Tutorial for Response Spectrum Analysis using CAEPIPE

General

- The Response Spectrum is a plot of the maximum response (maximum displacement, velocity, acceleration or any other quantity of interest) to a specified dynamic loading applied on all possible single degree-of-freedom systems. The abscissa of the spectrum is the natural frequency (or period) of the system, and the ordinate is the maximum response.

  In general, response spectra for a seismic event are prepared by calculating the maximum response to a specified ground motion excitation of single degree-of-freedom systems with various amounts of damping. Numerical integration with short time steps is used to calculate the response of each single degree-of-freedom system. The step-by-step process is continued until the total earthquake record is completed, the results of which becomes the response of that system to that excitation. Change the parameters of the system to change its natural frequency, repeat the process for the same excitation and record the new maximum response. This process is repeated until all frequencies of interest have been covered and the results plotted. Typically the El Centro, California earthquake of 1940 is used for this purpose. Attached ("ElCentro.txt") is an ASCII file that contains spectrum from El Centro, California earthquake of 1940. [*First line in this file is the name of the spectrum. Second line defines the "Units" for Abscissa (X-axis) and Ordinate (Y-axis) axes, separated by a space. Starting from the 3rd line, the first column is Abscissa and the second column is Ordinate. For further details on this ASCII file, refer to the "Spectrums" subsection under "Misc." section of Menus in the CAEPIPE User's Manual.*]

- Response Spectrum thus prepared as explained above is then input/imported into CAEPIPE Stress model for analysis through CAEPIPE Layout window > Misc > Spectrums.

- Once the inputting of different spectrums are done, input the Spectrum levels applicable for the current analysis through Layout window > Spectrum. Define a single level for uniform response spectrum analysis. For piping supported at different elevations with each elevation experiencing different seismic loads, define multiple levels with the corresponding spectrum loads. In the latter case, the levels should be assigned to each support.

- Save the model and perform analysis using CAEPIPE.

- Spectrum load specified will be applied at all supports, following which CAEPIPE will compute the modal and directional responses, which are further combined as per the combination method selected.

- Since the response spectra give only maximum response, only the maximum values for each mode are calculated and then superimposed (modal combination) to give a total response. A conservative upper bound for the total response may be obtained by adding the absolute values of the maximum modal components (absolute sum). However, this is excessively conservative and a more probable value of the maximum response is the square root of the sum of squares (SRSS) of the modal maxima.

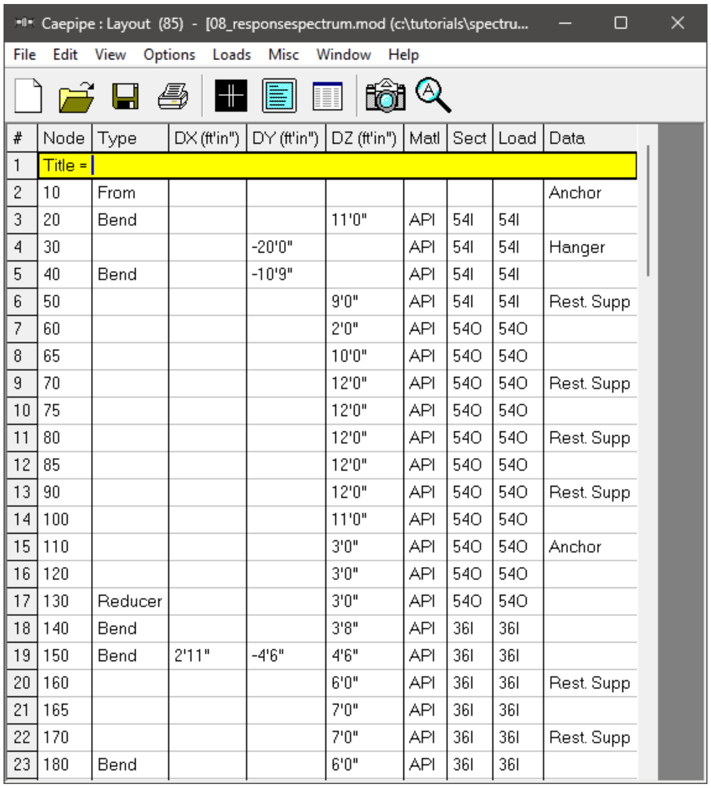
- Ensure the CAEPIPE results meet project specific analysis requirements. If not, make changes to the piping layout and/or changes to support types and their locations and then reanalyze the model until the analysis requirements are met.

Uniform Response Spectrum Analysis

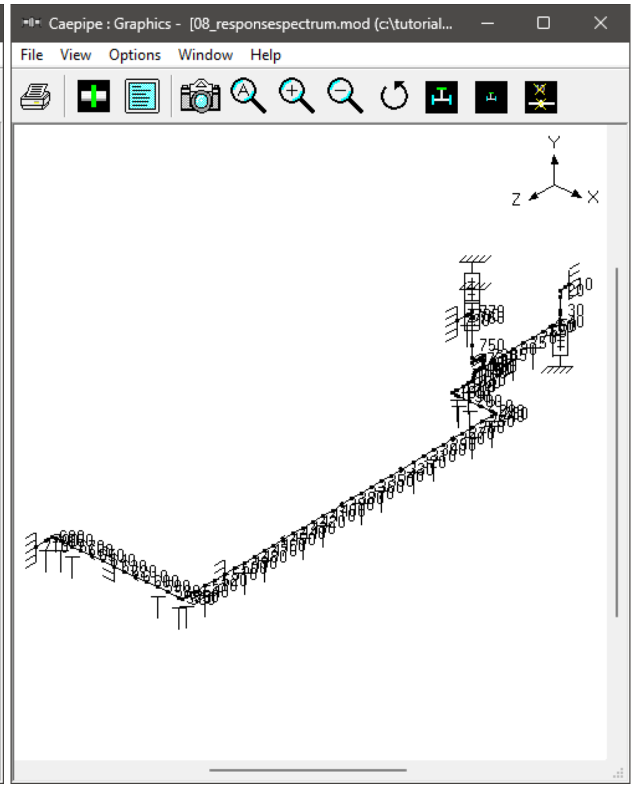
The following are the Steps for performing the Uniform Response Spectrum Analysis using CAEPIPE.

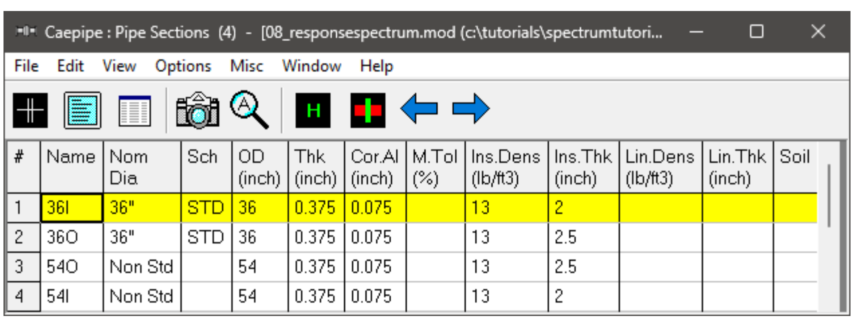
Step 1:

Attached is a sample CAEPIPE model with Response Spectrum. The piping layout shown below (extracted from the attached model) is for a water supply line that has the following layout and properties. The Analysis Code is selected as ASME B31.9 for this sample model.

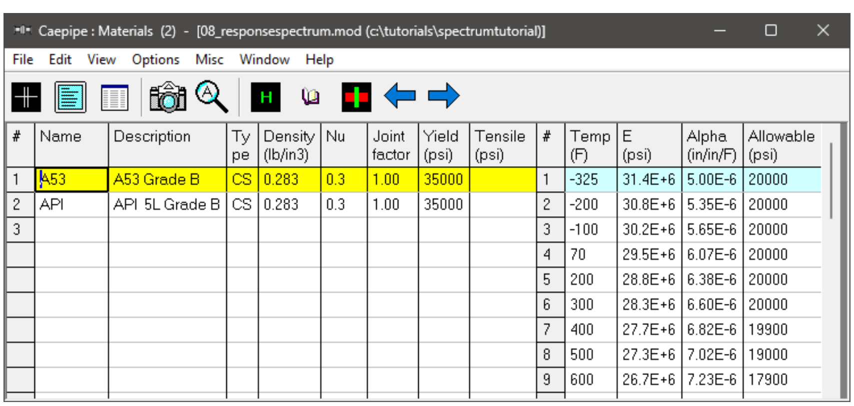


#	Node	Type	DX (ft'in")	DY (ft'in")	DZ (ft'in")	Matl	Sect	Load	Data
1	Title =								
2	10	From							Anchor
3	20	Bend			11'0"	API	54I	54I	
4	30			-20'0"		API	54I	54I	Hanger
5	40	Bend		-10'9"		API	54I	54I	
6	50				9'0"	API	54I	54I	Rest. Supp
7	60				2'0"	API	54O	54O	
8	65				10'0"	API	54O	54O	
9	70				12'0"	API	54O	54O	Rest. Supp
10	75				12'0"	API	54O	54O	
11	80				12'0"	API	54O	54O	Rest. Supp
12	85				12'0"	API	54O	54O	
13	90				12'0"	API	54O	54O	Rest. Supp
14	100				11'0"	API	54O	54O	
15	110				3'0"	API	54O	54O	Anchor
16	120				3'0"	API	54O	54O	
17	130	Reducer			3'0"	API	54O	54O	
18	140	Bend			3'8"	API	36I	36I	
19	150	Bend	2'11"	-4'6"	4'6"	API	36I	36I	
20	160				6'0"	API	36I	36I	Rest. Supp
21	165				7'0"	API	36I	36I	
22	170				7'0"	API	36I	36I	Rest. Supp
23	180	Bend			6'0"	API	36I	36I	



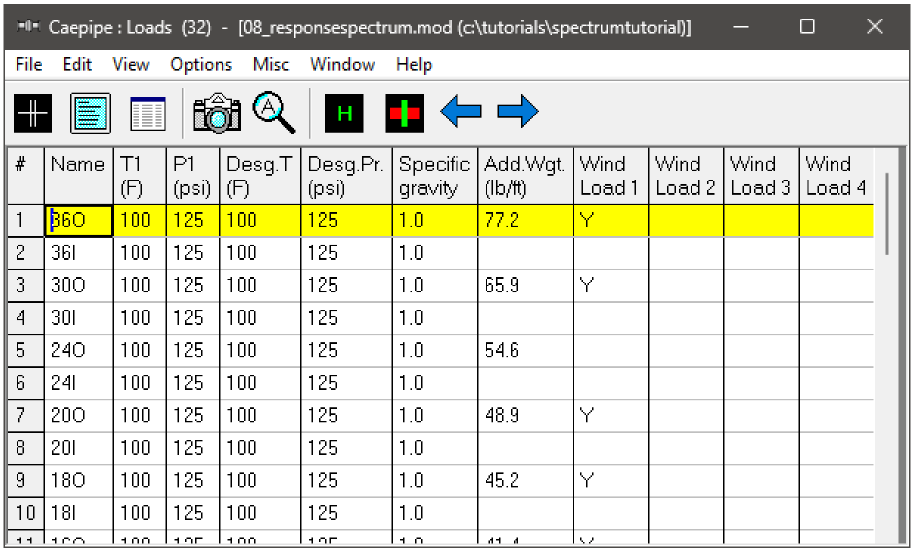


#	Name	Nom Dia	Sch	OD (inch)	Thk (inch)	Cor.Al (inch)	M.Tol (%)	Ins.Dens (lb/ft3)	Ins.Thk (inch)	Lin.Dens (lb/ft3)	Lin.Thk (inch)	Soil
1	36I	36"	STD	36	0.375	0.075		13	2			
2	36O	36"	STD	36	0.375	0.075		13	2.5			
3	54O	Non Std		54	0.375	0.075		13	2.5			
4	54I	Non Std		54	0.375	0.075		13	2			



