KP2CII™ User's Manual

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CAEPIPE - to - CAESAR II™

(KP2CII)

User's Manual

Server Version 10.xx

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1.0 Introduction

KP2CII: KP2CII Translator program is a stand-alone program, which shall be used for transferring pipe geometry, section properties and other engineering properties from CAEPIPE to CAESAR-II.

The sequence of this Translator operation is shown diagrammatically in Figure 1-1.

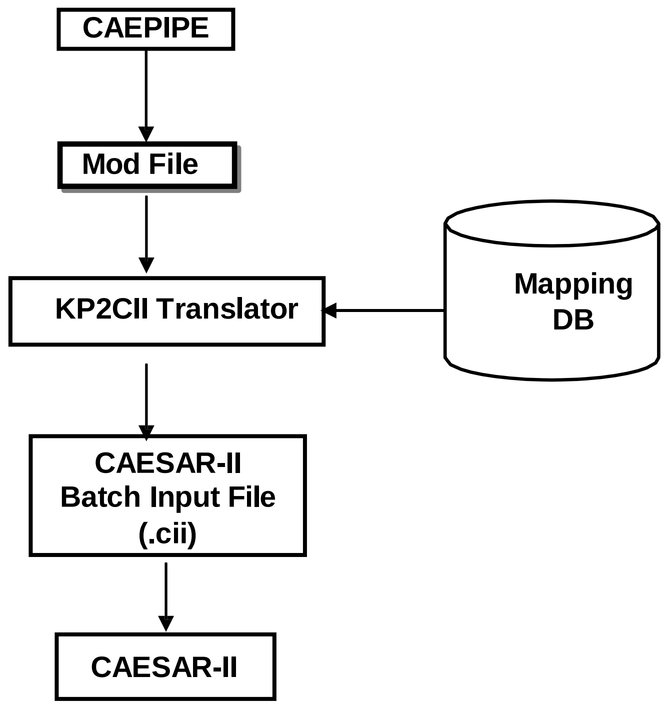


Figure 1-1

This manual describes the development done on KP2CII Translator. It is assumed that the user is already familiar with CAEPIPE and CAESAR II.

1.1 How the Translator works?

1.1.1 The pipe(s) modeled in CAEPIPE are saved as mod file by CAEPIPE.

1.1.2 The Windows compatible executable KP2CII.exe reads this mod file and maps it against the material and hanger mapping mdb to identify the valid CAESAR II material name and hanger name that correspond to the specified CAEPIPE material name and hanger specification. This executable finally generates the batch input file (*.cii), which can then be imported into CAESAR II to create binary model file (*._A) that can be opened and viewed in CAESAR II. During the conversion of Analysis model from CAEPIPE, the program simulates certain elements to have an identical mathematical model in CAESAR II. The details of such simulations are described under the section “Reference”.

Note: Refer **Appendix A** for more details on modifying the Material and Hanger mapping database.

2.0 Installing the Program

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

3.0 Limitations of Translator

The present version of the CAEPIPE-to-CAESAR II has the following limitations.

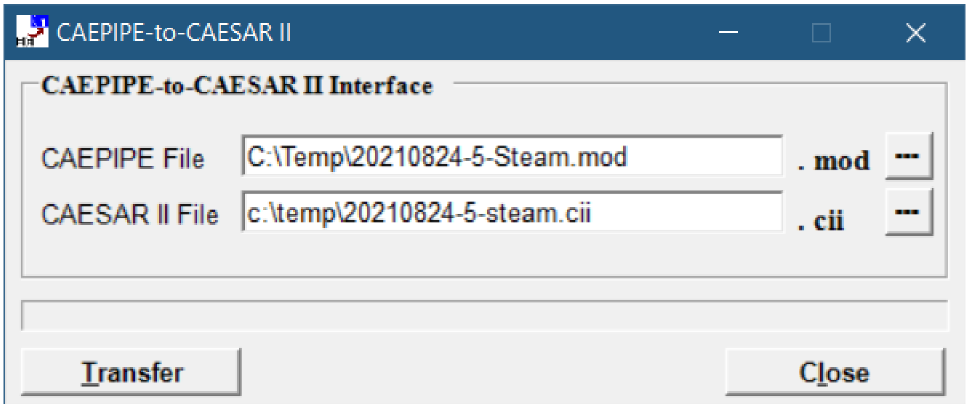
Presently the following CAEPIPE inputs are not transferred to CAESAR II input format.

