	1718	2908	3340	358	1.00	18.38
10	3604	985	1514	2908	3340	358	1.00	18.36
15A	1820	610	340	2908	1979	4268		20.41
15A	1820	610	340	2908	1979	4268	2.54	32.00
15B	667	1681	463	1917	2781	3765	2.54	35.04
15B	667	1681	463	1917	2781	3765		22.16
20A	1425	364	1777	1917	4103	2427		22.03
20A	1425	1777	364	1917	2427	4103	2.54	34.18
20B	1916	1513	245	2517	2002	4576	2.54	44.97
20B	1916	477	245	2517	2002	4576		27.23
25	2809	741	721	2517	1868	2751	1.00	34.27

Pipe forces in local coordinates: Seismic (g)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	SL+SO (MPa)
30	4616	1837	2519	2517	1989	2564	1.00	32.81
35	4686	1882	2589	2517	2365	2631	2.49	50.26
35	5966	2478	3348	1467	632	1516	2.49	42.14
40	6036	2523	3418	1467	1331	1898		25.27
40	6036	2523	3418	1467	1331	1898	2.00	33.84
45	6141	2591	3523	1467	3083	2971	2.00	52.28
45	6141	2591	3523	1467	3083	2971		37.47
50	6492	2820	3874	1467	10805	8417		83.02
35	761	631	1297	1117	2223	1152	2.49	58.02
100	599	532	1139	1117	961	700	1.00	24.27
105	10	242	564	1117	874	652	1.00	31.30
110A	12	242	561	1117	871	647		31.78
110A	12	242	561	1117	871	647	2.17	39.76
110B	235	50	524	852	998	601	2.17	47.86
110B	235	50	524	852	998	601		37.15
115A	271	337	301	852	275	302		29.82
115A	271	337	301	852	275	302	2.17	35.78
115B	378	287	278	302	815	279	2.17	45.85
115B	378	233	278	302	815	279		35.57
120A	825	362	395	302	237	1026		31.58
120A	825	362	395	302	237	1026	2.17	39.29
120B	522	782	423	301	276	951	2.17	37.18
120B	522	782	423	301	276	951		30.19
125	773	1189	798	301	2221	2703		52.40

Other forces in local coordinates: Seismic (g)

Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
25	Valve	3014	850	922	2517	1868	2751
30		4411	1705	2314	2517	1989	2564
100	Valve	530	491	1071	1117	961	700
105		65	261	627	1117	874	652

Pipe forces in global coordinates: Seismic (g)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
5	3856	1132	1764	2908	3676	539
10	3809	1105	1718	2908	3340	358
10	3604	985	1514	2908	3340	358
15A	1820	610	340	2908	1979	4268
15A	1820	610	340	2908	1979	4268
15B	1681	667	463	2781	1917	3765
15B	1681	667	463	2781	1917	3765
20A	364	1425	1777	4103	1917	2427
20A	364	1425	1777	4103	1917	2427
20B	245	1513	1916	4576	2002	2517
20B	245	477	1916	4576	2002	2517
25	721	741	2809	2751	1868	2517
30	2519	1837	4616	2564	1989	2517
35	2589	1882	4686	2631	2365	2517
35	3348	2478	5966	1516	632	1467
40	3418	2523	6036	1898	1331	1467
40	3418	2523	6036	1898	1331	1467
45	3523	2591	6141	2971	3083	1467
45	3523	2591	6141	2971	3083	1467
50	3874	2820	6492	8417	10805	1467
35	761	631	1297	1117	2223	1152
100	599	532	1139	1117	961	700

Pipe forces in global coordinates: Seismic (g)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
105	10	242	564	1117	874	652
110A	12	242	561	1117	871	647
110A	12	242	561	1117	871	647
110B	50	235	524	998	852	601
110B	50	235	524	998	852	601
115A	337	271	301	275	852	302
115A	337	271	301	275	852	302
115B	378	287	278	302	815	279
115B	378	233	278	302	815	279
120A	825	362	395	302	237	1026
120A	825	362	395	302	237	1026
120B	633	696	423	195	359	951
120B	885	318	423	340	225	951
125	1340	463	798	2228	244	2703

Other forces in global coordinates: Seismic (g)

Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
25	Valve	922	850	3014	2751	1868	2517
30		2314	1705	4411	2564	1989	2517
100	Valve	530	491	1071	1117	961	700
105		65	261	627	1117	874	652

Displacements: Seismic (g)

	Displacements (global)					
Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.094	0.000	0.000	0.0000	0.1343	0.1239
10	0.095	0.434	0.475	0.0033	0.1374	0.1243
15A	0.109	15.039	20.557	0.1312	0.1376	0.1026
15B	0.975	15.601	20.363	0.1723	0.1125	0.1538
20A	17.243	15.597	1.121	0.1858	0.1125	0.1460
20B	17.288	14.745	0.024	0.1372	0.1354	0.1094
25	7.646	6.236	0.018	0.1259	0.1504	0.0546
30	6.012	4.873	0.017	0.1254	0.1503	0.0522
35	5.226	4.220	0.016	0.1238	0.1488	0.0480
40	4.445	3.574	0.015	0.1221	0.1479	0.0455
45	3.099	2.471	0.013	0.1145	0.1406	0.0390
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	5.227	4.313	3.198	0.1052	0.1160	0.0205
105	5.227	4.370	4.002	0.1047	0.1138	0.0188
110A	5.227	4.374	4.054	0.1045	0.1133	0.0184
110B	5.213	4.380	4.507	0.1027	0.0850	0.0178
115A	4.219	4.379	6.826	0.1077	0.0310	0.0457
115B	4.135	4.224	7.111	0.1004	0.0348	0.0561
120A	4.132	1.197	4.384	0.0896	0.0569	0.0586
120B	3.937	0.977	3.950	0.0866	0.0501	0.0787
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Loads on Anchors: Wind

Node	Tag	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
50		1205	-152	148	-649	-3795	-662
125		592	13	-91	-228	163	-993

Loads on Hangers: Wind

Node	Tag	Type	Load (N)	No.of	Total (N)
20B		User hanger	-159	1	-159
115B		Grinnell	1	1	1

Loads on Nozzles: Wind

Node	Tag	Axial (N)	y Shear (N)	z Shear (N)	Torque (Nm)	Circ.Mom (Nm)	Long.Mom (Nm)
5		844	-57	-207	-314	-1	184

Pipe forces in local coordinates: Wind

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	SL+SO (MPa)
5	844	207	-57	-314	-184	-1		9.349
10	844	207	-57	-314	-195	-43	1.00	9.692
10	844	207	-57	-314	-195	-43	1.00	9.692
15A	844	207	-57	-314	-631	-1636		12.64
15A	844	207	-57	-314	-631	-1636	2.54	17.30
15B	207	-844	-57	-653	292	-1393	2.54	21.40
15B	207	-430	-57	-653	292	-1393		14.97
20A	207	-430	-57	-653	-35	1094		13.99
20A	207	-57	-23	-653	1094	35	2.54	19.01
20B	-57	-207	-23	1085	644	136	2.54	27.92
20B	-57	48	337	1085	-644	-136		18.16
25	-57	48	337	1085	658	-322	1.00	28.07
30	-57	48	745	1085	1074	-352	1.00	27.03
35	-57	48	745	1085	1298	-367	2.49	39.73
35	-148	152	853	662	798	-204	2.49	37.03
40	-148	152	853	662	1054	-250		21.50
40	-148	152	910	662	1054	-250	2.00	28.56
45	-148	152	910	662	1536	-330	2.00	35.82
45	-148	152	1075	662	1536	-330		26.12
50	-148	152	1075	662	3795	-649		46.02
35	-65	-104	-91	-163	500	-423	2.49	37.45
100	-65	-104	-91	-163	372	-278	1.00	15.94
105	-65	-104	-91	-163	335	-236	1.00	23.27
110A	-65	-104	-91	-163	332	-233		23.75
110A	-65	-104	-91	-163	332	-233	2.17	26.71
110B	-104	65	-91	312	142	-224	2.17	35.77
110B	-104	67	91	312	-142	224		29.69
115A	-104	67	91	312	86	57		25.35
115A	-104	216	91	312	86	57	2.17	28.55
115B	216	104	91	107	-291	-17	2.17	38.77
115B	233	-102	-91	107	291	17		31.20
120A	233	-102	-91	107	-64	413		26.65
120A	233	102	91	107	64	-413	2.17	31.39
120B	156	-202	91	104	-68	-396	2.17	29.84
120B	156	386	-91	104	68	396		25.63
125	156	386	-91	104	-260	-993		34.41