#	Name	Description	Type	Density (lb/in3)	Nu	Joint factor	Yield (psi)	Tensile (psi)
1	A53	A53 Grade B	CS	0.283	0.3	1.00	35000	
2	API	API 5L Grade B	CS	0.283	0.3	1.00	35000	
3								

#	Temp (F)	E (psi)	Alpha (in/in/F)	Allowable (psi)
1	-325	31.4E+6	5.00E-6	20000
2	-200	30.8E+6	5.35E-6	20000
3	-100	30.2E+6	5.65E-6	20000
4	70	29.5E+6	6.07E-6	20000
5	200	28.8E+6	6.38E-6	20000
6	300	28.3E+6	6.60E-6	20000
7	400	27.7E+6	6.82E-6	19900
8	500	27.3E+6	7.02E-6	19000
9	600	26.7E+6	7.23E-6	17900

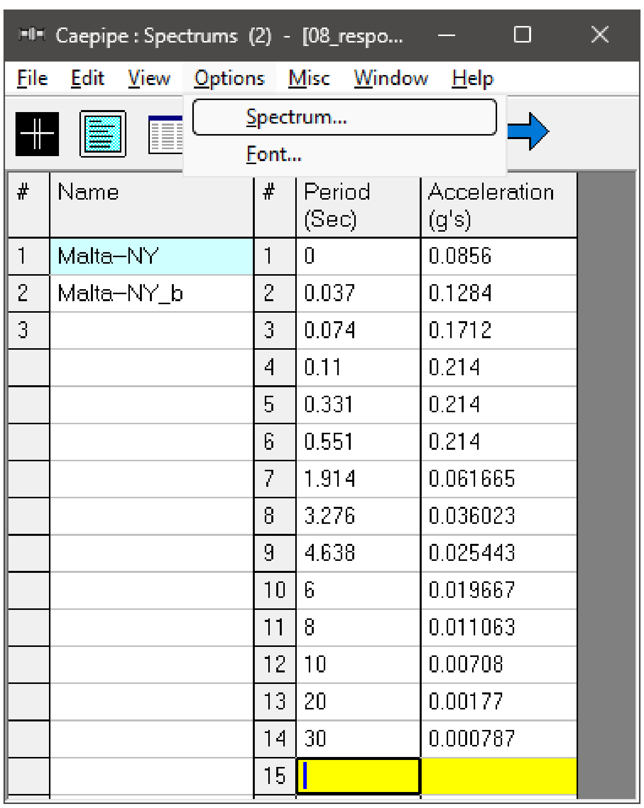


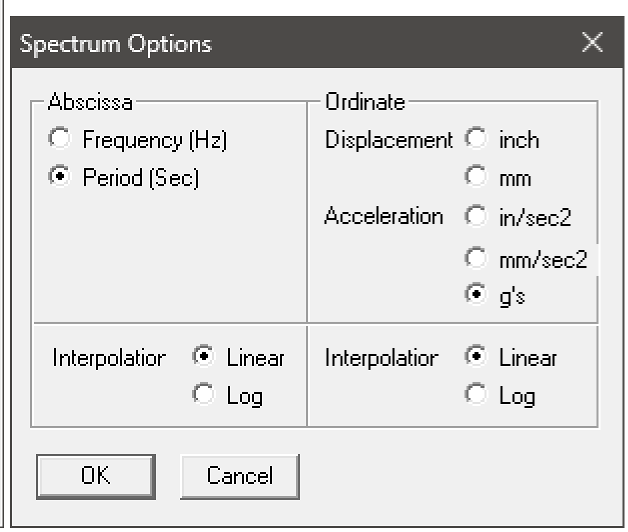
Step 2:

Input Spectrums into CAEPIPE. This can be done in three ways:

1. Input spectrums directly into the model.
2. Create a spectrum library and load spectrums from it.
3. Input spectrums from a text file.

When the first two methods are used, the units for the X-axis and Y-axis as well as the interpolation method are set through the menu Options > Spectrum.

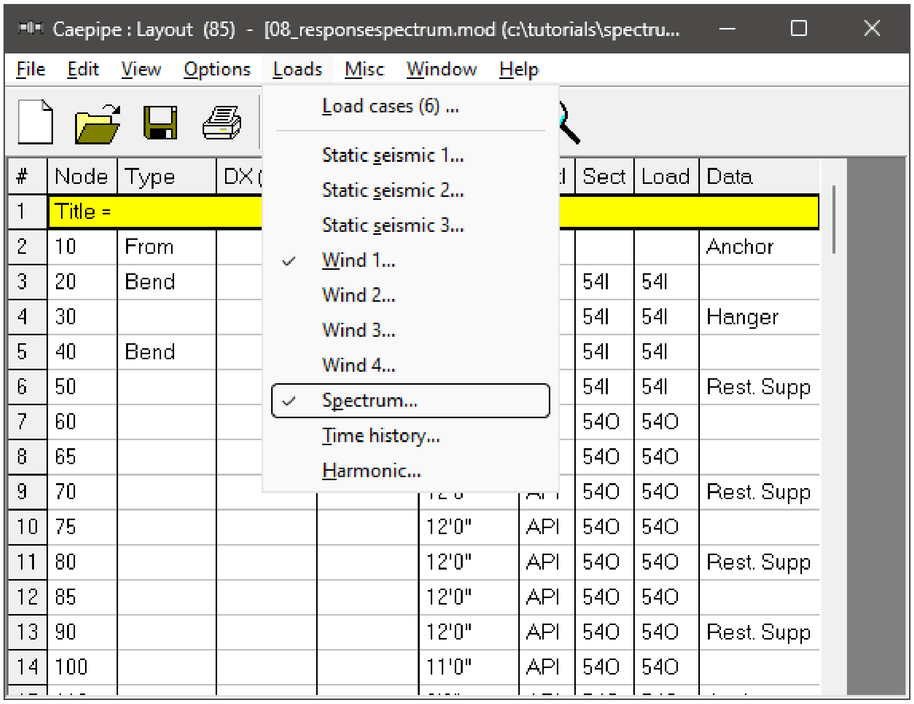


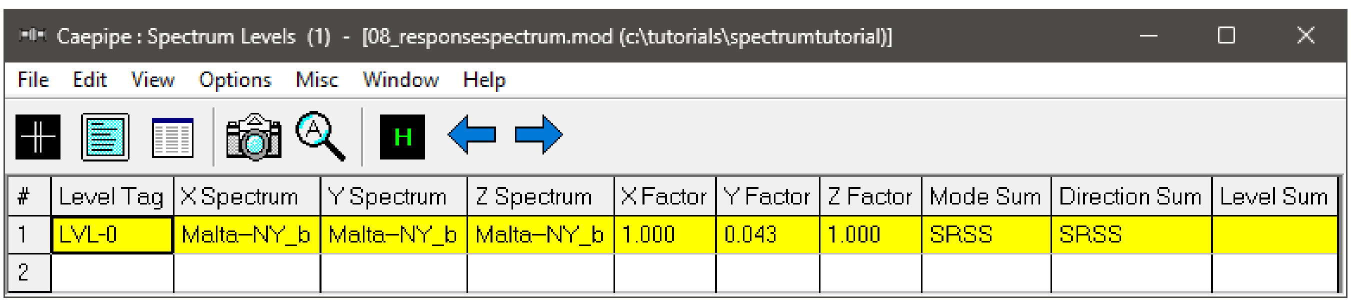


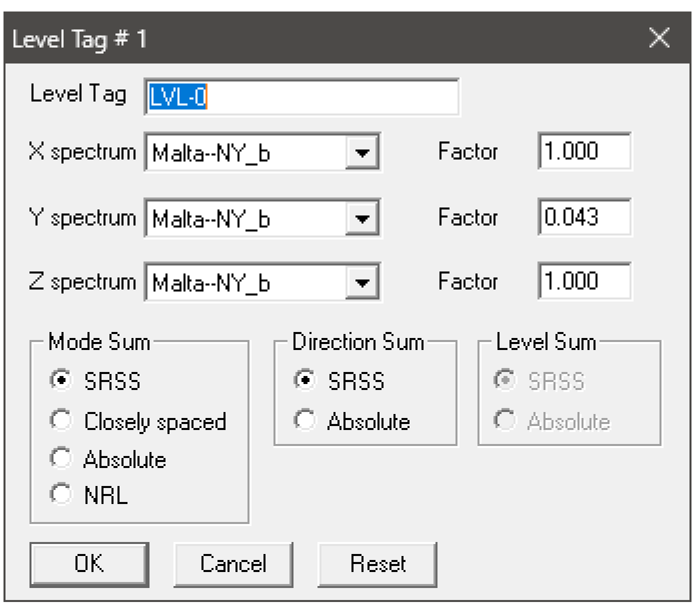
For the sample layout described above, spectrum was input directly into CAEPIPE model manually. If you wish to read the spectrum file "ElCentro.txt" supplied into the CAEPIPE model, select "Read Spectrum" through Spectrum List Window > File.

Step 3:

Once the inputting of different spectrums are done, input the Spectrum load itself for analysis through Layout window > Spectrum.







X, Y and Z spectrums

Select a spectrum from the drop-down combo box, which should have been input in the spectrum table for each direction.

Factor

The multiplying (scale) factor for the spectrum is input here. The same spectrum may be multiplied by different (Scale) factors to apply spectrum loads for different dynamic events. For example, vertical spectrum can be input as the same as that of the horizontal spectrum with a factor as shown above.

Mode Sum

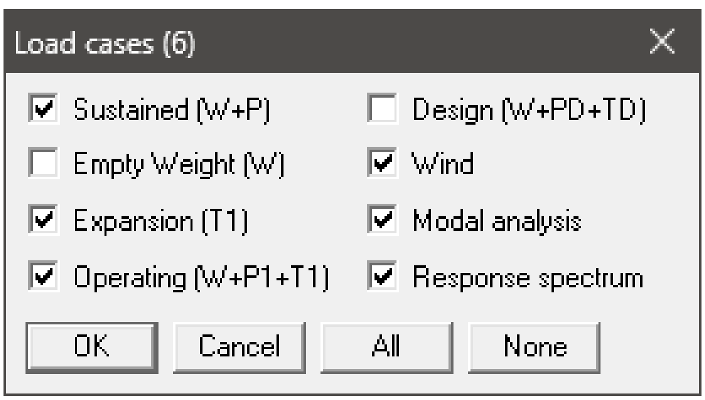
Pick one of three choices, “SRSS” (square root of sum of squares), “Closely spaced” or “Absolute”.

