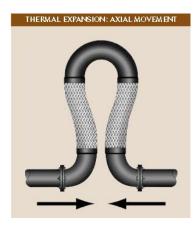
Tutorial for Modeling of MetraLoop using CAEPIPE

The following are the Steps for modeling and including MetraLoop in CAEPIPE analysis.

General

The MetraLoop is simply a flexible variation of the traditional hard pipe loop. For any given length of pipe and given temperature change, the amount of thermal growth/contraction can be calculated and an appropriate MetraLoop can be designed. When installed in a pipe run, the MetraLoop's legs simply bend as shown in the figure below to compensate for the pipe's expansion or contraction. Unique to the loop is the low amount of force required to bend its legs, minimizing anchor loads, guiding and installation costs.



Illustrated above is a typical MetraLoop. No support is required for the 180° return bend for standard loops 2-1/2" diameter and smaller. However, due to the weight of the return bend and the extreme flexibility of the loop, larger sizes require support (as shown below) to prevent the loop from sagging in all orientations except when installed hanging down. Guides are recommended but not always required.



The Steps provided in this tutorial are applicable for different types of MetraLoop such as SWEAT Ends, Threaded Ends, Flanged Ends, etc. with and without supports at the middle of the U-bend.

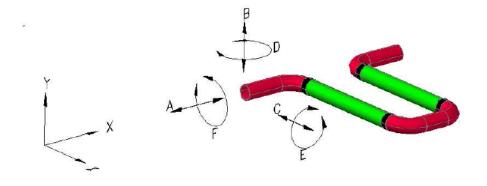
MetraLoop without Support at the middle of the U-bend

- As an example, dimensional details and mechanical properties corresponding to 6" 150# FLANGED ENDS •
 FITTINGS SCHED. 40 CARBON STEEL HOSE & BRAID SERIES 300 STAINLESS STEEL of MetraLoop are
 referred from http://www.metraflex.com/literature/metraloop/literature/Metraflex-Metraloop.pdf.
- The same is presented below for quick reference. The PDF file downloaded from the link mentioned above is attached herewith for convenience.

150#	FLANGE	D ENDS	• FITTINGS	- SCHED. 40 (CARBON STE	el • Hos	e & Braid	- SERIES 3	300 STAINL	ESS STEEL
	PIPE SIZE	MODEL #	MOVEMENT	END TO END A	LENGTH B	PSI SINGLE BRAID	†PSI DOUBLE BRAID	MAX STEAM PRESS.	*SPRING FORCE LBS.	WEIGHT LBS.
2"	(50mm)	MLF30200	±1.5"	12-1/2"	17-3/8"	500	750	300	78	21
	(301111)	MLF80200	±4"	14-1/2"	24-1/2"	500	750	300	10	24
2-1/2	?" (65mm)	MLF30250	±1.5"	15-1/2"	21"	387	619	300	83	30
2-1/2	. (051111)	MLF80250	±4"	16"	28-1/4"	507	013	500	00	36
3"	(80mm)	MLF30300	±1.5"	18-1/2"	23-3/8"	288	431	216	90	46
	(oomin)	MLF80300	±4"	18-1/2"	30"	200	401	210		50 63
4"	(100mm)	MLF30400	±1.5"	24-1/2"	28"	232	371	183	120	
4	(Toomin)	MLF80400	±4"	24-1/2"	35-3/8"	252	571	105	120	69
5"	(125mm)	MLF30500	±1.5"	30-1/2"	32-1/4"	191	306	153	186	91
	(TZ3IIIII)	MI E80500	+4"	30-1/2"	40-1/4"		300			101
6"	(150mm)	MLF30600	±1.5"	36-1/2"	36-3/4"	165	264	132	202	148
0	(130mm)	MLF80600	±4"	36-1/2"	45-3/8"	105	204	152		163
8"	(200mm)	WILL SOOOD	±1.5	40-172	44-1/2	212	230	115	260	207
0	(20011111)	MLF80800	±4"	48-1/2"	53-1/2"	212	230	115	200	309
10"	(250mm)	MLF31000	±1.5"	60-1/2"	53-1/4"	175	200	100	283	453
10	(25011111)	MLF81000	±4"	60-1/2"	63-1/4"	175	200	100	203	484
12"	(300mm)	MLF31200	±1.5"	72-1/2"	61-3/4"	160	188	94	390	636
12	(3001111)	MLF81200	±4"	72-1/2"	72-3/4"	100	100	94	390	666
4.42	(OEEmm)	MLF31400	±1.5"	84-1/2"	71"	110	105	63	706	636
14"	(355mm)	MLF81400	±4"	84-1/2"	80-1/2"	110	125	03	706	666
16" *"	(400mm)	MLF31600	±1.5"	96-1/2"	78-1/2"	110	170	85	900	636
10	(40011111)	MLF81600	±4"	96-1/2"	91-1/2"	110	170	60	900	666
4.02 **		MLF31800	±1.5"	108-1/2"	86-1/2"	05	450	75	1000	636
18" *"	(455mm)	MLF81800	±4"	108-1/2"	100"	85	150	75	1000	666