Other forces in local coordinates: Wind

Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
25	Valve	-57	48	669	1085	658	-322
30		-57	48	669	1085	1074	-352
100	Valve	-65	-104	-91	-163	372	-278
105		-65	-104	-91	-163	335	-236

Pipe forces in global coordinates: Wind

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
5	-844	-207	57	314	184	1
10	844	207	-57	-314	-195	-43
10	-844	-207	57	314	195	43
15A	844	207	-57	-314	-631	-1636
15A	-844	-207	57	314	631	1636
15B	844	207	-57	-292	-653	-1393

Pipe forces in global coordinates: Wind

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
15B	-430	-207	57	292	653	1393
20A	430	207	-57	35	-653	1094
20A	23	-207	57	-35	653	-1094
20B	-23	207	-57	136	-644	1085
20B	337	-48	57	-136	644	-1085
25	-337	48	-57	322	658	1085
30	745	-48	57	-352	-1074	-1085
35	-745	48	-57	367	1298	1085
35	853	-152	148	-204	-798	-662
40	-853	152	-148	250	1054	662
40	910	-152	148	-250	-1054	-662
45	-910	152	-148	330	1536	662
45	1075	-152	148	-330	-1536	-662
50	-1075	152	-148	649	3795	662
35	-65	104	-91	-163	-500	-423
100	65	-104	91	163	372	278
105	-65	104	-91	-163	-335	-236
110A	65	-104	91	163	332	233
110A	-65	104	-91	-163	-332	-233
110B	65	-104	91	142	312	224
110B	67	104	-91	-142	-312	-224
115A	-67	-104	91	-86	312	57
115A	216	104	-91	86	-312	-57
115B	-216	-104	91	-107	291	-17
115B	233	102	-91	107	-291	17
120A	-233	-102	91	-107	-64	-413
120A	233	102	-91	107	64	413
120B	-233	-102	91	-91	-84	-396
120B	413	58	-91	91	84	396
125	-413	-58	91	228	-163	993

Other forces in global coordinates: Wind

Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
25	Valve	669	-48	57	-322	-658	-1085
30		-669	48	-57	352	1074	1085
100	Valve	-65	104	-91	-163	-372	-278
105		65	-104	91	163	335	236

Displacements: Wind

	Displacements (global)					
Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.021	0.000	0.000	0.0000	-0.0067	-0.0003
10	0.021	0.000	0.024	-0.0004	-0.0069	-0.0004
15A	0.025	-1.349	1.721	-0.0142	-0.0209	-0.0288
15B	0.360	-1.623	1.792	-0.0143	-0.0270	-0.0616
20A	7.315	-1.622	0.115	-0.0175	-0.0485	-0.0654
20B	7.321	-1.511	0.000	-0.0159	-0.0625	-0.0485
25	2.988	-0.551	0.000	-0.0120	-0.0624	-0.0246
30	2.313	-0.422	0.000	-0.0118	-0.0617	-0.0235
35	1.993	-0.362	0.000	-0.0113	-0.0602	-0.0217
40	1.680	-0.303	0.000	-0.0110	-0.0589	-0.0206
45	1.152	-0.205	0.000	-0.0100	-0.0545	-0.0176
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	1.993	0.006	-1.273	-0.0039	-0.0449	-0.0094
105	1.993	0.070	-1.585	-0.0033	-0.0440	-0.0087

Displacements: Wind

Node	Displacements (global)					
	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
110A	1.993	0.074	-1.605	-0.0032	-0.0437	-0.0086
110B	1.995	0.089	-1.744	0.0067	-0.0304	0.0042
115A	1.581	0.089	-1.363	0.0084	-0.0051	0.0130
115B	1.526	0.033	-1.332	0.0095	0.0039	0.0139
120A	1.525	-0.422	-0.499	-0.0040	0.0149	-0.0070
120B	1.464	-0.363	-0.429	-0.0055	0.0139	-0.0269
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Loads on Anchors: Wind 2

Node	Tag	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
50		-6	236	1858	89	-16	-136
125		10	4	671	1753	-423	-20

Loads on Hangers: Wind 2

Node	Tag	Type	Load (N)	No.of	Total (N)
20B		User hanger	-207	1	-207
115B		Grinnell	1	1	1

Loads on Nozzles: Wind 2

Node	Tag	Axial (N)	y Shear (N)	z Shear (N)	Torque (Nm)	Circ.Mom (Nm)	Long.Mom (Nm)
5		-4	944	34	-1760	-74	1939

Pipe forces in local coordinates: Wind 2

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	SL+SO (MPa)
5	-4	-34	930	-1760	-1939	-74		13.84
10	-4	-34	930	-1760	-1753	-68	1.00	13.89
10	-4	-34	365	-1760	-1753	-68	1.00	13.89
15A	-4	-34	365	-1760	1057	196		13.10
15A	-4	-34	-224	-1760	1057	196	2.54	18.28
15B	-34	4	-224	972	1674	207	2.54	22.86
15B	-34	4	-677	972	1674	207		15.72
20A	-34	4	-677	972	-2243	183		16.37
20A	-34	-1129	-4	972	183	2243	2.54	23.56
20B	-1129	34	-4	182	-973	2660	2.54	34.16
20B	-1168	-241	4	182	973	-2660		21.51
25	-1168	-241	4	182	989	-1730	1.00	29.63
30	-1168	-241	4	182	991	-1580	1.00	27.80
35	-1168	-241	4	182	993	-1507	2.49	40.19
35	-1858	-236	-6	136	34	-602	2.49	35.58
40	-1858	-236	-6	136	32	-532		20.25
40	-1858	-236	-6	136	32	-532	2.00	26.58
45	-1858	-236	-6	136	29	-407	2.00	29.19
45	-1858	-236	-6	136	29	-407		21.80
50	-1858	-236	-6	136	16	89		32.75
35	10	-5	-616	-905	959	-46	2.49	43.79
100	10	-5	-616	-905	96	-38	1.00	18.93
105	10	-5	-484	-905	-111	-36	1.00	26.64
110A	10	-5	-484	-905	-124	-36		27.16
110A	10	-5	-466	-905	-124	-36	2.17	32.25
110B	-5	-10	-466	-230	798	-32	2.17	40.67
110B	-5	10	317	-230	-798	32		32.70
115A	-5	10	317	-230	-9	7		24.62
115A	-5	10	168	-230	-9	7	2.17	27.38
115B	10	5	168	29	268	4	2.17	38.25
115B	10	-4	55	29	-268	-4		30.85
120A	10	-4	55	29	-54	12		23.94

Pipe forces in local coordinates: Wind 2

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)	SIF	SL+SO (MPa)
120A	10	4	-276	29	54	-12	2.17	27.02
120B	6	-9	-276	12	-76	-11	2.17	25.87
120B	6	9	481	12	76	11		23.17
125	6	9	481	12	1803	-20		39.91

Other forces in local coordinates: Wind 2

Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
25	Valve	-1168	-241	4	182	989	-1730
30		-1168	-241	4	182	991	-1580
100	Valve	10	-5	-514	-905	96	-38
105		10	-5	-514	-905	-111	-36