Direction Sum

Pick one of two choices, “SRSS” (square root of sum of squares) or “Absolute”.

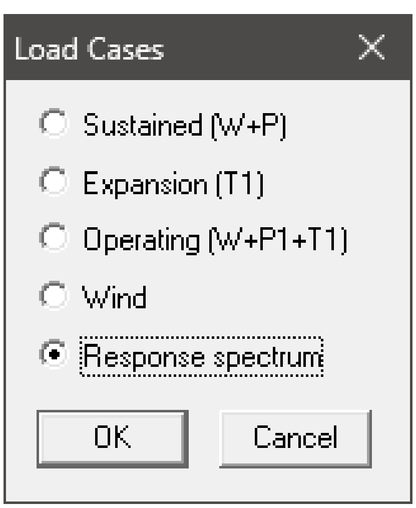
Step 4:

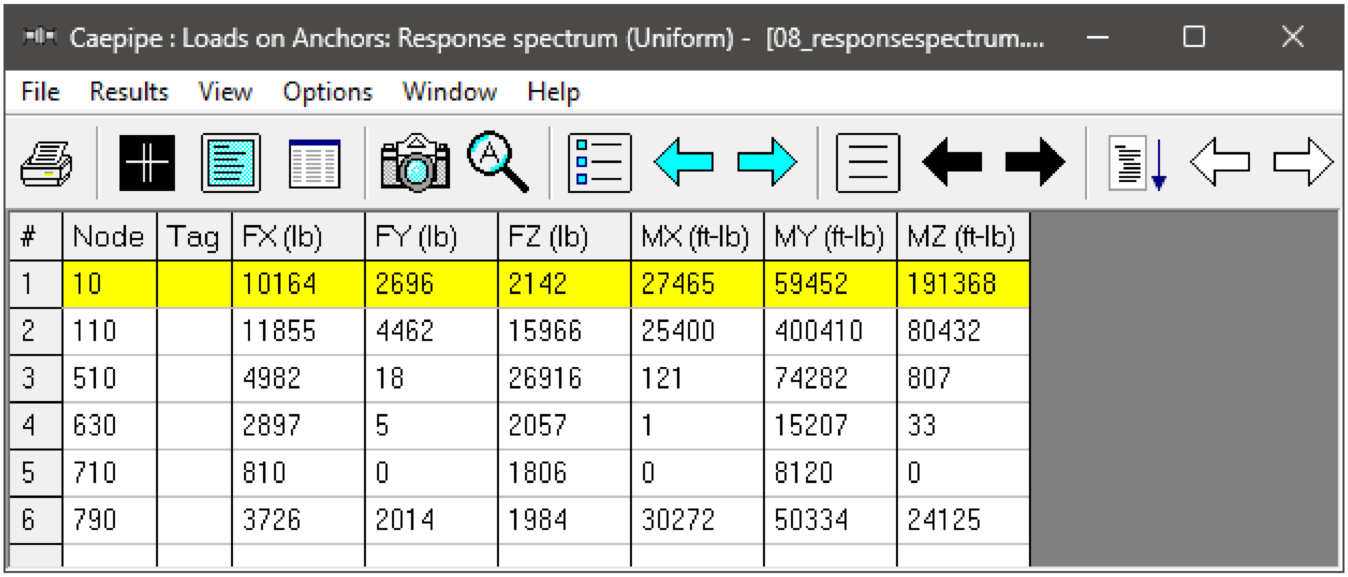
Turn ON the load case “Response spectrum” through Layout window > Loads > Load cases. Save the model and perform the analysis through Layout window > File > Analyze. CAEPIPE will apply these loads to compute the response of the piping system by performing a Response Spectrum analysis along with other load cases defined in the piping system.



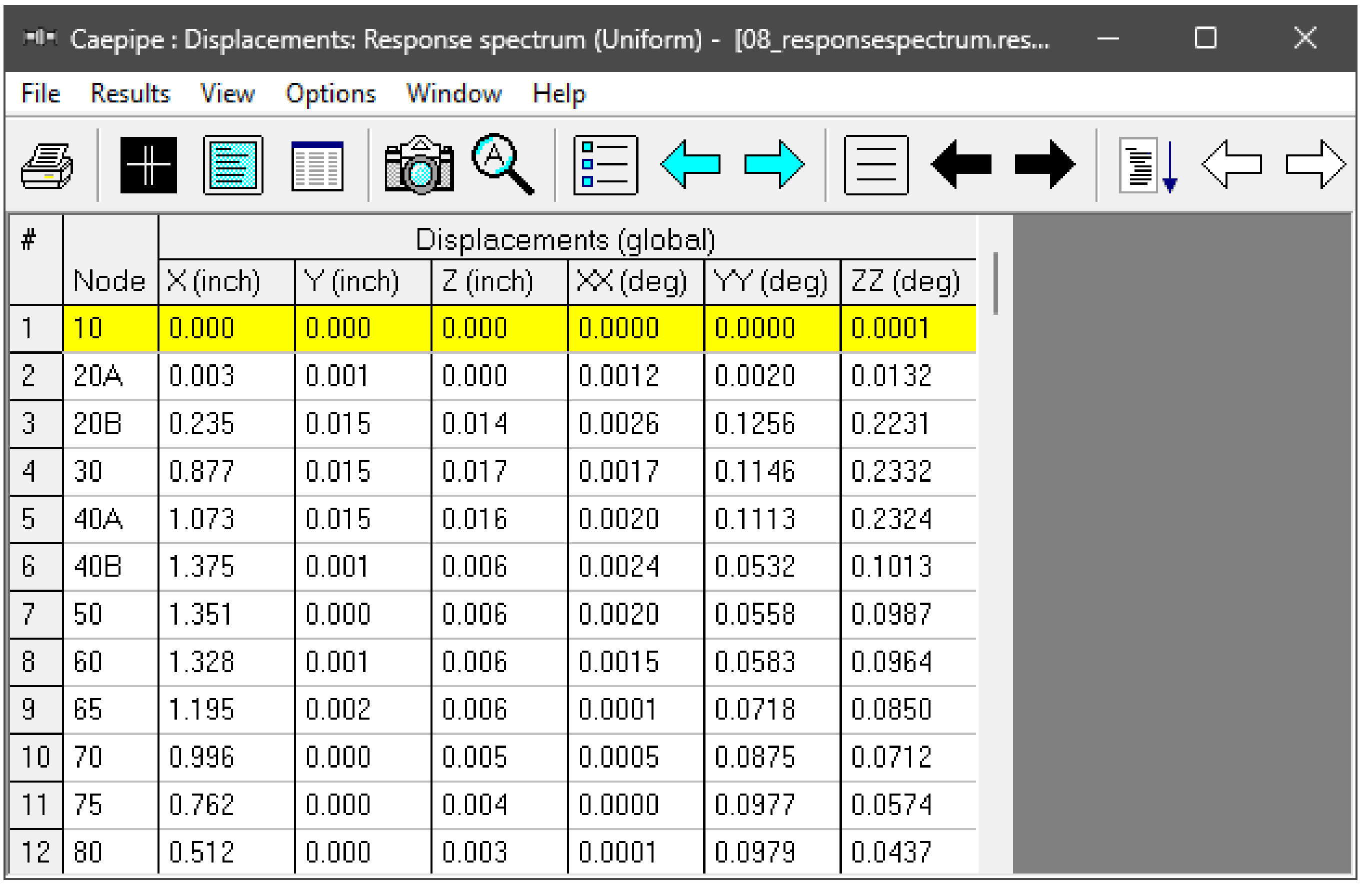
Step 5:

Upon analysis, CAEPIPE will show a “Load case” with name “Response spectrum” under “Support Loads”, “Displacements”, “Element forces” and “Support load summary” results.