Spring Rates for NS 6" MetraLoop are received from the manufacturer as given below.

	Metraloop Spring Rate Data (use same rates for stainless steel & copper)									
		Spring Rate "B"	Spring Rate 'C'	Spring Rate 'D'	Spring Rate 'E'					
	Spring Rate "A"	Lateral	Lateral	Angular	Angular	Spring Rate 'F'				
Nominal	Axial (+ or - x)	(transverse) 'y'	(transverse) 'z'	(rotation) 'y' (in-	(rotation) 'z'	Torsion 'x'				
Size (in)	(lb/in)	(lb/in)	(lb/in)	lb/deg)	(in-lb/deg)	(in-lb/deg)				
6	50.5	50.5	32.9	32.9	8663	50.5				



Notes 1. Movements at the ends of the loop in directions 'A', 'B' and 'F' induce lateral offset in the loop legs.

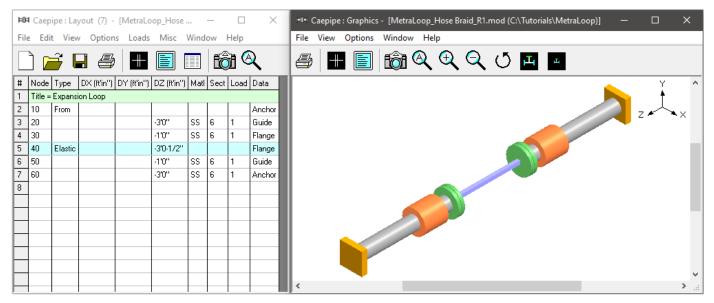
- 2. Movements in directions 'C' and 'D' induce angular rotation in the loop legs.
- 4. Movement in direction 'E' will induce torsion on the hose legs.

The Spring Rates provided in the above Table are for the whole loop (End to End) and NOT for the Braided Hose.

Hence, the whole loop (End to End) is modeled as an Elastic element between Nodes 30 and 40 with its Spring Rates taken from the above Table. The lengths of the various elements of this MetraLoop are derived using the overall dimensions A and B given in the catalog. Weight of the flanged MetraLoop including the weight of the single flange at each end is included in the two (2) flange weights (= 27 + 148 + 27 = 202 lbs for 2 flanges or 101 lbs for each flange).

Step 1:

Snap shots shown below are from the CAEPIPE model input file wherein the MetraLoop is modeled as an Elastic Element as mentioned above.



Elastic element from 30 to 40									
 Translational Stiffness (lb/inch) 	Rotational Stiffness (in-Ib/deg)								
kx 50.5	kxx 50.50								
ky 50.5	kyy 32.90								
kz 32.9	kzz 8663								
Local x axis	Local y axis								
× comp 0.0000	× comp 0.0000								
Y comp 0.0000	Y comp 1.0000								
Z comp -1.0000	Z comp 0.0000								
OK Cancel]								