Pipe forces in global coordinates: Wind 2

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
5	4	34	-930	1760	1939	74
10	-4	-34	930	-1760	-1753	-68
10	4	34	-365	1760	1753	68
15A	-4	-34	365	-1760	1057	196
15A	4	34	224	1760	-1057	-196
15B	-4	-34	-224	-1674	972	207
15B	4	34	677	1674	-972	-207
20A	-4	-34	-677	2243	972	183
20A	4	34	1129	-2243	-972	-183
20B	-4	-34	-1129	2660	973	182
20B	4	241	1168	-2660	-973	-182
25	-4	-241	-1168	1730	989	182
30	4	241	1168	-1580	-991	-182
35	-4	-241	-1168	1507	993	182
35	-6	236	1858	-602	-34	-136
40	6	-236	-1858	532	32	136
40	-6	236	1858	-532	-32	-136
45	6	-236	-1858	407	29	136
45	-6	236	1858	-407	-29	-136
50	6	-236	-1858	-89	16	136
35	10	5	-616	-905	-959	-46
100	-10	-5	616	905	96	38
105	10	5	-484	-905	111	-36
110A	-10	-5	484	905	-124	36
110A	10	5	-466	-905	124	-36
110B	-10	-5	466	798	-230	32
110B	10	5	-317	-798	230	-32
115A	-10	-5	317	9	-230	7
115A	10	5	-168	-9	230	-7
115B	-10	-5	168	-29	-268	4
115B	10	4	55	29	268	-4
120A	-10	-4	-55	-29	-54	-12
120A	10	4	276	29	54	12
120B	-10	-4	-276	-77	7	-11
120B	10	4	481	77	-7	11
125	-10	-4	-481	-1753	423	20

Other forces in global coordinates: Wind 2

Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
25	Valve	4	241	1168	-1730	-989	-182
30		-4	-241	-1168	1580	991	182

Other forces in global coordinates: Wind 2

Node	Type	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
100	Valve	10	5	-514	-905	-96	-38
105		-10	-5	514	905	-111	36

Displacements: Wind 2

	Displacements (global)					
Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.000	0.000	0.000	0.0000	-0.0708	-0.0171
10	0.000	-0.060	0.251	-0.0020	-0.0725	-0.0172
15A	0.000	-2.321	11.852	-0.0794	-0.0842	-0.0150
15B	0.082	-2.410	11.726	-0.1059	-0.0622	-0.0107
20A	0.910	-2.410	0.544	-0.0986	-0.0301	-0.0058
20B	0.786	-1.971	0.008	-0.0461	-0.0193	-0.0090
25	0.047	-0.214	0.005	-0.0089	-0.0026	-0.0049
30	0.022	-0.124	0.005	-0.0076	-0.0019	-0.0048
35	0.015	-0.090	0.005	-0.0056	-0.0006	-0.0045
40	0.012	-0.063	0.004	-0.0048	-0.0006	-0.0042
45	0.008	-0.026	0.004	-0.0033	-0.0005	-0.0036
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	0.015	0.000	0.285	0.0357	0.0179	-0.0030
105	0.015	0.021	0.412	0.0388	0.0179	-0.0029
110A	0.015	0.023	0.420	0.0396	0.0178	-0.0029
110B	0.022	0.031	0.709	0.0660	0.0243	-0.0009
115A	0.029	0.031	4.316	0.0913	0.0056	0.0003
115B	0.027	0.029	4.681	0.0874	-0.0032	0.0006
120A	0.027	-0.007	3.811	0.0838	-0.0189	0.0002
120B	0.027	-0.007	3.484	0.0826	-0.0191	-0.0004
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Frequencies

#	Frequency	Period	Participation factors			Modal mass / Total mass		
	(Hz)	(second)	X	Y	Z	X	Y	Z
1	1.693	0.5906	-0.7527	1.9267	-1.2144	0.0325	0.2127	0.0845
2	2.462	0.4061	0.8865	-2.1829	-1.5177	0.0450	0.2731	0.1320
3	2.671	0.3744	-2.4670	-1.4160	0.2429	0.3488	0.1149	0.0034
4	4.054	0.2467	-0.3463	0.3532	-1.2605	0.0069	0.0071	0.0911
5	6.574	0.1521	1.1232	-1.0279	0.1158	0.0723	0.0605	0.0008
6	6.771	0.1477	-0.6486	-1.0894	0.0612	0.0241	0.0680	0.0002
7	7.343	0.1362	-0.0836	0.1428	0.1341	0.0004	0.0012	0.0010
8	9.350	0.1069	1.1979	0.1907	-0.1923	0.0822	0.0021	0.0021
9	11.417	0.0876	-0.0592	0.8514	-0.0625	0.0002	0.0415	0.0002
10	11.948	0.0837	-0.6685	-0.0892	-1.1706	0.0256	0.0005	0.0785
11	30.955	0.0323	2.2988	0.0522	-0.0056	0.3028	0.0002	0.0000
12	51.880	0.0193	0.1948	0.0117	0.0547	0.0022	0.0000	0.0002
13					Total	0.9430	0.7818	0.3940

Mode 1: 1.69 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.000	0.000	0.000	0.0000	0.0578	0.0446
10	0.000	0.156	-0.204	0.0017	0.0591	0.0448
15A	0.000	6.303	-10.081	0.0654	0.0763	0.0446
15B	-0.284	6.590	-10.046	0.0855	0.0622	0.0412
20A	-4.073	6.589	-0.568	0.0923	0.0466	0.0320
20B	-3.962	6.063	0.000	0.0703	0.0439	0.0277
25	-1.373	2.070	0.000	0.0478	0.0316	0.0154
30	-1.033	1.557	0.000	0.0467	0.0309	0.0148

Mode 1: 1.69 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
35	-0.875	1.318	0.000	0.0447	0.0294	0.0139
40	-0.724	1.089	0.000	0.0427	0.0282	0.0132
45	-0.479	0.717	0.000	0.0375	0.0248	0.0113
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	-0.875	1.038	0.611	0.0382	0.0209	0.0089
105	-0.875	0.977	0.756	0.0378	0.0203	0.0085
110A	-0.875	0.973	0.766	0.0377	0.0202	0.0084
110B	-0.886	0.952	0.961	0.0299	0.0107	-0.0005
115A	-0.781	0.952	2.125	0.0247	-0.0065	-0.0016
115B	-0.785	0.941	2.177	0.0209	-0.0139	0.0053
120A	-0.784	0.243	0.893	0.0185	-0.0193	0.0144
120B	-0.735	0.183	0.772	0.0164	-0.0157	0.0171
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 2: 2.46 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.000	0.000	0.000	0.0000	0.0598	-0.0423
10	0.000	-0.148	-0.212	0.0018	0.0612	-0.0425
15A	0.003	-5.961	-9.681	0.0703	0.0624	-0.0419
15B	0.270	-6.232	-9.455	0.0961	0.0368	-0.0396
20A	3.990	-6.229	-0.222	0.0634	-0.0077	-0.0322
20B	4.053	-6.290	-0.005	-0.0213	-0.0262	-0.0191
25	1.800	-3.186	-0.003	-0.0621	-0.0369	-0.0095
30	1.400	-2.507	-0.003	-0.0625	-0.0367	-0.0090
35	1.208	-2.178	-0.003	-0.0626	-0.0362	-0.0083
40	1.020	-1.850	0.000	-0.0621	-0.0355	-0.0078
45	0.700	-1.286	0.000	-0.0588	-0.0330	-0.0067
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	1.208	-2.039	-0.794	-0.0611	-0.0279	-0.0038
105	1.208	-2.013	-0.988	-0.0610	-0.0272	-0.0037
110A	1.208	-2.011	-1.001	-0.0609	-0.0269	-0.0036
110B	1.214	-2.002	-1.315	-0.0551	-0.0156	-0.0004
115A	1.268	-2.002	-3.647	-0.0518	0.0103	-0.0046
115B	1.302	-1.955	-3.779	-0.0452	0.0220	-0.0157
120A	1.301	-0.412	-1.747	-0.0380	0.0307	-0.0276
120B	1.213	-0.302	-1.529	-0.0341	0.0251	-0.0294
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 3: 2.67 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	-0.024	0.000	0.000	0.0000	-0.0052	-0.0517
10	-0.025	-0.181	0.019	0.0003	-0.0053	-0.0519
15A	-0.030	-4.304	-0.089	0.0107	0.0149	0.0139
15B	-0.473	-4.010	-0.194	0.0057	0.0300	0.0956
20A	-12.484	-4.010	0.086	-0.0052	0.0756	0.1182
20B	-12.570	-3.884	0.000	-0.0264	0.1032	0.0873
25	-5.211	-1.731	0.000	-0.0351	0.1092	0.0448
30	-4.028	-1.349	0.000	-0.0351	0.1084	0.0430
35	-3.464	-1.165	0.000	-0.0348	0.1062	0.0397
40	-2.913	-0.984	0.000	-0.0342	0.1038	0.0376
45	-1.985	-0.676	0.000	-0.0318	0.0954	0.0322
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	-3.464	-1.817	2.410	-0.0351	0.0899	0.0133
105	-3.464	-1.904	3.038	-0.0351	0.0884	0.0112