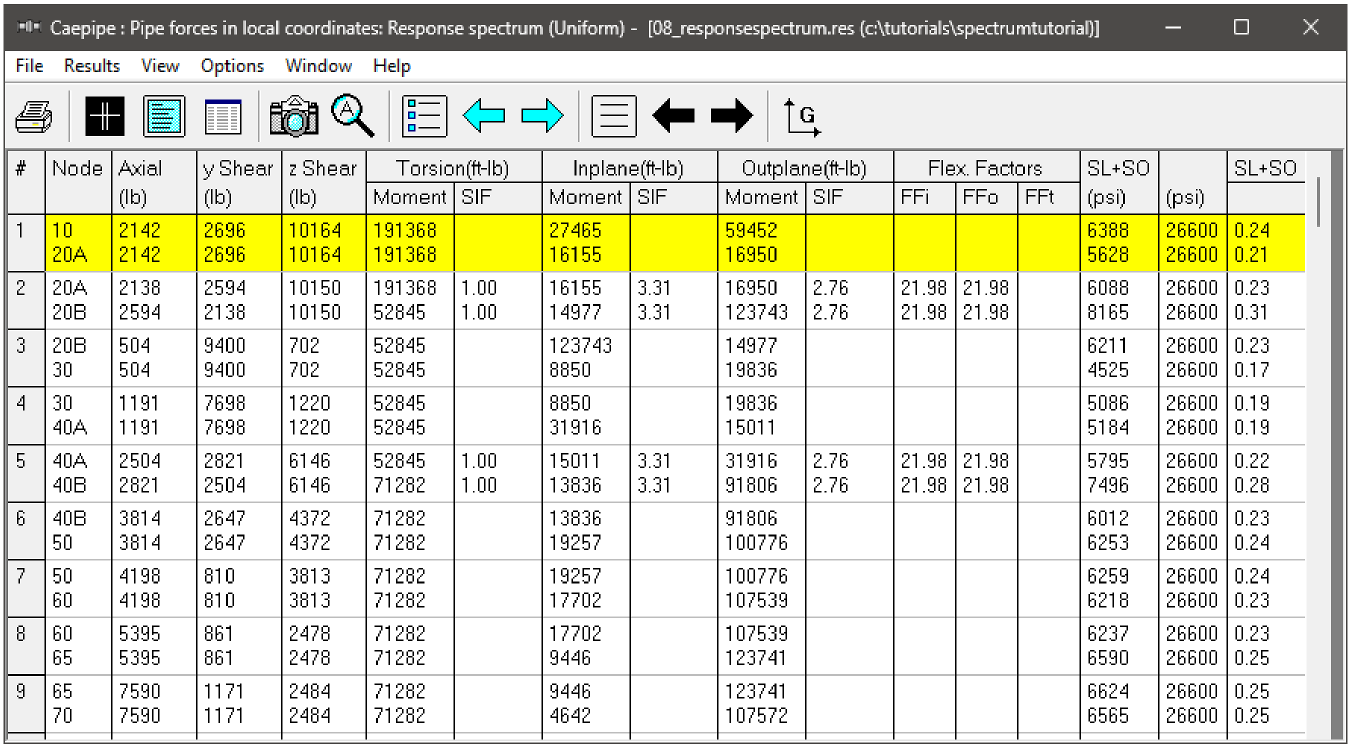




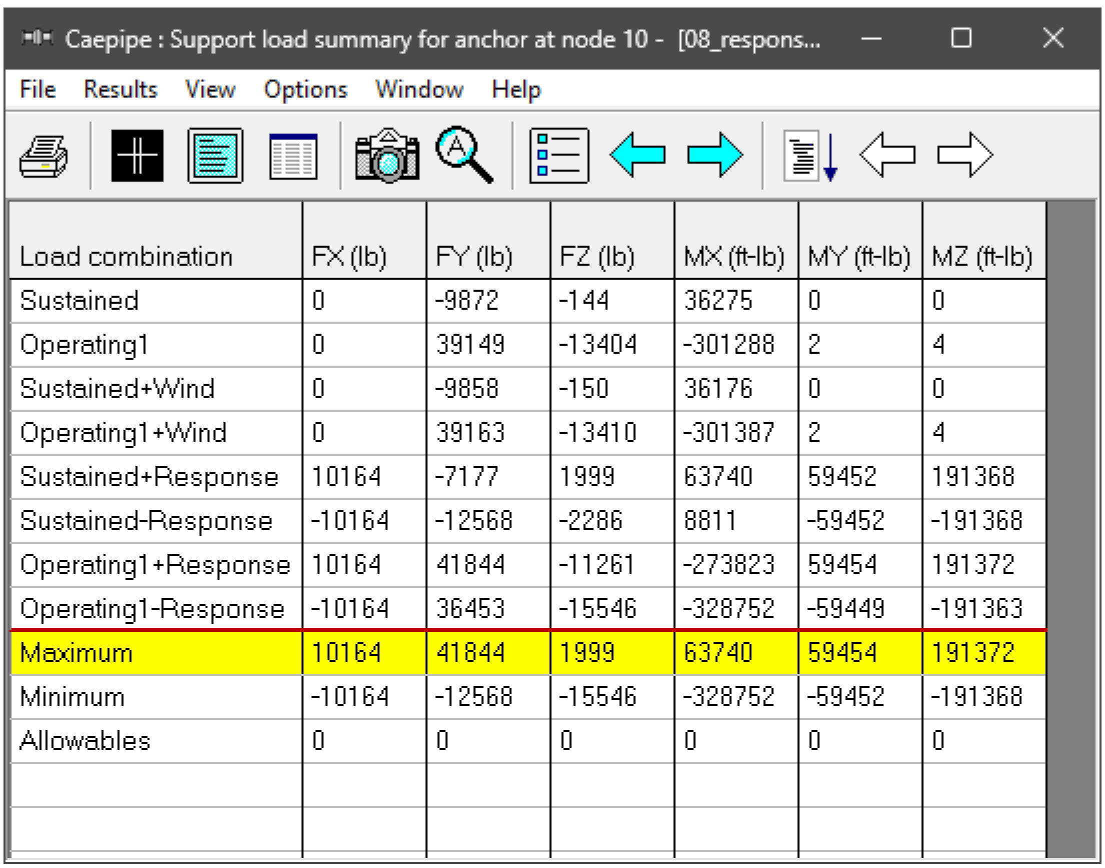
#	Node	Tag	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
1	10		10164	2696	2142	27465	59452	191368
2	110		11855	4462	15966	25400	400410	80432
3	510		4982	18	26916	121	74282	807
4	630		2897	5	2057	1	15207	33
5	710		810	0	1806	0	8120	0
6	790		3726	2014	1984	30272	50334	24125



#		Displacements (global)					
	Node	X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
1	10	0.000	0.000	0.000	0.0000	0.0000	0.0001
2	20A	0.003	0.001	0.000	0.0012	0.0020	0.0132
3	20B	0.235	0.015	0.014	0.0026	0.1256	0.2231
4	30	0.877	0.015	0.017	0.0017	0.1146	0.2332
5	40A	1.073	0.015	0.016	0.0020	0.1113	0.2324
6	40B	1.375	0.001	0.006	0.0024	0.0532	0.1013
7	50	1.351	0.000	0.006	0.0020	0.0558	0.0987
8	60	1.328	0.001	0.006	0.0015	0.0583	0.0964
9	65	1.195	0.002	0.006	0.0001	0.0718	0.0850
10	70	0.996	0.000	0.005	0.0005	0.0875	0.0712
11	75	0.762	0.000	0.004	0.0000	0.0977	0.0574
12	80	0.512	0.000	0.003	0.0001	0.0979	0.0437



#	Node	Axial (lb)	y Shear (lb)	z Shear (lb)	Torsion(ft-lb) Moment	SIF	Inplane(ft-lb) Moment	SIF	Outplane(ft-lb) Moment	SIF	Flex. Factors FFi	FFo	FFt	SL+SO (psi)	(psi)	SL+SO
1	10 20A	2142 2142	2696 2696	10164 10164	191368 191368		27465 16155		59452 16950					6388 5628	26600 26600	0.24 0.21
2	20A 20B	2138 2594	2594 2138	10150 10150	191368 52845	1.00 1.00	16155 14977	3.31 3.31	16950 123743	2.76 2.76	21.98 21.98	21.98 21.98		6088 8165	26600 26600	0.23 0.31
3	20B 30	504 504	9400 9400	702 702	52845 52845		123743 8850		14977 19836					6211 4525	26600 26600	0.23 0.17
4	30 40A	1191 1191	7698 7698	1220 1220	52845 52845		8850 31916		19836 15011					5086 5184	26600 26600	0.19 0.19
5	40A 40B	2504 2821	2821 2504	6146 6146	52845 71282	1.00 1.00	15011 13836	3.31 3.31	31916 91806	2.76 2.76	21.98 21.98	21.98 21.98		5795 7496	26600 26600	0.22 0.28
6	40B 50	3814 3814	2647 2647	4372 4372	71282 71282		13836 19257		91806 100776					6012 6253	26600 26600	0.23 0.24
7	50 60	4198 4198	810 810	3813 3813	71282 71282		19257 17702		100776 107539					6259 6218	26600 26600	0.24 0.23
8	60 65	5395 5395	861 861	2478 2478	71282 71282		17702 9446		107539 123741					6237 6590	26600 26600	0.23 0.25
9	65 70	7590 7590	1171 1171	2484 2484	71282 71282		9446 4642		123741 107572					6624 6565	26600 26600	0.25 0.25



Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
Sustained	0	-9872	-144	36275	0	0
Operating1	0	39149	-13404	-301288	2	4
Sustained+Wind	0	-9858	-150	36176	0	0
Operating1+Wind	0	39163	-13410	-301387	2	4
Sustained+Response	10164	-7177	1999	63740	59452	191368
Sustained-Response	-10164	-12568	-2286	8811	-59452	-191368
Operating1+Response	10164	41844	-11261	-273823	59454	191372
Operating1-Response	-10164	36453	-15546	-328752	-59449	-191363
Maximum	10164	41844	1999	63740	59454	191372
Minimum	-10164	-12568	-15546	-328752	-59452	-191368
Allowables	0	0	0	0	0	0

Multi-level Response Spectrum Analysis

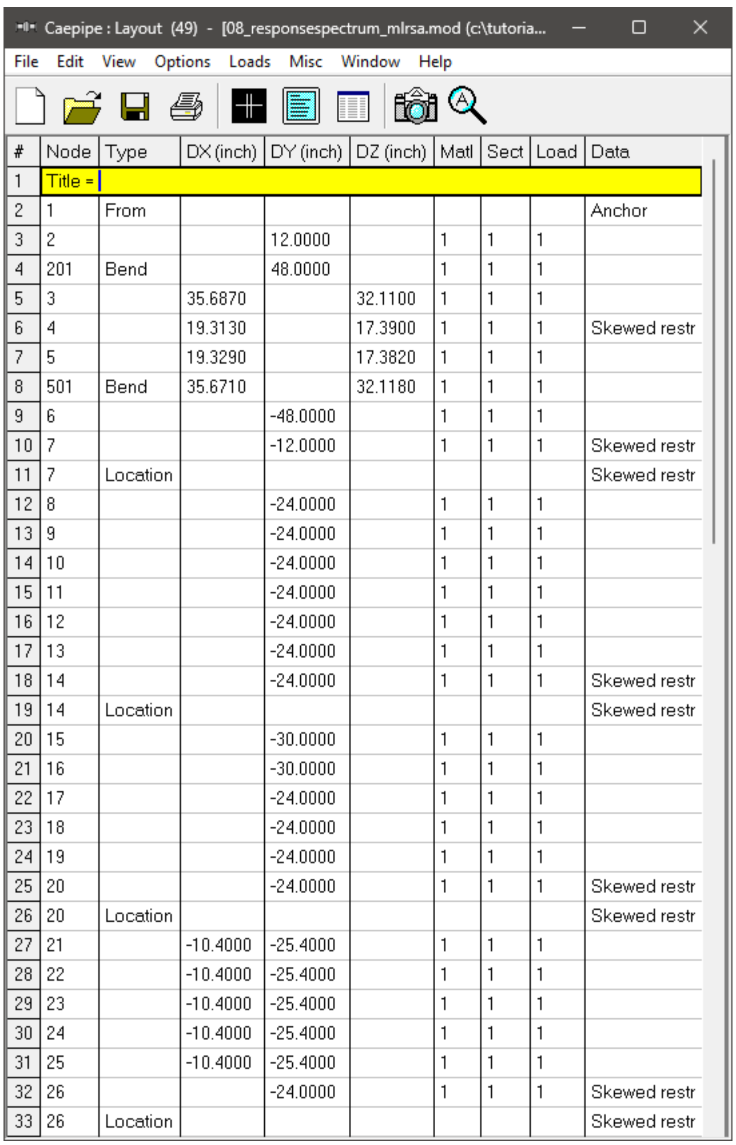
The model shown below is a 3 inch nominal diameter water line extending between two elevations, namely Level L1 and Level L2, with each Level experiencing different seismic loads. The layout has two anchors with a number of intermediate supports. The seimsic excitation consists of two separate spectra, with each spectrum corresponding to the two different Levels. All supports connected from node 1 through mode 11 (inclusive of the two end nodes) experience the upper level (Level L1) spectra excitation, while the remaining supports experience the lower level (Level L2) spectra excitation.

For this Multi-Level Response Spectrum Analysis, only the first 15 modes are used to approximate the response of the system. For each Level, the same spectrum load is applied along X, Y and Z directions with weighting factors of 1.0, 0.667 and 0.0 in the three global directions respectively.

