CPTOPS™ User's Manual

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CAEPIPE-to-PIPESTRESS

CPTOPS™

User's Manual

Server Version 10.xx

SYSTEMS, INC.

INDIA PVT.LTD

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1.0 Introduction

CPTOPS: CPTOPS Translator program is a stand-alone program, which shall be used for transferring pipe geometry, section properties and other engineering properties from SST System Inc. Pipe Stress Analysis software CAEPIPE to DST Computer Services Pipe Stress Analysis software PIPESTRESS.

The sequence of this Translator operation is shown diagrammatically in Figure 1.1.

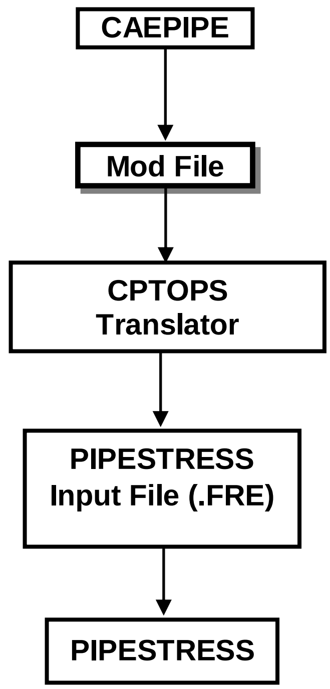


Figure 1.1

This manual describes the development done on CPTOPS. It is assumed that the user is already familiar with CAEPIPE and PIPESTRESS.

1.1 How the Translator Works?

The windows executable 'CPTOS.exe' reads the CAEPIPE mod file (which is in binary format) and extracts all the information of the piping system and creates the 'Free format' file for PIPESTRESS. It not only creates the piping layout but also creates the analysis cards taking care of all the design considerations. During transfer suitable assumptions are made wherever necessary. The analysis cards are customized so as to have same result in PIPESTRESS and CAEPIPE.

1.2 Points to be considered

The following are the points to be considered before transferring the stress model from CAEPIPE to PIPESTRESS.

CAEPIPE offers numerous options and flexibility during modeling. Though PIPESTRESS offers tremendous flexibility and options in the analysis front, when it comes to modeling it follows some stringent rules. A few things, which can be done quite easily in CAEPIPE, cannot be done so easily in PIPESTRESS. For example CAEPIPE allows junction points at the near end or far end of a bend, and also the user can apply a force at these points, which cannot be done in PIPSTRESS. In CAEPIPE, one can apply as many numbers of forces as the user wants at any node point using 'Location' element. Doing the same in

PIPESTRESS is not easy. Though ‘CPTOPS’ transfers most data present in CAEPIPE, in certain situations (as mentioned before), the user may need to alter a few things in the *.fre file generated. For the Translator to work at its best, the user can keep a few points in mind while modeling in CAEPIPE. These points are mentioned below. It is worthwhile going through these points as it may save the user a lot of time at a later stage.

1. It is advisable to model a header line first, and then a branch should be started from a junction point using ‘FROM’ element in CAEPIPE.
2. While modeling in CAEPIPE, it is advisable to define the type of weld (at a junction) in the same line where ‘FROM’ element is defined.
3. It is advisable not to have concentrated mass and force, or multiple forces acting at the same node. In PIPESTRESS, ‘FORC’, ‘MOMT’ and ‘LUMP’ cards are required to be defined immediately after a member or junction having the same node number. If multiple forces are present at a node, one needs multiple ‘FORC’ cards and it is not possible to have all of them follow the member or junction immediately. Though ‘CPTOPS’ transfers all the forces with the help of ‘FORC’ card, an attempt to run this file will fail. To solve this problem, the user has to manually change the ‘*.fre ‘ file. The user may judicially take the help of ‘JUNC’ cards to split the pipeline at the node and use the ‘FORC’ cards.
4. After a reducer, the pipe cross-section should change.
5. There are a few element types in CAEPIPE (e.g. Valve, Bellows, Rigid element etc.), which are modeled with the help of multiple cards in PIPESTRESS. Avoid having such elements back to back, or if it is inevitable check the *.fre file for any inconsistency.
6. It is highly recommended to turn ON all the load cases shown in the “load cases” dialog of CAEPIPE and save them in the .mod file before transferring the same to PIPESTRESS.

After transferring the *.mod file to *.fre file, it is advisable to check the *.fre file; particularly the junction points, ‘LUMP’ cards, ‘FORC’ cards, ‘MOMT’ cards and ‘MTXS’ cards.

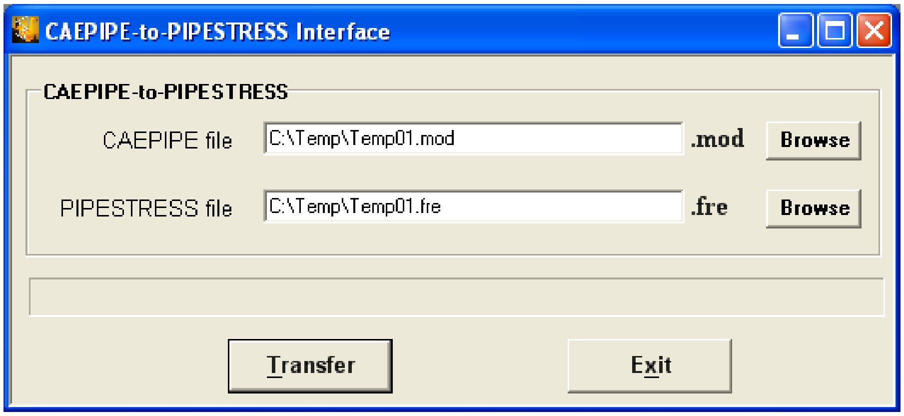
2.0 Installing the Program

Refer Section 1.0 in SST License Manager User's Manual for details.

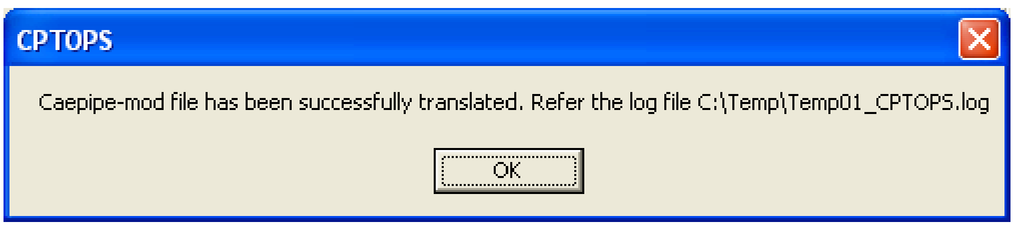
3. Limitations of CPTOPS

1. For To-be-Designed hangers, 'VSUP' card is created, but is commented. The user has to fill the values for 'FO' (hot load) and 'LO' field.
2. 'VSUP' card for user hanger is created and commented if cold load for user hanger is specified in the CAEPIPE mod file. The user has to fill the 'FO' (hot load) field manually.
3. Non-linear load cases for limit stops and rod hangers are not created. The user has to create them manually.
4. Slip joint is not transferred.
5. Jacketed pipe and jacketed bend are not transferred.
6. Spider is not transferred.
7. Guide is not transferred.
8. 'Connected to' node information, if present (as in the case of 'To be designed Hanger', 'User Hanger', 'Rod Hanger ','Skewed Restraint', 'Limit Stop' etc. in CAEPIPE), is ignored by the Translator.
9. Pump, Compressor and Turbine data are not transferred at this time.

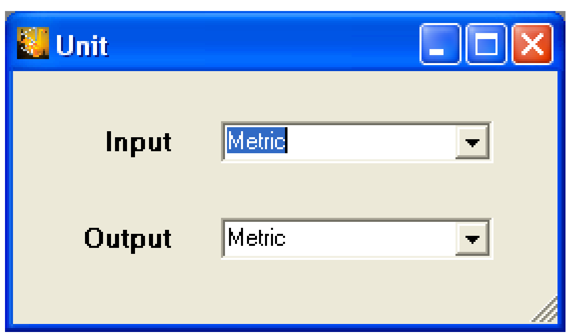
4. Working Procedure



1. Selection of CAEPIPE mod file can be done in two ways viz. by entering the name of the CAEPIPE mod file along with the valid path in the text box provided or by clicking the button available near the text box opens a file dialog and lets the user to navigate and select the CAEPIPE mod file.
2. Similarly, enter the name of the PIPESTRESS free format file to be created.
3. Click the button “Transfer” to transfer model from CAEPIPE to PIPESTRESS free format. Upon successful transfer, user gets the message as shown below.



4. Launch PIPESTRESS software or Edit Pipe to view the free format file.
5. To change input and output unit, in the free format file, choose ‘Unit’ sub menu from ‘Option’ menu. The following dialog box will appear. Make necessary changes and close the dialog box.



5.0 Reference

This section describes in detail, the methodology followed for transferring the Elements and Data types from CAEPIPE to PIPESTRESS.

5.1 Load Cases created by CPTOPS

'CPTOPS' generates a number of load cases and load combinations in PIPESTRESS input file, based on analysis options and load cases chosen in the CAEPIPE mod file. All the cases and combinations generated in PIPESTRESS input file are customized so as to obtain almost identical results from PIPESTRESS as those from CAEPIPE. The user can modify these cases as per requirements. The following paragraphs discuss the load cases generated by CPTOPS. For details of cases and case numbers created, refer Appendix D.

Weight Case

'LCAS' cards for weight case(s) are created irrespective of the options chosen in CAEPIPE, with Case number (CA) ranging from 1 to 10. In the present version, three weight cases are created, namely, empty weight, operating weight and hydrotest weight.

If hydrotest is performed in CAEPIPE, then a load case (CA = 3) is created by 'CPTOPS'. In this version of 'CPTOPS', the 'Exclude Insulation' option in CAEPIPE is ignored for this case.

Pressure Case

'LCAS' cards are created to analyze response due to pressure only, irrespective of the options chosen in CAEPIPE. Case numbers for 'LCAS' cards in this category are in the 10 series. At most, four cases are created. CAEPIPE can have at most three pressure inputs, so three 'LCAS' cards for three pressures and one separate 'LCAS' card for the maximum pressure.

Expansion Case

'LCAS' and 'CCAS' cards are created to analyze thermal expansion cases. Case numbers for 'LCAS' cards in this category are given in the 20s. Different 'LCAS' cards are created for different thermal expansions (at most 3 thermal loads T1, T2, T3 are allowed in CAEPIPE) and then combination cases for thermal ranges namely (T1-T2), (T1-T3) and (T2-T3) are automatically generated. Also a 'CCAS' card for maximum thermal range is created (CA=124).

Wind Load Case

'LCAS' and 'CCAS' cards involving wind are created with case numbers in the 60s and 160s respectively. One 'LCAS' for analysis of pure wind load is created. This 'LCAS' is then combined with sustained and operating cases to get combination cases. In CAEPIPE the user can input pressure/velocity at different elevations. CPTOPS transfers the maximum of these pressure/velocity values to PIPESTRESS.

Sustained Load Case

This is a combination case (with 'CA=61') wherein weight case and maximum pressure case are algebraically added.

Settlement Load

A 'LCAS' card for settlement load is created with case number 41.

Operating Load Case

These cases are combination cases of weight, pressure and thermal expansion cases with case numbers in the 130s.

Cold Spring

If cold spring is present in the CAEPIPE mod file, then a 'LCAS' card with case number 31 is created.

Static Seismic Case

If static seismic analysis option is turned on in CAEPIPE, ‘LCAS’ cards are prepared for all three directional accelerations (case numbers are in the 50s), and then they are combined together (CA=151). The mode of summation is as chosen by the user in the CAEPIPE mod file.

If seismic displacement is present, a new combination case is prepared, combining the ‘CCAS’ card resulting from static seismic case and the ‘LCAS’ card from seismic displacement case. The mode of combination is always absolute (in CAEPIPE this summation is always absolute). The user can modify the mode of summation in the PIPESTRESS file generated to suit his/her requirements.

Several ’CCAS’ cards are created combining Seismic, Operating and Sustained cases.

Seismic Displacement

If seismic displacement(s) at support(s) are specified, a load case (LCAS with CA = 54) is created.

Response Case

A ‘RCAS’ card (CA = 71) is created if response analysis option is turned on in CAEPIPE. If seismic displacement is present in CAEPIPE, then a separate combination case (CA = 171) is created combining the response case and seismic displacement case. The mode of summation for this combination case (CA = 171) is always absolute (in CAEPIPE this summation is always absolute). The user can modify the mode of summation to suit his/her requirements.

In CAEPIPE, for modal superposition the user has got three options, namely :

1) SRSS
2) Closely Spaced
3) Absolute

Also the user has the freedom to choose the spatial summation. They are :

1) SRSS
2) Absolute

Based on the options chosen, CPTOPS sets the value of ‘SU’ field in the ‘RCAS’ card. Table 6.1 presents the values of ‘SU’ chosen by CPTOPS.

Table 5.1

MODAL SUPERPOSITION	SPATIAL SUMMATION	SU
SRSS	SRSS	3
	Absolute	8**
Absolute	SRSS	9**
	Absolute	4
Closely Spaced	SRSS	1
	Absolute	0**

**** For these combinations, there are no combinations available in PIPESTRESS. The user is free to change the ‘SU’ value for these combinations.**

Response Spectrum

'CPTOPS' transfers the response spectrum data using 'RCAS' card, and 'SPEC' card. For the Translator to work properly, the following points should be kept in mind while inputting spectral data in CAEPIPE.

1. Spectrums have to be in Frequency/Period vs Acceleration format as PIPESTRESS does not support any other format. Any other format will result in the program being aborted.
2. The entire spectrum should use the same interpolation method for Frequency/Period, or else the program will abort.

Only linear interpolation is allowed for acceleration. Any other interpolation method will result in the program being aborted.

5.2 Analysis Options

In CAEPIPE, a user has different analysis options to choose from. These options change the way the analysis is performed and the results may vary to different extent depending upon the options selected for a particular CAEPIPE model. Given below are different CAEPIPE analysis options and the corresponding PIPESTRESS options created by CPTOPS.

Code

Depending upon codes chosen in CAEPIPE, CPTOPS chooses the value of 'CD' field in the 'IDEN' card and 'CV' field of 'TITL' card. Table 6.2 gives the CD and CV values corresponding to different codes in CAEPIPE.

Table 5.2

CAEPIPE CODE	CD	CV	CAEPIPE CODE	CD	CV
NONE	0	16	ASME Class 3 (2017)	3	24
B31.1	0	16	BS 806 (1986)	0	16
B31.1 (1967)	0	-4	IGEM	4	13
B31.3	4	13	NORWEGIAN (1983)	4	13
B31.4	4	13	NORWEGIAN (1990)	4	13
B31.5	4	13	RCC-M (1985)	8	2
B31.8	4	13	CODETI (SNCT)	5	5
B31.9	0	16	STOOMWEZEN (1989)	0	16
B31.12	4	13	SWEDISH (1978)	0	16
ASME Class 2 (1980)	2	5	Z183 (1990)	0	16
ASME Class 2 (1986)	2	7	Z184 (1992)	0	16
ASME Class 2 (1992)	2	11	EN 13480-3	F	1
ASME Class 2 (2015)	2	24	Z662	0	16
ASME Class 2 (2017)	2	24			

Elastic Modulus

In PIPESTRESS, the 'MD' field in the 'TITL' card decides which modulus (Hot or Cold) is to be used. If cold modulus is chosen, then 'MD = 0', else 'MD = 1'.

Pressure Stress Option

If pressure stress = PD / 4t in CAEPIPE, then 'PR = 1' (in 'TITL' card)

If pressure stress = $Pd^2/(D^2-d^2)$, then 'PR = 0'

If Bourdon effect is included, then 'IP = 1' (in 'TITL' card), else 'IP = 0'

If pressure correction is 'ON' for bends, then 'OF = 0' (in 'TITL' card), else 'OF = 1'.

5.3 Element Types

Pipe

Pipe from CAEPIPE is transferred as 'TANG' card in PIPESTRESS. If the pipe element is a branch pipe, then it is transferred as a 'BRAN' card. The Translator uses the same node numbers used in CAEPIPE while identifying the nodes in PIPESTRESS. It should be noted here that PIPESTRESS allows node numbers to be a string of four characters only, so the CAEPIPE model should not have node numbers greater than 9999.

The material properties are transferred using 'MATH' and 'MATD' cards.

The cross-sectional properties are transferred using 'CROS' card.

The loads are transferred using 'OPER' cards. Additional weight per unit length (for example, to represent snow load) is not transferred.

Bend

In CAEPIPE, the term Bend refers to all elbows and bends (custom-bent pipes). Some of the items associated with the bend are shown in Fig. 6.1

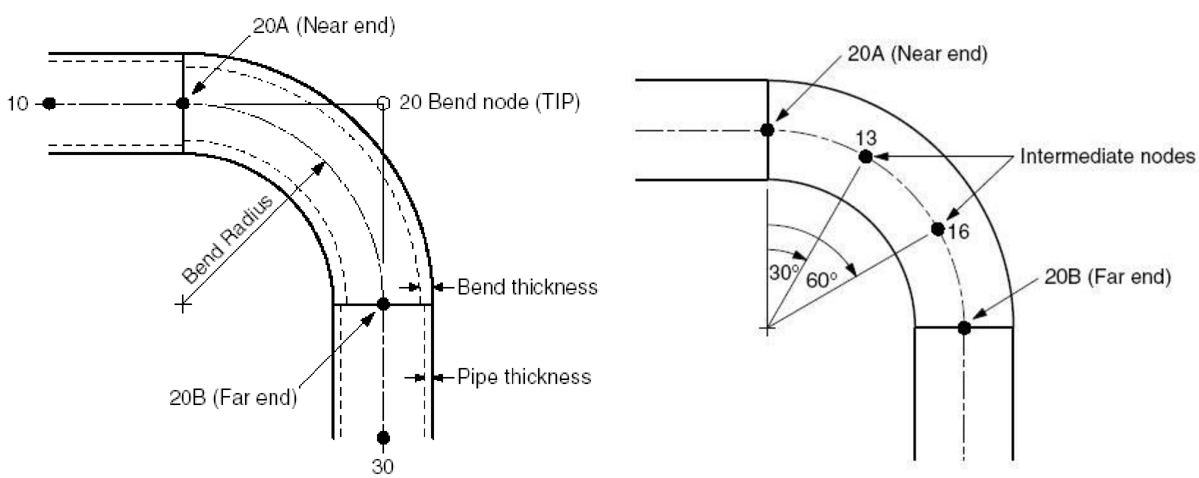


Fig. 5.1

Node 20 is the Bend node, which is at the Tangent Intersection Point (TIP). As one can see in Fig.6.1, TIP is not physically located on the bend. Its only purpose is to define the bend. CAEPIPE automatically generates the end nodes of the curved portion of the bend (nodes 20A and 20B, called the near and far ends of the bend). The data items such as flanges, hangers, forces, etc. can be specified at the bend end nodes (20A and 20B in the figure). Also CAEPIPE has provision to specify intermediate nodes (at most two intermediate nodes) at specific angles as shown in Fig.6.1. A typical CAEPIPE-bend has a straight portion and a curved portion. In Fig.6.1, Node 10 to 20A is the straight portion and 20A to 20B is the curved portion. 20B to 30 is not part of the bend. If a bend has one or two intermediate nodes, then the curved portion is again subdivided into two or three curved portions respectively.

The Translator uses either a BRAD card or BEND card in PIPESTRESS to transfer a bend. If CAEPIPE bend has intermediate nodes, then BEND card is used, or else BRAD card is used.

If intermediate nodes are present, the Translator transfers the straight portion of a CAEPIPE-bend as a 'TANG' card or 'BRAN' card. The curved portion(s) is/are transferred as 'BEND' card(s).

The node numbers used in CAEPIPE are used for node numbering in PIPESTRESS. However, if the bend node number in CAEPIPE is greater than 999 e.g. 5000, then the near end and far end become 5000A and 5000B respectively; these node numbers having more than four characters cannot be transferred to PIPESTRESS. For such a case, the first three digits of the node number are retained and then any letter from 'C' to 'V' is added depending on the last digit. For near end node, letters 'C' to 'L' are used. For far end node, letters 'K' to 'V' are used. For example, if the bend node number is 5000, the near and far ends will be transferred as 500C and 500K respectively.

Miter Bend

CAEPIPE offers two types of miter bend namely:
1) Closely-spaced miter bend
2) Widely-spaced miter bend

Closely-spaced miter bend

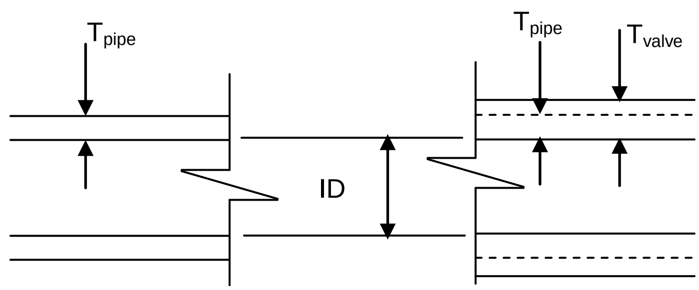
A closely-spaced miter bend in CAEPIPE is modeled as a 'MITC' card in PIPESTRESS. PIPESTRESS dictates a miter bend to be preceded and followed by straight members only. So, the CAEPIPE user is required to do the same, or else the Translator throws an error message and does not transfer the CAEPIPE mod file.

Widely-spaced miter bend

A widely-spaced miter bend in CAEPIPE is modeled as a 'MITW' card in PIPESTRESS. In CAEPIPE, a widely spaced miter bend (with cuts more than or equal to two) is modeled with as many separate widely spaced miter bend elements as the number of cuts. For example, a widely spaced miter bend with number of cuts equal to 3 is modeled as three widely spaced miter bend elements in CAEPIPE. So, the Translator allows CAEPIPE mod files to have widely-spaced miter bend preceded or followed by another widely spaced miter bend, provided they have the same radius. For example, if there are three back-to-back widely spaced miter bends of same radius; the Translator transfers them as one widely spaced miter bend with three cuts.