1-0	 Caepi 	pe : L	oads	(1) -	[Metra	Loop_	Hose B	Braid_R1.	mo	d (—		×
<u>F</u> il	e <u>E</u> dit	<u>V</u> ie	ew .	<u>O</u> ptio	ns <u>M</u> is	sc <u>W</u>	indow	<u>H</u> elp					
	+			Ē.) (2	Н		¢		\Rightarrow		
#	Name	T1 (F)	P1 (psi)	Desg. (F)	T Desg (psi)			Add.Wgt. (Ib/ft)		/ind oad 1	Wind Load 2		Wind Load 4
1 2	1	470	<u>150</u>	470	150	0.	1						
	■ Caepipe : Pipe Sections (1) - [MetraLoop_Hose Braid_R1 — □ × File Edit Options Help									×			
				f	}} 🙆	2	Н						
#	Name	Dia	Sch	OD (inch	Thk) (inch)	Cor.Al (inch)	M.Tol (%)	Ins.Dens (Ib/ft3)		ns.Thk nch)	Lin.Der (Ib/ft3)	ns Lin.Th (inch)	k Soil
1 2	6	6"	STD	6.62	5 0.28								
Fil		Opti		Help	Internet			d_R1.mod	. (×
-				iði	Q	Η	(ja		¢		>		
#	Name	Des	scriptio				U Joint factor	Yield (psi)		Temp (F)	E (psi)	Alpha (in/in/F)	Allowable (psi)
1	Name			n Ty	(lb/in3)	_	Joint	(psi) 30000	1	(F) -20	(psi) 28.8E+6	(in/in/F) 8.28E-6	(psi) 20000
			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1	(F) -20 100	(psi) 28.8E+6 28.0E+6	(in/in/F) 8.28E-6 8.59E-6	(psi) 20000 20000
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3	(F) -20 100 200	(psi) 28.8E+6 28.0E+6 27.5E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6	(psi) 20000 20000 16700
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3 4	(F) -20 100 200 300	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6	(psi) 20000 20000 16700 15000
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3 4 5	(F) -20 100 200 300 400	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 26.4E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.50E-6	(psi) 20000 20000 16700 15000 13800
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000 20000	1 2 3 4 5 6	(F) -20 100 200 300 400 500	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 25.9E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.50E-6 9.70E-6	(psi) 20000 20000 16700 15000 13800 12900
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000 20000 2000 2000 2000 2000 2000 2	1 2 3 4 5 6 7	(F) -20 100 200 300 400 500 600	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 26.4E+6 25.9E+6 25.3E+6	(in/in/F) 8.28E-6 8.59E-6 9.20E-6 9.20E-6 9.50E-6 9.70E-6 9.90E-6	(psi) 20000 20000 16700 15000 13800 12900 12300
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000 	1 2 3 4 5 6 7 8	(F) -20 100 200 300 400 500 600 650	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 26.4E+6 25.9E+6 25.3E+6 25.0E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.50E-6 9.90E-6 9.90E-6	(psi) 20000 20000 16700 15000 13800 12900 12300 12000
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000 	1 2 3 4 5 6 7 8 9	(F) -20 100 200 300 400 500 600 650 700	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 26.4E+6 25.9E+6 25.3E+6 25.0E+6 24.8E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.50E-6 9.90E-6 9.95E-6 10.00E-6	(psi) 20000 20000 16700 15000 13800 12900 12300 12000 11700
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3 4 5 6 7 8 9 10	(F) -20 100 200 300 400 500 600 650 700 750	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 26.4E+6 25.9E+6 25.3E+6 24.8E+6 24.5E+6	(in/in/F) 8.28E-6 8.59E-6 9.20E-6 9.50E-6 9.30E-6 9.30E-6 10.00E-6 10.10E-6	(psi) 20000 20000 16700 15000 13800 12900 12300 12000 11700 11500
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3 4 5 6 7 8 9 10 11	(F) -20 100 200 300 400 500 600 650 700 750 800	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 26.4E+6 25.9E+6 25.3E+6 24.8E+6 24.5E+6 24.1E+6	(in/in/F) 8.28E-6 8.59E-6 8.30E-6 9.20E-6 9.30E-6 9.30E-6 9.30E-6 10.00E-6 10.10E-6 10.10E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 11700 11500 11200