1. Additional weight of Valves
2. Flange placed at disconnected end
3. Flange placed at "Bend" Node
4. Hinge Direction
5. Force Spectrum Load
6. Harmonic Load
7. Wind Load
8. Jacket end cap
9. Negative gap used in Limit Stops
10. Beam Element
11. Due to the limitation in the CAESAR II batch input file, the Analysis Option from CAEPIPE is not transferred to CAESAR II. The User has to set the same manually in CAESAR II
12. Pumps, Compressors and Turbines
13. Spectra, Spectrum levels, Force spectrum and Time history
14. Pressure (P10) and Thermal load (T10)
15. Generic Support details
16. Piping system with node numbers greater than 32000 as CAESAR II has limitations in node numbers (i.e., max node number = 32000)

Transfers of certain "element" types and "data" types from CAEPIPE input into CAESAR II input format takes place as follows

Sl. No	CAEPIPE Input	Being transferred to CAESAR II as
1.	Valves	Rigid Element
2.	Flange	Rigid Element with 0.1mm length
3.	Concentrated Mass	Rigid Element with 0.1mm length
4.	Hinge	Expansion Joint with zero length
5.	Bellows	Expansion Joint
6.	Ball Joint	Expansion Joint
7.	Elastic Element	Expansion Joint
8.	Cut Pipe	Cold Spring
9.	Tie Rod	Rigid Element
10.	Limit Stops	Equivalent Restraints
11.	Rod Hangers	Restraints (+Y or +Z)
12.	Threaded Joints	SIF or TEES
13.	User SIF	SIF or TEES
14.	Branch SIF	SIF or TEES

4.0 Working Procedure



4.1 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.

4.2 Similarly, enter the name of the CAESAR II batch file to be created as explained in Step 4.1.

4.3 User can specify the Default Material and Hanger to be used in CAESAR II during the transfer through “Option->Set Default CII Material and Hanger”.

4.4 Program checks for the availability of Material and Hanger in CAESAR II corresponding to CAEPIPE and replaces them with the default Material and Hanger specified by the user upon unavailability.

4.5 Design option for CAESAR II Hanger can be specified through “Option->Design Option for CII Hanger”.

4.6 Click the button “Transfer” to transfer model from CAEPIPE to CAESAR II format. Upon successful transfer, user gets the message box as shown below.

4.7 Launch CAESAR II software and from the “Tools” menu select “External Interfaces->CAESAR II Neutral File”.

4.8 Select the radio button “Convert Neutral File to CAESAR II Input File” and then press the button “Browse”.

4.9 Navigate and select the “.cii” file thus created and press the button “open”. Upon successful import user will receive the message “The conversion was completed successfully”.

5.0 Reference

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

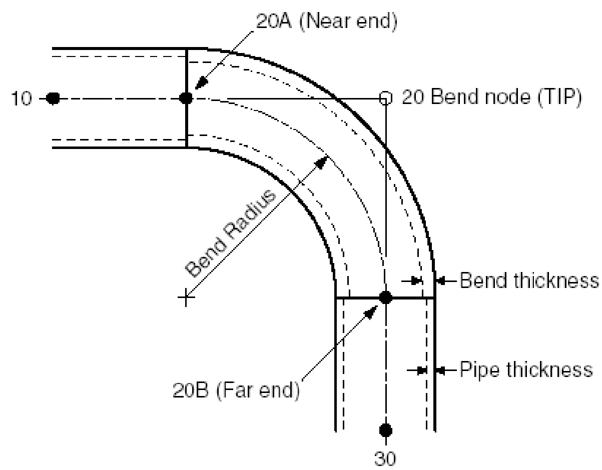
5.1 Element Types

Pipe

Pipe from CAEPIPE is transferred as PIPE to CAESAR II. Translator uses the same node numbers used in CAEPIPE while transferring to CAESAR II. The section, material properties and load corresponding to the pipe element read from the CAEPIPE are assigned directly to the section property, material property and load fields (Auxiliary fields) of CAESAR II.