Mode 3: 2.67 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
110A	-3.464	-1.909	3.078	-0.0351	0.0880	0.0107
110B	-3.396	-1.887	3.227	-0.0434	0.0683	-0.0321
115A	-1.387	-1.887	1.454	-0.0355	0.0220	-0.0518
115B	-1.188	-1.697	1.379	-0.0347	0.0068	-0.0442
120A	-1.186	0.296	0.698	-0.0001	-0.0172	-0.0087
120B	-1.161	0.288	0.622	0.0056	-0.0186	0.0171
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 4: 4.05 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	-0.003	0.000	0.000	0.0000	-0.0050	0.0073
10	-0.003	0.025	0.018	-0.0001	-0.0051	0.0073
15A	-0.004	1.206	0.616	-0.0055	-0.0011	0.0112
15B	-0.099	1.292	0.558	-0.0087	0.0038	0.0164
20A	-1.838	1.290	-0.050	0.0006	0.0149	0.0155
20B	-1.807	1.214	-0.004	0.0166	0.0200	0.0103
25	-0.605	0.253	-0.005	0.0039	0.0111	0.0048
30	-0.490	0.220	-0.005	0.0021	0.0100	0.0045
35	-0.443	0.217	-0.005	-0.0015	0.0077	0.0041
40	-0.399	0.219	-0.004	0.0003	0.0088	0.0039
45	-0.307	0.197	-0.003	0.0038	0.0106	0.0033
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	-0.443	0.161	-0.676	-0.2010	-0.0454	0.0010
105	-0.443	0.155	-0.996	-0.2156	-0.0449	0.0009
110A	-0.443	0.154	-1.017	-0.2194	-0.0445	0.0008
110B	-0.442	0.154	-2.363	-0.3500	-0.0778	-0.0010
115A	-0.375	0.154	-21.106	-0.4664	0.0046	-0.0017
115B	-0.369	0.159	-22.822	-0.4390	0.0486	-0.0010
120A	-0.369	0.107	-16.790	-0.3820	0.1098	0.0035
120B	-0.351	0.087	-15.241	-0.3658	0.0994	0.0071
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 5: 6.57 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.009	0.000	0.000	0.0000	-0.0112	0.0187
10	0.009	0.066	0.040	-0.0003	-0.0114	0.0188
15A	0.011	2.309	0.963	-0.0137	0.0067	0.0115
15B	-0.044	2.369	0.728	-0.0236	0.0237	0.0085
20A	-2.007	2.360	-0.302	0.0193	0.0636	0.0400
20B	-1.963	1.929	0.003	0.0867	0.0603	0.0657
25	1.191	-2.727	0.000	0.0106	0.0126	0.1282
30	1.302	-2.795	0.000	0.0018	0.0076	0.1309
35	1.318	-2.762	0.000	-0.0146	-0.0015	0.1358
40	1.283	-2.637	0.000	-0.0295	-0.0099	0.1286
45	1.103	-2.209	0.000	-0.0567	-0.0256	0.1103
50	0.000	0.000	0.000	-0.0000	0.0000	0.0000
100	1.327	-7.640	-0.015	-0.0111	0.0003	0.1951
105	1.328	-8.979	-0.012	-0.0108	0.0005	0.1828
110A	1.328	-9.063	-0.012	-0.0108	0.0005	0.1788
110B	1.541	-9.256	-0.038	-0.0071	0.0040	-0.1849
115A	13.907	-9.268	-0.238	-0.0019	0.0095	-0.2853
115B	14.791	-8.582	-0.193	0.0020	0.0130	-0.1086
120A	14.793	-4.220	0.704	0.0126	0.0105	-0.1211
120B	14.120	-3.503	0.691	0.0161	0.0059	-0.2760

Mode 5: 6.57 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 6: 6.77 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.024	0.000	0.000	0.0000	-0.0032	0.0222
10	0.024	0.078	0.011	-0.0004	-0.0033	0.0222
15A	0.029	1.951	0.555	-0.0144	-0.0041	-0.0035
15B	0.170	1.856	0.471	-0.0174	-0.0027	-0.0287
20A	2.007	1.849	-0.248	0.0163	-0.0053	0.0140
20B	1.596	1.498	0.000	0.0703	-0.0295	0.0654
25	-0.027	-2.250	0.000	0.0076	-0.0125	0.1576
30	-0.155	-2.295	0.000	0.0004	-0.0108	0.1616
35	-0.203	-2.263	0.000	-0.0128	-0.0076	0.1688
40	-0.233	-2.156	0.000	-0.0248	-0.0044	0.1599
45	-0.240	-1.803	0.000	-0.0467	0.0018	0.1372
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	-0.207	-9.280	-0.203	-0.0106	-0.0077	0.3526
105	-0.207	-11.771	-0.255	-0.0104	-0.0073	0.3536
110A	-0.207	-11.934	-0.259	-0.0103	-0.0072	0.3533
110B	-1.528	-13.300	-0.308	-0.0062	-0.0012	0.3112
115A	-11.795	-13.300	-0.470	-0.0007	0.0118	0.1180
115B	-11.845	-13.036	-0.400	0.0054	0.0188	-0.1686
120A	-11.838	2.845	1.020	0.0192	0.0176	-0.1257
120B	-11.664	2.884	1.008	0.0242	0.0105	0.1562
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 7: 7.34 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	-0.004	0.000	0.000	0.0000	-0.0013	0.0003
10	-0.004	0.000	0.005	-0.0000	-0.0013	0.0003
15A	-0.005	0.186	0.076	-0.0007	0.0015	0.0035
15B	-0.046	0.219	0.048	-0.0019	0.0039	0.0076
20A	-0.741	0.218	-0.033	0.0015	0.0101	0.0029
20B	-0.651	0.185	-0.010	0.0064	0.0144	-0.0040
25	-0.003	-0.012	-0.010	-0.0055	-0.0010	-0.0140
30	-0.021	0.054	-0.010	-0.0067	-0.0025	-0.0144
35	-0.041	0.096	-0.010	-0.0092	-0.0055	-0.0152
40	-0.065	0.135	-0.009	-0.0064	-0.0039	-0.0144
45	-0.084	0.163	-0.007	-0.0007	-0.0007	-0.0123
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	-0.042	0.720	-1.023	-0.2056	-0.0437	-0.0293
105	-0.042	0.925	-1.315	-0.2200	-0.0379	-0.0287
110A	-0.042	0.938	-1.333	-0.2237	-0.0360	-0.0285
110B	0.018	1.022	-2.380	-0.3090	0.0208	-0.0070
115A	-0.070	1.023	-17.524	-0.3105	0.3231	0.0080
115B	-0.109	0.978	-16.759	-0.1315	0.5067	0.0128
120A	-0.110	0.056	21.139	0.3385	0.4719	0.0110
120B	-0.088	0.022	21.329	0.4901	0.2786	0.0050
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 8: 9.35 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	-0.029	0.000	0.000	0.0000	-0.0228	-0.0221
10	-0.029	-0.077	0.081	0.0007	-0.0232	-0.0221
15A	-0.035	-1.019	0.317	0.0274	0.0495	0.0235