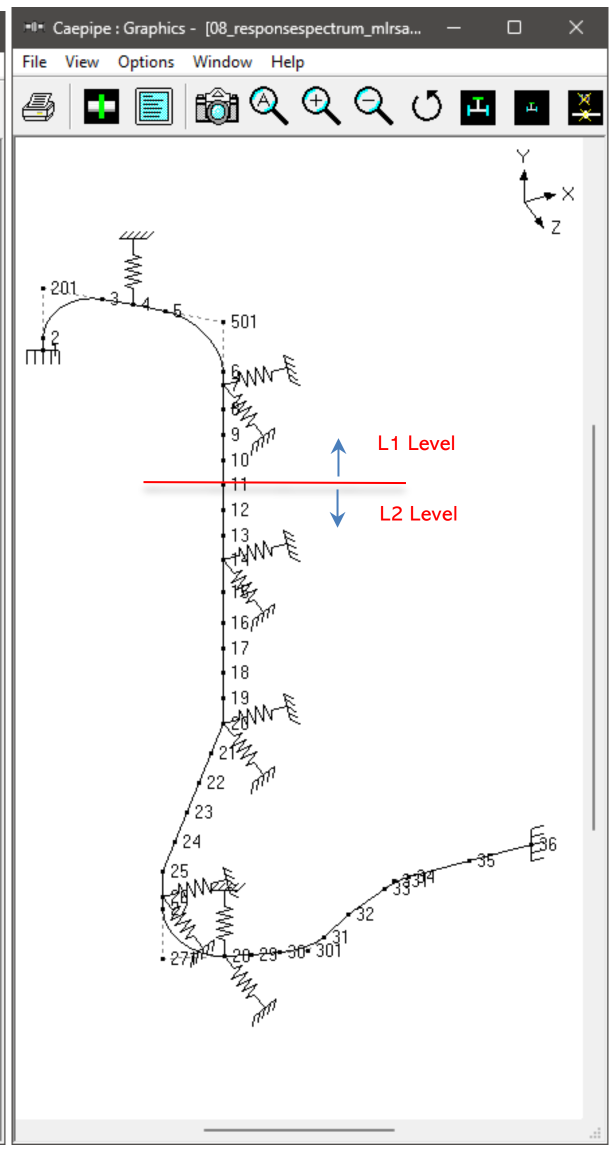
The following are the Steps to perform the Multi-level Response Spectrum Analysis using CAEPIPE.

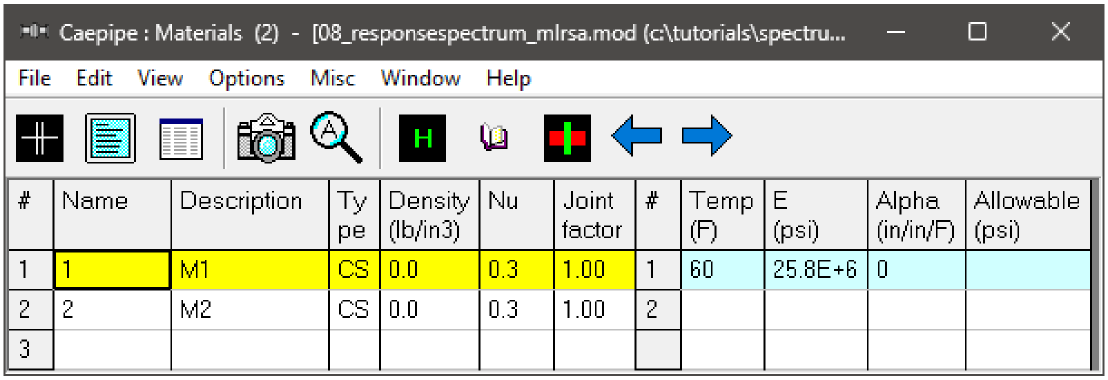
Step 1:

Attached is a sample CAEPIPE model with Response Spectrum. The piping layout shown below (extracted from the attached model “08_ResponseSpectrum_MLRSA.mod”) has the following layout and properties.



#	Node	Type	DX (inch)	DY (inch)	DZ (inch)	Matl	Sect	Load	Data
1	Title =								
2	1	From							Anchor
3	2			12.0000		1	1	1	
4	201	Bend		48.0000		1	1	1	
5	3		35.6870		32.1100	1	1	1	
6	4		19.3130		17.3900	1	1	1	Skewed restr
7	5		19.3290		17.3820	1	1	1	
8	501	Bend	35.6710		32.1180	1	1	1	
9	6			-48.0000		1	1	1	
10	7			-12.0000		1	1	1	Skewed restr
11	7	Location							Skewed restr
12	8			-24.0000		1	1	1	
13	9			-24.0000		1	1	1	
14	10			-24.0000		1	1	1	
15	11			-24.0000		1	1	1	
16	12			-24.0000		1	1	1	
17	13			-24.0000		1	1	1	
18	14			-24.0000		1	1	1	Skewed restr
19	14	Location							Skewed restr
20	15			-30.0000		1	1	1	
21	16			-30.0000		1	1	1	
22	17			-24.0000		1	1	1	
23	18			-24.0000		1	1	1	
24	19			-24.0000		1	1	1	
25	20			-24.0000		1	1	1	Skewed restr
26	20	Location							Skewed restr
27	21		-10.4000	-25.4000		1	1	1	
28	22		-10.4000	-25.4000		1	1	1	
29	23		-10.4000	-25.4000		1	1	1	
30	24		-10.4000	-25.4000		1	1	1	
31	25		-10.4000	-25.4000		1	1	1	
32	26			-24.0000		1	1	1	Skewed restr
33	26	Location							Skewed restr





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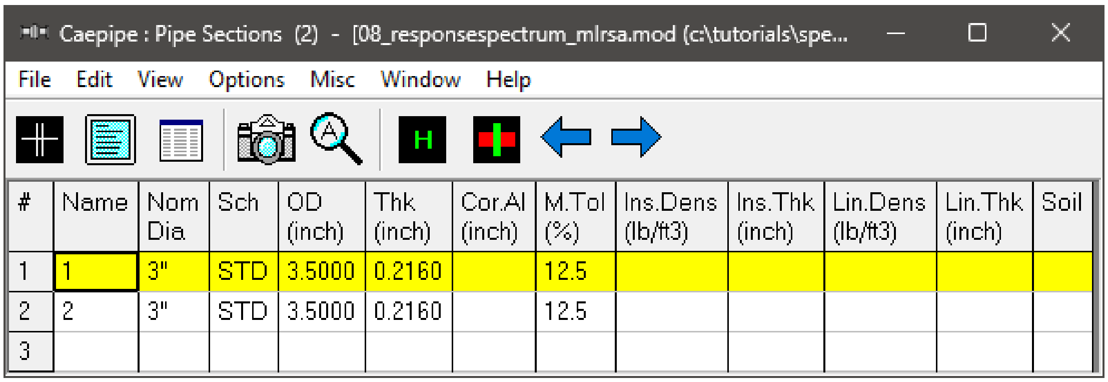
File Edit View Options Misc Window Help

#	Name	Description	Type	Density (lb/in3)	Nu	Joint factor	#	Temp (F)	E (psi)	Alpha (in/in/F)	Allowable (psi)
1	1	M1	CS	0.0	0.3	1.00	1	60	25.8E+6	0	
2	2	M2	CS	0.0	0.3	1.00	2				
3											



Caepipe : Pipe Sections (2) - [08_responsespectrum_mlrsa.mod (c:\tutorials\spe...

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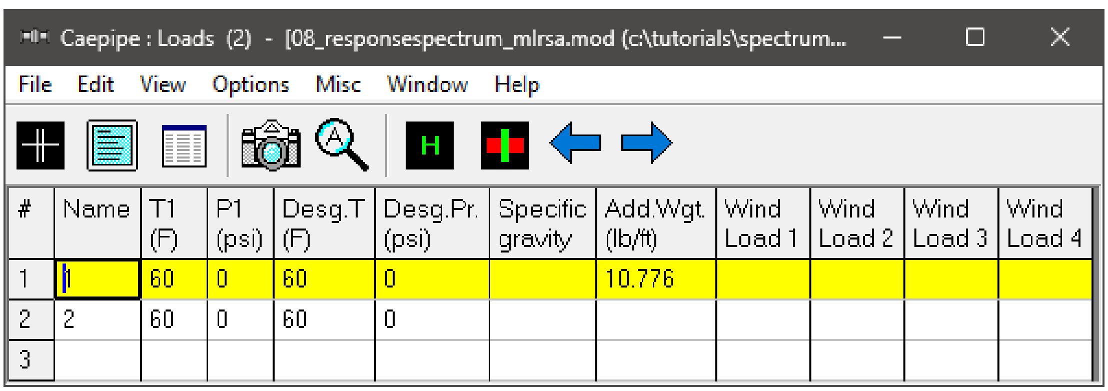
#	Name	Nom Dia	Sch	OD (inch)	Thk (inch)	Cor.Al (inch)	M.Tol (%)	Ins.Dens (lb/ft3)	Ins.Thk (inch)	Lin.Dens (lb/ft3)	Lin.Thk (inch)	Soil
1	1	3"	STD	3.5000	0.2160		12.5					
2	2	3"	STD	3.5000	0.2160		12.5					
3												



Caepipe : Loads (2) - [08_responsespectrum_mlrsa.mod (c:\tutorials\spectrum...

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#	Name	T1 (F)	P1 (psi)	Desg.T (F)	Desg.Pr. (psi)	Specific gravity	Add.Wgt. (lb/ft)	Wind Load 1	Wind Load 2	Wind Load 3	Wind Load 4
1	1	60	0	60	0		10.776				
2	2	60	0	60	0						
3											

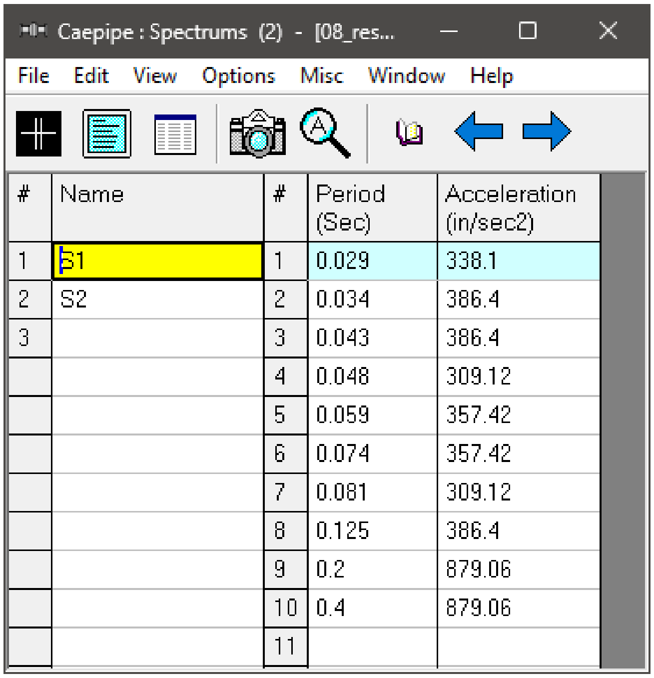
Step 2:

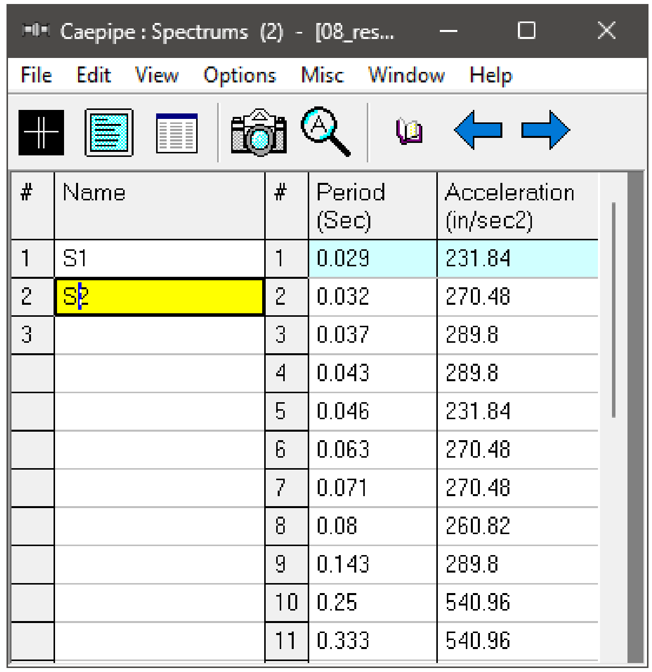
Input Spectrum load data from layout window: Misc Menu > Spectrums. This can be done in three ways:

1. Input spectrums directly into the model.
2. Create a spectrum library and load spectrums from it.
3. Input spectrums from a text file.