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 figure below.



Node 20 is the Bend node, which is at the Tangent Intersection Point (TIP). As you can see from the figure, 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).

In CAESAR II, the actual bend curvature is always referred from the "**To**" end (Far end) of the element. Hence, to simulate CAEPIPE bends with CAESAR II bends, the Translator performs the following.

Transfers Bend as Bend to CAESAR II.

Node number used for defining the Bend in CAEPIPE (TIP) will be transferred as "To" end (Far end) in CAESAR II.

Creates a Near end node in CAESAR II by adding the node number with 10000.

Locates the Near end node at (Bend_Max_angle – 5 degree) from the Far end. If this location is already used for defining the intermediate bend node, then Translator tries to locate the Near end node at (Bend_Max_angle – (5 + 5)) and so on. Failure of locating such node point by the Translator will be reported in the .log file for user reference and the Data types such as Hanger, Rod hanger, etc., placed at this location will not be transferred properly.

Long radius in CAEPIPE is transferred as long radius in CAESAR II

User defined bend radius from CAEPIPE is transferred as Bend radius in CAESAR II with value corresponding to the User Bend Radius value in CAEPIPE. Please note the CAESAR II will generate an error message if the Radius of the Bend is less than Outer Diameter of the Section.

Short radius in CAEPIPE is transferred as User defined in CAESAR II with the value equivalent to the OD of the preceding pipe.

At this time, the “Bend Material” defined in the bend input dialog of CAEPIPE is not transferred to CAESAR II. The material specified in CAEPIPE “Layout” frame is used for the bend.

Miter Bend

Miter Bend from CAEPIPE is transferred as Bend with number of cuts in CAESAR II

Widely spaced Miter bend from CAEPIPE is transferred as bend with two (2) miter points in CAESAR II.

Closely spaced Miter bend in CAEPIPE is transferred as bend with three (3) miter points in CAESAR II. All other parameters are the same as that of Bend.

Valve

Transferred as Rigid Element to CAESAR II. The weight entered in CAEPIPE is the empty weight (without contents, insulation, etc.,) and will be transferred to CAESAR II as Rigid Element weight. The additional weight entered into CAEPIPE will not be transferred to CAESAR II. By default, for valve elements, the Thickness factor and the Insulation Weight factor are always assumed as 10 and 1.75 respectively in CAESAR II. Hence, to have the identical results between CAEPIPE and CAESAR II, it is necessary to model the valve elements in CAEPIPE with Thickness factor as 10 and Insulation Weight factor as 1.75.

Reducer

Transfers Reducer as Reducer to CAESAR II. The OD1 and Thk1 entered in Reducer Input dialog of CAEPIPE will be transferred as Diameter and Wall thickness of the current piping element (element on which the Reducer is placed). The OD2 and Thk2 entered in Reducer Input dialog of CAEPIPE will be transferred to CAESAR II as “To” end Diameter and Thickness of the reducer element, if the “To” end is a disconnected end. For continuous piping, the Translator will not transfer the OD2 and Thk2 to CAESAR II. CAESAR II, by default, will take the Diameter and Thickness from the following element Diameter and Thickness.

CAEPIPE calculates reducer weight as the weight of a pipe with its OD as the average between OD1 ad OD2 and its thickness as the average between Thk1 and Thk2. On the other hand, CAESAR II calculates the reducer weight as the weight of a pipe with its OD and thickness as OD1 and Thk1 of the reducer. This is contrary to the statement given in CAESAR II Technical Reference Manual, which states that the reducer element is assumed as 10 pipe cylinders, each of successively larger (or smaller) diameter and thickness over the length for calculating the weight.

The observation made during the verification and validation of the Translator for reducer element is listed in Appendix E for reference on the above subject. Hence, you could see a difference in the Total Weight of the piping system between CAEPIPE and CAESAR II depending upon the number of reducers in the piping system.