Mode 8: 9.35 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
15B	-0.411	-0.732	-0.119	0.0070	0.1050	0.0728
20A	-8.412	-0.727	0.167	-0.0119	0.2666	0.0666
20B	-6.761	-0.481	-0.010	-0.0486	0.3148	0.0288
25	8.132	1.869	-0.009	0.0049	0.0071	0.0295
30	8.054	1.785	-0.009	0.0104	-0.0210	0.0296
35	7.808	1.704	-0.009	0.0194	-0.0679	0.0296
40	7.337	1.581	-0.008	0.0260	-0.1031	0.0281
45	6.019	1.273	-0.007	0.0377	-0.1672	0.0241
50	0.000	0.000	0.000	0.0000	-0.0000	0.0000
100	7.820	0.447	-2.988	0.0595	-0.1478	0.0794
105	7.820	-0.129	-4.029	0.0625	-0.1471	0.0845
110A	7.820	-0.168	-4.096	0.0632	-0.1467	0.0859
110B	7.168	-0.686	-4.281	0.1040	-0.1111	0.2075
115A	-2.637	-0.684	0.853	0.1161	-0.0554	0.1929
115B	-3.188	-1.064	1.091	0.1051	-0.0424	0.0387
120A	-3.190	0.781	-0.332	0.0237	-0.0070	-0.0263
120B	-3.135	0.775	-0.384	0.0062	0.0053	0.0434
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 9: 11.42 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	0.046	0.000	0.000	0.0000	0.0067	-0.0175
10	0.046	-0.061	-0.024	0.0011	0.0069	-0.0176
15A	0.055	-2.502	-0.783	0.0420	0.0004	-0.0185
15B	0.237	-2.647	-0.441	0.0516	-0.0077	-0.0349
20A	1.596	-2.618	0.941	-0.0692	-0.0100	0.0426
20B	0.784	-1.333	-0.005	-0.2485	-0.0475	0.1268
25	-1.305	10.097	-0.004	0.0458	0.0012	0.2766
30	-1.270	9.439	-0.004	0.0731	0.0050	0.2831
35	-1.226	8.922	-0.004	0.1117	0.0101	0.2947
40	-1.154	8.234	-0.003	0.1433	0.0157	0.2793
45	-0.951	6.583	-0.003	0.1999	0.0260	0.2395
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	-1.223	-2.611	-0.152	0.0535	-0.0150	0.5326
105	-1.223	-6.336	-0.259	0.0492	-0.0150	0.5209
110A	-1.222	-6.576	-0.266	0.0481	-0.0150	0.5164
110B	-2.169	-8.023	-0.222	0.0097	-0.0256	0.0698
115A	1.894	-8.042	-0.815	-0.0238	-0.0034	-0.1640
115B	2.491	-7.499	-0.888	-0.0159	0.0086	-0.1217
120A	2.501	-0.850	0.271	0.0012	0.0178	-0.0782
120B	2.297	-0.574	0.316	0.0066	0.0113	-0.0625
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 10: 11.95 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	-0.005	0.000	0.000	0.0000	-0.0004	-0.0013
10	-0.005	-0.004	0.000	-0.0000	-0.0004	-0.0013
15A	-0.006	0.000	0.024	-0.0014	0.0004	0.0027
15B	-0.044	0.031	0.008	-0.0020	0.0010	0.0071
20A	-0.689	0.030	-0.094	0.0012	0.0022	0.0026
20B	-0.667	0.000	-0.074	0.0059	0.0024	-0.0015
25	-1.767	-0.419	-0.073	0.0052	-0.0522	-0.0060
30	-2.359	-0.474	-0.073	0.0052	-0.0581	-0.0062
35	-2.690	-0.501	-0.073	0.0060	-0.0732	-0.0065

Mode 10: 11.95 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
40	-2.964	-0.518	-0.068	0.0013	-0.0381	-0.0062
45	-2.943	-0.480	-0.056	-0.0078	0.0307	-0.0053
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	-2.698	-0.147	-14.621	0.2232	-0.8681	-0.0235
105	-2.698	0.024	-20.755	0.2392	-0.8679	-0.0250
110A	-2.699	0.035	-21.155	0.2432	-0.8656	-0.0254
110B	-2.513	0.184	-22.784	0.4827	-0.6537	-0.0593
115A	0.335	0.184	2.252	0.5802	-0.2890	-0.0572
115B	0.504	0.305	3.499	0.5451	-0.1870	-0.0144
120A	0.505	-0.110	-0.266	0.1506	0.0163	0.0095
120B	0.505	-0.125	-0.466	0.0713	0.0629	-0.0051
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 11: 30.95 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	9.397	0.000	0.000	0.0000	0.0029	0.1125
10	9.448	0.398	-0.010	-0.0001	0.0029	0.1122
15A	10.713	1.277	-0.024	-0.0025	-0.0061	-0.1880
15B	12.535	-0.523	0.032	-0.0009	-0.0121	-0.1384
20A	0.190	-0.557	-0.026	0.0019	-0.0282	0.2355
20B	-1.317	-0.578	0.000	-0.0015	0.0087	0.1861
25	-0.078	-0.088	0.000	-0.0098	0.0164	0.0682
30	0.094	0.017	0.000	-0.0093	0.0147	0.0631
35	0.162	0.063	0.000	-0.0074	0.0105	0.0539
40	0.207	0.096	0.000	-0.0054	0.0073	0.0511
45	0.238	0.123	0.000	-0.0010	0.0002	0.0438
50	0.000	0.000	0.000	0.0000	0.0000	0.0000
100	0.165	-0.053	-0.011	-0.0039	-0.0070	-0.0261
105	0.165	0.138	-0.061	-0.0036	-0.0072	-0.0271
110A	0.165	0.151	-0.065	-0.0036	-0.0072	-0.0271
110B	0.228	0.239	-0.099	0.0001	-0.0052	-0.0053
115A	0.000	0.244	0.004	0.0033	-0.0021	0.0087
115B	-0.027	0.225	0.011	0.0033	-0.0011	0.0038
120A	-0.028	0.013	0.000	0.0010	0.0003	0.0022
120B	-0.024	0.006	0.000	0.0005	0.0006	0.0010
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Mode 12: 51.88 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
5	-0.900	0.000	0.000	0.0000	0.3354	0.1323
10	-0.905	0.475	-1.218	0.0114	0.3386	0.1310
15A	-0.902	0.971	-3.949	0.4488	-0.5863	-0.1913
15B	1.023	-0.831	5.064	0.3657	-0.8969	-0.2592
20A	4.639	-0.869	2.572	-0.2957	-0.9920	0.3000
20B	-4.705	0.892	0.457	-0.1382	-0.7667	0.3891
25	-9.063	0.618	0.245	0.1091	0.9963	0.1566
30	2.353	-0.595	0.233	0.1075	1.0239	0.1465
35	7.632	-1.123	0.213	0.0882	0.8393	0.1284
40	11.583	-1.539	0.197	0.0680	0.6542	0.1217
45	15.351	-1.914	0.163	0.0125	0.1627	0.1044
50	0.000	0.000	0.000	-0.0000	-0.0001	0.0000
100	8.143	-1.095	1.778	-0.0063	-0.5018	-0.1460
105	8.168	0.010	-1.938	-0.0133	-0.5338	-0.1623
110A	8.170	0.088	-2.189	-0.0150	-0.5353	-0.1645