For further details, refer to the section titled “Spectrum Loads” in CAEPIPE User’s Manual.

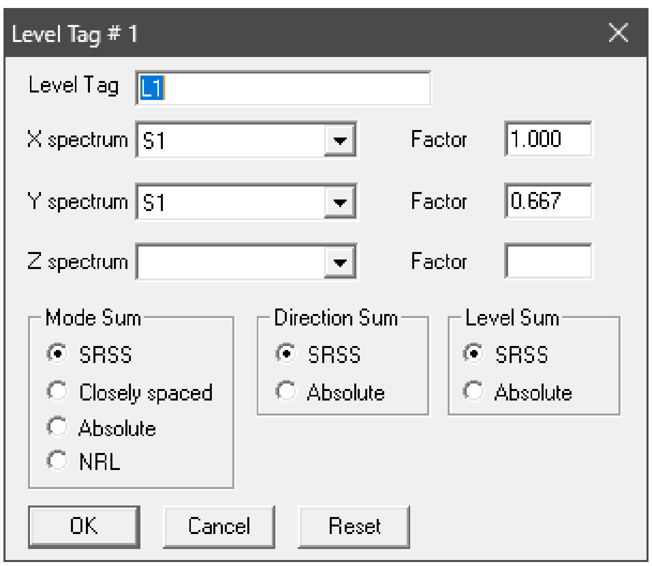
When the first two methods are used, the units for the X-axis & Y-axis and the interpolation method are set through the Options > Spectrum.

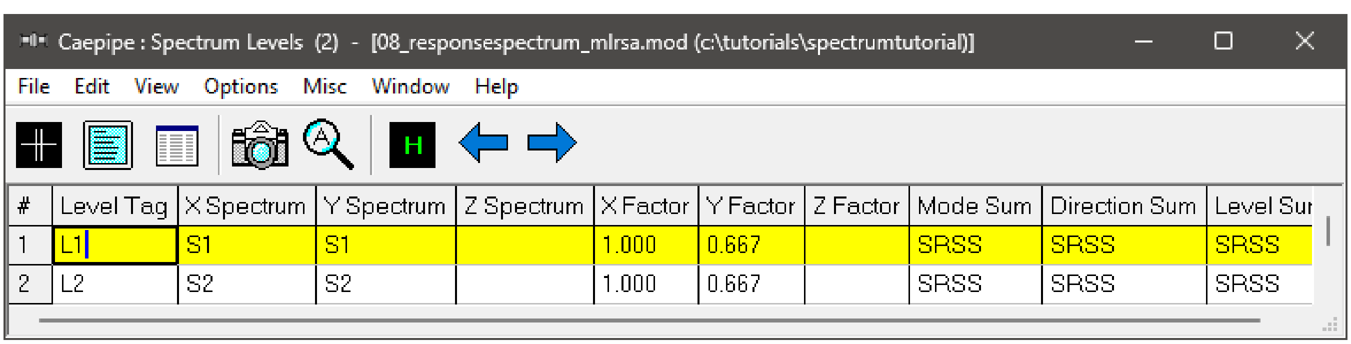




Step 3:

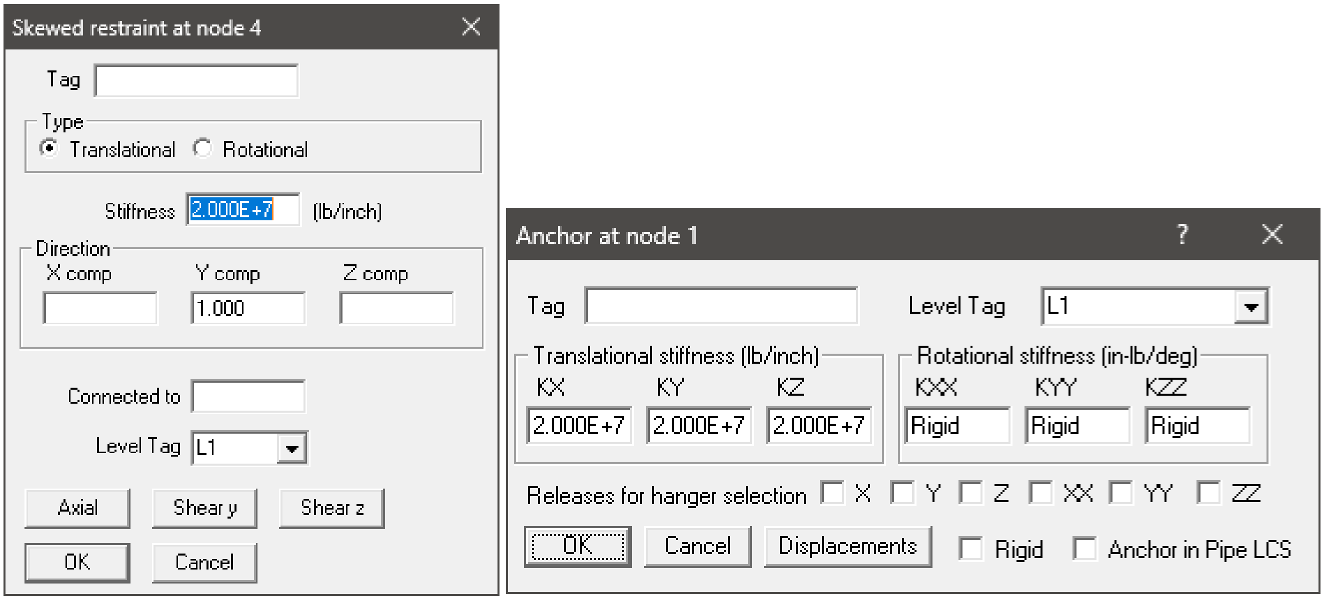
Define Spectrum Levels through Layout window > Loads > Spectrum. From the list window shown, double click on an empty row and input Level Tag, select Spectrums; input factors and select Mode Sum, Direction Sum and Level Sum. Levels L1 and L2 defined for this analysis are shown below.



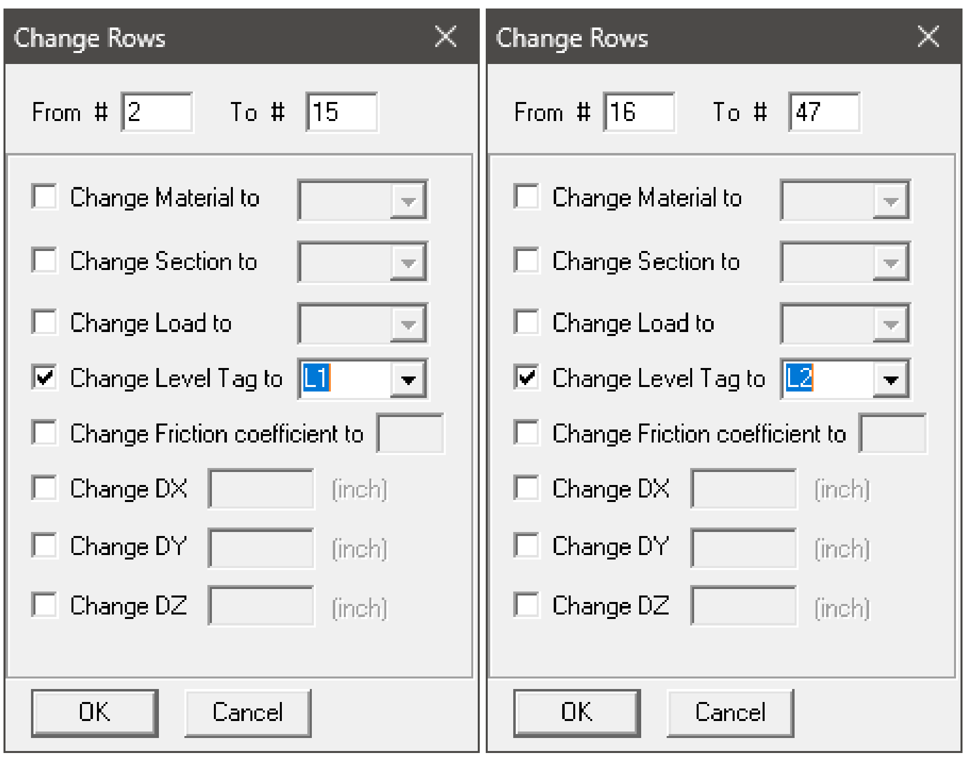


Step 4:

Assign Spectrum Level to each support in the analysis model by selecting the appropriate Level Tag from the list. Snapshots shown below are for a Restraint and an Anchor.



Alternatively, one can use the command “Change” through “Layout Window > Edit” to assign Level Tag for all supports in the Layout for a range specified as shown below.



Note:

The Level Tag selection list will be enabled and available for selection only when two or more Spectrum Levels are input in the analysis model. On the other hand, the Level Tag selection list will be disabled and the same Level Tag will be assigned automatically to all supports when only one Spectrum Level is defined in the analysis model.

Step 5:

The users can review the Levels assigned to different supports using the List command. Snapshots shown below are from List command for Anchors and Skewed Restraints.

Caepipe : Anchors (2) - [08_responsespectrum_mlrsa.mod (c:\tutorials\spectrumtutorial)]

File Edit View Options Misc Window Help

#	Node	Tag	KX/kx (lb/inch)	KY/ky (lb/inch)	KZ/kz (lb/inch)	KXX/kxx (in-lb/deg)	KYY/kyy (in-lb/deg)	KZZ/kzz (in-lb/deg)	Releases X	Y	Z	XX	YY	ZZ	Anchor in	Level Tag
1	1		2.000E+7	2.000E+7	2.000E+7	Rigid	Rigid	Rigid							GCS	L1
2	36		2.000E+7	2.000E+7	2.000E+7	1.00E+11	1.00E+11	1.00E+11							GCS	L2

Caepipe : Skewed restraints (11) - [08_responsespectrum_mlrsa.mod (c:\tutorials\...