Bellows

Transfers Bellows as Expansion Joints to CAESAR II. The Axial Stiffness, Bending Stiffness, Torsional Stiffness and Lateral Stiffness entered in CAEPIPE will be transferred as Axial Stiffness, Bending Stiffness, Torsional Stiffness and Translational Stiffness respectively. Translator calculates the Effective ID from the Pressure thrust area entered in CAEPIPE and then transfers the same to CAESAR II.

Slip Joint

CAESAR II does not have a Slip Joint element. It could be modeled, as two annular packing glands separated axially along the joint by a dead air space, or by a small bellows sleeve. Hence, it is difficult to generate a mathematical model through the Translator. Refer CAESAR II – Application Guide for more details on generating a mathematical model for slip joints.

At this time, the Translator transfers only the section property and the material property entered at the slip joint of CAEPIPE to material property and section property fields (Piping Spread Sheet) of CAESAR II. The Friction force, Friction torque, Pressure thrust area and the weight entered in at the Slip Joint of CAEPIPE will not be transferred to CAESAR II and will be explicitly reported to the .log file.

Hinge Joint

Transfers as Expansion Joint using zero length elements with axial, transverse and torsional stiffness as rigid. Transfers the bending stiffness entered at the Hinge joint of CAEPIPE as bending stiffness of Expansion Joint in CAESAR II. Hinge direction in CAESAR II cannot be entered directly and is defined using restraints and connection nodes. In addition, the restraint line of action should be defined normal to the hinge axis. Hence, at this time, the hinge direction defined in CAEPIPE will not be transferred to CAESAR II and will be explicitly stated in the .log file for reference. Refer CAESAR II – Application Guide for more details on modeling Hinge Joints.

Ball Joint

Transfers as Expansion Joint using a zero length element with axial and transverse stiffnesses as rigid and essentially zero bending and torsional stiffnesses.

Rigid Element

Transfers Rigid Element as Rigid Element to CAESAR II. The rigid element weight in CAESAR II is the empty weight and does not include content and insulation weight. CAESAR II internally adds content and insulation weight to this empty weight. On the other hand, when the option "Add Content, Insulation and Lining weight" is turned OFF in CAEPIPE, then the weight of Rigid Element in CAEPIPE is the total weight inclusive of content and insulation. Hence, the Translator will deduct the content weight and insulation weight from the CAEPIPE Rigid Element weight and transfer the resulting empty weight to CAESAR II.

Note: If you do not want the Translator to deduct the content weight and insulation weight from Rigid Element, then define an Environmental variable "SubRigidContWt" with value of the variable set as "No". In other words, to match with CAEPIPE Rigid Weight input, Translator will write the Insulation Thickness, Insulation Density and Fluid Density values as 0.00 in CAESAR II input file for Rigid Elements. This will make CAESAR II not to add content weight and insulation weight during analysis.

Elastic Element

Transfers Elastic Element as Expansion Joint to CAESAR II. Transfers the stiffness entered in CAEPIPE Elastic Element to CAESAR II Expansion Joint Element as listed below.

"kx" as Axial Stiffness

Higher of "ky" and "kz" as Lateral Stiffness

"kxx" as Torsional Stiffness

Higher of "kyy" and "kzz" as Bending Stiffness and

Temperature for the elastic element in CAESAR II will be set as Reference Temperature for temperatures T1 through T9.

Jacketed Pipe and Bend

Jacketed Pipe modeling is difficult in CAESAR II. For modeling the Jacketed Pipe in CAESAR II, the user has to model the core piping first and then the Jacket Pipe by copying and modifying the core pipe information. Hence, it is difficult to fully automate the transfer of Jacketed Pipe from CAEPIPE to CAESAR II using the Translator.

At this time, the Translator transfers the Jacketed Pipe from CAEPIPE to CAESAR II as core piping with section and material properties as entered and then Jacketed Piping by copying and modifying the section property and the material property of the core piping. The Translator duplicates and assigns the same node numbering for both core piping and the Jacketed Piping. User has to manually change the node numbers for Jacketed Piping and also has to verify the model for its correctness.