Valve

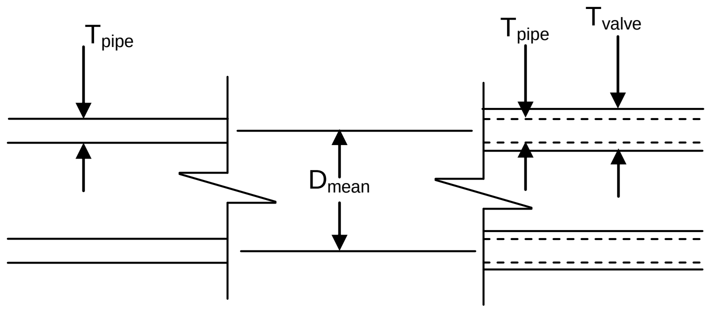
Valve is transferred as a 'VALV' card in PIPESTRESS. Internally, a valve element is modeled as a pipe, both in CAEPIPE and PIPESTRESS; but both these software introduce the valve thickness in different ways as explained next.



Valve modeled in CAEPIPE

Fig.5.2

Fig. 5.2 shows how a valve is modeled in CAEPIPE. OD and Tpipe are the outer diameter and thickness of the pipe section entered for the valve element. T_{valve} is the thickness of the valve, which is nothing but thickness factor times T_{pipe}. The thickness is increased by increasing the outer diameter and keeping the inner diameter fixed.



Valve modeled in PIPESTRESS

Fig.5.3

Fig. 5.3 shows how a valve is modeled in PIPESTRESS. In PIPESTRESS also, T_{valve} is calculated in the same manner as in CAEPIPE (i.e., thickness factor times pipe thickness). But, unlike CAEPIPE, the valve thickness is introduced by keeping the mean diameter fixed, and increasing the outer diameter and decreasing the inner diameter equally.

So, when a valve is modeled in CAEPIPE and in PIPESTRESS (using 'VALV' card in PIPESTRESS) with same reference-pipe-section and same thickness factor, their stiffnesses are different. The valve in PIPESTRESS is going to have a smaller inner diameter than CAEPIPE. So, the weight of the fluid contained in the valve (in PIPESTRESS) is going to be less than that for CAEPIPE.

While transferring a valve to PIPESTRESS, CPTOPS creates three nodes for the valve. One at each end of the valve and one at the middle. The total weight of the valve (including insulation weight and excluding additional weight) is divided by two and each half is applied as a lumped mass at both ends of the valve. If additional weight is present, then the stem is modeled as a rigid element (with no mass) starting from the middle node and additional weight is applied at the far end of the rigid element.

The 'FROM' and 'TO' nodes in CAEPIPE are used for naming the end nodes of the valve in PIPESTRESS. For naming the intermediate node in PIPESTRESS, the alphabet 'M' is prefixed to a sequential number starting from 101. For the far end of the rigid element (if additional weight is present) the alphabet 'V' is prefixed to the same sequential number used for the intermediate node. Fig. 5.4 illustrates this point.

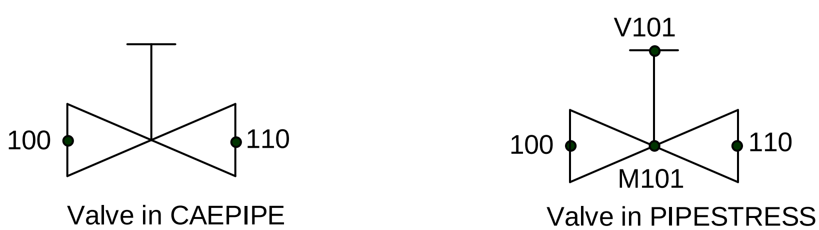


Fig. 5.4

Reducer

Reducer in CAEPIPE is transferred as 'CRED' or 'ERED' card in PIPESTRESS. Concentric reducer is transferred as 'CRED' card and eccentric reducer is transferred as 'ERED' card. Outer diameter and thickness at the start and end of the reducer are taken from CAEPIPE. Like valve, reducer is also modeled differently in CAEPIPE and PIPESTRESS, as explained next.

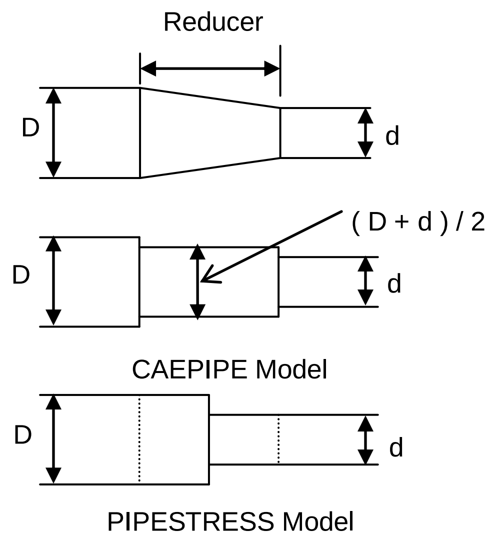


Fig.5.5

Figure 5.5 shows how a reducer is modeled in CAEPIPE and PIPESTRESS. In CAEPIPE, the properties such as empty weight, stiffness, contents weight and insulation weight of a reducer are based on the average diameter (of OD1 and OD2) and average thickness (of Thk1 and Thk2) between the two ends of the reducer; whereas, PIPESTRESS changes the pipe diameter from OD1 to OD2 and the wall thickness from Thk1 to Thk2 at the mid-point of the reducer.

Bellows

A bellow in CAEPIPE is translated to a 'MTXS' card in PIPESTRESS. 'FROM node' to 'TO node' direction of the bellow is taken as the local Z-axis direction for the 'MTXS' card and an arbitrary perpendicular direction is taken as the local X-axis direction. Pressure and pressure thrust area for the bellow (read from the CAEPIPE-mod file) are multiplied and applied as force at both the ends of the 'MTXS' element.

Slip Joint

Slip joint is not transferred to PIPESTRESS.

Hinge Joint

A hinge joint in CAEPIPE is translated to a 'MTXS' card in PIPESTRESS. A hinge joint in CAEPIPE has zero length. PIPESTRES does not allow any member having zero length; to prevent PIPESTRESS from generating an error, CPTOPS assigns a length of 1mm to 'MTXS' element representing a hinge joint. The axis direction of the hinge joint in CAEPIPE is taken as the X-axis of the 'MTXS' card in PIPESTRESS. The rotational stiffness of the 'MTXS' card is assigned the value of rotational stiffness of the hinge joint in CAEPIPE. For all other directions, the 'MTXS' card behaves as a rigid element. Rotational limit and friction torque values in CAEPIPE are ignored by CPTOPS.

Ball Joint

Like hinge joint, a ball joint in CAEPIPE is transferred as a 'MTXS' card in PIPESTRESS with 1 mm as its length. The torsional direction of the ball joint (for definition refer CAEPIPE Manual) in CAEPIPE is transferred as the local Z-axis direction of the 'MTXS' card. One arbitrary direction orthogonal to local Z-axis of the 'MTXS' card is taken as the local X-axis direction for the 'MTXS' card. The torsional stiffness obtained from the CAEPIPE-mod file is used as the rotational stiffness about the local Z-axis of the 'MTXS' card. Bending stiffness obtained from CAEPIPE-mod file is used for the rotational stiffness of 'MTXS' card about the local X-axis and the local Y-axis. 'MTXS' card behaves rigidly for all other directions.

Rigid Element

Rigid element in CAEPIPE is transferred as a 'RIGD' card in PIPESTRESS. The mass of the rigid element in CAEPIPE is equally divided between two 'LUMP' cards, one at each end node of the 'RIGD' card.

Elastic Element

Elastic element in CAEPIPE is transferred as 'MTXS' card in PIPESTRESS. Elastic element in CAEPIPE is a 6x6 matrix with zero off-diagonal terms. The X-axis and Z-axis of elastic element in CAEPIPE are transferred as X-axis and Z-axis of 'MTXS' card respectively.

Jacketed Pipe and Bend

Jacketed pipe and bend are not transferred to PIPESTRESS.

Cold Spring (Cut Pipe)

Cold spring is transferred as 'CLDS' card in PIPESTRESS.

Beam

Beam element in CAEPIPE is transferred as 'BEAM' card in PIPESTRESS. In CAEPIPE two separate conventions are used to determine the local axes of beam element, depending on whether Global Y-Axis is vertical or Global Z-Axis is vertical. In CAEPIPE, local X-axis is always in the element direction ('From' to 'To' node). If Global Y-axis is vertical in CAEPIPE, then I_{zz} is major principal axis and I_{yy} is minor principal axis. If Global Z-axis is vertical in CAEPIPE, then I_{zz} is minor principal axis and I_{yy} is major principal axis.

In PIPESTRESS, local Z-axis is along the element direction. So, CAEPIPE local X-axis direction is assigned to the local Z-axis direction in PIPESTRESS. Minor moment of inertia for a beam in CAEPIPE is assigned to 'IX' field of 'BEAM' card in PIPESTRESS, and major principal moment of inertia is assigned to the 'IY' field.

Tie Rod

Tie rod in CAEPIPE is not transferred to PIPESTRESS.

Comment

Comments in CAEPIPE are ignored during transfer.

Hydrotest Load

For hydrotest load, the 'Exclude Insulation' option of CAEPIPE is ignored. For more details on 'Hydrotest Load', see 'Weight Case' reported earlier in this chapter.

5.4 Data Types

Anchor

Anchor in CAEPIPE is transferred as 'ANCH' card in PIPESTRESS. For a rigid anchor, a translational stiffness of 1.751×10^8 kN/mm is used. Rotational stiffness for the same is 1.13×10^8 kN m/radian. Anchor movements may be specified in CAEPIPE for different thermal loads. For each thermal load, CPTOPS creates an 'AMVT' card to specify displacements. For seismic anchor movement and settlement also, CPTOPS creates suitable 'AMVT' cards.

Branch SIF

Branch SIF in CAEPIPE is transferred to PIPESTRESS as suitable 'TE' and 'PD' fields in 'BRAN' card. Table 5.3 lists different Branch SIFs available in CAEPIPE and the corresponding 'TE' and 'PD' fields generated by CPTOPS.

Table 5.3

Branch SIF in CAEPIPE	Corresponding TE and PD fields
Welding Tee	TE = 1
Reinforced Fabricated Tee	TE = 3, PD = Pad thickness
Unreinforced Fabricated Tee	TE = 3, PD = Pad thickness=0
Weldolet	TE = 6
Extruded Welding Tee	TE =7
Sweepolet	TE = 4
Branch Connection	TE = 0

User SIF

CPTOPS transfers User SIF in PIPESTRESS through 'INDI' card.

Concentrated Mass

Concentrated mass is transferred as a 'LUMP' card in PIPESTRESS. In case offsets for concentrated mass are specified in CAEPIPE, then a 'RIGD' card with no mass is created. DX, DY and DZ fields of the 'RIGD' card are set to DX, DY and DZ offset values in CAEPIPE respectively and then the 'LUMP' card is created, with its position at the far end of the rigid element ('RIGD' card).

Constant Support

Constant support in CAEPIPE is transferred as 'CSUP' card, but this card is commented. The user has to enter suitable value for the 'FO' field (i.e. cold load) and use it. Please note, for a constant support (i.e. 'CSUP' card), hot load = cold load.

Flange

Flange is transferred as a 'LUMP' card. The weight of flange in CAEPIPE is transferred, but other properties like Flange type, Gasket diameter and Allowable pressure are ignored.

Force

'FORC' and 'MOMT' cards are used to transfer forces and moments from CAEPIPE to PIPESTRESS. These cards are created with load case number assigned to the operating weight case. It is advisable not to have a concentrated mass and force at the same location in CAEPIPE.

Force Spectrum Load

Force spectrum load is not transferred to PIPESTRESS.

Guide

Guide is not transferred to PIPESTRESS.

Hanger

In CAEPIPE a hanger can be a 'Rod Hanger', 'User Hanger' or a To-Be-Designed hanger called 'Hanger'. To-Be-Designed hanger and 'User Hanger' are transferred as 'VSUP' card in PIPESTRESS. 'VSUP' card requires the value of cold load to be entered ('FO' field). For To-Be-Designed hanger, CAEPIPE automatically calculates cold load. That load has to be entered in the PIPESTRESS input file manually by the user.

In CAEPIPE a ‘Rod Hanger’ acts as a one-way restraint. It prevents downward movement, but allows upward movement. In PIPESTRESS, a ‘HANG’ card acts as a two-way restraint. So, ‘HANG’ card cannot be used to transfer a ‘Rod Hanger’ from CAEPIPE; instead, a ‘NRST’ card is used to represent a ‘Rod Hanger’ in PIPESTRESS. However, this ‘NRST’ card is commented and no ‘NCAS’ card is created by ‘CPTOPS’. The user can analyze the model in CAEPIPE and check the piping response at the node (at which ‘Rod Hanger’ is present) in CAEPIPE. If the node moves down, then the ‘NRST’ card can be uncommented, so that ‘NRST’ card is activated, in which case the ‘NRST’ card is treated as a ‘RSTN’ card for all dynamic analyses (including ‘FREQ’ card and ‘RCAS’ card) and for all ‘LCAS’ cards.

Harmonic Load

Harmonic load is not transferred to PIPESTRESS.

Jacketed End Cap

Jacketed end cap is not transferred to PIPESTRESS.

Limit Stop

Limit stop is transferred as ‘NRST’ card, but the corresponding ‘NCAS’ cards are not provided by the Translator. The user has to manually create ‘NCAS’ card. Please note that the ‘NRST’ card is treated as a ‘RSTN’ card for all dynamic analyses (including ‘FREQ’ card and ‘RCAS’ card) and for all ‘LCAS’ cards.

Nozzle

Nozzle is transferred as ‘NOZZ’ card in PIPESTRESS.

Restraint

Restraint is transferred as ‘MULR’ card.

Rod Hanger

Rod hanger is transferred as ‘NRST’ card in PIPESTRESS as described in the article titled ‘Hanger’ above. Global co-ordinate system (i.e. LO=0 in PIPESTRESS) is used in the free format file to define the direction of hanger. A translational stiffness of 1.751 x 10^8 kN/mm is set for the ‘SP’ and ‘K1’ fields in ‘NRST’ card. The user should note that this ‘NRST’ card is commented in the ‘PIPESTRESS’ input file. In case the user wants to see the PIPESTRESS results for the sustained load case, the user should run the *.fre file with the ‘NRST’ card commented so that ‘NRST’ card is not activated, and note the pipe movement at the node(s) where ‘Rod Hanger(s)’ is/are present. If the pipe moves down at certain ‘Rod Hanger’ node(s), the user should uncomment the ‘NRST’ card(s) so that they get activated and re-run the *.fre file to get the correct results.

Skewed Restraint

Translational skewed restraint is transferred as ‘RSTN’ card and rotational skewed restraint is transferred as ‘ROTR’ card. The stiffness value is assigned to the corresponding ‘SP’ field. Connected node information is ignored by the Translator.

Snubber

Snubber is transferred as ‘SNUB’ card. The stiffness is assigned to the corresponding ‘SP’ field of the ‘SNUB’ card.

Spider

Spider is not transferred.

Weld

CPTOPS transfers different welds specified in CAEPIPE by assigning suitable values to TA, LW, EW and MM fields for the corresponding piping elements. Table 5.4 lists different welds available in CAEPIPE and the corresponding TA, LW, EW and MM fields used by CPTOPS to transfer them. In CAEPIPE, it is advisable to input the type of weld in the same line where the node is defined.

Table 5.4

Weld in CAEPIPE	Corresponding TA, LW, EW and MM fields
Butt Weld	LW = 2, MM = Mismatch
Fillet Weld, Concave Fillet Weld	EW = 3
Tapered Transition	TA = 2, MM = Mismatch

Material

The Translator transfers all the material properties used in a CAEPIPE mod file with the help of 'MATH' and 'MATD' cards. If material properties at negative temperatures are present in the CAEPIPE mod file, PIPESTRESS may issue a warning.

6.0 Verification and Validation of Translator

6.1. General

To verify that CPTOPS transfers the data present in CAEPIPE properly, a number of models were considered with different options and complexity. The models were then transferred using CPTOPS and analyzed. The analyses were performed in both the software and the results thus obtained were compared against each other. Some of the models and their analysis results are included in this manual for the users' reference. The user can find more models in the distribution CD that they can run and test themselves.

The models are presented with increasing complexity, starting from a four-nodded piping system to piping system with many more elements and data types.

The models chosen for testing and comparing results are included with the distribution CD for reference. Due to space constraints in listing the results for all nodes, the table listed below shows values for Total weight, Support loads under different loading conditions and frequencies.

During the verification, the 'Cold Load' and the 'Spring Rate' obtained from the hanger results report of CAEPIPE were entered manually at the 'FO' and 'SP' fields of PIPESTRESS hanger input to get identical results between CAEPIPE and PIPESTRESS. Hence, we recommend the user to input the above said parameters manually to PIPESTRESS before performing the analysis.

***Important:* PIPESTRESS creates intermediate nodes automatically (based on the value input for 'MP' field., i.e, for 'Automatic Mass Modeling Frequency/Period') to have more accurate results during dynamic analysis. This feature is not present in CAEPIPE. Because of this, when dynamic analysis is performed, the CAEPIPE and PIPESTRESS results may vary more often than not. To get identical results, the user can either set the automatic mass modeling off in PIPESTRESS (by setting 'MP = 0' in 'FREQ' card) or create additional intermediate nodes in CAEPIPE. (Information on the additional nodes created by PIPESTRESS can be found in the corresponding *.prd file after running the *.fre file). For more details, refer study Model-027.**

6.2 Verification Models

About Model-001

This model has the following

a. Three Pipe elements with 4 node points starting from node 10. The length of each piping element is 1m.

b. Rigid anchor at node 10.

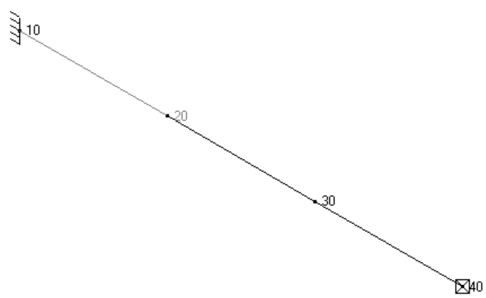
c. Concentrated mass of 1000 kg at node 40.

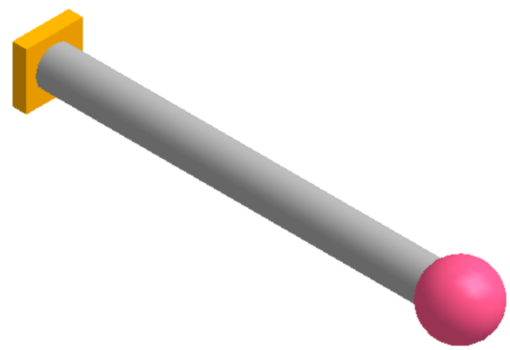
d. Design pressure and design temperature are 0 kg/cm2 and 148.9^{0} C respectively.

e. A53 Grade B material and 10" Nominal diameter section are used.

f. Insulation, Fluid density and Pipe material density are taken to be zero.

The pictorial representation of the CAEPIPE model is shown below.





Name of the Model	**Model – 001**
Analysis Options in CAEPIPE	

1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Do not include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (Kg)	
CAEPIPE	1000
PIPESTRESS	1000.001

Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0	-9807	0	0	0	-29420
PIPESTRESS	10	0	-9807	0	0	0	-29420

Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0	-9807	0	0	0	-29420
PIPESTRESS	10	0	-9807	0	0	0	-29420

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRSS (MP=0)	PIPESTRSS (MP=33)
1	7.586	7.586	7.586
2	7.586	7.586	7.586

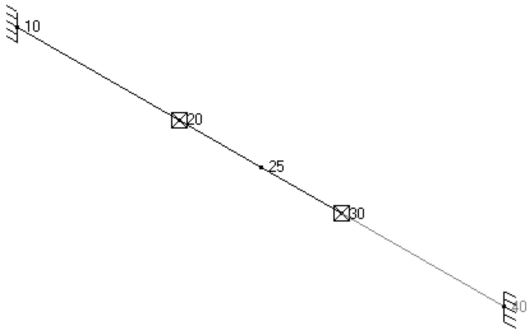
About Model-002

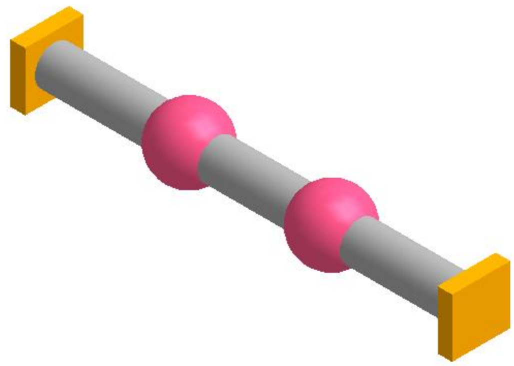
This model shown below is the same as Model-001 above, with the following modifications.

a. Concentrated mass at node 40 is replaced by Rigid anchor.

b. Two concentrated masses of 500 kg each are added at nodes 20 and 30.

c. An intermediate node is inserted at mid point between nodes 20 and 30.