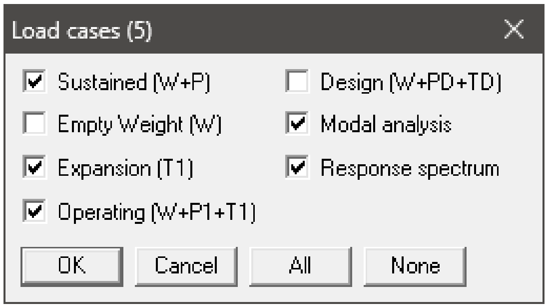
File Edit View Options Misc Window Help

#	Node	Tag	Type	Stiffness	Units	X comp	Y comp	Z comp	CNode	Level Tag
1	4		Translational	2.000E+7	(lb/inch)		1.000			L1
2	7		Translational	2.000E+7	(lb/inch)	1.000				L1
3	7		Translational	2.000E+7	(lb/inch)			1.000		L1
4	14		Translational	20000	(lb/inch)	1.000				L2
5	14		Translational	20000	(lb/inch)			1.000		L2
6	20		Translational	20000	(lb/inch)	1.000				L2
7	20		Translational	20000	(lb/inch)			1.000		L2
8	26		Translational	2.000E+7	(lb/inch)	1.000				L2
9	26		Translational	2.000E+7	(lb/inch)			1.000		L2
10	28		Translational	2.000E+7	(lb/inch)		1.000			L2
11	28		Translational	2.000E+7	(lb/inch)			1.000		L2

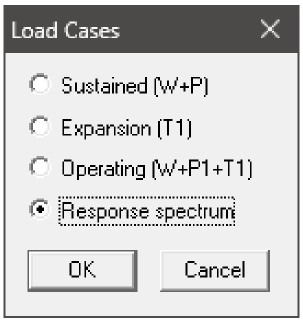
Note: CAEPIPE will terminate the analysis, if a level tag is not assigned to a support. For further details, refer to the flowchart under the section titled "Spectrum Loads" in CAEPIPE User's Manual.

Step 6:

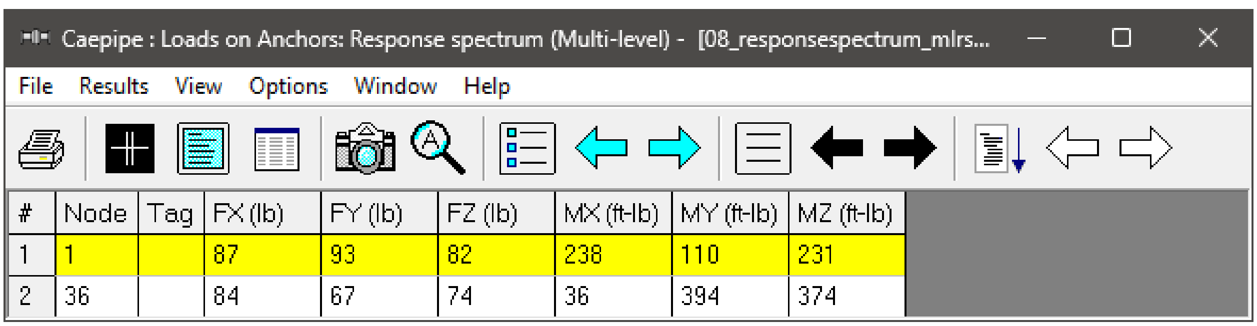
Turn ON the load case "Response spectrum" through Layout window > Loads > Load cases. Save the model and perform the analysis through Layout window > File > Analyze. CAEPIPE will apply these loads to compute the response of the piping system by performing a Response Spectrum analysis along with other load cases defined in the piping system.



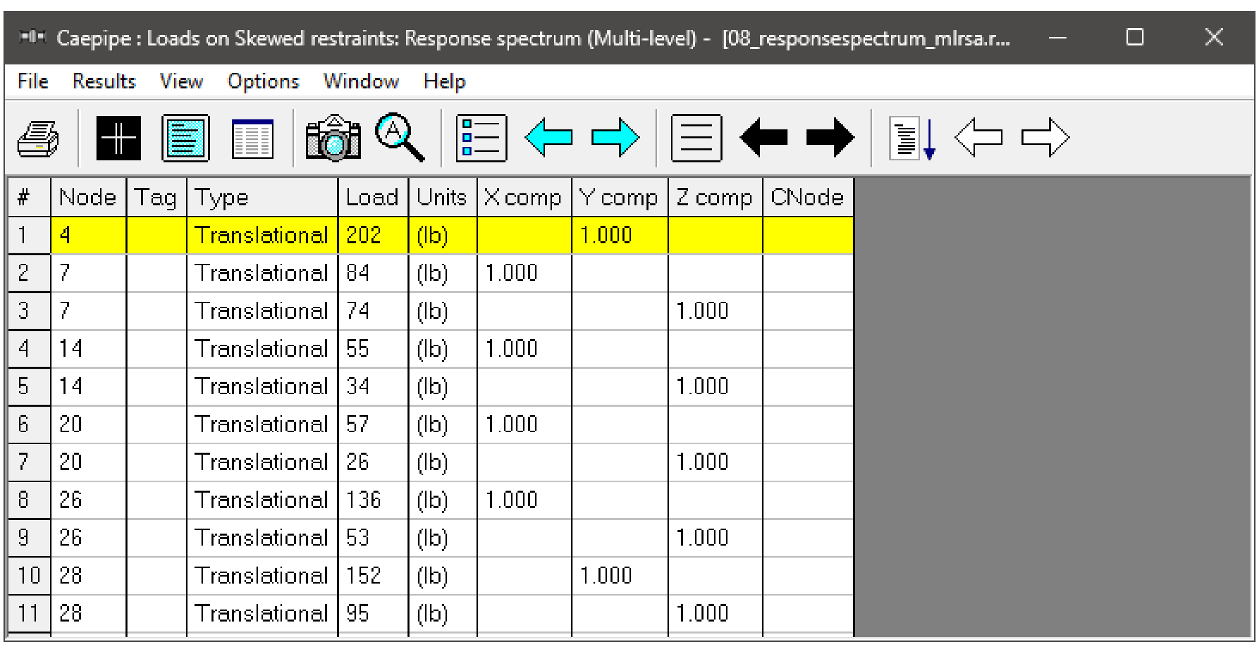
Upon analysis, CAEPIPE will show a “Load case” with name “Response spectrum” under “Support Loads”, “Displacements”, “Element forces” and “Support load summary” results.



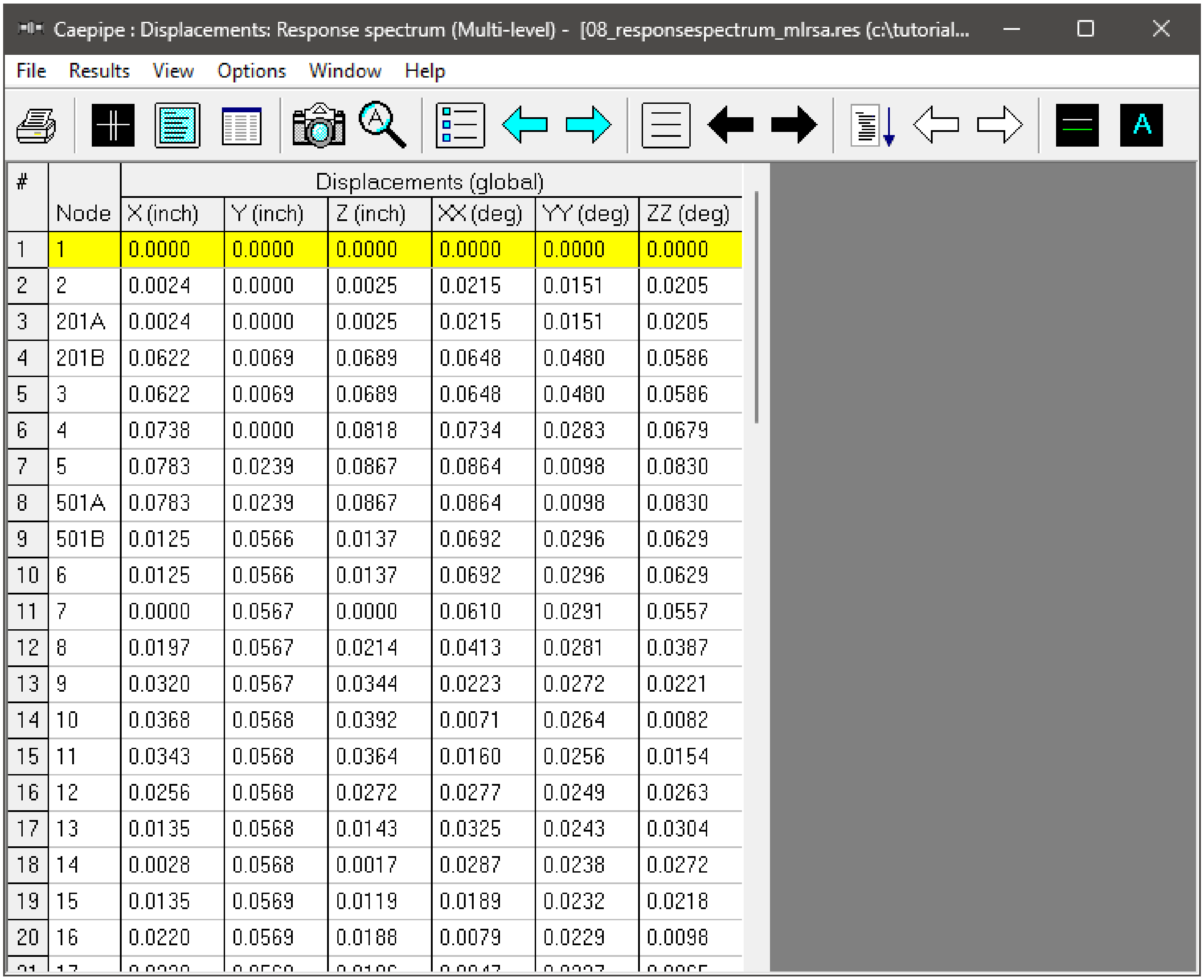
When selected, each results window (such as Support Loads, Displacements, etc.) will display the title as “Response Spectrum (Multi-level)” as shown in the snapshots below.