Mode 12: 51.88 Hz

Node	X (mm)	Y (mm)	Z (mm)	XX (deg)	YY (deg)	ZZ (deg)
110B	8.822	0.859	-4.453	0.0366	-0.5116	-0.0141
115A	0.547	0.888	0.126	0.1285	-0.2177	0.2603
115B	-0.298	0.233	0.004	0.1539	-0.1085	0.1000
120A	-0.329	-0.021	0.000	0.0455	0.0502	-0.0380
120B	-0.406	0.099	0.084	0.0293	0.0532	-0.0117
125	0.000	0.000	0.000	0.0000	0.0000	0.0000

Dynamic susceptibility

Mode	Frequency (Hz)	Maxima Nodes		Susceptibility (psi / ips)
		Velocity	Stress	
8	9.350	20A	35	1306
10	11.948	110B	35	1179
9	11.417	25	35	1051
6	6.771	115B	35	815
12	51.880	45	45	768
5	6.574	120B	110B	587
2	2.462	15A	20B	445
3	2.671	20B	50	412
1	1.693	15A	45	404
4	4.054	115B	110B	391
7	7.343	120B	125	361
11	30.955	15B	15B	249

Dynamic stresses for mode 8: 9.35 Hz, susceptibility = 1306

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	1.8655E+02	1.00	1.8655E+02
10	4.4081E-03	1.3788E+02	1.00	1.3789E+02
15A	4.2001E-02	1.6211E+03	2.54	4.1168E+03
15B	1.6866E-02	6.0065E+02	2.54	1.5254E+03
20A	3.3123E-01	9.3283E+02	2.54	2.3689E+03
20B	2.6684E-01	8.0485E+02	2.54	2.0439E+03
25	3.2850E-01	1.1671E+04	1.00	1.1672E+04
30	3.2477E-01	1.1241E+04	1.00	1.1242E+04
35	3.1462E-01	1.0227E+04	2.49	2.5417E+04
40	2.9550E-01	7.2098E+03	2.00	1.4420E+04
45	2.4219E-01	7.3521E+03	2.00	1.4704E+04
50	0.0000E+00	1.6167E+04	1.00	1.6167E+04
100	1.1896E-01	1.9699E+03	1.00	1.9701E+03
105	1.5869E-01	2.2624E+03	1.00	2.2626E+03
110A	1.6141E-01	2.2789E+03	2.17	4.9347E+03
110B	3.2871E-01	2.3953E+03	2.17	5.1868E+03
115A	1.0911E-01	2.7344E+03	2.17	5.9211E+03
115B	6.0004E-02	2.8775E+03	2.17	6.2310E+03
120A	3.3412E-02	1.4290E+03	2.17	3.0944E+03
120B	1.2802E-01	1.6582E+03	2.17	3.5907E+03
125	0.0000E+00	2.5883E+03	1.00	2.5883E+03

Dynamic stresses for mode 10: 11.95 Hz, susceptibility = 1179

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	3.3441E+00	1.00	3.3441E+00
10	1.8389E-04	2.4010E+00	1.00	2.4012E+00
15A	9.6286E-04	6.9989E+01	2.54	1.7774E+02
15B	1.7480E-03	5.1605E+01	2.54	1.3105E+02
20A	2.7368E-02	1.7513E+02	2.54	4.4475E+02
20B	2.6243E-02	1.0216E+02	2.54	2.5945E+02

Dynamic stresses for mode 10: 11.95 Hz, susceptibility = 1179

Node	Displacement	Nominal Stress	SIF	Intensified Stress
25	7.1491E-02	1.8192E+03	1.00	1.8194E+03
30	9.4736E-02	2.9409E+03	1.00	2.9412E+03
35	1.0774E-01	3.2146E+04	2.49	7.9894E+04
40	1.1845E-01	7.2781E+03	2.00	1.4556E+04
45	1.1738E-01	8.5753E+03	2.00	1.7151E+04
50	0.0000E+00	1.0196E+04	1.00	1.0196E+04
100	5.7564E-01	3.5141E+03	1.00	3.5144E+03
105	8.1712E-01	3.6627E+03	1.00	3.6630E+03
110A	8.3289E-01	3.7927E+03	2.17	8.2128E+03
110B	9.0244E-01	5.9154E+03	2.17	1.2809E+04
115A	8.9626E-02	2.7317E+03	2.17	5.9152E+03
115B	1.3829E-01	4.1374E+03	2.17	8.9593E+03
120A	1.1331E-02	4.0649E+02	2.17	8.8021E+02
120B	2.7501E-02	2.9922E+03	2.17	6.4794E+03
125	0.0000E+00	1.7837E+03	1.00	1.7837E+03

Dynamic stresses for mode 9: 11.42 Hz, susceptibility = 1051

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	5.9140E+01	1.00	5.9140E+01
10	2.5930E-03	4.8916E+01	1.00	4.8921E+01
15A	1.0323E-01	1.5934E+02	2.54	4.0465E+02
15B	1.9716E-02	3.1527E+02	2.54	8.0062E+02
20A	7.2931E-02	3.6121E+03	2.54	9.1730E+03
20B	6.0866E-02	1.7704E+03	2.54	4.4961E+03
25	4.0084E-01	1.2155E+04	1.00	1.2157E+04
30	3.7494E-01	9.9628E+03	1.00	9.9638E+03
35	3.5454E-01	1.2155E+04	2.49	3.0209E+04
40	3.2733E-01	6.4413E+03	2.00	1.2883E+04
45	2.6185E-01	6.3710E+03	2.00	1.2742E+04
50	0.0000E+00	1.6735E+04	1.00	1.6735E+04
100	1.0299E-01	2.3584E+03	1.00	2.3587E+03
105	2.4964E-01	7.0383E+03	1.00	7.0390E+03
110A	2.5911E-01	7.2527E+03	2.17	1.5705E+04
110B	8.5852E-02	8.4568E+03	2.17	1.8312E+04
115A	8.1185E-02	5.8997E+02	2.17	1.2775E+03
115B	2.9729E-01	6.7593E+02	2.17	1.4637E+03
120A	3.5134E-02	3.7925E+02	2.17	8.2124E+02
120B	9.4040E-02	3.2672E+02	2.17	7.0749E+02
125	0.0000E+00	1.1955E+03	1.00	1.1955E+03

Dynamic stresses for mode 6: 6.77 Hz, susceptibility = 815

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	3.8798E+01	1.00	3.8798E+01
10	3.0907E-03	2.8052E+01	1.00	2.8054E+01
15A	7.9852E-02	4.6307E+02	2.54	1.1760E+03
15B	1.9702E-02	2.5632E+02	2.54	6.5092E+02
20A	7.9601E-02	1.5013E+03	2.54	3.8125E+03
20B	8.6168E-02	5.9256E+02	2.54	1.5048E+03
25	8.8607E-02	2.8476E+03	1.00	2.8479E+03
30	9.0568E-02	3.0636E+03	1.00	3.0639E+03
35	8.9435E-02	7.1612E+03	2.49	1.7798E+04
40	8.5393E-02	2.4994E+03	2.00	4.9988E+03
45	7.1604E-02	2.6104E+03	2.00	5.2207E+03
50	0.0000E+00	4.9734E+03	1.00	4.9734E+03

Dynamic stresses for mode 6: 6.77 Hz, susceptibility = 815

Node	Displacement	Nominal Stress	SIF	Intensified Stress
100	3.6545E-01	1.1763E+03	1.00	1.1764E+03
105	4.6352E-01	4.0564E+02	1.00	4.0568E+02
110A	4.6994E-01	4.4430E+02	2.17	9.6209E+02
110B	6.1384E-02	1.1497E+03	2.17	2.4897E+03
115A	4.6472E-01	5.2877E+03	2.17	1.1450E+04
115B	5.1346E-01	5.0601E+03	2.17	1.0957E+04
120A	1.1898E-01	5.9780E+03	2.17	1.2945E+04
120B	4.7470E-01	5.9439E+03	2.17	1.2871E+04
125	0.0000E+00	9.5715E+03	1.00	9.5715E+03