Name of the Model	Model – 002
Analysis Options in CAEPIPE	

1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Do not include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (Kg)	
CAEPIPE	1000
PIPESTRESS	1000.001

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0	-4903	0	0	0	-3268
PIPESTRESS	10	0	-4903	0	0	0	-3268
CAEPIPE	40	0	-4903	0	0	0	-3268
PIPESTRESS	40	0	-4903	0	0	0	-3268

Support Load (Operating Case)

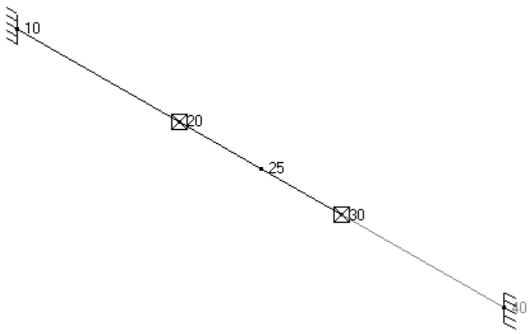
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-3769512	-4902	0	0	0	-3268
PIPESTRESS	10	-3769536	-4903	0	0	0	-3268
CAEPIPE	40	3769512	-4902	0	0	0	3268
PIPESTRESS	40	3769536	-4903	0	0	0	3268

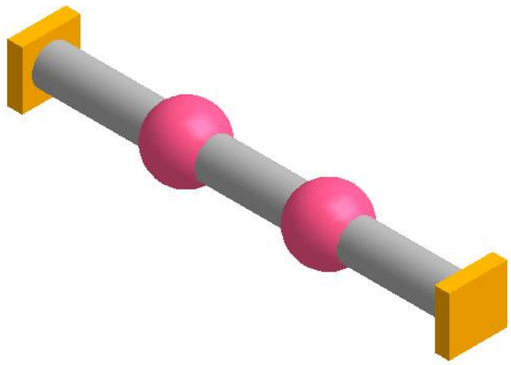
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	70.777	70.732	70.732

About Model-003

This model shown below is the same as Model-002 above with the following modifications.

a. Rigid anchors at nodes 10 and 40 are replaced by flexible anchor with the following stiffnesses kx=ky=kz=1000kg/mm and kxx=kyy=kzz=1000kg-m/deg.





Name of the Model			**Model – 003**				
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	1000						
PIPESTRESS	1000.001						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0	-4903	0	0	0	-128
PIPESTRESS	10	0	-4903	0	0	0	-128
CAEPIPE	40	0	-4903	0	0	0	128
PIPESTRESS	40	0	-4903	0	0	0	128
Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-22200	-4903	0	0	0	-128
PIPESTRESS	10	-22201	-4903	0	0	0	-128
CAEPIPE	40	22200	-4903	0	0	0	128
PIPESTRESS	40	22201	-4903	0	0	0	128

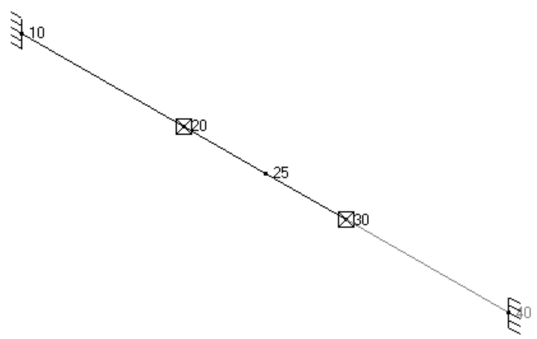
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRSS (MP=0)	PIPESTRESS (MP=33)
1	18.83	18.829	18.829
2	18.83	18.829	18.829
3	22.254	22.254	22.254

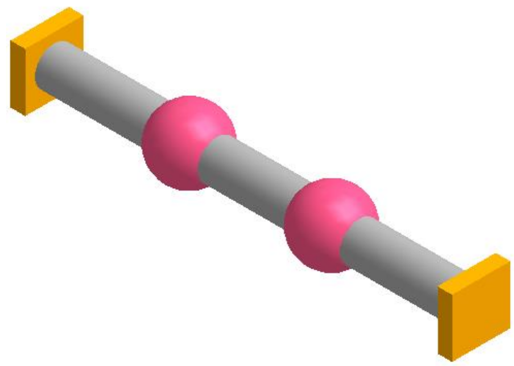
About Model-004

This model shown below is the same as Model-003 above with the following modifications.

a. Insulation density of section as 400 kg/m3 and

b. Insulation thickness of section as 100mm.





Name of the Model	**Model – 004**

Analysis Options in CAEPIPE	
1	Code – B 31.3
2	Reference Temperature = 20^0c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Do not include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (kg)	
CAEPIPE	1140.6
PIPESTRESS	1140.637

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0.0	-5593	0.0	0.0	0.0	-141
PIPESTRESS	10	0.0	-5593	0.0	0.0	0.0	-141
CAEPIPE	40	0.0	-5593	0.0	0.0	0.0	141
PIPESTRESS	40	0.0	-5593	0.0	0.0	0.0	141

Operating Case

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-22200	-5593	0.0	0.0	0.0	-141
PIPESTRESS	10	-22201	-5593	0.0	0.0	0.0	-141
CAEPIPE	40	22200	-5593	0.0	0.0	0.0	141
PIPESTRESS	40	22201	-5593	0.0	0.0	0.0	141

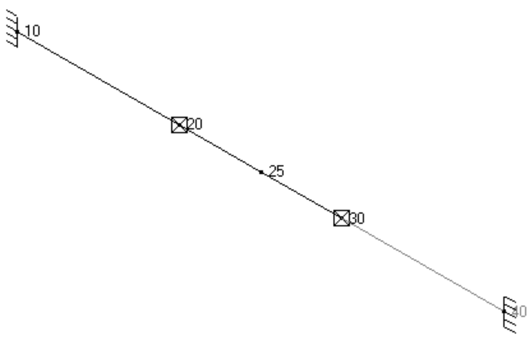
Frequencies (in Hz)

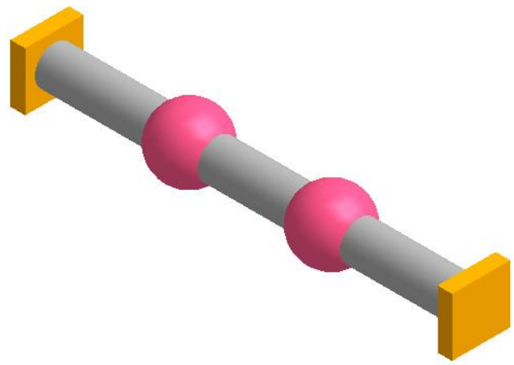
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	17.795	17.794	17.794
2	17.795	17.794	17.794
3	20.841	20.841	20.841

About Model-005

This model shown below is the same as Model-004 above with the following modification.

a. Fluid density as 1000 kg/m3.





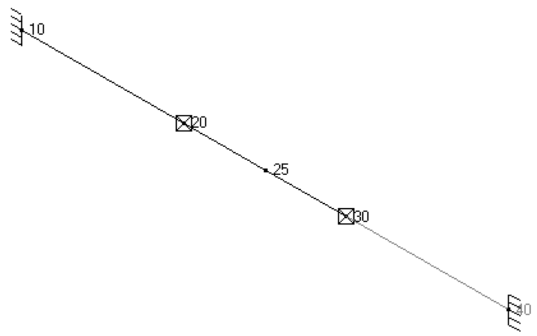
Name of the Model		Model – 005					
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	1279.5						
PIPESTRESS	1279.621						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0	-6274	0	0	0	-154
PIPESTRESS	10	0	-6274	0	0	0	-155
CAEPIPE	40	0	-6274	0	0	0	154
PIPESTRESS	40	0	-6274	0	0	0	155
Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-22200	-6274	0	0	0	154
PIPESTRESS	10	-22201	-6274	0	0	0	-155
CAEPIPE	40	22200	-6274	0	0	0	154
PIPESTRESS	40	22201	-6274	0	0	0	155

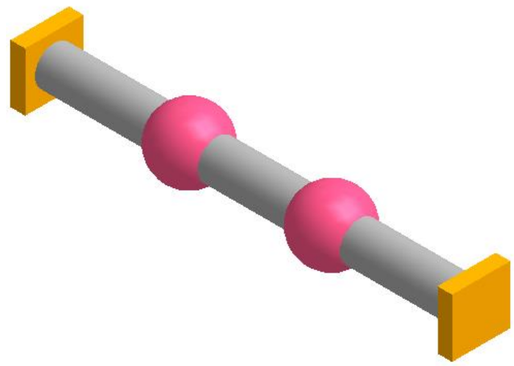
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	16.922	16.920	16.92
2	16.922	16.920	16.92
3	19.679	19.679	19.679

About Model-006

This model shown below is the same as Model-005 above with the following modification.

a. Density of material as 7833 kg/m3.





Name of the Model	Model – 006

Analysis Options in CAEPIPE

1	Code – B 31.3
2	Reference Temperature = 20^0c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Do not include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (Kg)

CAEPIPE	1566.40
PIPESTRESS	1566.487

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0	-7681	0	0	0	-182
PIPESTRESS	10	0	-7681	0	0	0	-182
CAEPIPE	40	0	-7681	0	0	0	182
PIPESTRESS	40	0	-7681	0	0	0	182

Operating Case

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-22200	-7681	0	0	0	-182
PIPESTRESS	10	-22201	-7681	0	0	0	-182
CAEPIPE	40	22200	-7681	0	0	0	182
PIPESTRESS	40	22201	-7681	0	0	0	182

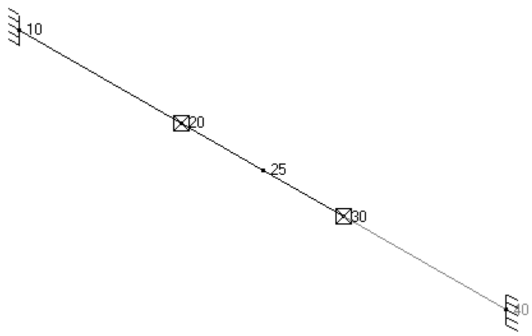
Frequencies (in Hz)

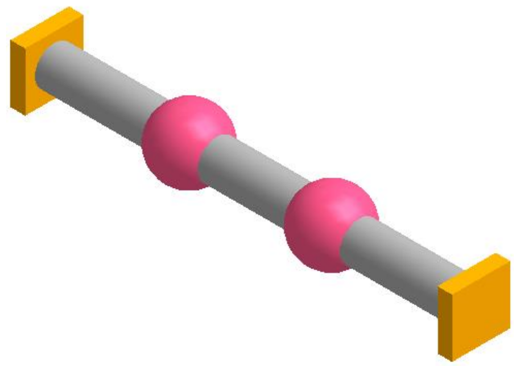
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	15.458	15.458	15.458
2	15.458	15.458	15.458
3	17.789	17.789	17.789

About Model-007

This model shown below is the same as Model-006 above with the following modification.

a. Internal fluid pressure of 50 kg/cm2.





Name of the Model	**Model – 007**

Analysis Options in CAEPIPE

1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Do not include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (Kg)

CAEPIPE	1566.4
PIPESTRESS	1566.487

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0	-7681	0.0	0	0	-182
PIPESTRESS	10	0	-7681	0.0	0	0	-182
CAEPIPE	40	0	-7681	0.0	0	0	182
PIPESTRESS	40	0	-7681	0.0	0	0	182

Operating Case

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-22200	-7681	0	0	0	-182
PIPESTRESS	10	-22201	-7681	0	0	0	-182
CAEPIPE	40	22200	-7681	0	0	0	182
PIPESTRESS	40	22201	-7681	0	0	0	182

Frequencies (in Hz)

Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	15.458	15.458	15.458
2	15.458	15.458	15.458
3	17.789	17.789	17.789

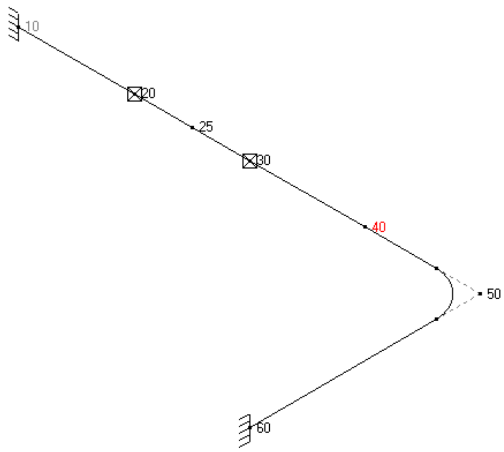
About Model-011

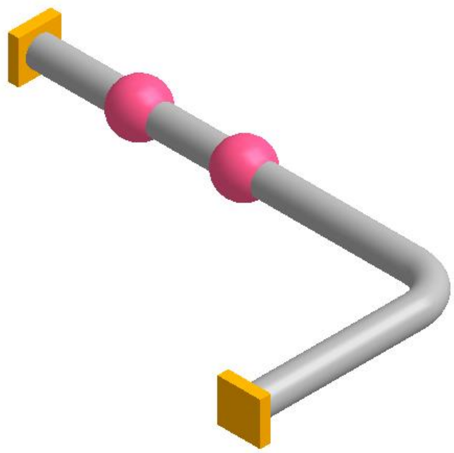
This model shown below is the same as Model-007 above with the following modifications.

a. Long radius bend at node 50.

b. Straight pipe of 2m length and

c. Flexible anchor at node 60 with stiffnesses kx=ky=kz=1000 kg/mm and kxx=kyy=kzz=1000 kg-m/deg.





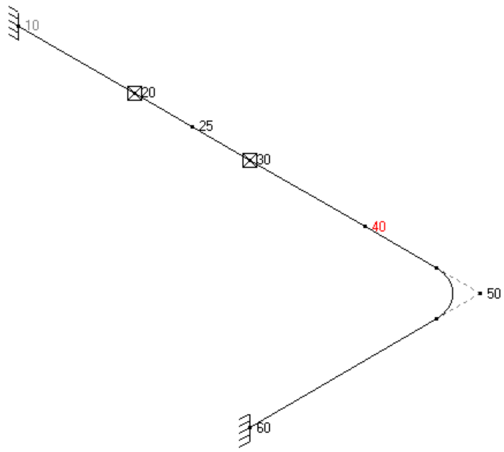
Name of the Model			Model – 011				
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	2101.9						
PIPESTRESS	2102.095						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0	-11624	0	-6565	0	-4129
PIPESTRESS	10	0	-11625	0	-6566	0	-4130
CAEPIPE	60	0	-8989	0	-7690	0	-3021
PIPESTRESS	60	0	-8989	0	-7691	0	-3021
Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-8495	-11624	-4052	-6565	597	-4129
PIPESTRESS	10	-8495	-11625	-4052	-6566	597	-4130
CAEPIPE	60	8495	-8989	4052	-7690	-1381	-3021
PIPESTRESS	60	8495	-8989	4052	-7691	-1381	-3021

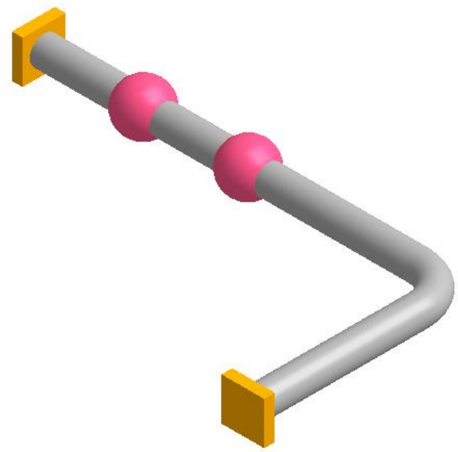
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	3.79	3.790	3.790
2	11.819	11.819	11.819
3	13.073	13.072	13.072
4	19.189	19.189	19.189
5	25.437	25.436	25.436

About Model-012

This model shown below is the same as Model-011 above with the following modification.

a. Flexible anchor at node 60 is replaced by rigid anchor.





Name of the Model			**Model – 012**				
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^0c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	2101.9						
PIPESTRESS	2102.095						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	0.0	-9250	0.0	-465	0.0	-355
PIPESTRESS	10	0.0	-9250	0.0	-465	0.0	-355
CAEPIPE	60	0.0	-11363	0.	-18539	0.0	2703
PIPESTRESS	60	0.	-11364	0.0	-18541	0.0	2704
Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-33372	-9250	-4486	-465	677	-355
PIPESTRESS	10	-33375	-9250	-4486	-465	677	-355
CAEPIPE	60	33372	-11363	4486	-18539	-49478	2703
PIPESTRESS	60	33375	-11364	4486	-18541	-49485	2704

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	12.556	12.556	12.556
2	14.430	14.429	14.429
3	18.485	18.485	18.485
4	29.96	29.958	29.958

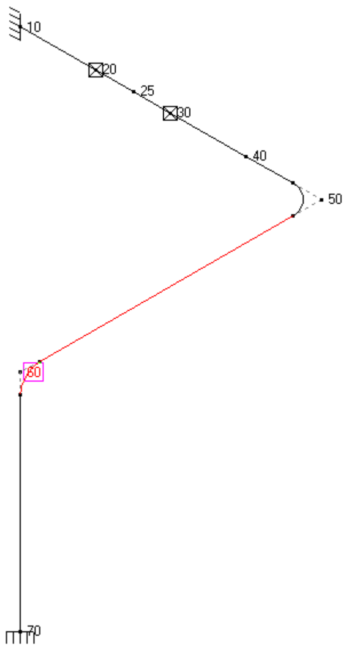
About Model-013

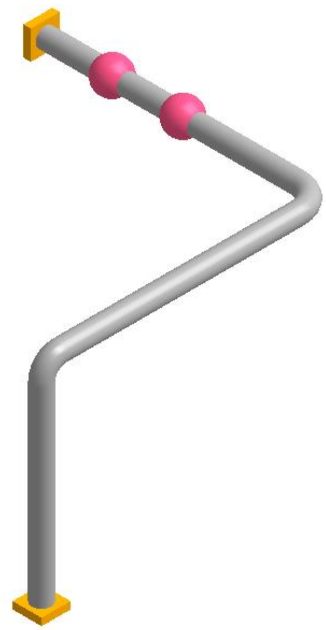
This model shown below is the same as Model-012 above with the following modification.

a. Short radius bend at node 60.

b. Vertically downward pipe of length 3m and

c. Rigid anchor at node 70.





Name of the Model		Model – 013					
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	3025.4						
PIPESTRESS	3025.655						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	100	-13702	-842	-3437	737	-4236
PIPESTRESS	10	100	-13702	-842	-3437	737	-4236
CAEPIPE	70	-100	-15967	842	-21673	3029	-10924
PIPESTRESS	70	-100	-15969	842	-21675	3029	-10925

Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-4320	-12721	-4110	-3736	1662	-3783
PIPESTRESS	10	-4320	-12721	-4110	-3736	1662	-3784
CAEPIPE	70	4320	-16948	4110	-15494	-2503	-20711
PIPESTRESS	70	4320	-16950	4110	-15496	-2503	-20712

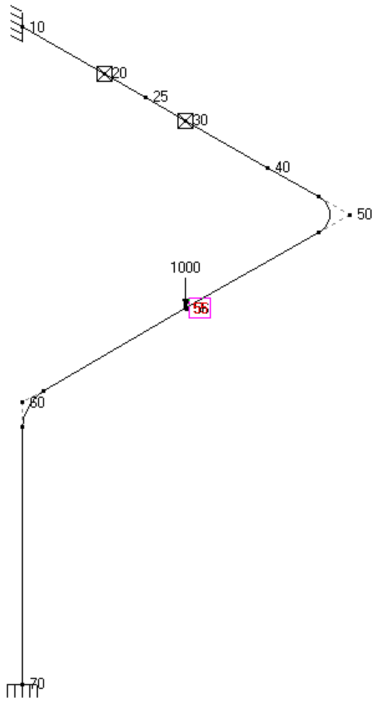
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	3.489	3.488	3.638
2	8.133	8.133	8.352
3	10.827	10.827	10.907
4	12.38	12.379	13.988
5	18.177	18.176	18.856

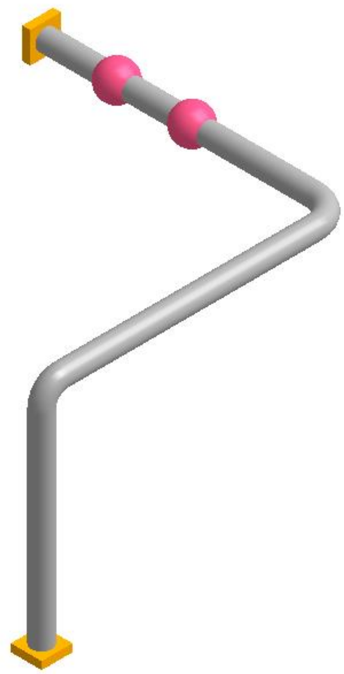
About Model-014

This model shown below is the same as Model-013 above with the following modifications.

a. Welding tee at node 55 and

b. Force of 100kg in vertical direction at node 55.