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3 4 5 6 7 8 9 10 11 12	(F) -20 100 200 300 400 500 600 650 700 750 800 850	[psi] 28.8E+6 28.0E+6 27.5E+6 27.0E+6 25.9E+6 25.9E+6 25.0E+6 24.8E+6 24.5E+6 24.1E+6 23.8E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.70E-6 9.70E-6 9.90E-6 10.00E-6 10.10E-6 10.10E-6 10.20E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 11700 11500 11200 11000
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3 4 5 6 7 8 9 10 11 12 13	(F) -20 100 200 300 400 500 650 700 750 800 850 900	[psi] 28.8E+6 28.0E+6 27.5E+6 27.0E+6 25.9E+6 25.3E+6 25.0E+6 24.8E+6 24.4E+6 24.4E+6 23.8E+6 23.5E+6	(m/m/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.50E-6 9.30E-6 9.30E-6 9.35E-6 10.00E-6 10.10E-6 10.10E-6 10.20E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 11700 11500 11200 11000 10800
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3 4 5 6 7 8 9 10 11 12 13 14	(F) -20 100 200 300 400 500 650 700 750 850 850 900 950	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 26.4E+6 25.3E+6 25.0E+6 24.8E+6 24.5E+6 24.5E+6 23.8E+6 23.5E+6 23.5E+6 23.5E+6	(m/m/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.50E-6 9.30E-6 9.30E-6 9.35E-6 10.00E-6 10.10E-6 10.20E-6 10.20E-6 10.30E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 11700 11500 11200 11000 10800 10600
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor	(psi) 30000	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	(F) -20 100 200 300 400 500 600 650 700 750 800 850 900 950 1000	(psi) 28.8E+6 28.0E+6 27.5E+6 27.0E+6 25.9E+6 25.3E+6 25.0E+6 24.8E+6 24.5E+6 24.1E+6 23.8E+6 23.5E+6 23.9E+6 22.8E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.30E-6 9.30E-6 9.30E-6 10.00E-6 10.10E-6 10.10E-6 10.20E-6 10.20E-6 10.20E-6 10.30E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 11700 11500 11200 11000 10800 10600 10400
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	(F) -20 100 200 300 400 500 600 650 700 850 850 900 950 1000 1050	[psi] 28.8E+6 28.0E+6 27.5E+6 27.0E+6 25.9E+6 25.3E+6 25.0E+6 24.8E+6 24.5E+6 24.5E+6 23.8E+6 23.5E+6 23.9E+6 22.8E+6 22.5E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.30E-6 9.30E-6 9.30E-6 10.00E-6 10.10E-6 10.10E-6 10.20E-6 10.20E-6 10.30E-6 10.30E-6 10.30E-6 10.30E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 11700 11500 11200 11000 10800 10600 10400 10100
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	(F) -20 100 200 300 400 500 600 650 700 750 800 800 850 900 950 1000 1050 1100	[psi] 28.8E+6 28.0E+6 27.5E+6 27.0E+6 25.9E+6 25.3E+6 25.0E+6 24.8E+6 24.5E+6 24.5E+6 23.8E+6 23.5E+6 23.9E+6 22.5E+6 22.0E+6	(in/in/F) 8.28E-6 8.59E-6 8.90E-6 9.20E-6 9.30E-6 9.30E-6 9.30E-6 10.00E-6 10.10E-6 10.10E-6 10.20E-6 10.20E-6 10.30E-6 10.30E-6 10.30E-6 10.40E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 11700 11500 11200 11000 10800 10600 10400 10100 3800
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	(F) -20 100 200 300 400 500 600 650 700 750 800 850 900 950 1000 1050 1100 1150	[psi] 28.8E+6 28.0E+6 27.5E+6 27.0E+6 25.9E+6 25.3E+6 25.0E+6 24.8E+6 24.4E+6 24.4E+6 23.8E+6 23.3E+6 23.3E+6 22.8E+6 22.5E+6 22.0E+6 22.6E+6	(in/in/F) 8.28E-6 8.59E-6 9.20E-6 9.20E-6 9.30E-6 9.30E-6 9.30E-6 10.00E-6 10.10E-6 10.20E-6 10.20E-6 10.30E-6 10.30E-6 10.30E-6 10.40E-6 10.50E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 11700 11500 11200 11200 11000 10600 10600 10400 10100 9800 7700
1			scriptio	n Ty	(lb/in3)	Nu	Joint factor		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	(F) -20 100 200 300 400 500 600 650 700 750 800 800 850 900 950 1000 1050 1100	[psi] 28.8E+6 28.0E+6 27.5E+6 27.0E+6 25.9E+6 25.3E+6 25.0E+6 24.8E+6 24.5E+6 24.5E+6 23.8E+6 23.5E+6 23.9E+6 22.5E+6 22.0E+6	(in/in/F) 8.28E-6 8.59E-6 9.20E-6 9.20E-6 9.30E-6 9.30E-6 9.30E-6 10.00E-6 10.10E-6 10.10E-6 10.20E-6 10.20E-6 10.30E-6 10.30E-6 10.30E-6 10.40E-6	(psi) 20000 20000 16700 15000 13800 12900 12900 12000 12000 11700 11500 11200 10000 10600 10400 10100 9800