Dynamic stresses for mode 12: 51.88 Hz, susceptibility = 768

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	2.7230E+03	1.00	2.7230E+03
10	5.1476E-02	1.2143E+03	1.00	1.2144E+03
15A	1.6012E-01	1.6248E+04	2.54	4.1262E+04
15B	2.0339E-01	1.2088E+04	2.54	3.0697E+04
20A	2.0883E-01	1.0973E+04	2.54	2.7865E+04
20B	1.8853E-01	1.4074E+04	2.54	3.5742E+04
25	3.5764E-01	4.8964E+04	1.00	4.8968E+04
30	9.5551E-02	2.7010E+04	1.00	2.7013E+04
35	3.0372E-01	5.6352E+04	2.49	1.4005E+05
40	4.6004E-01	4.3307E+04	2.00	8.6614E+04
45	6.0907E-01	7.6273E+04	2.00	1.5255E+05
50	0.0000E+00	6.7877E+04	1.00	6.7877E+04
100	8.2228E-02	2.4733E+04	1.00	2.4735E+04
105	7.6299E-02	4.6903E+03	1.00	4.6908E+03
110A	8.6269E-02	3.9729E+03	2.17	8.6031E+03
110B	3.8906E-01	1.1674E+04	2.17	2.5280E+04
115A	2.2095E-02	2.0376E+03	2.17	4.4123E+03
115B	9.1717E-03	4.7699E+03	2.17	1.0329E+04
120A	8.3032E-04	2.8934E+02	2.17	6.2653E+02
120B	1.6770E-02	1.1655E+03	2.17	2.5238E+03
125	0.0000E+00	7.6335E+02	1.00	7.6335E+02

Dynamic stresses for mode 5: 6.57 Hz, susceptibility = 587

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	9.3685E+01	1.00	9.3685E+01
10	3.0141E-03	7.8708E+01	1.00	7.8716E+01
15A	9.8502E-02	4.2005E+02	2.54	1.0667E+03
15B	2.8712E-02	6.2902E+01	2.54	1.5974E+02
20A	7.9916E-02	1.2611E+03	2.54	3.2026E+03
20B	1.0836E-01	7.7261E+02	2.54	1.9621E+03
25	1.1715E-01	3.8865E+03	1.00	3.8869E+03
30	1.2140E-01	4.2069E+03	1.00	4.2074E+03
35	1.2048E-01	5.3549E+03	2.49	1.3309E+04
40	1.1544E-01	3.4466E+03	2.00	6.8933E+03
45	9.7227E-02	3.6012E+03	2.00	7.2023E+03
50	0.0000E+00	6.7939E+03	1.00	6.7939E+03
100	3.0079E-01	3.7529E+03	1.00	3.7532E+03
105	3.5350E-01	6.2165E+03	1.00	6.2171E+03
110A	3.5681E-01	6.3343E+03	2.17	1.3716E+04
110B	6.0699E-02	6.4210E+03	2.17	1.3904E+04
115A	5.4759E-01	3.0796E+03	2.17	6.6686E+03
115B	3.3796E-01	3.0621E+03	2.17	6.6307E+03

Dynamic stresses for mode 5: 6.57 Hz, susceptibility = 587

Node	Displacement	Nominal Stress	SIF	Intensified Stress
120A	1.6843E-01	3.3303E+03	2.17	7.2115E+03
120B	5.7342E-01	3.2281E+03	2.17	6.9903E+03
125	0.0000E+00	9.6135E+03	1.00	9.6135E+03

Dynamic stresses for mode 2: 2.46 Hz, susceptibility = 445

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	4.8769E+02	1.00	4.8769E+02
10	1.0164E-02	4.6294E+02	1.00	4.6298E+02
15A	4.4761E-01	4.4300E+02	2.54	1.1250E+03
15B	3.7241E-01	4.2039E+02	2.54	1.0676E+03
20A	1.5734E-01	1.1884E+03	2.54	3.0181E+03
20B	2.9460E-01	1.2147E+03	2.54	3.0848E+03
25	1.4406E-01	2.7066E+02	1.00	2.7069E+02
30	1.1305E-01	1.2266E+02	1.00	1.2267E+02
35	9.8062E-02	1.9762E+02	2.49	4.9116E+02
40	8.3168E-02	2.3822E+02	2.00	4.7644E+02
45	5.7635E-02	8.5247E+02	2.00	1.7049E+03
50	0.0000E+00	2.6242E+03	1.00	2.6242E+03
100	8.6170E-02	3.0940E+02	1.00	3.0943E+02
105	8.8291E-02	3.2991E+02	1.00	3.2994E+02
110A	8.8449E-02	3.3086E+02	2.17	7.1645E+02
110B	7.0448E-02	6.5222E+01	2.17	1.4123E+02
115A	1.5202E-01	2.0439E+02	2.17	4.4259E+02
115B	1.6750E-01	3.7891E+02	2.17	8.2050E+02
120A	7.0668E-02	1.4624E+02	2.17	3.1666E+02
120B	7.7762E-02	1.2534E+02	2.17	2.7142E+02
125	0.0000E+00	1.0460E+03	1.00	1.0460E+03

Dynamic stresses for mode 3: 2.67 Hz, susceptibility = 412

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	7.8894E+01	1.00	7.8894E+01
10	7.1724E-03	4.6065E+01	1.00	4.6070E+01
15A	1.6950E-01	1.2467E+03	2.54	3.1659E+03
15B	2.0141E-02	1.0898E+03	2.54	2.7675E+03
20A	4.9152E-01	6.3733E+02	2.54	1.6185E+03
20B	5.1797E-01	4.9944E+02	2.54	1.2683E+03
25	2.1618E-01	2.0793E+02	1.00	2.0795E+02
30	1.6724E-01	4.3297E+02	1.00	4.3302E+02
35	1.4390E-01	6.1609E+02	2.49	1.5312E+03
40	1.2103E-01	6.2420E+02	2.00	1.2484E+03
45	8.2571E-02	1.5967E+03	2.00	3.1934E+03
50	0.0000E+00	3.5802E+03	1.00	3.5802E+03
100	1.1885E-01	1.0079E+03	1.00	1.0080E+03
105	1.4113E-01	1.0155E+03	1.00	1.0156E+03
110A	1.4260E-01	1.0134E+03	2.17	2.1944E+03
110B	1.8445E-01	7.3546E+02	2.17	1.5926E+03
115A	7.9117E-02	2.6771E+02	2.17	5.7970E+02
115B	8.6092E-02	5.9430E+02	2.17	1.2869E+03
120A	2.9836E-02	5.7207E+02	2.17	1.2388E+03
120B	5.3065E-02	5.6613E+02	2.17	1.2259E+03
125	0.0000E+00	1.0213E+03	1.00	1.0213E+03