Name of the Model		Model – 014					
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	3025.6						
PIPESTRESS	3025.843						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	159	-15460	-1231	-4684	1082	-5904
PIPESTRESS	10	159	-15461	-1231	-4685	1082	-5905
CAEPIPE	70	-159	-24017	1231	-31842	4477	-16111
PIPESTRESS	70	-159	-24019	1231	-31844	4477	-16112

Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-4260	-14479	-4499	-4983	2007	-5452
PIPESTRESS	10	-4260	-14480	-4499	-4983	2007	-5452
CAEPIPE	70	4260	-24998	4499	-25663	-1054	-25898
PIPESTRESS	70	4260	-25000	4499	-25665	-1054	-25899

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	3.628	3.629	3.638
2	8.172	8.171	8.352
3	10.767	10.767	10.906
4	13.196	13.196	13.998
5	18.395	18.394	18.850

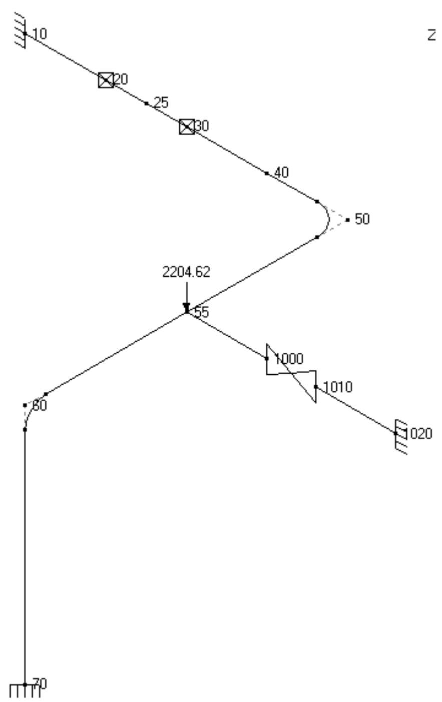
About Model-015

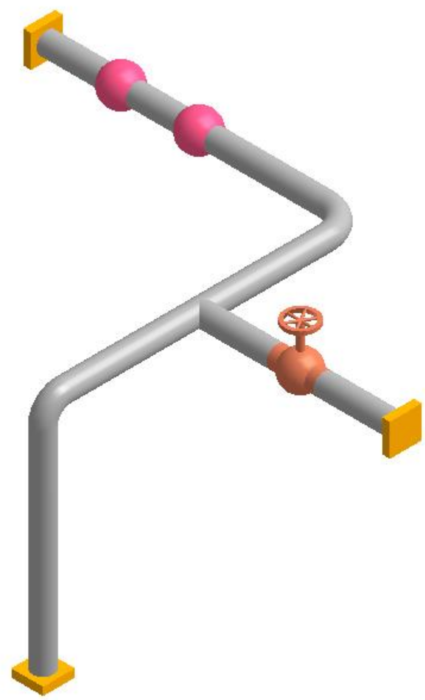
This model shown below is the same as Model-014 above with the following modifications.

a. Two horizontal pipes of length 1m and force of 9806.65 N (Downward).

b. Valve between two pipes with 100 kg weight and 600mm length.

c. Welding Tee at Node 55.





Name of the Model	Model – 015
Analysis Options in CAEPIPE	
1	Code – B 31.3
2	Reference Temperature = 20^0c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Do not include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (Kg)	
CAEPIPE	3580
PIPESTRESS	3580.329

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	1227	-12108	-167	-886	69	-1258
PIPESTRESS	10	1273	-12102	-164	-865	67	-1236
CAEPIPE	70	1384	-10957	2933	1171	-1442	398
PIPESTRESS	70	1438	-11017	2882	1163	-1490	397
CAEPIPE	1020	-2611	-21849	-2766	-12288	-5465	37360
PIPESTRESS	1020	-2711	-21547	-2718	-12587	-5320	36435

Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-39489	-12206	-7806	-1545	1250	-1457
PIPESTRESS	10	-39815	-12137	-7827	-1528	1260	-1434
CAEPIPE	70	-17211	-23858	11456	13258	515	42207
PIPESTRESS	70	-17120	-24088	11176	12681	590	41913
CAEPIPE	1020	56699	-8851	-3649	-23753	-24584	17346
PIPESTRESS	1020	56935	-8441	-3349	-24630	-24638	16578

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	8.030	8.079	8.082
2	11.139	11.154	11.289
3	16.276	16.635	16.692
4	19.010	19.076	19.594
5	21.909	22.030	22.047

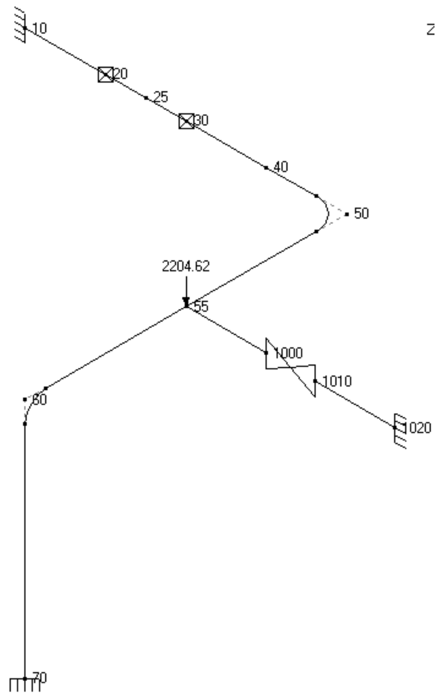
Note:

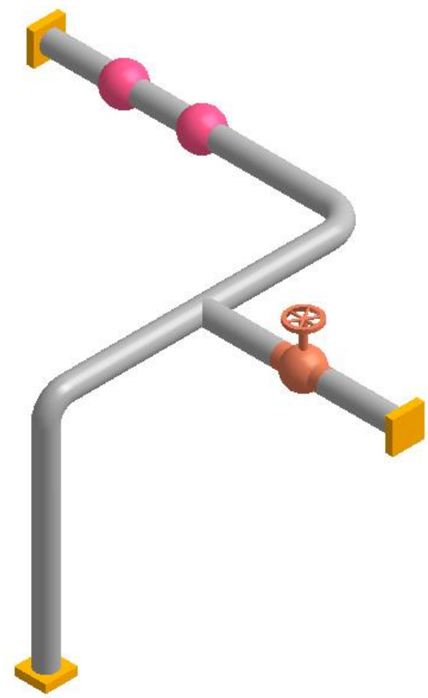
The difference in the support loads for this model is mainly due to the conceptual change in tee joint modeling between CAEPIPE and PIPESTRESS. i.e., PIPESTRESS models an “imaginary” element connecting the center line of the header pipe to the surface of the run pipe with zero flexibility when a welding tee is defined in the model. On the other hand, CAEPIPE do not create such imaginary element and includes the same as a part of branch pipe.

To confirm the above statement, another model had been created by removing the welding tee at node 55. The results thus obtained were compared against PIPESTRESS and are listed in the next model for reference.

About Model-015_a

This model shown below is the same as Model-015 without welding tee at Node 55.





Name of the Model	Model – 015_a
Analysis Options in CAEPIPE	
1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Do not include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (Kg)	
CAEPIPE	3580
PIPESTRESS	3580.329

Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	1227	-12108	-167	-886	69	-1258
PIPESTRESS	10	1238	-12125	-168	-889	69	-1262
CAEPIPE	70	1384	-10957	2933	1171	-1442	398
PIPESTRESS	70	1393	-10931	2938	1166	-1452	403
CAEPIPE	1020	-2611	-21849	-2766	-12288	-5465	37360
PIPESTRESS	1020	-2630	-21862	-2770	-12179	-5459	37299

Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-39489	-12206	-7806	-1545	1250	-1457
PIPESTRESS	10	-39428	-12230	-7810	-1550	1252	-1464
CAEPIPE	70	-17211	-23858	11456	13258	515	42207
PIPESTRESS	70	-17226	-23769	11438	13201	494	42273
CAEPIPE	1020	56699	-8851	-3649	-23753	-24584	17346
PIPESTRESS	1020	56653	-8919	-3628	-23521	-24343	17419

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	8.030	8.018	8.080
2	11.139	11.135	11.271
3	16.276	16.275	16.350
4	19.010	19.017	19.508
5	21.909	21.912	21.928

About Model-017

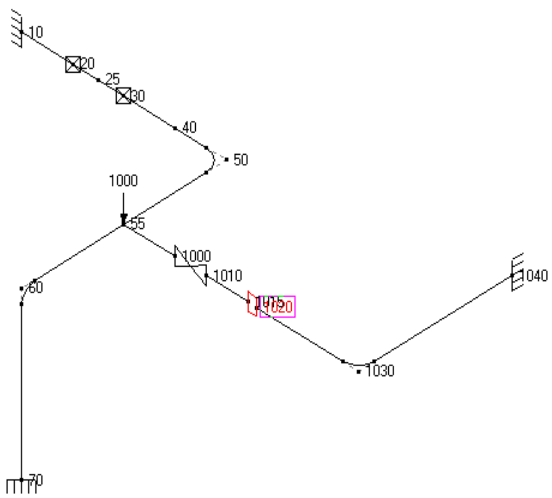
This model shown below is the same as Model-015 above with the following modifications.

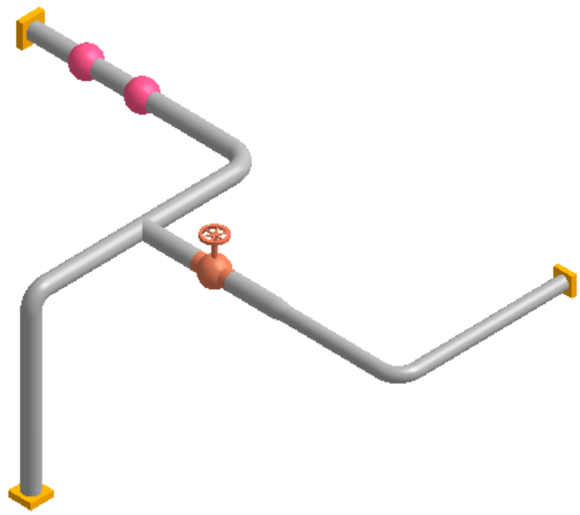
a. Long radius bend at node 1030.

b. Reducer of length 128 mm between nodes 1015 and 1020.

c. Horizontal pipe of length 3m in negative z direction and

d. Rigid anchor at node 1040.





Name of the Model		Model – 017					
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	4227.40						
PIPESTRESS	4228.101						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	132	-15540	-1301	-2328	545	-3432
PIPESTRESS	10	126	-15542	-1302	-2335	547	-3440
CAEPIPE	70	-1564	-23045	3815	-11302	-474	4093
PIPESTRESS	70	-1572	-23055	3818	-11344	-459	4062
CAEPIPE	1040	1432	-12679	-2514	19075	1256	5799
PIPESTRESS	1040	1446	-12673	-2516	19099	1278	5817

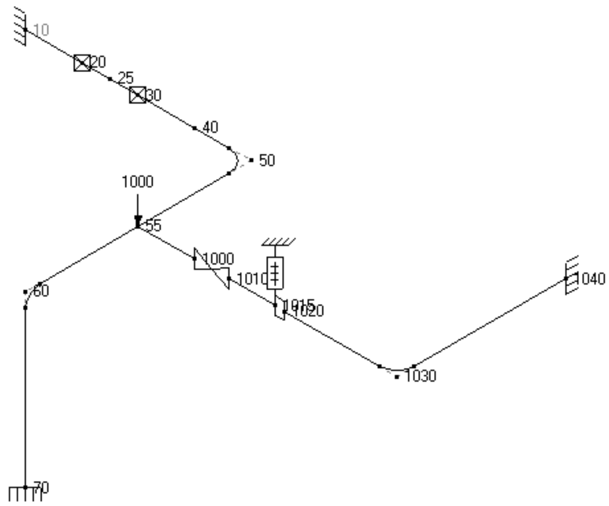
Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-11731	-14518	-5483	-2676	1351	-3004
PIPESTRESS	10	-11725	-14521	-5483	-2683	1352	-3011
CAEPIPE	70	-5699	-25797	12178	6067	-4176	13582
PIPESTRESS	70	-5710	-25805	12184	6041	-4166	13569
CAEPIPE	1040	17430	-10949	-6695	14405	34186	4415
PIPESTRESS	1040	17435	-10944	-6701	14432	34197	4427

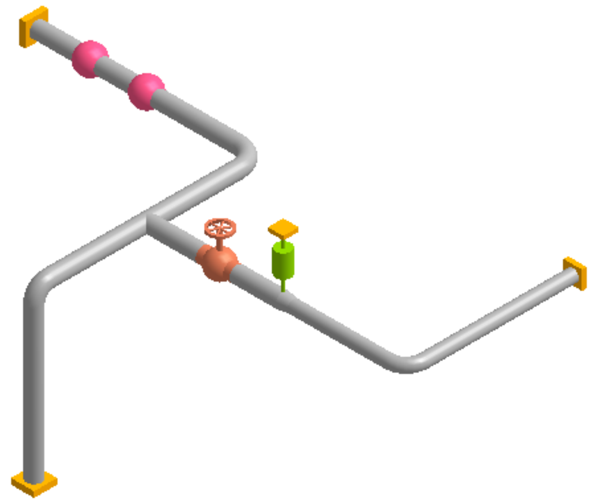
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	4.857	4.851	4.862
2	7.941	7.937	8.082
3	9.659	9.658	9.911
4	10.692	10.693	11.264
5	14.637	14.613	15.051

About Model-018

This model shown below is the same as Model-017 above with the following modification.

a. Hanger at node 1015.





Name of the Model				**Model – 018**			
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
CAEPIPE	**Hanger Report**						
Node	Spring Rate	Hot Load					
1015	19.287	2430					
Refer Appendix D for details							
Total Weight (Kg)							
CAEPIPE	4227.4						
PIPESTRESS	4228.101						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-847	-14942	-1015	-1470	340	-2319
PIPESTRESS	10	-891	-14908	-1000	-1411	327	-2247
CAEPIPE	70	869	-11859	1699	-7354	-1987	3970
PIPESTRESS	70	1004	-11349	1590	-7077	-2093	4030
CAEPIPE	1040	-21	-629	-684	-7056	-935	2197
PIPESTRESS	1040	-113	-405	-683	-7435	-1085	2037

Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-12710	-13920	-5197	-1819	1146	-1890
PIPESTRESS	10	-12655	-13893	-5186	-1785	1136	-1848
CAEPIPE	70	-3266	-14611	10061	10015	-5689	13458
PIPESTRESS	70	-3272	-14388	10072	10329	-5754	13666
CAEPIPE	1040	15976	1101	-4860	-11727	31995	813
PIPESTRESS	1040	15926	1089	-4885	-11613	31903	732

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	4.857	4.9	4.912
2	7.941	7.94	8.084
3	9.659	9.699	9.935
4	10.692	10.832	11.441
5	14.637	14.613	15.053

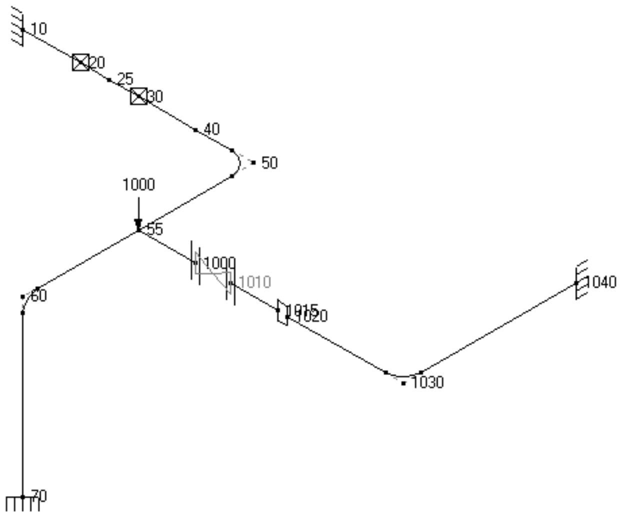
Note : The value of spring constant and cold load for the hanger at node 1015 have been taken from CAEPIPE results are inserted manually in PIPESTRESS input file.

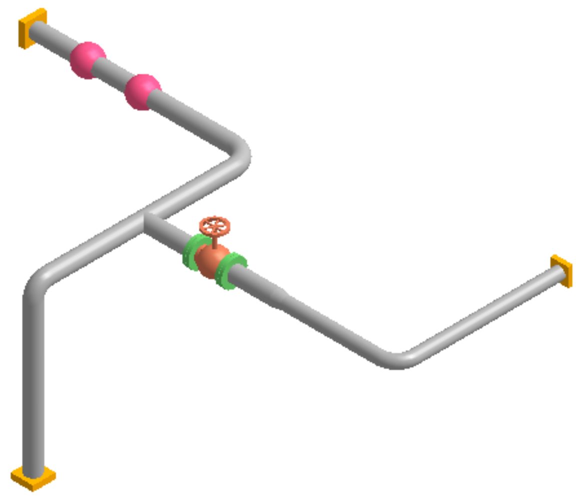
About Model-019

This model shown below is the same as Model-018 above with the following modifications.

a. Two flanges on both sides of the valve with weight 495.32 kg each and

b. Hanger removed from node 1015.





Name of the Model		Model – 019					
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	5218.1						
PIPESTRESS	5218.741						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	372	-16429	-1535	-2733	663	-4054
PIPESTRESS	10	365	-16431	-1536	-2743	665	-4065
CAEPIPE	70	-2323	-28513	4793	-13669	-191	4652
PIPESTRESS	70	-2334	-28528	4798	-13723	-169	4610
CAEPIPE	1040	1950	-16036	-3258	25694	1919	7393
PIPESTRESS	1040	1968	-16026	-3262	25716	1949	7421

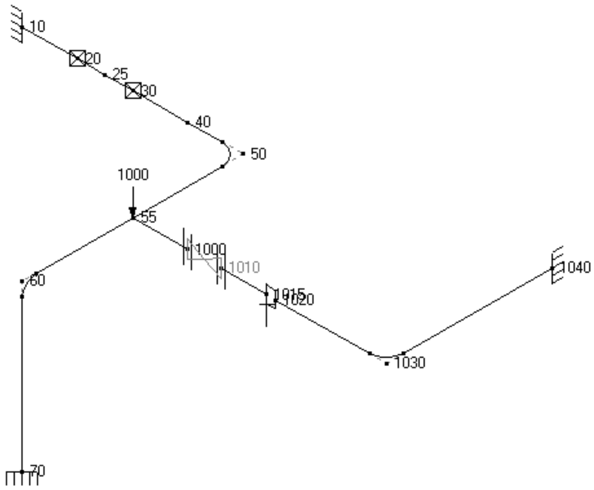
Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-11491	-15407	-5717	-3082	1468	-3625
PIPESTRESS	10	-11486	-15410	-5717	-3091	1470	-3635
CAEPIPE	70	-6457	-31265	13155	3700	-3893	14140
PIPESTRESS	70	-6472	-31278	13164	3662	-3876	14117
CAEPIPE	1040	17947	-14306	-7438	21023	34849	6008
PIPESTRESS	1040	17958	-14298	-7446	21049	34869	6031

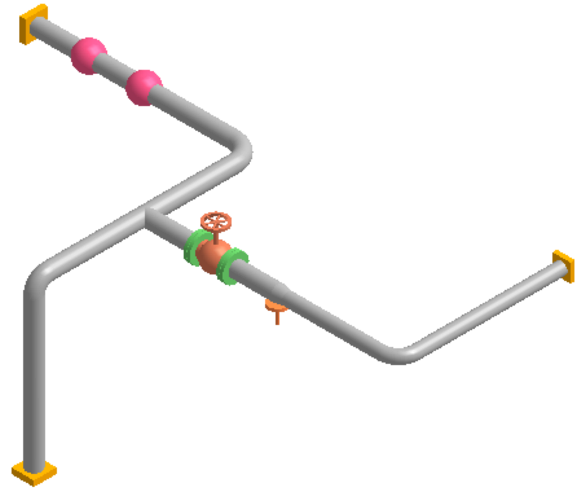
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	4.403	4.395	4.406
2	6.978	6.972	7.067
3	8.342	8.339	8.500
4	9.626	9.627	9.975
5	13.51	13.487	13.682

About Model-020

This model shown below is the same as Model-019 above with the following modification.

a. Limit stop at node 1015 without friction coefficient.





Name of the Model			Model – 020				
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						

Total Weight (Kg)	
CAEPIPE	5218.1
PIPESTRESS	5218.741

Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-925	-15637	-1156	-1597	391	-2578
PIPESTRESS	10	-928	-15639	-1156	-1599	391	-2581
CAEPIPE	70	902	-13689	1988	-8436	-2195	4488
PIPESTRESS	70	900	-13697	1989	-8451	-2191	4480
CAEPIPE	1040	23	-67	-832	-8936	-986	2619
PIPESTRESS	1040	27	-67	833	8928	-979	-2612

Operating Case							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-12440	-14828	-5439	-2251	1269	-2546
PIPESTRESS	10	-12433	-14830	-5439	-2253	1270	-2549
CAEPIPE	70	-4099	-20424	11104	7527	-5359	14021
PIPESTRESS	70	-4104	-20419	11107	7522	-5356	14021
CAEPIPE	1040	16538	-2627	-5664	-4303	32725	2517
PIPESTRESS	1040	16536	-2612	-5668	-4317	32714	2510

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	5.39	5.388	5.422
2	7.127	7.121	7.201
3	8.532	8.530	8.667
4	13.488	13.465	13.654
5	17.186	17.148	17.829

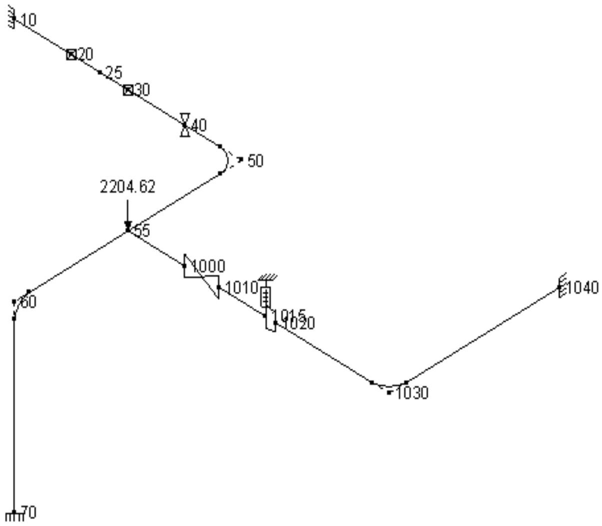
Note: For the limit stop to behave properly (i.e. Non-linear behavior), the user has to define ‘NCAS’ cards separately. CPTOPS does not define ‘NCAS’ card.

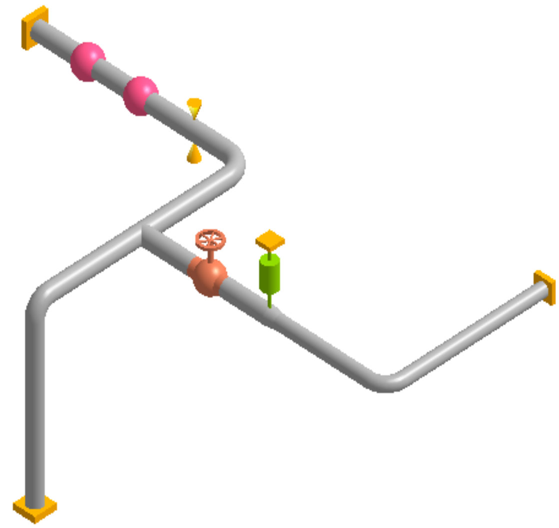
About Model-021

This model shown below is the same as Model-020 above with the following modification.

a. User hanger at node 1015 with spring rate = 19.287 kg/mm and hot load = 2430 and

b. Flexible limit stop with stiffness=1000kg/mm in vertical direction at node 40 and without friction coefficient.