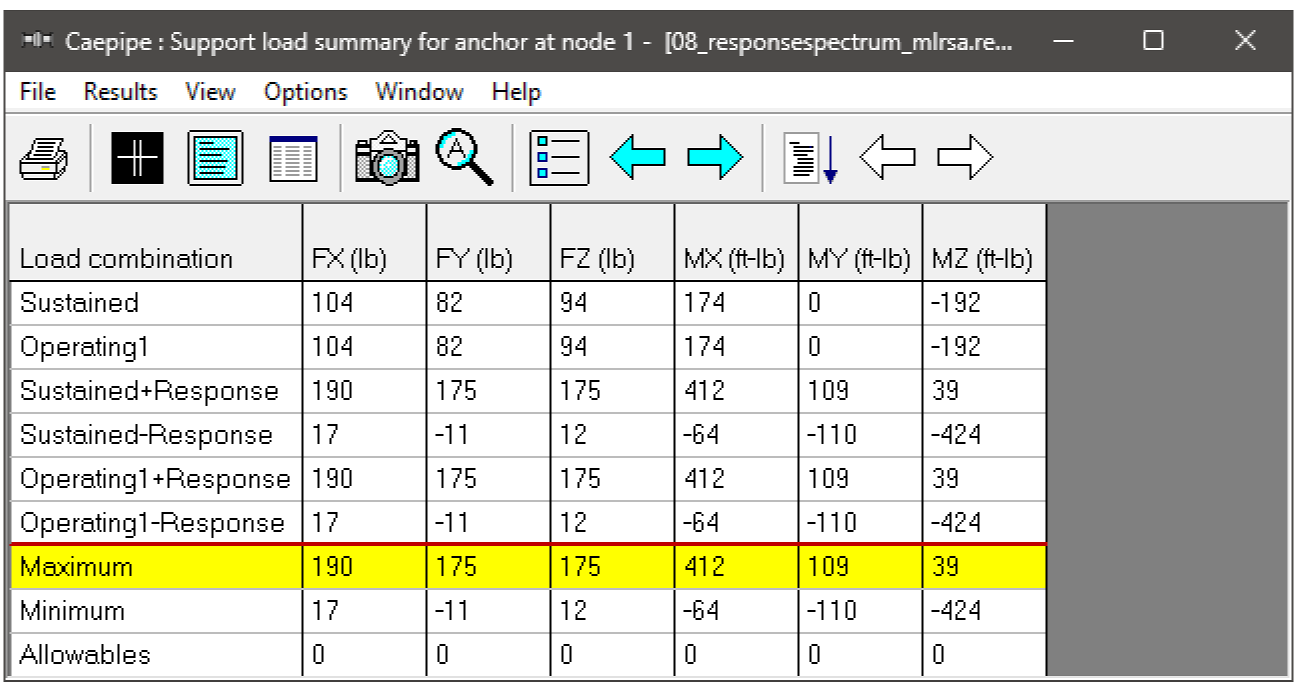
#	Node	Tag	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
1	1		87	93	82	238	110	231
2	36		84	67	74	36	394	374



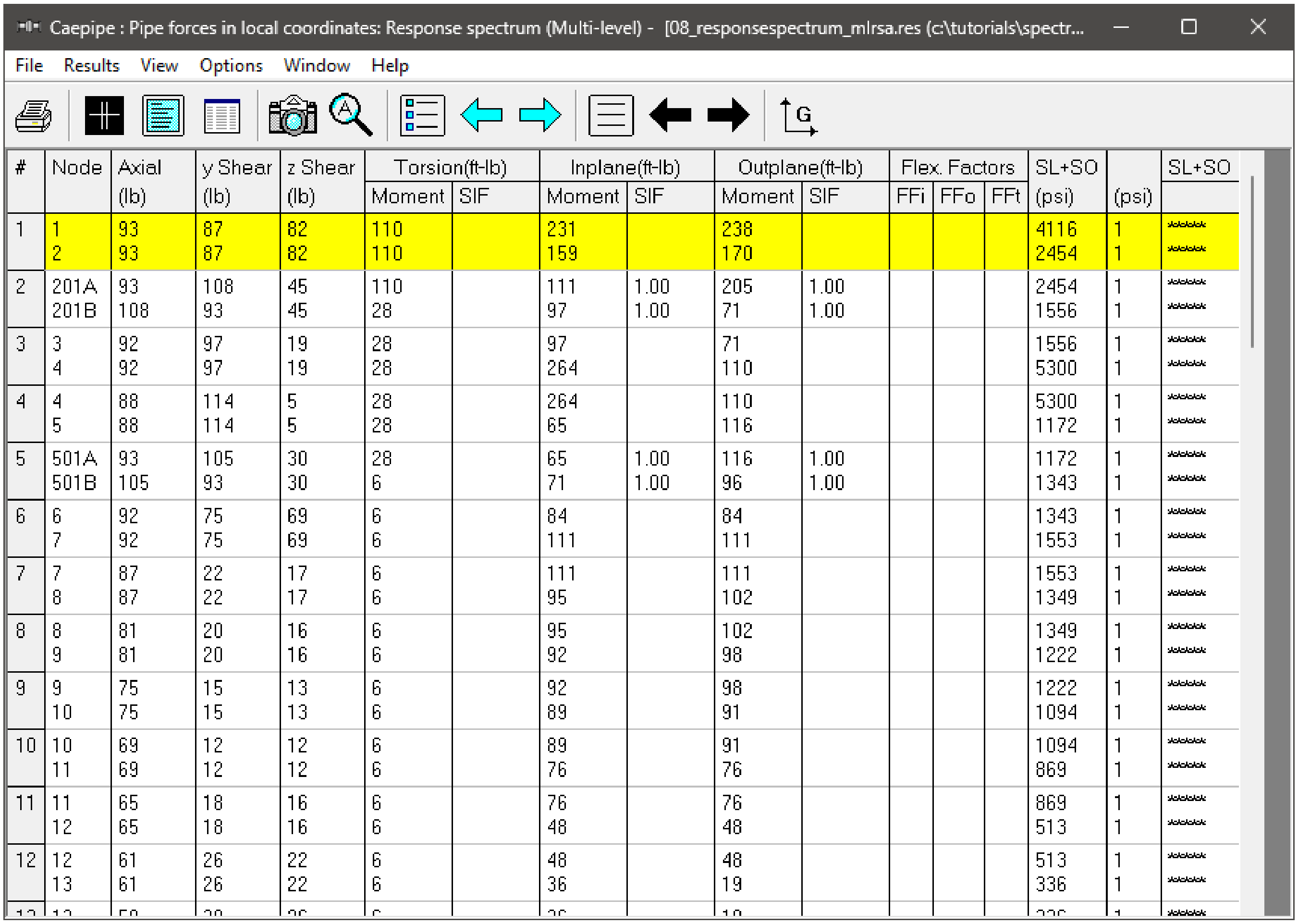
#	Node	Tag	Type	Load	Units	X comp	Y comp	Z comp	CNode
1	4		Translational	202	(lb)		1.000		
2	7		Translational	84	(lb)	1.000			
3	7		Translational	74	(lb)			1.000	
4	14		Translational	55	(lb)	1.000			
5	14		Translational	34	(lb)			1.000	
6	20		Translational	57	(lb)	1.000			
7	20		Translational	26	(lb)			1.000	
8	26		Translational	136	(lb)	1.000			
9	26		Translational	53	(lb)			1.000	
10	28		Translational	152	(lb)		1.000		
11	28		Translational	95	(lb)			1.000	



#	Node	Displacements (global)					
		X (inch)	Y (inch)	Z (inch)	XX (deg)	YY (deg)	ZZ (deg)
1	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	2	0.0024	0.0000	0.0025	0.0215	0.0151	0.0205
3	201A	0.0024	0.0000	0.0025	0.0215	0.0151	0.0205
4	201B	0.0622	0.0069	0.0689	0.0648	0.0480	0.0586
5	3	0.0622	0.0069	0.0689	0.0648	0.0480	0.0586
6	4	0.0738	0.0000	0.0818	0.0734	0.0283	0.0679
7	5	0.0783	0.0239	0.0867	0.0864	0.0098	0.0830
8	501A	0.0783	0.0239	0.0867	0.0864	0.0098	0.0830
9	501B	0.0125	0.0566	0.0137	0.0692	0.0296	0.0629
10	6	0.0125	0.0566	0.0137	0.0692	0.0296	0.0629
11	7	0.0000	0.0567	0.0000	0.0610	0.0291	0.0557
12	8	0.0197	0.0567	0.0214	0.0413	0.0281	0.0387
13	9	0.0320	0.0567	0.0344	0.0223	0.0272	0.0221
14	10	0.0368	0.0568	0.0392	0.0071	0.0264	0.0082
15	11	0.0343	0.0568	0.0364	0.0160	0.0256	0.0154
16	12	0.0256	0.0568	0.0272	0.0277	0.0249	0.0263
17	13	0.0135	0.0568	0.0143	0.0325	0.0243	0.0304
18	14	0.0028	0.0568	0.0017	0.0287	0.0238	0.0272
19	15	0.0135	0.0569	0.0119	0.0189	0.0232	0.0218
20	16	0.0220	0.0569	0.0188	0.0079	0.0229	0.0098



Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)
Sustained	104	82	94	174	0	-192
Operating1	104	82	94	174	0	-192
Sustained+Response	190	175	175	412	109	39
Sustained-Response	17	-11	12	-64	-110	-424
Operating1+Response	190	175	175	412	109	39
Operating1-Response	17	-11	12	-64	-110	-424
Maximum	190	175	175	412	109	39
Minimum	17	-11	12	-64	-110	-424
Allowables	0	0	0	0	0	0



#	Node	Axial (lb)	y Shear (lb)	z Shear (lb)	Torsion(ft-lb) Moment	Torsion(ft-lb) SIF	Inplane(ft-lb) Moment	Inplane(ft-lb) SIF	Outplane(ft-lb) Moment	Outplane(ft-lb) SIF	Flex. Factors FFi	Flex. Factors FFo	Flex. Factors FFt	SL+SO (psi)	(psi)	SL+SO
1	1	93	87	82	110		231		238					4116	1	*****
	2	93	87	82	110		159		170					2454	1	*****
2	201A	93	108	45	110		111	1.00	205	1.00				2454	1	*****
	201B	108	93	45	28		97	1.00	71	1.00				1556	1	*****
3	3	92	97	19	28		97		71					1556	1	*****
	4	92	97	19	28		264		110					5300	1	*****
4	4	88	114	5	28		264		110					5300	1	*****
	5	88	114	5	28		65		116					1172	1	*****
5	501A	93	105	30	28		65	1.00	116	1.00				1172	1	*****
	501B	105	93	30	6		71	1.00	96	1.00				1343	1	*****
6	6	92	75	69	6		84		84					1343	1	*****
	7	92	75	69	6		111		111					1553	1	*****
7	7	87	22	17	6		111		111					1553	1	*****
	8	87	22	17	6		95		102					1349	1	*****
8	8	81	20	16	6		95		102					1349	1	*****
	9	81	20	16	6		92		98					1222	1	*****
9	9	75	15	13	6		92		98					1222	1	*****
	10	75	15	13	6		89		91					1094	1	*****
10	10	69	12	12	6		89		91					1094	1	*****
	11	69	12	12	6		76		76					869	1	*****
11	11	65	18	16	6		76		76					869	1	*****
	12	65	18	16	6		48		48					513	1	*****
12	12	61	26	22	6		48		48					513	1	*****
	13	61	26	22	6		36		19					336	1	*****