Step 4:

Select the Load Cases shown below for analysis through Layout Window > Loads > Load cases. Save the model and perform the analysis through Layout window > File > Analyze.

Load cases (3)	×			
Empty Weight (W)	🔽 Operating (W+P1+T1)			
🔽 Sustained (W+P)	🔲 Design (W+PD+TD)			
🔽 Expansion (T1)	🔲 Modal analysis			
OK Cancel	All None			

Step 5:

From the Displacements results of CAEPIPE for "Operating (W+P1+T1)" Load case for the model with temperature Increase, note the following.

			1996 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -				MetraLoo	op_Hose Braid_R1.res (C:\Tutorials\MetraL — 🛛 🗙
Fi	le Res	sults Vie	ew Opti	ons Wir	ndow H	elp		
4	9	+) Q		\ •	⇒ 🗏 ← → 📳 ← → 🗏 🔺
#				Displaceme				
		X (inch)	Y (inch)		XX (deg)	YY (deg)		
1	10	0.000	0.000	0.000	0.0000	0.0000	0.0000	
2	20	0.000	0.000	-0.139	-0.0009	0.0000	0.0000	
3	30	0.000	-0.000	-0.185	-0.0014	0.0000	0.0000	
4	40	0.000	-0.000	0.185	0.0014	0.0000	0.0000	
5	50	0.000	0.000	0.139	0.0009	0.0000	0.0000	
6	60	0.000	0.000	0.000	0.0000	0.0000	0.0000	
Fi		ipe : Flex sults Vie				coord: O elp	perating ((W+P1+T1) - [MetraLoop_Hose Braid_R1.r — 🗆 🗙
ł	5	+) Q		<u> </u>	
#	From	То Тур	be x (inc	h) y (inch) z (inch)	xx (deg)	yy (deg)	zz (deg)
1	30	40 Ela	stic -0.37	0.000	0.000	0.0000	0.0000	0.0028

The <u>differential Axial Deflection (local x direction)</u> between Nodes 30 - 40 = **0.370" < 1.5"** (Allowable Movement specified in the catalog).

Summary

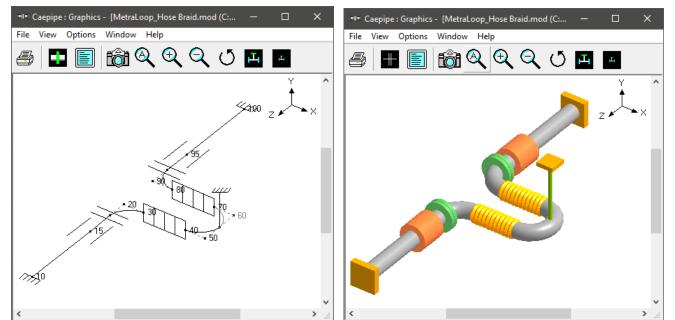
From the above, it is noted that the differential axial displacement of 0.37" computed by CAEPIPE for Operating Load Case 1 for the Elastic element between Nodes 30 and 40 is less than the Allowable Movement (1.5") provided in the catalog, thereby meeting the criteria.