Name of the Model	Model – 021
Analysis Options in CAEPIPE	

1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Do not include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (Kg)	
CAEPIPE	4227.4
PIPESTRESS	4228.101

Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	10	-724	-7365	-253	306	39	-35
PIPESTRESS	10	-786	-7499	-258	303	38	-37
CAEPIPE	70	1344	-8608	-266	-1050	-1368	1409
PIPESTRESS	70	1451	-8272	-330	-1075	-1435	1398
CAEPIPE	1040	-620	3291	519	-11934	-1267	-1436
PIPESTRESS	1040	-665	3408	587	-12178	-1340	-1490

Operating Case							
	Node	Fx (N)	Fy (N)	Fz (lb)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	10	-12611	-7793	-4581	-383	902	-43
PIPESTRESS	10	-12573	-7858	-4581	-386	899	-44
CAEPIPE	70	-2882	-11982	8473	15112	-5188	11388
PIPESTRESS	70	-2897	-11835	8499	15232	-5224	11522
CAEPIPE	1040	15493	4271	-3892	-15671	31727	-2125
PIPESTRESS	1040	15471	4244	-3918	-15584	31684	-2155

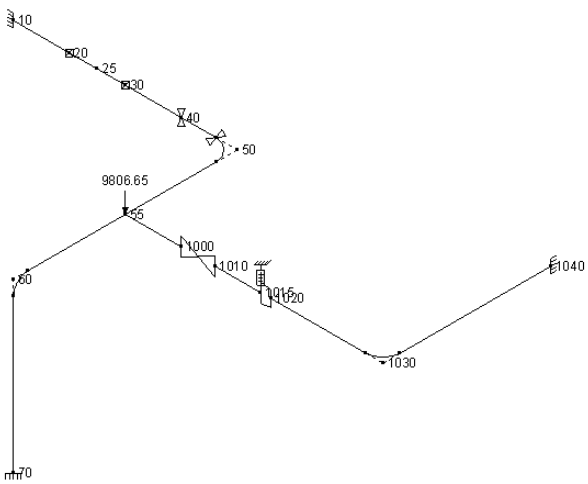
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	7.625	7.623	7.777
2	9.599	9.658	9.910
3	10.574	10.718	11.287
4	14.637	14.613	15.053
5	18.212	18.210	18.608

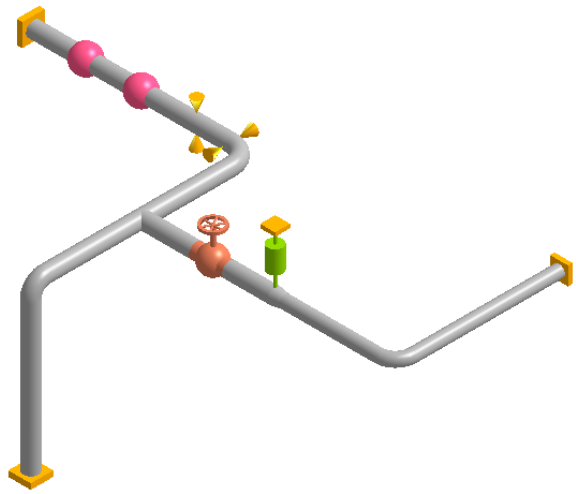
Note: The user has to read the cold load for the hanger from the CAEPIPE result files and input that value fin the ‘FO’ field for the ‘VSUP’ card in the PIPESTRESS input files.

About Model-023a

This model shown below is the same as Model-022a above with the following modification.

a. Restraint in +Z direction at node 50.





Name of the Model			Model – 023a				
Analysis Options in CAEPIPE							
1	Code – B 31.3						
2	Reference Temperature = 20^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Do not include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	4227.4						
PIPESTRESS	4228.101						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	10	-205	-5431	83	322	-3	3
PIPESTRESS	10	-221	-5495	77	318	-3	2
CAEPIPE	70	281	-14568	1888	1946	-236	86
PIPESTRESS	70	312	-14341	1828	1887	-261	100
CAEPIPE	1040	-76	-2699	80	2161	-146	-420
PIPESTRESS	1040	-91	-2620	98	1979	-173	-445
Operating Case							
	Node	Fx (N)	Fy (N)	Fz N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	10	-13276	-6374	-1167	-580	47	-15
PIPESTRESS	10	-13331	-6391	-1159	-585	47	-16
CAEPIPE	70	-1172	-21057	27499	56663	-3637	3196
PIPESTRESS	70	-1100	-20921	27460	56616	-3625	3014

CAEPIPE	1040	14448	-1660	-1117	-1814	31865	-1305
PIPESTRESS	1040	14431	-1652	-1044	-1838	31868	-1317

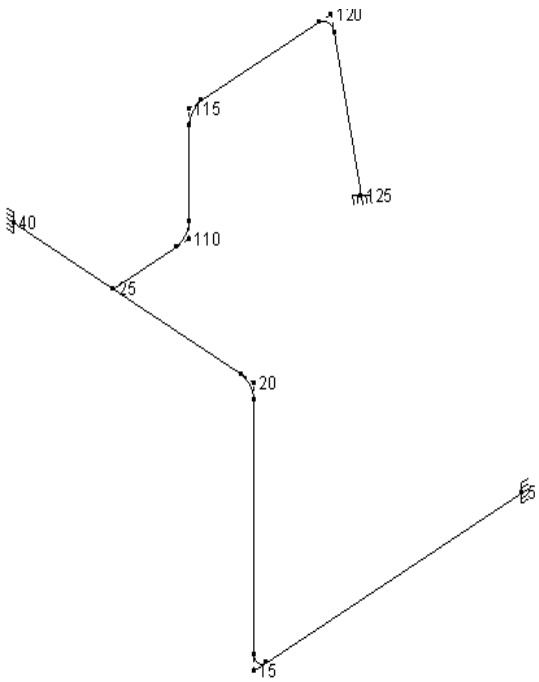
Frequencies (in Hz)

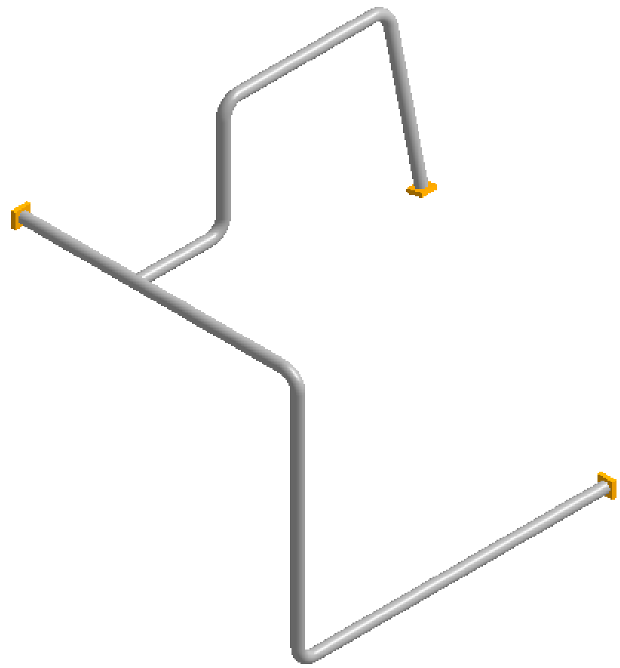
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	9.589	9.613	9.874
2	10.536	10.596	11.145
3	14.535	14.516	14.876
4	17.298	17.289	17.636
5	18.623	18.611	18.796

Note: The user has to read the cold load for the hanger from the CAEPIPE result files and input that value fin the ‘FO’ field for the ‘VSUP’ card in the PIPESTRESS input files.

About Model-025

The model contains static seismic load in X, Y and Z-direction.





Name of the Model	**Model – 025**
Analysis Options in CAEPIPE	
1	Code – B 31.1
2	Reference Temperature = 21.11^{0}c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (Kg)	
CAEPIPE	3857.8
PIPESTRESS	3858.772

Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	5	-1510	-11395	-1507	44747	-11150	-1394
PIPESTRESS	5	-1510	-11398	-1508	-44758	-11152	1394
CAEPIPE	40	67	-17330	1124	-2644	-4982	-57026
PIPESTRESS	40	67	17335	1125	2645	4983	57040
CAEPIPE	125	1442	-9106	383	7789	3986	-1851
PIPESTRESS	125	1443	-9109	383	7791	3987	-1851

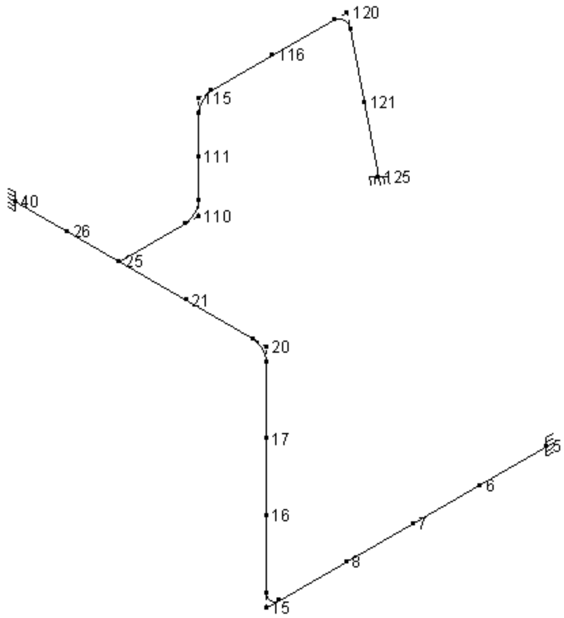
Static Seismic Case							
	Node	Fx (N)	Fy (N)	Fz N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	5	9777	5832	14328	22863	38304	5721
PIPESTRESS	5	9780	5834	14331	22869	38314	5723
CAEPIPE	40	20502	8944	12933	2084	36755	29495
PIPESTRESS	40	20507	8947	12936	2085	36765	29503
CAEPIPE	125	7881	4713	10616	25651	9585	20666
PIPESTRESS	125	7883	4715	10618	25657	9587	20671

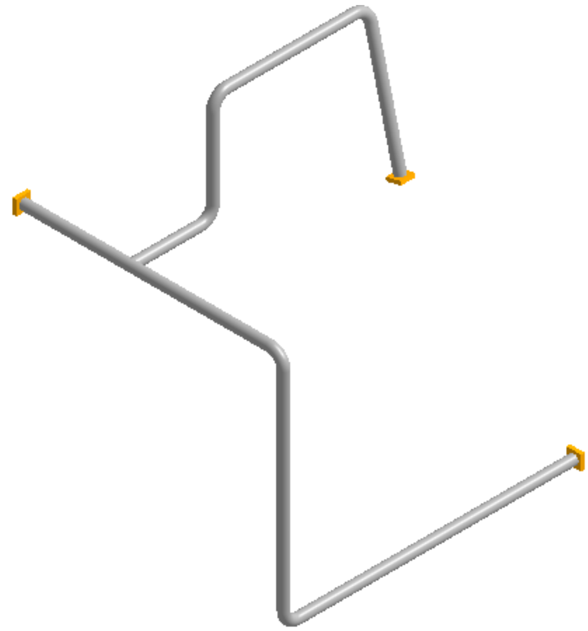
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	1.991	1.99	2.267
2	2.689	2.688	3.166
3	3.378	3.377	3.726
4	5.424	5.423	5.663
5	7.156	7.155	7.414
6	7.697	7.696	8.099
7	9.611	9.61	11.662
8	13.763	13.762	13.306
9	18.944	18.942	13.901
10	19.132	19.129	15.261
11	--	--	17.937
12	--	--	20.206
13	--	--	20.607
14	--	--	21.482

Note: The user can see that when the automatic mass modeling is turned on (‘MP=33’ in ‘FREQ’ card), not only natural frequencies are different but also numbers of modes are different. To get identical results in CAEPIPE the user can create additional nodes in the CAEPIPE model. The next model (Model-026) is created with additional nodes (as created internally by PIPESTRESS). The information about the additional nodes can be found in the *.prd file, after running the *.fre file.

About Model-026

The model is same as Model-025, except for the additional nodes created.





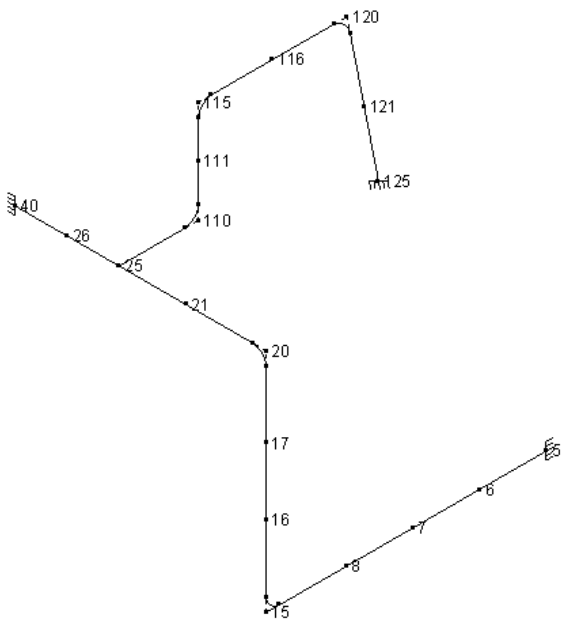
Name of the Model			**Model – 026**				
Analysis Options in CAEPIPE							
1	Code – B 31.1						
2	Reference Temperature = 21.11^{0}c						
3	Do not include bourdon effect						
4	Do not use pressure correction for bends						
5	Include missing mass correction						
6	Do not use friction in dynamic analysis						
7	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	3857.8						
PIPESTRESS	3858.772						
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	5	-1510	-11395	-1507	44747	-11150	-1394
PIPESTRESS	5	-1510	-11398	-1508	-44758	-11152	1394
CAEPIPE	40	67	-17330	1124	-2644	-4982	-57026
PIPESTRESS	40	67	17335	1125	2645	4983	57040
CAEPIPE	125	1442	-9106	383	7789	3986	-1851
PIPESTRESS	125	1443	-9109	383	7791	3987	-1851

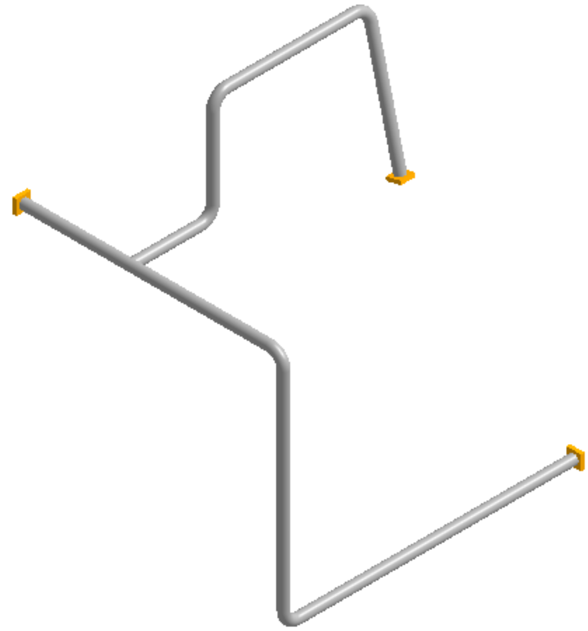
Static Seismic Case							
	Node	Fx (N)	Fy (N)	Fz N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	5	9777	5832	14328	22863	38304	5721
PIPESTRESS	5	9780	5834	14331	22869	38314	5723
CAEPIPE	40	20502	8944	12933	2084	36755	29495
PIPESTRESS	40	20507	8947	12936	2085	36765	29503
CAEPIPE	125	7881	4713	10616	25651	9585	20666
PIPESTRESS	125	7883	4715	10618	25657	9587	20671

Frequencies (in Hz)		
Mode Number	CAEPIPE	PIPESTRESS (MP=33)
1	2.268	2.267
2	3.166	3.166
3	3.727	3.726
4	5.664	5.663
5	7.415	7.414
6	8.100	8.099
7	11.663	11.662
8	13.308	13.306
9	13.903	13.901
10	15.263	15.261
11	17.939	17.937
12	20.209	20.206
13	20.610	20.607
14	21.484	21.482

About Model-027

The model is same as Model-026, spectrums are defined and applied.





Name of the Model	**Model – 027**
Analysis Options in CAEPIPE	

1	Code – B 31.1
2	Reference Temperature = 21.11^{0}c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

Total Weight (N)	
CAEPIPE	3857.8
PIPESTRESS	3858.772

Support Load (Sustained)

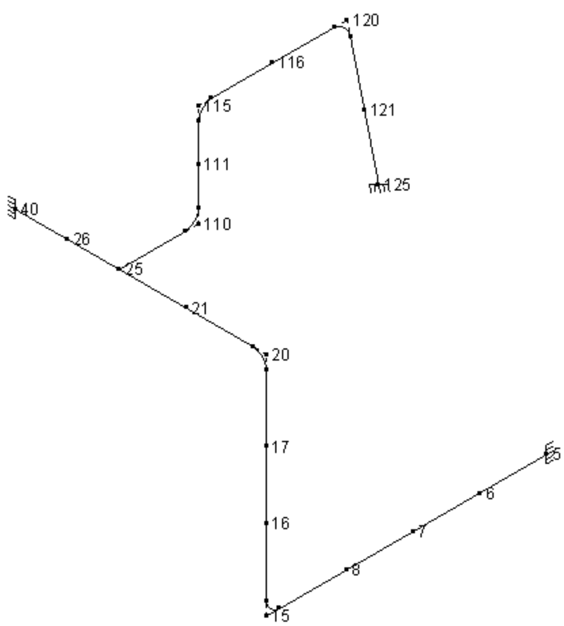
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	5	-1510	-11395	-1507	44747	-11150	-1394
PIPESTRESS	5	-1510	-11398	-1508	-44758	-11152	1394
CAEPIPE	40	67	-17330	1124	-2644	-4982	-57026
PIPESTRESS	40	67	17335	1125	2645	4983	57040
CAEPIPE	125	1442	-9106	383	7789	3986	-1851
PIPESTRESS	125	1443	-9109	383	7791	3987	-1851

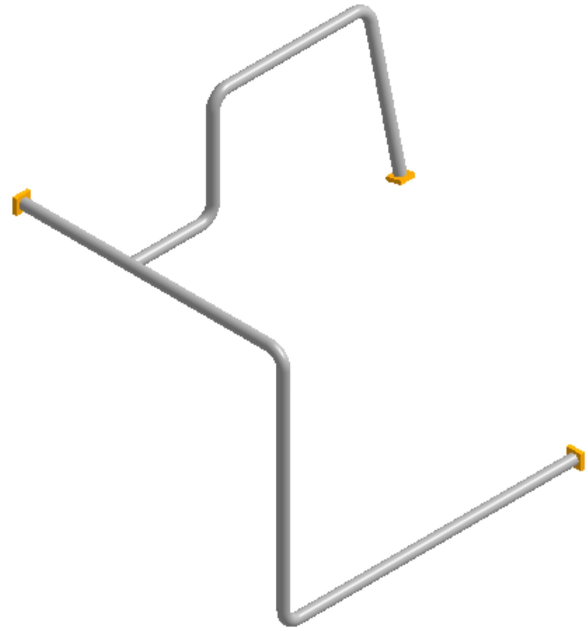
Response Case							
	Node	Fx (N)	Fy (N)	Fz N)	Mx (N-mm)	My (N-mm)	Mz (N-mm)
CAEPIPE	5	5299	4630	4038	22015	28395	5004
PIPESTRESS	5	5295	4612	3822	22018	28399	5005
CAEPIPE	40	5367	6934	5680	3514	23764	26378
PIPESTRESS	40	5205	6926	5678	3515	23769	26382
CAEPIPE	125	4508	2363	4517	13035	6280	15729
PIPESTRESS	125	4496	2001	4511	13037	6281	15734

Frequencies (in Hz)		
Mode Number	CAEPIPE	PIPESTRESS (MP=33)
1	2.268	2.267
2	3.166	3.166
3	3.727	3.726
4	5.664	5.663
5	7.415	7.414
6	8.100	8.099
7	11.663	11.662
8	13.308	13.306
9	13.903	13.901
10	15.263	15.261
11	17.939	17.937
12	20.209	20.206
13	20.610	20.607
14	21.484	21.482

About Model-028

The model is same as Model-026, spectrums are defined and applied.