Dynamic stresses for mode 1: 1.69 Hz, susceptibility = 404

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	4.7153E+02	1.00	4.7153E+02

Dynamic stresses for mode 1: 1.69 Hz, susceptibility = 404

Node	Displacement	Nominal Stress	SIF	Intensified Stress
10	1.0118E-02	4.5504E+02	1.00	4.5509E+02
15A	4.6808E-01	1.6258E+02	2.54	4.1287E+02
15B	3.9567E-01	4.1933E+02	2.54	1.0649E+03
20A	1.6191E-01	3.0987E+02	2.54	7.8692E+02
20B	2.8515E-01	3.9572E+02	2.54	1.0049E+03
25	9.7800E-02	5.0584E+02	1.00	5.0589E+02
30	7.3581E-02	5.4912E+02	1.00	5.4918E+02
35	6.2289E-02	5.7609E+02	2.49	1.4318E+03
40	5.1492E-02	5.2290E+02	2.00	1.0458E+03
45	3.3953E-02	1.0047E+03	2.00	2.0093E+03
50	0.0000E+00	1.3080E+03	1.00	1.3080E+03
100	4.7437E-02	2.8532E+02	1.00	2.8534E+02
105	4.8638E-02	2.8235E+02	1.00	2.8238E+02
110A	4.8742E-02	2.8217E+02	2.17	6.1101E+02
110B	5.1451E-02	2.0437E+02	2.17	4.4254E+02
115A	8.9150E-02	1.1793E+02	2.17	2.5536E+02
115B	9.3382E-02	2.4363E+02	2.17	5.2756E+02
120A	3.6433E-02	1.1543E+02	2.17	2.4995E+02
120B	4.2571E-02	7.4144E+01	2.17	1.6055E+02
125	0.0000E+00	5.8965E+02	1.00	5.8965E+02

Dynamic stresses for mode 4: 4.05 Hz, susceptibility = 391

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	4.1380E+01	1.00	4.1380E+01
10	1.2164E-03	3.7748E+01	1.00	3.7752E+01
15A	5.3311E-02	1.2157E+02	2.54	3.0873E+02
15B	2.2302E-02	8.1329E+01	2.54	2.0653E+02
20A	7.2400E-02	2.6278E+02	2.54	6.6733E+02
20B	8.5704E-02	1.9802E+02	2.54	5.0287E+02
25	2.5836E-02	7.3720E+02	1.00	7.3727E+02
30	2.1145E-02	9.1704E+02	1.00	9.1713E+02
35	1.9419E-02	2.1803E+03	2.49	5.4189E+03
40	1.7914E-02	4.2636E+02	2.00	8.5273E+02
45	1.4341E-02	4.3708E+02	2.00	8.7416E+02
50	0.0000E+00	9.2899E+02	1.00	9.2899E+02
100	2.7345E-02	1.9634E+02	1.00	1.9636E+02
105	3.9695E-02	5.8645E+02	1.00	5.8651E+02
110A	4.0508E-02	6.3515E+02	2.17	1.3754E+03
110B	9.4631E-02	4.1279E+03	2.17	8.9385E+03
115A	8.3109E-01	2.4887E+02	2.17	5.3890E+02
115B	8.9853E-01	1.2753E+03	2.17	2.7616E+03
120A	6.6104E-01	8.5948E+01	2.17	1.8611E+02
120B	6.0022E-01	7.2714E+02	2.17	1.5745E+03
125	0.0000E+00	8.0368E+03	1.00	8.0368E+03

Dynamic stresses for mode 7: 7.34 Hz, susceptibility = 361

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	1.0371E+01	1.00	1.0371E+01
10	1.8284E-04	8.5910E+00	1.00	8.5918E+00
15A	7.9260E-03	7.9296E+01	2.54	2.0137E+02
15B	2.5956E-03	5.4362E+01	2.54	1.3805E+02
20A	2.9204E-02	1.8346E+02	2.54	4.6589E+02
20B	2.6649E-02	4.8951E+01	2.54	1.2431E+02
25	4.7028E-04	7.2440E+02	1.00	7.2447E+02

Dynamic stresses for mode 7: 7.34 Hz, susceptibility = 361

Node	Displacement	Nominal Stress	SIF	Intensified Stress
30	2.2965E-03	8.4770E+02	1.00	8.4778E+02
35	4.1008E-03	2.9204E+03	2.49	7.2583E+03
40	5.8993E-03	6.7437E+02	2.00	1.3487E+03
45	7.2325E-03	8.1134E+02	2.00	1.6227E+03
50	0.0000E+00	7.6143E+02	1.00	7.6143E+02
100	4.9243E-02	1.5937E+03	1.00	1.5938E+03
105	6.3294E-02	3.0566E+03	1.00	3.0569E+03
110A	6.4162E-02	3.1439E+03	2.17	6.8079E+03
110B	9.3706E-02	3.7530E+03	2.17	8.1267E+03
115A	6.8994E-01	3.6815E+03	2.17	7.9719E+03
115B	6.6094E-01	4.0560E+03	2.17	8.7829E+03
120A	8.3226E-01	4.7999E+03	2.17	1.0394E+04
120B	8.3975E-01	4.5635E+03	2.17	9.8819E+03
125	0.0000E+00	1.3997E+04	1.00	1.3997E+04

Dynamic stresses for mode 11: 30.95 Hz, susceptibility = 249

Node	Displacement	Nominal Stress	SIF	Intensified Stress
5	0.0000E+00	1.4673E+02	1.00	1.4673E+02
10	1.5672E-02	3.1503E+02	1.00	3.1506E+02
15A	5.0303E-02	4.9407E+03	2.54	1.2547E+04
15B	4.9349E-01	9.4130E+03	2.54	2.3904E+04
20A	7.5538E-03	7.1967E+02	2.54	1.8276E+03
20B	5.6624E-02	7.8850E+02	2.54	2.0024E+03
25	4.6402E-03	4.5602E+02	1.00	4.5607E+02
30	3.7613E-03	9.6342E+02	1.00	9.6352E+02
35	6.8264E-03	2.9070E+03	2.49	7.2249E+03
40	8.9843E-03	8.1499E+02	2.00	1.6300E+03
45	1.0556E-02	1.1155E+03	2.00	2.2311E+03
50	0.0000E+00	1.0785E+03	1.00	1.0785E+03
100	2.1230E-03	9.0906E+02	1.00	9.0915E+02
105	5.9398E-03	7.0875E+01	1.00	7.0882E+01
110A	6.4555E-03	1.1909E+02	2.17	2.5787E+02
110B	9.7885E-03	5.8978E+02	2.17	1.2771E+03
115A	1.6033E-04	1.1096E+02	2.17	2.4027E+02
115B	8.8499E-03	3.1880E+01	2.17	6.9034E+01
120A	5.0759E-04	2.5277E+01	2.17	5.4735E+01
120B	9.7871E-04	2.6086E+01	2.17	5.6487E+01
125	0.0000E+00	9.6883E+00	1.00	9.6883E+00

Weight & Center of gravity

Empty weight = 2538.2 (kg)
Insulation weight = 386.05 (kg)
Content weight = 134.28 (kg)
Lining weight = 0 (kg)
Total weight = 3058.5 (kg)
Center of Gravity for Total weight
X = 6456.92, Y = 4741.34, Z = 2737.32 (mm)

Bill of materials: Materials

#	Name	Description
1	312	A312 TP316

Bill of materials: Pipes

#	Material	OD (mm)	Thk (mm)	Total length (mm)	Total weight (kg)
1	312	168.27	7.112	11394.6	329.35
2	312	219.07	8.1788	2100	91.344

Bill of materials: Pipes

#	Material	OD (mm)	Thk (mm)	Total length (mm)	Total weight (kg)
3	312	273.05	9.271	18146	1119.1

Bill of materials: Bends

#	Material	OD (mm)	Thk (mm)	Radius (mm)	Angle (deg)	Count	Total weight (kg)
1	312	168.27	7.112	228.6	76.04	1	8.7687
2	312	168.27	7.112	228.6	90.00	2	20.758
3	312	273.05	9.271	381	90.00	2	73.817

Bill of materials: Reducers

#	Material	OD1 (mm)	Thk1 (mm)	OD2 (mm)	Thk2 (mm)	Length (mm)	Count	Total weight (kg)
1	312	273.05	9.271	219.07	8.1788	530	1	27.676

Bill of materials: Valves

#	OD (mm)	Thk (mm)	Weight (kg)	Add.Weight (kg)	Count	Total weight (kg)
1	168.27	7.112	151.56	0	1	151.56
2	273.05	9.271	459.23	0	1	459.23