MetraLoop with Support at the middle of the U-bend

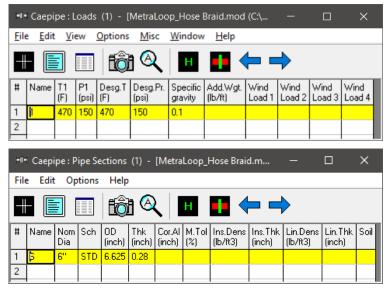
Step 1:

Attached is a sample CAEPIPE input file wherein the two "Hose Braid" Pipes of the Flexible U joint are modeled using CAEPIPE's Bellow Elements. The lengths of the various elements of this Flexible U joint are derived using the overall dimensions A and B given in the catalog.

-0-	Саер	ipe : Layo	out (16) -	[MetraLo	op_Hose B	ra		C	x c
File	e Edi	t View	Options	Loads	Misc W	indov	v He	elp	
] 🔽	j 🗖	9				Î) (
#	Node	Туре	DX (ft'in'')	DY (ft'in'')	DZ (ft'in'')	Matl	Sect	Load	Data
1	Title =	Expansion	Loop						
2	10	From							Anchor
3	15				-3'0''	SS	6	1	Guide
4	20	Bend			-1'9-1/4''	SS	6	1	
5	20A	Location							Flange
6	30		0'9''			SS	6	1	
7	40	Bellows	1'7''			SS	6	1	
8	50	Bend	0'9''			SS	6	1	
9	50B	Location							Rod hanger
10	50	Bend			-1'6''	SS	6	1	
11	70		-0'9''			SS	6	1	
12	80	Bellows	-1'7''			SS	6	1	
13	90	Bend	-0'9''			SS	6	1	
14	90B	Location							Flange
15	95				-1'9-1/4''	SS	6	1	Guide
16	100				-3'0''	SS	6	1	Anchor
17									
J					1				



-1-1	📲 Caepipe : Materials (1) - [MetraLoop_Hose Braid.mod (C:\Tutorials\ — 🛛 🗙											
File	e Edit (Options He	lp									
-			đ	Q	Н	(ja		4		>		
#	Name	Description	Ty pe	Density (Ib/in3)	Nu	Joint factor	Yield (psi)	#	Temp (F)	E (psi)	Alpha (in/in/F)	Allowable (psi)
1	<mark>6</mark> S	A312 TP304	AS	0.290	0.3	1.00	30000	1	-20	28.8E+6	8.28E-6	20000
2								2	100	28.0E+6	8.59E-6	20000
								3	200	27.5E+6	8.90E-6	16700
								4	300	27.0E+6	9.20E-6	15000
								5	400	26.4E+6	9.50E-6	13800
								6	500	25.9E+6	9.70E-6	12900
								7	600	25.3E+6	9.90E-6	12300
								8	650	25.0E+6	9.95E-6	12000
								9	700	24.8E+6	10.00E-6	11700
								10	750	24.5E+6	10.10E-6	11500
								11	800	24.1E+6	10.10E-6	11200
								12	850	23.8E+6	10.20E-6	11000
								13	900	23.5E+6	10.20E-6	10800
								14	950	23.9E+6	10.30E-6	10600
								15	1000	22.8E+6	10.30E-6	10400
								16	1050	22.5E+6	10.40E-6	10100
								17	1100	22.0E+6	10.40E-6	9800
								18	1150	22.6E+6	10.50E-6	7700
								19	1200	21.2E+6	10.60E-6	6100
								20				



Step 2:

From the attached model, you may observe that the Bellows are modelled between Nodes 30-40 and Nodes 70-80. The stiffnesses of the bellows are calculated and entered as listed in Step 3 below.

Step 3:

Pipe OD = 6.625"

Pipe Wall Thickness = 0.28"

Length of Braided Pipe = 19"

Elastic Modulus = 28.5E+06 psi

The Braided Hose of the MetraLoop is normally "stiff" in axial and torsional directions and "flexible" for lateral and bending directions. Accordingly, the stiffnesses for Braided Hose are **calculated** and **assumed** as given below.