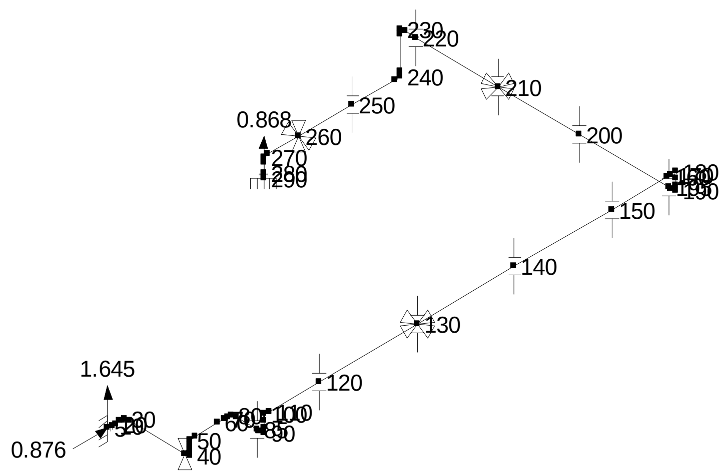
Name of the Model	**Model – 027**
Analysis Options in CAEPIPE	
1	Code – B 31.1
2	Reference Temperature = 21.11^{0}c
3	Do not include bourdon effect
4	Do not use pressure correction for bends
5	Include missing mass correction
6	Do not use friction in dynamic analysis
7	Y – Vertical

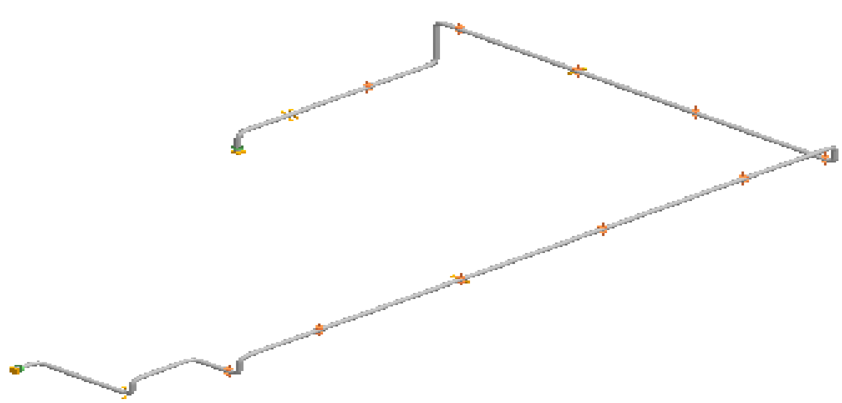
Total Weight (N)	
CAEPIPE	3857.8
PIPESTRESS	3858.772

6.3 Live Project Models

About Model- 7509002_D69

This model is an 8” nominal diameter carbon steel (A106 Grade B) insulated 150 lb class piping system between LP Amine Absorber and LP Amine Absorber KO Drum in a Oil Refinery Expansion Project. Operating temperature is 135^0 C. The model consists of straight pipes and elbows. The piping system is of welded construction with 12 limit stops and 3 lateral restraints. Cases considered are sustained, operating and seismic. Cut-off frequency is 33Hz. Friction at supports is considered in dynamic analysis. Piping code used is ASME B31.3.





Name of the Model	Model – 7509002_D69

Analysis Options in CAEPIPE

1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

Total Weight (Kg)

CAEPIPE	4463.5
PIPESTRESS	4464.724

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	5	13	-2389	38	-2080	-228	-133
PIPESTRESS	5	13	-2390	38	-2080	-228	-133
CAEPIPE	290	-114	-1588	-15	-82	-15	217
PIPESTRESS	290	- 114	- 1588	-15	-82	-15	217

Support Load (Operating Case)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	5	-517	-2570	1134	-1878	-2451	-780
PIPESTRESS	5	-517	-2570	1134	-1878	-2450	-780
CAEPIPE	290	1223	-4393	1010	-591	-433	-775
PIPESTRESS	290	1233	-4392	1010	-591	-433	-774

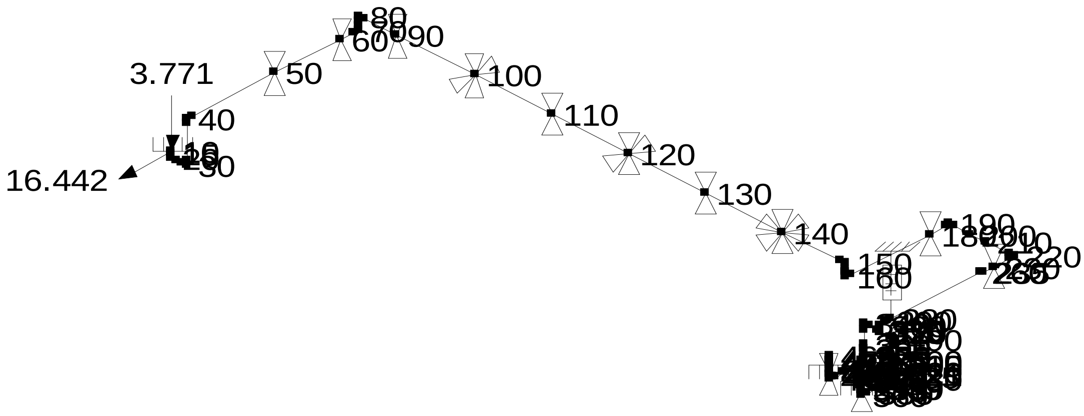
Frequencies (in Hz)

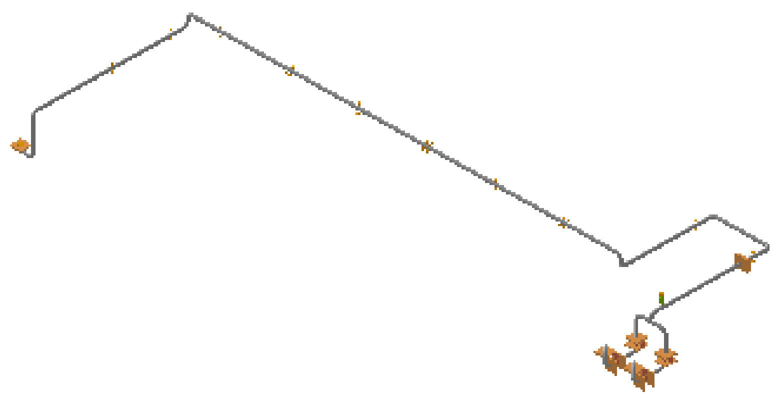
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	2.291	2.291	2.225
2	3.276	3.275	3.373
3	4.039	4.037	4.106
4	5.256	5.255	5.419
5	5.287	5.285	5.547

About Model- 7510016_D77

This model is a 10” nominal dia carbon steel (A53 Grade B) 300 lb class piping between MHC stripper Bottom Pumps and Atmospheric Distillation Feed Bottom Exchanger ina Oil Refinery Expansion Project. The model conists of straight pipes, elbows, tees and flanges. There are limit stops, lateral restraints and concentrated masses such as valves. The system is of welded construction. Cases considered for analysis are sustained, operating, and seismic. Cut-off frequency is 33 Hz. Piping code used is ASME B31.3

Diagram





Name of the Model	Model – 7510016_D77
Analysis Options in CAEPIPE	
1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Do not use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

Total Weight (Kg)	
CAEPIPE	11569
PIPESTRESS	11530.594

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-66	-7683	81	-321	263	-5742
PIPESTRESS	10	-66	-7681	80	-321	263	-5744
CAEPIPE	480	551	-3067	-132	-26	-243	-737
PIPESTRESS	480	545	-2906	-137	-23	-244	-634
CAEPIPE	630	-604	-2006	-10	-637	343	-542
PIPESTRESS	630	-599	-1847	-9	-579	340	-445

Support Load (Operating)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-2398	-9805	3538	2803	8856	-2892
PIPESTRESS	10	-2394	-9803	3535	2801	8830	-2892
CAEPIPE	480	-1068	-3345	-411	-1311	655	131
PIPESTRESS	480	-1061	-3181	-415	-1257	644	215
CAEPIPE	630	1649	-1769	801	-2367	-2397	-2525
PIPESTRESS	630	1640	-1628	801	-2295	-2383	-2412

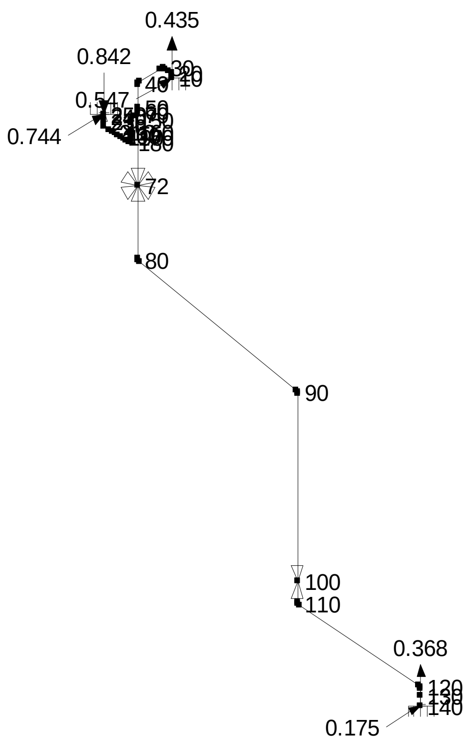
Frequencies (in Hz)

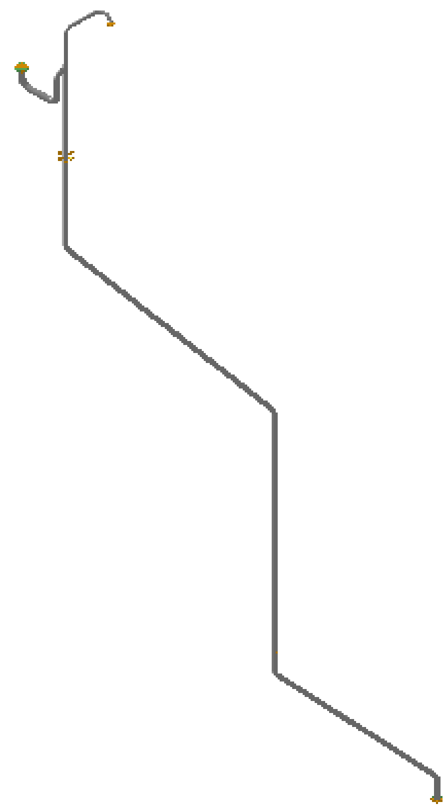
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	1.546	1.545	1.602
2	2.585	2.586	2.614
3	2.974	2.972	2.979
4	3.325	3.331	3.303
5	3.439	3.437	3.462

About Model- 7522029_D105

This model is a carbon steel (A53 Grade B) insulated 150 lb class piping system connected to a Dryer Overhead Receiver and operating at 41^0 C in a Oil Refinery Expansion Project. The model has line sizes of nominal diameter 2”, 3” and 4” and comprises of straight pipes, elbows, tees, reducers and WN flanges. The system is of welded constructions and has 2 limit stops and 1 lateral restraint. Cases considered for analysis are sustained, operating and seismic. Cut-off frequency is 33 Hz. Piping code used is ASME B31.3

Diagram





Name of the Model	Model – 7522029_D105
Analysis Options in CAEPIPE	
1	Code – B 31.3
2	Reference Temperature = 20^0c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Do not use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

Total Weight (Kg)	
CAEPIPE	309.65
PIPESTRESS	309.668

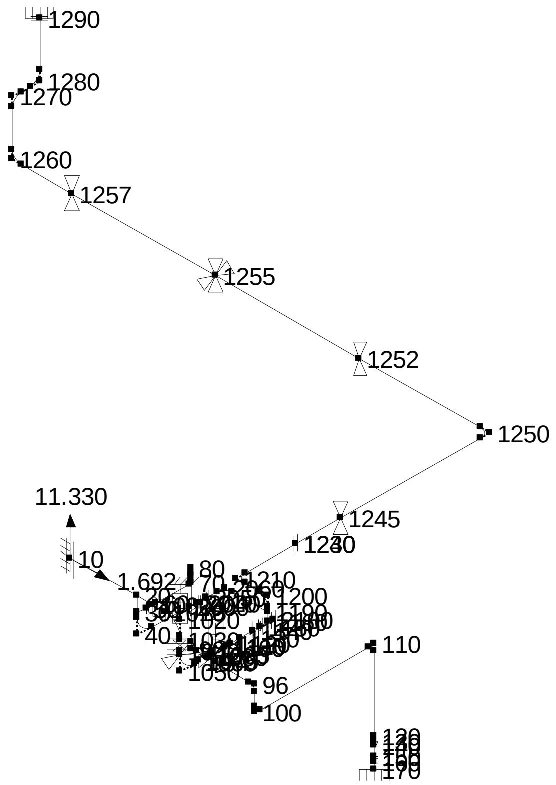
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-3	-573	6	1	1	4
PIPESTRESS	10	-3	-573	6	1	1	4
CAEPIPE	140	4	-372	-3	68	6	29
PIPESTRESS	140	4	-372	-3	68	6	29
CAEPIPE	250	42	-254	-33	8	18	1
PIPESTRESS	250	42	-254	-33	8	17	2
Support Load (Operating)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	279	1607	-1032	-845	-128	-333
PIPESTRESS	10	256	1430	-946	-776	-118	-304
CAEPIPE	140	591	-2708	-754	1299	362	-192
PIPESTRESS	140	546	-2526	-695	1204	334	-174
CAEPIPE	250	-1309	5030	1435	461	-883	2876
PIPESTRESS	250	-1241	4687	1337	412	-818	2651

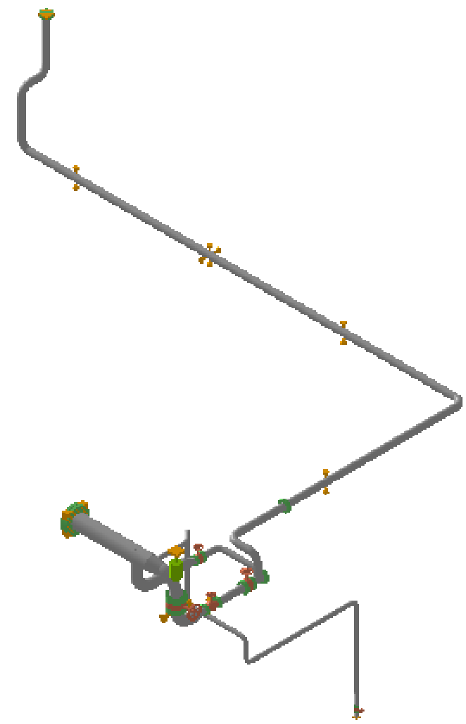
Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	1.991	1.987	2.049
2	3.662	3.653	4.538
3	6.041	6.030	5.633
4	8.686	8.664	8.850

About Model- 7521020_d54

This model is a carbon steel (A53 Grade B), 150 lb class insulated piping system connected to a Dryer and operating at 120^{0} C in an Oil Refinery Expansion Project. The model has line sizes of nominal diameter 4”, 6”, 8”, 10”, 16” and 24” and comprises of straight pipes, elbows, reducers, tees and welding neck flanges. There are concentrated masses such as valves. The system is of welded construction and has 2 spring hangers, 4 limit stops and 2 lateral restraints. Cases considered for analysis are sustained, operating, seismic and wind. Cut-off frequency is 33Hz. Friction at support is considered in dynamic analysis. Piping code used is ASME B31.3.

Diagram





Name of the Model	Model – 7521020_d54
Analysis Options in CAEPIPE	
1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Do not use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

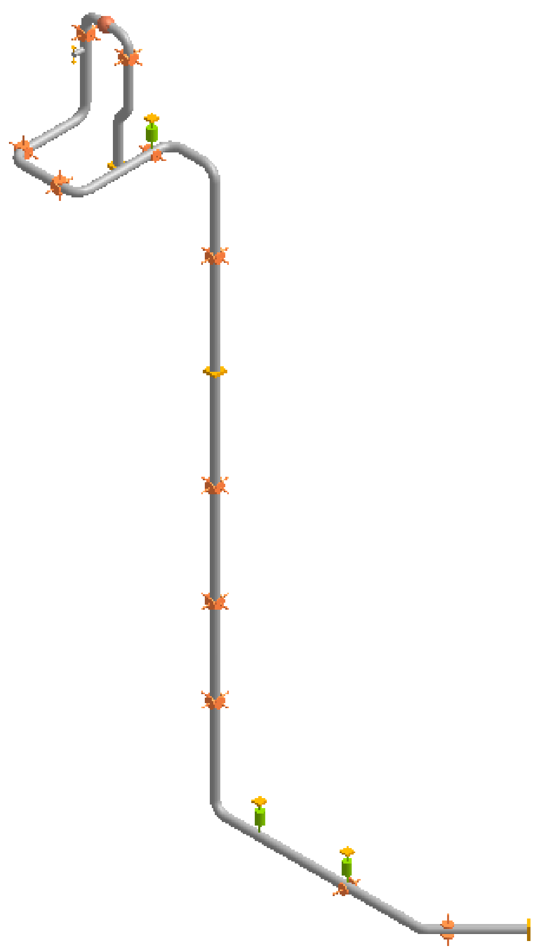
Total Weight (Kg)	
CAEPIPE	7606.7
PIPESTRESS	7615.16

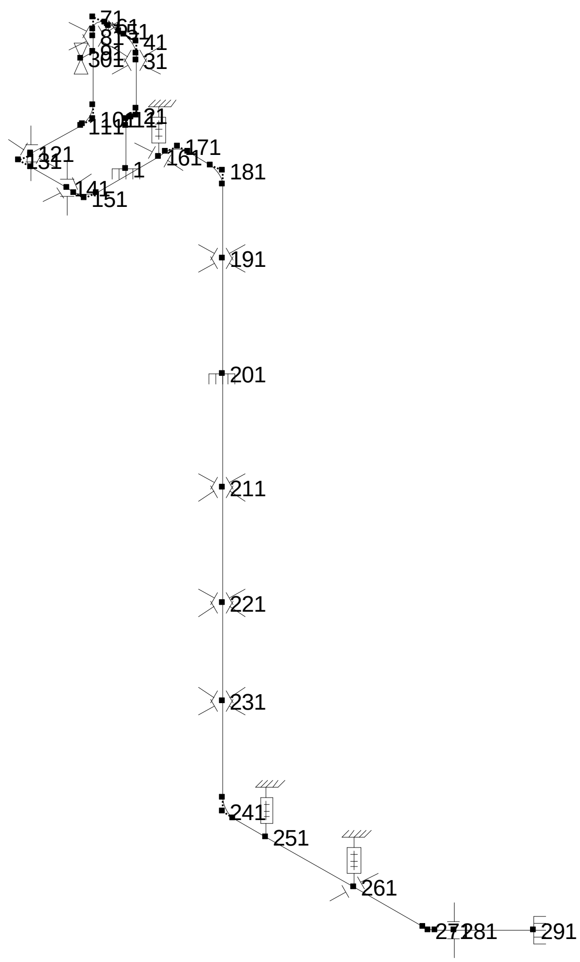
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	64	-8975	-407	-21152	768	8014
PIPESTRESS	10	63	-9039	-408	-21156	781	7902
CAEPIPE	170	17	-4141	-58	-74	22	-130
PIPESTRESS	170	17	-4144	-59	-75	19	-128
CAEPIPE	1290	-81	-2717	-15	529	-15	-145
PIPESTRESS	1290	-80	-2719	-15	531	-14	-141

Support Load (Operating)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	862	-11574	-1554	-21545	928	-2965
PIPESTRESS	10	813	-11761	-1479	-21904	939	-3437
CAEPIPE	170	246	-4637	-591	-1153	299	-977
PIPESTRESS	170	192	-4541	-479	-920	220	-814
CAEPIPE	1290	-1108	3392	375	-6663	-354	-1416
PIPESTRESS	1290	-1005	2789	336	-5957	-317	-1286

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	2.340	2.328	2.414
2	2.442	2.435	2.435
3	2.575	2.550	2.585
4	2.781	2.774	2.794
5	3.194	3.157	3.662

About Model- PRUEBA_original





Name of the Model	Model – PRUEBA_original
Analysis Options in CAEPIPE	
1	Code – B 31.3
2	Reference Temperature = 20^0c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Include bourdon effect
6	Do not use pressure correction for bends
7	Do not include missing mass correction
8	Use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

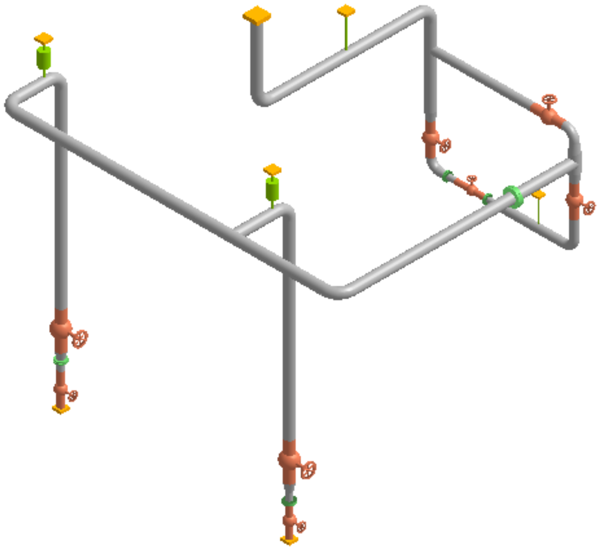
Total Weight (Kg)	
CAEPIPE	31627
PIPESTRESS	31486.387

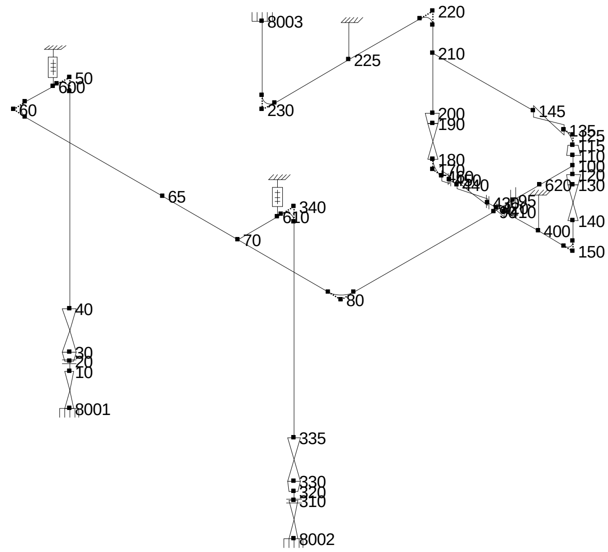
Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	1	-3388	36362	1485	3739	-982	4209
PIPESTRESS	1	-3219	35702	1440	3605	-981	3760
CAEPIPE	201	-608	-126939	1150	2989	-2219	1715
PIPESTRESS	201	-610	-126962	1167	3015	-2271	1770
CAEPIPE	291	857	-6375	-175	5168	2375	1659
PIPESTRESS	291	1029	-6392	-235	5236	2717	1847

Support Load (Operating)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	1	4385	-33319	3863	9234	-9259	-23011
PIPESTRESS	1	4382	-32501	3818	9134	-9172	-22752
CAEPIPE	201	6272	-129585	-8580	-20597	19569	-29191
PIPESTRESS	201	6320	-129614	-8650	-20777	19589	-28753
CAEPIPE	291	-32976	-13665	11559	24633	-65110	-3119
PIPESTRESS	291	-32935	-13692	11562	24716	-64749	-3075

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	2.188	2.187	2.243
2	2.823	2.818	3.158
3	3.924	3.902	4.031
4	4.281	4.277	4.199
5	4.389	4.386	4.616
6	4.474	4.470	4.723
7	5.869	5.857	6.378
8	11.817	11.993	12.250
9	12.499	12.413	12.343
10	12.555	12.540	12.679
11	13.354	13.335	13.110
12	13574	13.535	14.413
13	14.303	14.342	15.067
14	15.484	15.497	16.025
15	16.225	16.456	17.193
16	17.738	17.488	17.576
17	20.950	20.382	17.879
18	22.996	22.976	18.157
19	23.445	23.600	20.142
20	25.897	25.288	20.823

About Model- BFW-SPI





Name of the Model	Model – BFW-SPI
Analysis Options in CAEPIPE	
1	Code – B 31.1
2	Reference Temperature = 20^{0}c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

Total Weight (Kg)	
CAEPIPE	1623.8
PIPESTRESS	1619.408

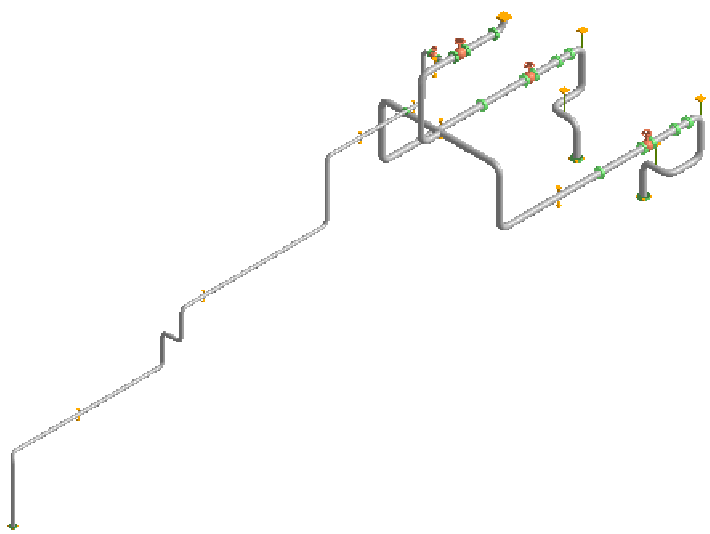
Support Load (Sustained)

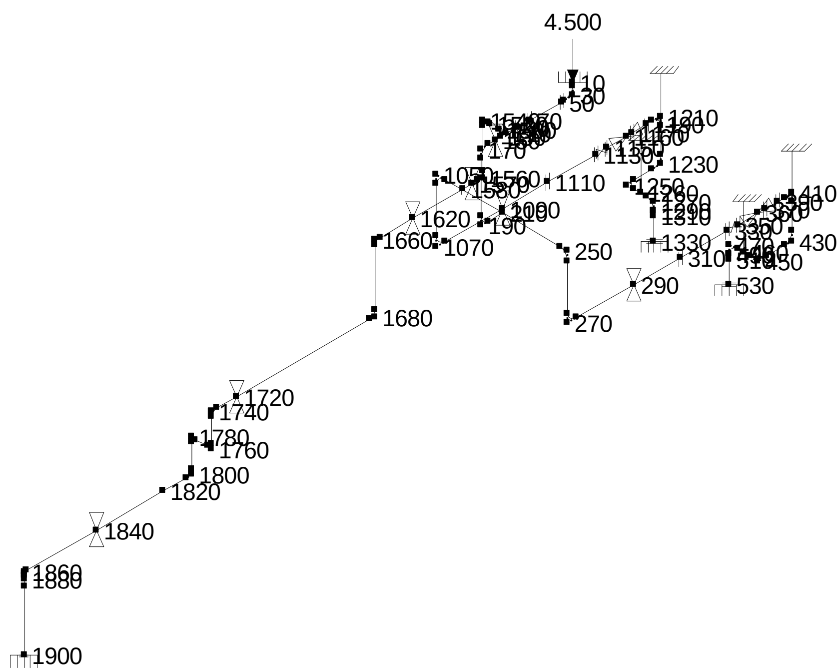
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	8001	18	-2451	5	-6	-5	-50
PIPESTRESS	8001	17	-2433	6	-4	-6	-44
CAEPIPE	8002	-16	-284	36	52	-14	-17
PIPESTRESS	8002	-15	-275	33	44	-13	-16
CAEPIPE	8003	-2	897	-41	167	24	34
PIPESTRESS	8003	-1	914	-39	168	21	33

Support Load (Operating)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	8001	-221	-2477	3	-69	-49	545
PIPESTRESS	8001	-184	-2462	5	-62	-40	426
CAEPIPE	8002	196	-868	20	-44	37	-553
PIPESTRESS	8002	155	-851	22	-37	27	-426
CAEPIPE	8003	25	2076	-23	1063	16	273
PIPESTRESS	8003	28	2081	-27	1066	14	273

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	2.041	1.999	2.004
2	4.231	4.045	4.071
3	5.245	4.801	4.941
4	6.323	6.147	6.210
5	8.155	7.941	8.114
6	14.184	14.151	14.167
7	16.089	16.001	16.054
8	20.126	19.736	19.613
9	23.838	23.556	22.197
10	25.362	25.197	24.825
11	28.664	28.186	26.568
12	31.363	30.549	29.000
13	32.991	30.902	30.243

About Model-EGTL-05-002A-0





Name of the Model	Model – EGTL-05-002A-0
Analysis Options in CAEPIPE	
1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Do not use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

Total Weight (Kg)	
CAEPIPE	10757
PIPESTRESS	10758.691

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-67	-3249	-81	645	-303	566
PIPESTRESS	10	-67	-3248	-83	647	-302	563
CAEPIPE	530	-112	-3547	-3240	-4052	3553	189
PIPESTRESS	530	-112	-3546	-3251	-4066	3566	189
CAEPIPE	1330	133	-3690	-3264	-4092	-3467	-204
PIPESTRESS	1330	133	-3688	-3275	-4105	-3480	-204
CAEPIPE	1900	46	-1793	-231	-352	-379	600
PIPESTRESS	1900	46	-1793	-231	- 351	-379	601

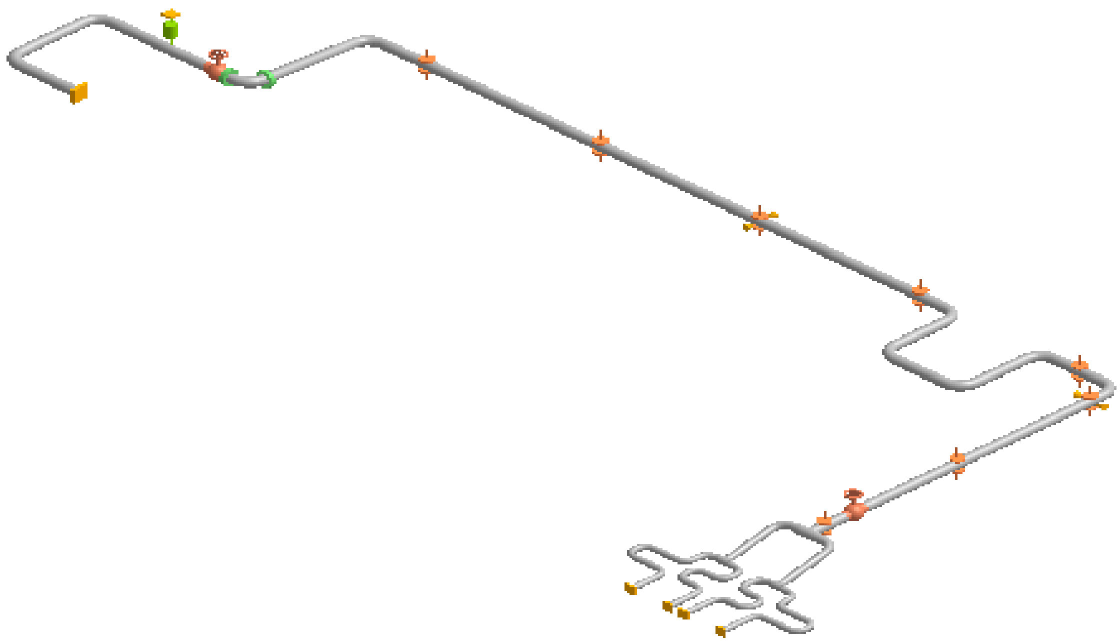
Support Load (Operating Case)

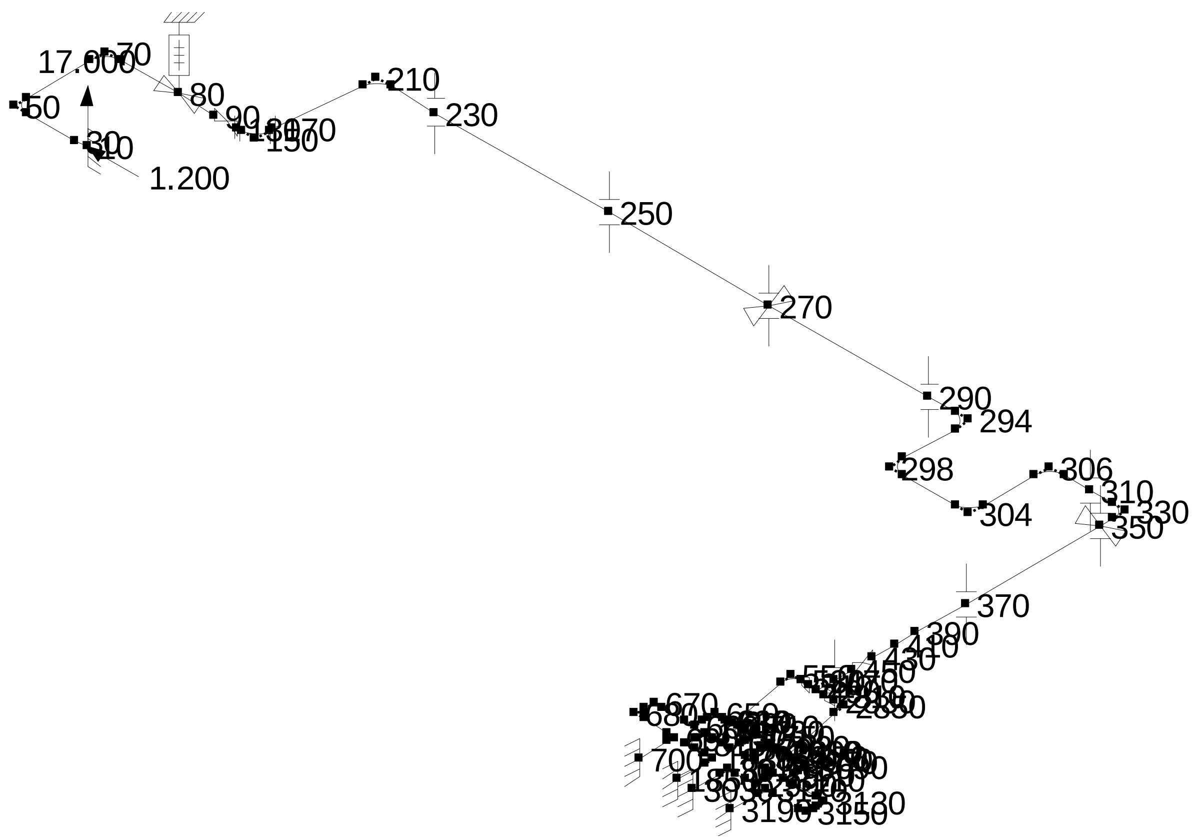
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	944	-2985	1434	-2914	570	-8960
PIPESTRESS	10	941	-2998	1435	-2904	562	-8891
CAEPIPE	530	-114	-21361	2906	-4158	-4633	-17769
PIPESTRESS	530	-113	-21364	2904	-4159	-4624	-17779
CAEPIPE	1330	-559	-21700	3556	-2490	1778	20705
PIPESTRESS	1330	-557	-21704	3550	-2503	1780	20705
CAEPIPE	1900	-271	-2972	4399	9073	1312	1331
PIPESTRESS	1900	-271	-2972	4395	9065	1312	1331

Frequencies (in Hz)

Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	0.743	0.743	0.739
2	1.563	1.562	1.593
3	1.923	1.922	2.056
4	2.754	2.753	2.873
5	3.050	3.048	3.405
6	3.903	3.903	3.921
7	4.242	4.243	4.287
8	4.832	4.831	4.939
9	4.914	4.912	5.095
10	5.341	5.340	5.429
11	5.601	5.592	5.567
12	5.666	5.659	5.717
13	6.002	6.001	6.184
14	6.047	6.047	6.275
15	6.420	6.416	6.730
16	6.740	6.740	6.967
17	8.083	8.089	8.364
18	8.541	8.537	8.758
19	9.294	9.291	9.304
20	9.555	9.553	9.871

About Model-EGTL-05-0027A-0





Name of the Model	Model – EGTL-05-0027A-0

Analysis Options in CAEPIPE

1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Do not use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

Total Weight (Kg)

CAEPIPE	21385
PIPESTRESS	21180.126

Support Load (Sustained)

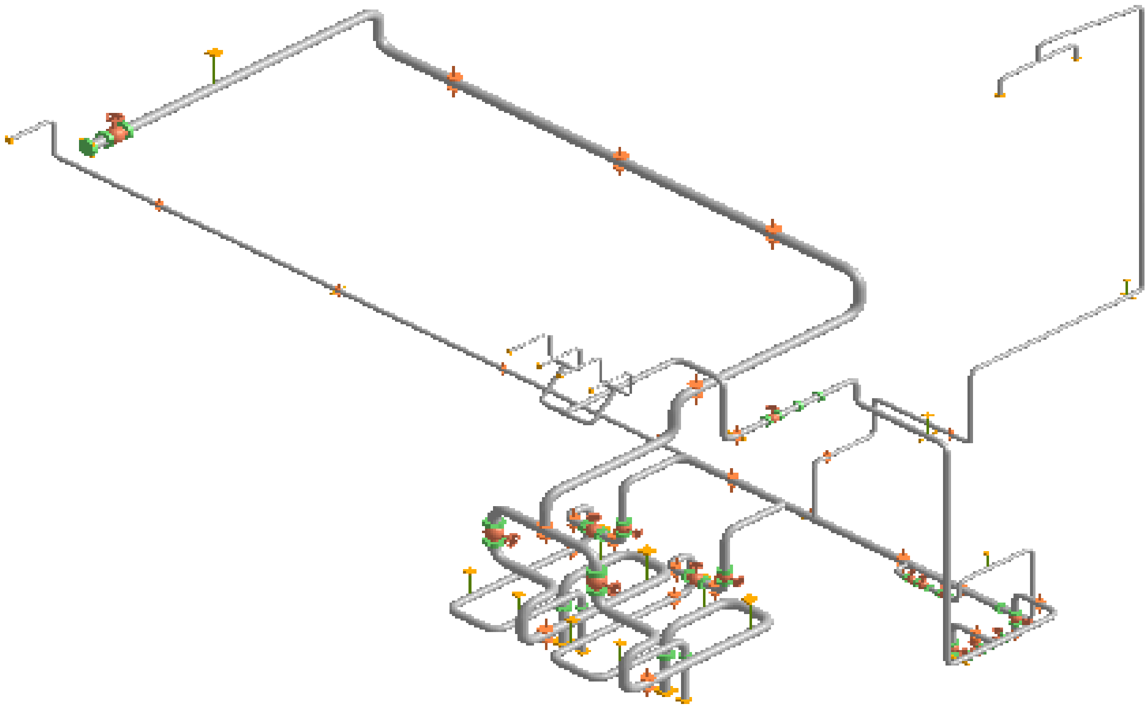
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-47	-6614	-28	10678	-45	5867
PIPESTRESS	10	-39	-6097	-30	11251	-50	5886
CAEPIPE	700	63	-7499	-44	-9474	-193	4344
PIPESTRESS	700	63	-7510	-43	-9501	-191	4345
CAEPIPE	1850	47	-6362	501	-7868	55	2822
PIPESTRESS	1850	47	-6387	500	7921	55	2827
CAEPIPE	3030	-76	-6541	-303	-7707	272	-1970
PIPESTRESS	3030	-76	-6569	-306	-7767	272	-1976
CAEPIPE	3190	-99	-6148	-179	-6566	290	-2939
PIPESTRESS	3190	-99	-6164	-178	-6601	288	-2943

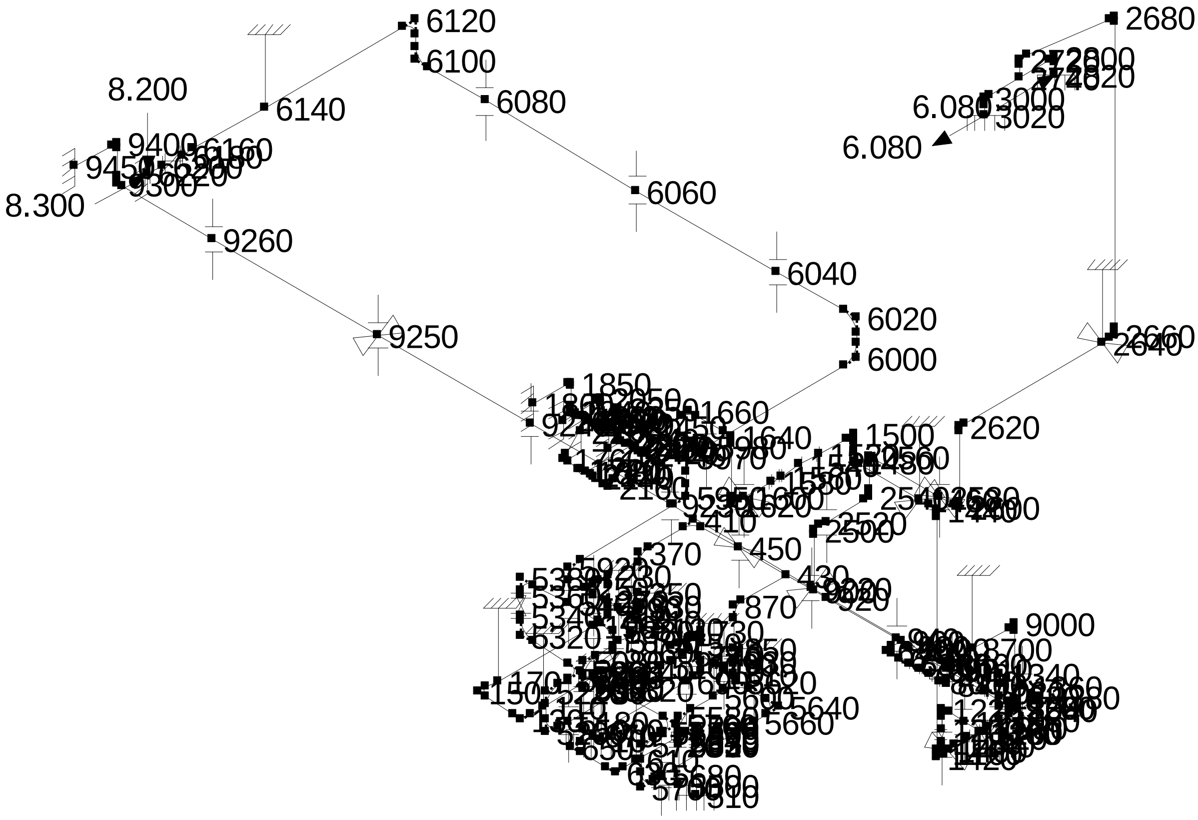
Support Load (Operating Case)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	7699	-8176	9072	4408	15744	5399
PIPESTRESS	10	7666	- 8200	9071	4889	15755	5422
CAEPIPE	700	-5350	-7880	894	-10657	10114	4528
PIPESTRESS	700	-5336	-7887	891	-10676	10087	4528
CAEPIPE	1850	3858	-6934	-944	-9446	-7333	3004
PIPESTRESS	1850	3855	-6952	-941	-9485	-7333	3007
CAEPIPE	3030	-2423	-7747	2114	-10283	2277	-2616
PIPESTRESS	3030	-2426	-7769	2112	-10332	2286	-2620
CAEPIPE	3190	7860	-7269	6730	-8988	-18934	-3624
PIPESTRESS	3190	7847	-7282	6726	-9017	-18908	-3627

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	1.582	1.599	1.599
2	1.951	1.954	1.984
3	2.712	2.722	2.793
4	2.799	2.821	2.844
5	3.451	3.488	3.550
6	3.585	3.664	3.752
7	4.952	4.963	4.974
8	5.156	5.159	5.345
9	5.685	5.700	5.726
10	7.469	7.505	7.411
11	9.363	9.392	9.489
12	9.974	9.978	9.977
13	11.237	11.237	11.303
14	11.780	11.761	11.758
15	11.975	11.995	11.954
16	13.079	13.062	12.315
17	13.359	13.308	13.103
18	14.211	14.191	13.351
19	16.059	16.097	14.189
20	16.223	16.197	15.660

About Model-EGTL-05-045A-0





Name of the Model	**Model – EGTL-05-045A-0**

Analysis Options in CAEPIPE

1	Code – B 31.3
2	Reference Temperature = 20^0c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Do not use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

Total Weight (Kg)

CAEPIPE	32875
PIPESTRESS	32870.880

Support Load (Sustained)