Axial Stiffness = 1% of Adjoining Pipe Stiffness = (1/100) * (AE/L) = 83700 lb/in

Lateral Stiffness = 0.1% of Adjoining Pipe Stiffness = $(0.1/100) * (3EI/L^3) = 351$ lb/in

Bending Stiffness = 0.1% of Adjoining Pipe Stiffness = (0.1/100) * (EI/L) = 4.22E+04 in-lb/rad = 737 in-lb/deg

Torsional Stiffness = 1% of Adjoining Pipe Stiffness = (1/100) * (GJ/L) = 3.25E+05 in-lb/rad = 5670 in-lb/deg

Pressure Thrust is not entered as it is not applicable for Braided Hose.

Lastly, the weight of each bellow is entered as 29 lbs, so that after performing a separate analysis for a stand-alone MetroLoop, the total empty weight of 148 lbs for the MetroLoop assembly matches with the value given in the catalog.

Bellows from 30 to 40	×
Axial stiffness 83700	(lb/inch)
Bending stiffness 737	(in-lb/deg)
Torsional stiffness 5670	(in-lb/deg)
Lateral stiffness 351	(lb/inch)
Pressure thrust area	(in2)
Weight 29	(lb)
Mean diameter 0	(inch)
OK Cancel	

Step 4:

Select the Load Cases shown below for analysis through Layout Window > Loads > Load cases. Save the model and perform the analysis through Layout window > File > Analyze.

Load cases (3)	×				
🔲 Empty Weight (W)	🔽 Operating (W+P1+T1)				
🔽 Sustained (W+P)	🔲 Design (W+PD+TD)				
💌 Expansion (T1)	🔲 Modal analysis				
OK Cancel	All None				

Step 5:

From the Displacements results of CAEPIPE for "Operating (W+P1+T1)" Load case for the model with temperature Increase, note the following.

-0-	🗝 Caepipe : Displacements: Operating (W+P1+T1) - [MetraLoop_Hose Braid.res (C:\Tutorials\MetraLoop)] — 🛛 🗙								
File	File Results View Options Window Help								
4	$\underline{\texttt{A}} \mid \underline{\blacksquare} \mid \underline{\blacksquare} \mid \underline{\texttt{C}} \mid $								
#					ents (globa	<u> </u>	•		
	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	0.0000		
2	15	0.000	0.000	-0.139	-0.0012	-0.0010	-0.0012		
3	20A	0.000	-0.000	-0.186	-0.0021	-0.0021	-0.0017		
4	20B	0.036	-0.001	-0.220	-0.0029	-0.0079	-0.0024		
5	30	0.036	-0.001	-0.220	-0.0029	-0.0079	-0.0024		
6	40	0.109	-0.018	0.034	0.0002	-0.0072	0.1136		
7	50A	0.109	-0.018	0.034	0.0002	-0.0072	0.1136		
8	50B	0.144	0.000	0.000	0.0000	0.0000	0.1139		
9	60A	0.144	0.000	0.000	0.0000	0.0000	0.1139		
10	60B	0.109	-0.018	-0.034	-0.0002	0.0072	0.1136		
11	70	0.109	-0.018	-0.034	-0.0002	0.0072	0.1136		
12	80	0.036	-0.001	0.220	0.0029	0.0079	-0.0024		
13	90A	0.036	-0.001	0.220	0.0029	0.0079	-0.0024		
14	90B	0.000	-0.000	0.186	0.0021	0.0021	-0.0017		
15	95	0.000	0.000	0.139	0.0012	0.0010	-0.0012		
16	100	0.000	0.000	0.000	0.0000	0.0000	0.0000		

The <u>differential Lateral Deflection</u> (in Z direction) between Nodes 30 and 80 = 2 * 0.22 = 0.44'' < 1.5'' (Allowable Movement specified in the catalog).

Summary

From the above, it is noted that the differential lateral displacement computed by CAEPIPE for Operating Load Case between Nodes 30 and 80 are less than the Allowable Movement (1.5") provided in the catalog, thereby meeting the criteria.

Lastly, the differential displacement of 0.37" computed from the MetraLoop model <u>without</u> Support at the middle of U-bend is closer to the differential displacement of 0.44" computed for this model with a vertical support at the middle of U-bend thereby confirming that the stiffnesses assumed for the braided hoses are reasonable.