	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-33	-3007	40	135	8	100
PIPESTRESS	10	-34	-3008	41	136	8	101
CAEPIPE	510	-45	-3019	9	79	-23	118
PIPESTRESS	510	-46	-3021	9	80	-23	119
CAEPIPE	1860	-82	-2149	678	-2938	109	-63
PIPESTRESS	1860	-79	-2152	676	-2945	105	-63
CAEPIPE	2060	-145	-2362	80	-3001	319	15
PIPESTRESS	2060	-147	-2364	82	-3007	323	16
CAEPIPE	2260	-150	-1223	-52	-1334	252	-41
PIPESTRESS	2260	-149	-1225	-53	-1337	251	-41
CAEPIPE	2460	-209	-1277	-510	-1243	323	-32
PIPESTRESS	2460	-210	-1278	-508	-1243	325	-31
CAEPIPE	2820	-10	-1675	-1466	-402	-6	-19
PIPESTRESS	2820	-10	-1675	-1467	-402	-6	-19
CAEPIPE	3020	15	-1391	1406	417	1	-31
PIPESTRESS	3020	15	-1391	1407	417	1	-31
CAEPIPE	5000	169	-4379	71	168	196	-472
PIPESTRESS	5000	170	-4381	72	168	195	-474
CAEPIPE	5500	-185	-4323	-33	-26	26	299
PIPESTRESS	5500	-185	-4327	-33	-27	25	300
CAEPIPE	6220	16	-10008	-39	-4094	312	1837
PIPESTRESS	6220	15	-10015	-39	-4156	318	1837
CAEPIPE	9450	30	-1922	-5	-2656	-9	76
PIPESTRESS	9450	30	-1923	-5	-2657	-10	76

Support Load (Operating Case)

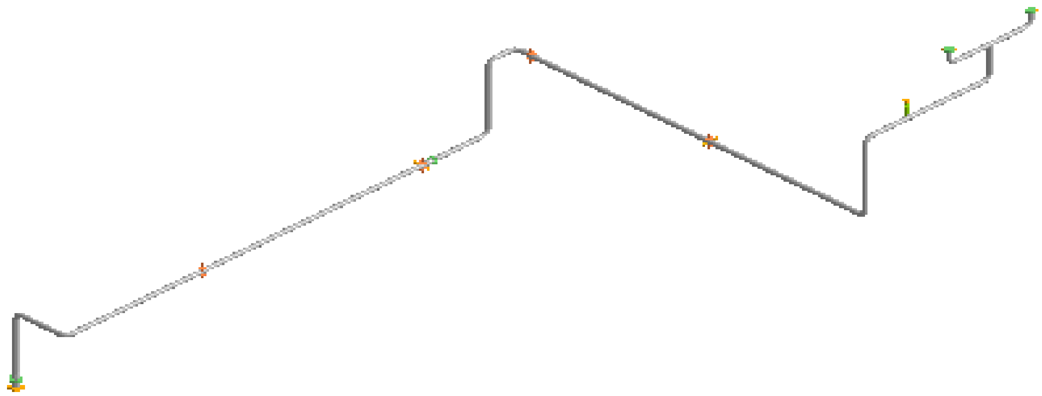
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	10	-327	-6327	-107	4317	95	629
PIPESTRESS	10	-329	-6329	-107	4308	96	631
CAEPIPE	510	190	-6556	-566	3723	-465	-657
PIPESTRESS	510	187	-6557	-558	3728	-458	-653
CAEPIPE	1860	-1854	-1085	1614	-1890	2166	-989
PIPESTRESS	1860	-1844	-1089	1610	-1899	2156	-989
CAEPIPE	2060	-253	-2690	599	-3689	369	-228
PIPESTRESS	2060	-256	-2692	598	-3695	375	-225
CAEPIPE	2260	-739	-611	641	-672	1121	-208
PIPESTRESS	2260	-735	-615	634	-678	1118	-209
CAEPIPE	2460	842	-752	-657	-371	-845	-458
PIPESTRESS	2460	837	-754	-650	-374	-838	-458
CAEPIPE	2820	-145	2003	-310	-557	7	305
PIPESTRESS	2820	-145	2003	-310	-557	7	305
CAEPIPE	3020	53	-2855	75	-346	-44	205
PIPESTRESS	3020	53	-2855	75	-346	-44	205
CAEPIPE	5000	241	-16551	-853	-13572	-85	-5203
PIPESTRESS	5000	262	-16592	-910	-13756	-25	-5318
CAEPIPE	5500	1408	-15290	1349	-7369	-1347	-8606
PIPESTRESS	5500	1395	-16163	1405	-8610	-1326	-9612
CAEPIPE	6220	-1649	2713	-495	46260	17148	-80
PIPESTRESS	6220	-1657	2518	-495	45350	17241	-79
CAEPIPE	9450	-5142	-437	130	-217	7812	-3329
PIPESTRESS	9450	-5125	-441	130	-224	7786	-3317

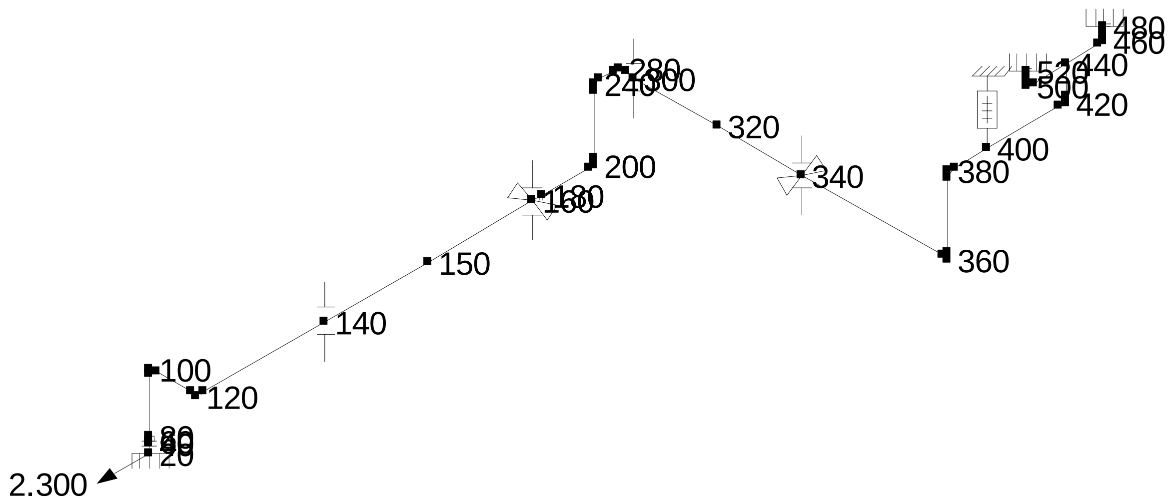
Frequencies (in Hz)

Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRSS (MP=33)
1	0.843	0.844	0.851
2	0.926	0.925	0.977
3	0.960	0.971	0.986
4	1.083	1.104	1.108
5	1.334	1.334	1.413
6	1.401	1.400	1.420
7	1.513	1.512	1.526
8	1.799	1.798	1.814
9	2.031	2.030	2.077
10	2.238	2.238	2.255
11	2.381	2.380	2.430
12	2.472	2.494	2.469
13	2.515	2.514	2.535
14	2.582	2.582	2.588
15	2.627	2.625	2.675

16	2.801	2.800	2.790
17	2.894	2.914	2.962
18	2.960	2.959	3.127
19	3.045	3.043	3.186
20	3.126	3.151	3.247

About Model- EGTL-50-46H-0





Name of the Model	Model – EGTL-50-46H-0
Analysis Options in CAEPIPE	

1	Code – B 31.3
2	Reference Temperature = 20^{0}c
3	Number of Thermal Cycles = 7000
4	Use modulus at reference temperature
5	Do not include bourdon effect
6	Use pressure correction for bends
7	Include missing mass correction
8	Do not use friction in dynamic analysis
9	Include Hanger Stiffness
10	Y – Vertical

Total Weight (Kg)	
CAEPIPE	2567.1
PIPESTRESS	2567.745

Support Load (Sustained)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	20	-10	-3541	66	444	-20	-1552
PIPESTRESS	20	-10	-3542	67	445	-20	-1551
CAEPIPE	480	-78	-1326	869	-185	-17	-28
PIPESTRESS	480	-78	-1325	873	-187	-17	-29
CAEPIPE	520	82	-983	-760	197	-17	40
PIPESTRESS	520	83	-989	-764	197	-17	39

Support Load (Operating)							
	Node	Fx (N)	Fy (N)	Fz (N)	Mx (N-m)	My (N-m)	Mz (N-m)
CAEPIPE	20	-4	-3537	39	380	3	-1564
PIPESTRESS	20	-4	-3538	39	380	3	-1563
CAEPIPE	480	-76	-1304	854	-183	-15	-38
PIPESTRESS	480	-76	-1304	855	-183	-15	-38
CAEPIPE	520	74	-999	-766	197	-16	25
PIPESTRESS	520	74	-1000	-767	197	-16	25

Frequencies (in Hz)			
Mode Number	CAEPIPE	PIPESTRESS (MP=0)	PIPESTRESS (MP=33)
1	1.282	1.288	1.294
2	1.876	1.944	1.973
3	2.044	2.185	2.389
4	2.963	2.963	3.005
5	4.056	4.126	4.518
6	5.166	5.159	5.573
7	5.535	5.534	5.860
8	5.586	5.590	6.016
9	7.483	7.482	7.786
10	7.926	7.920	8.272
11	9.897	9.894	10.241
12	10.531	10.525	11.081
13	10.655	10.641	11.587
14	12.047	12.043	12.694
15	12.725	12.723	13.338
16	13.634	13.621	14.066
17	15.325	15.341	15.146
18	17.220	17.174	17.814
19	23.197	23.195	18.162
20	26.109	26.241	18.357

Appendix A

Units used in CAEPIPE and PIPESTRESS

CAEPIPE ELEMENT	PIPESTRESS				
	Equivalent PS Card(s)	**Field**	**USA1**	**Metric**	**USA2**
Pipe	TANG	DX, DY, DZ	Feet	meter	inch
Bend	TANG	See TANG card under Pipe			
	BRAD	RA	Feet	meter	inch
Valve	VALV	DX, DY, DZ	Feet	meter	inch
		MA	Kips	1000 kg	Lbs
		BX, BY, BZ	Feet	meter	inch
Reducer	CRED, ERED	DX, DY, DZ	Feet	meter	Inch
Bellows	MTXS	DX, DY, DZ	Feet	meter	Inch
		11, 21, 22, 31, 32, 33	Kips/inch	KN/mm	lbs/inch
		41, 42, 43, 51, 52, 53, 61, 62, 63	Ft kips/in	kN m/mm	ft lbs/in
		44, 54, 55, 64, 65, 66	Ft Kips/rad	kN m/rad	ft lbs/rad
	FORC	FX, FY, FZ	Kips	KN	lbs
Rigid Element	RIGD	DX, DY, DZ	Feet	meter	inch
Elastic Element	MTXS	See MTXS card under Bellows			
Cold spring (Cut pipe)	CLDS	DL	Inch	mm	inch
Beam	BEAM	DX, DY, DZ	Feet	meter	Inch
		AR	In^2	mm^2	in^2
		EC	10^6 psi	10^3 N/mm^2	10^6 psi
		IX, IY, TO	In^4	mm^4	in^4
Anchor	ANCH	KX, KY, KZ	Kips/in	KN/mm	lbs/in
		MX,MY,MZ	ft Kips/radian	m KN/radian	ft lbs/radian
	AMVT	DX,DY,DZ	inch	mm	inch
		RX,RY,RZ	Radian	Radian	radian
Concentrated Mass	LUMP	MA	Kips	100 kg	lbs
Constant Support	CSUP	FO	Kips	KN	lbs

Flange	LUMP	See LUMP card under Concentrated Mass			
Force	FORC	See FORC card under Bellows			
Rod Hanger	HANG	SP	Kips/in	KN/mm	lbs/in
User Hanger	VSUP	SP	KN/mm	lbs/in	Kips/in
		FO	Kips	KN	lbs
Limit Stop	NRST	D1,D2	inch	mm	inch
		K1,K2,K3,K4	Kips/in	KN/mm	lbs/in
Skewed Restraint	RSTN	SP	Kips/in	KN/mm	lbs/in
	ROTR	SP	ft Kips/rad	KN m/rad	ft lbs/rad
Snubber	SNUB	SP	Kips/in	KN/mm	lbs/in

Appendix B

Weight Calculations

The following paragraphs explain how CPTOPS calculates the weight of pipe and valve.

Pipe

The following equation is used to calculate the mass of the pipe per unit length. The mass includes mass of the pipe and mass of the insulation.

$$\mathbf{W} = \pi \times (\mathbf{D} - \mathbf{T_P}) \times \mathbf{T_P} \times \gamma_I + \pi \times (\mathbf{D} + \gamma_T) \times \mathbf{T_I} \times \gamma_I$$

Where

π	=	Pi
W	=	Mass of pipe per unit length
D	=	Outer diameter of pipe
T_P	=	Wall thickness of pipe
T_I	=	Insulation thickness
γ_P	=	Density of pipe material
γ_I	=	Density of insulation material

Valve

The following equation is used to calculate the mass of valve. The mass of valve consists of the mass of the valve alone and mass of the insulation material.

$$\mathbf{W} = \mathbf{W_V} + \pi \times (\mathbf{D} + \mathbf{T_I}) \times \mathbf{T_I} \times \gamma_I \times \mathbf{I.F} \times \mathbf{L}$$

Where

π	=	Pi
W	=	Mass of the valve
W_V	=	Empty weight of valve (From CAEPIPE mod file)
D	=	Outer diameter of previous pipe section
T_I	=	Insulation thickness of previous pipe section
γ_I	=	Density of insulation material of previous pipe section
I.F	**=**	Thickness factor for insulation
L	=	Length of valve

Appendix C

The following tables give information about CAEPIPE elements and data types and the equivalent data cards used by CPTOPS to model them for PIPESTRESS.

ETYPES

Table C.1

CAEPIPE	PIPESTRESS	CAEPIPE	PIPESTRESS	CAEPIPE	PIPESTRESS
From	JUNC	Location	Taken care of through DTYPEs	Pipe	TANG/ BRAN
Bend	TANG + BRAD / BEND	Miter Bend	MITC / MITW	Jacketed Pipe	Not allowed
Jacketed Bend	Not allowed	Valve	VALV + LUMP	Reducer	CRED / ERED
Bellows	MTXS + FORC	Slip Joint	Not allowed	Hinge Joint	MTXS
Ball Joint	MTXS	Rigid Element	RIGD	Elastic Element	MTXS
Cut Pipe	CLDS	Beam	BEAM		

DTYPES

Table C.2

CAEPIPE	PIPESTRESS	CAEPIPE	PIPESTRESS	CAEPIPE	PIPESTRESS
Anchor	ANCH + AMVT	Branch SIF	(1)	Concentrated Mass	LUMP
Constant Support	CSUP	Flange	LUMP	Force	FORC/ MOMT
Guide	Not transferred	To-be-Designed Hanger	VSUP	Jacket End Cap	Not allowed
Limit Stop	NRST	Nozzle	NOZZ + AMVT	Restraint	MULR
Rod Hanger	NRST	Skewed Restraint	RSTN / ROTR	Snubber	SNUB
Spider	Not allowed	Threaded Joint	(2)	User Hanger	VSUP
User SIF	INDI	Weld	(2)		

(1) See table C.3.

(2) Translate to weld codes (EW, LW and TA fields) for corresponding piping components. See table C.4.

Branch SIFs

Table C.3

Branch SIF in CAEPIPE	Corresponding TE and PD field
Welding Tee	TE = 1
Reinforced Fabricated Tee	TE = 3, PD = Pad thickness
Unreinforced Fabricated Tee	TE = 3, PD = Pad thickness
Weldolet	TE = 6
Extruded Welding Tee	TE = 7
Sweepolet	TE = 4
Branch Connection	TE = 0

Welds

Table C.4

Weld in CAEPIPE	Corresponding TA, LW, EW and MM field
Butt Weld	LW = 2, MM = Mismatch
Fillet Weld, Concave Fillet Weld	EW = 3
Tapered Transition	TA =2, MM = Mismatch
Threaded Joint	TA = 3

Appendix D

The following table lists the case numbers used by 'CPTOPS, to define 'LCAS', 'CCAS' and 'CSTR' cards and brief description about the cards

Case number	Description (P = Pressure, T = Temperature, RF = Reference case)
'LCAS' cards	
1	Empty weight case (P = 0, T= Ambient)
2	Operating weight case (P = 0, T= Ambient)
3	Hydrotest case (P = Hydrotest pressure, T = Ambient)
11	Pure pressure case (P = P1, T = Ambient)
12	Pure pressure case (P = P2, T = Ambient)
13	Pure pressure case (P = P3, T = Ambient)
14	Pure pressure case (P = Max (P1, P2, P3), T = Ambient)
21	Pure thermal case (P = 0, T = T1)
22	Pure thermal case (P = 0, T = T2)
23	Pure thermal case (P = 0, T = T3)
31	Cold spring case (RF = 1)
41	Settlement case (RF = 1)
51	Pure X-Seismic (g) case (RF = 1)
52	Pure Y-Seismic (g) case (RF = 1)
53	Pure Y-Seismic (g) case (RF = 1)
54	Seismic Displacement case (RF = 1)
61	Wind load case (RF = 1)
'RCAS' card	
71	Response case (RF =1)
'CCAS' cards	
102	Sustained case - Operating weight + Max (P1, P2, P3) (RF = 14)
111	Operating 1 - Operating weight + P1 + T1 (RF = 11)
112	Operating 2 - Operating weight + P2 + T2 (RF = 12)
113	Operating 3 - Operating weight + P3 + T3 (RF = 13)
121	Expansion case – T1 – T2
122	Expansion case – T1 – T3
123	Expansion case – T2 – T3
124	Thermal range case

‘CCAS’ cards	
131	Operating weight + P1 + T1 + Cold spring
132	Operating weight + P2 + T2 + Cold spring
133	Operating weight + P3 + T3 + Cold spring
134	Operating weight + Sustained + Cold spring
151	Seismic case – X-g + Y-g + Z-g
152	Seismic + Seismic Displacement
153	Sustained + Seismic
154	Sustained - Seismic
155	Operating1 + Seismic
156	Operating1 - Seismic
157	Operating2 + Seismic
158	Operating2 - Seismic
159	Operating3 + Seismic
160	Operating3 - Seismic
161	Sustained + Wind
162	Operating1 + Wind
163	Operating2 + Wind
164	Operating3 + Wind
171	Response + Seismic Displacement
172	Sustained + Response
173	Sustained - Response
174	Operating1 + Response
175	Operating1 - Response
176	Operating2 + Response
177	Operating2 - Response
178	Operating3 + Response
179	Operating3 - Response
‘CSTR’ cards	
211	Sustained + Seismic
221	Sustained + Response
231	Sustained + Wind

Appendix E

Errors and Descriptions

a. “Enter all the Necessary Data and Proceed”

User has to enter the CAEPIPE mod file name and PIPESTRESS free format file name.

b. “CAEPIPE mod file does not exist”

The CAEPIPE model file name entered is not a valid .mod file.

c. "Jacketed pipe is not transferred. The program will be aborted"

The CAEPIPE mod file contains jacketed pipe. ‘CPTOPS’ does not transfer jacketed pipe. Refer error log file for more information.

d. "Jacketed bend is not transferred. The program will be aborted"

The CAEPIPE mod file contains jacketed bend. ‘CPTOPS’ does not transfer jacketed bend. Refer error log file for more information.

e. "Slip joint is not transferred. The program will be aborted"

The CAEPIPE mod file contains slip joint. ‘CPTOPS’ does not transfer slip joint. Refer error log file for more information.

f. "ERROR : At node number <Node Number> pipe cross-section does not change after reducer."

Either OD1 and OD2 for reducer are not chosen from section profiles defined in CAEPIPE or there is no change in the cross-section of preceeding and succeeding pipe for the reducer.

Messages in Log file

a. "At node number= <Node Number> enter spring constant and cold load for the To-Be-Designed hanger"

To-be-designed hanger is present at node number = /Node Number/ in the free format file. The hanger is transferred as a ‘VSUP’ card but is commented. Get the spring rate and cold load from CAEPIPE result file and enter the spring rate multiplied by number of hangers, in the ‘SP’ field and hot load in the ‘FO’ field. The user has to convert the values to proper units.

b. "At node number= <Node Number> enter cold load for user hanger"

User hanger is present at node number = <Node Number> in the free format file. The hanger is transferred as a ‘VSUP’ card but is commented. In the CAEPIPE mod file either cold load is specified or hot load is zero. If cold load is indeed zero uncomment the ‘VSUP’ card. If hot load is specified, get cold load from CAEPIPE result file and enter the value in the ‘FO’ field with proper unit conversion.

c. "At node number= <Node Number> a constant support is present. Enter FO = Cold load"

Constant support is present at node number = <Node Number> in the free format file. The constant support is transferred as a ‘CSUP’ card but is commented. Get cold load from CAEPIPE result file and enter the value in the ‘FO’ field with proper unit conversion.

d. "ERROR : Miter bend at Element number: <Element Number> in CAEPIPE-mod file is of wrong type."

In CAEPIPE mod file at element number= <Element Number> more than one widely spaced miter bend with different radius are present or widely spaced miter bend is proceeded/succeeded by closely spaced miter bend. PIPESTRESS does not allow kind of arrangement for miter bends.

e. "ERROR : At node number <Node Number> pipe cross-section does not change after reducer."

PIPESTRESS requires the pipe cross-section to be changed after a reducer.

f. "For spectral data, modal superposition is 'ABSOLUTE' and spatial superposition is ‘SRSS'. PIPESTRESS does not have a combination for this case"

Refer table 5.1

g. "For spectral data, modal superposition is 'SRSS' and spatial superposition is ‘ABSOLUTE'. PIPESTRESS does not have a combination for this case"

Refer table 5.1

h. "For spectral data, modal superposition is 'CLOSELY SPACED' and spatial superposition is ‘ABSOLUTE'. PIPESTRESS does not have a combination for this case"

Refer table 5.1