Cold Spring (Cut Pipe)

Transfers Cold Spring as Cold Spring to CAESAR II. As stated in the CAESAR II – Applications Guide, Translator selects and writes the Material as 18 and 19 to represent the Cut Short and Cut Long Pipe respectively from CAEPIPE to CAESAR II.

Beam

Since CAESAR II does not have the provision to store the information of Beam Element into batch input file (.cii), Translator cannot transfer the Beam Element details from CAEPIPE.

Tie Rod

Transfers the Tie Rod as Rigid Element to CAESAR II with weight of the Rigid Element as 0.

Comment

Comments from CAEPIPE are ignored during the conversion.

Hydrotest Load

Transfers the Hydrotest Load as "Hydro Pressure" to CAESAR II.

5.2 Data Types

Anchor

Transfers Anchor as Restraints to CAESAR II. The following are the algorithm used for transferring the Anchor details from CAEPIPE to CAESAR II.

1. Transfers Rigid Anchor (Rigid in all the six degrees of freedom) as "ANC" restraint to CAESAR II.
2. Transfers Rigid Anchor with Displacement as "ANC" Restraint to CAESAR II and creates a virtual connected node with the available free number (1 to 32000) in CAESAR II and writes the displacements defined for each temperature in CAEPIPE (T1 to T9) to vector 1 through 9 of CAESAR II. The displacements defined under the T10, Seismic and Settlement will be ignored and NOT written to CAESAR II at this time. User has to add/create the load combination in CAESAR II before performing the analysis. This is explicitly reported in the .log file.
3. Transfers flexible anchors as six flexible restraints to CAESAR II (X, Y, Z, RX, RY and RZ). The stiffnesses defined in CAEPIPE in the six degree of freedom are written to each restraint type in CAESAR II. Since CAESAR II does not have the provision to write all the restraint types in one element, Translator writes the first four restraints in one element and the balance two restraints are filled in the available free element by clearly indicating the Anchor Node number.
4. Transfers flexible anchors with displacements as listed below
    a. Transfers flexible anchors as six flexible restraints.
    b. Transfers four restraints in one element and the last two restraints on the next available

free element.

c. Creates a unique connection node with the available free number (1 to 32000) and writes the displacement details in the vectors 1 through 9 corresponding to CAEPIPE temperature (T1 through T9).

d. Displacement due to T10, Seismic and Settlement will not be transferred to CAESAR II as CAESAR II does not have provision to define the same. Accordingly Translator will report the message into the .log file.

e. Writes the same CNODE number to all the six flexible restraints.

5. Transfers flexible anchors and displacements defined in Local Coordinate System (LCS) as follows.

   a. Transfers flexible anchors as six flexible restraints in Global coordinate system and report the same in to the log file.

   b. Transfers four restraints in one element and the last two restraints on the next available free element.

   c. Creates a unique connection node with the available free number (1 to 32000) and writes the displacement details in Global coordinates in the vectors 1 through 9 corresponding to CAEPIPE temperature (T1 through T9) and notify the user by writing the message in to the log file.

   d. Displacement due to T10, Seismic and Settlement will not be transferred to CAESAR II as CAESAR II does not have provision to define the same. Accordingly Translator will report the message into the .log file.

   e. Writes the same CNODE number to all the six flexible restraints.

Branch SIF

Transfers Branch SIF as SIF & TEES to CAESAR II. The table below shows the CAEPIPE Branch SIF and the corresponding CAESAR II SIF & TEES.

Branch SIF in CAEPIPE	SIF & TEES in CAESAR II	Internal Ref. number in CAESAR II
Welding Tee	Welding Tee	3
Reinforced Fabricated Tee	Reinforce Fabricated Tee	1
Unreinforced Fabricated Tee	Unreinforced Fabricated Tee	2
Weldolet	Weldolet	5
Extruded Welding Tee	Extruded Welding Tee	6
Sweepolet	Sweepolet	4
Branch Connection	Full Encirclement	17

Concentrated Mass (CMASS)

Transfers CMASS as Rigid Element with 0.1mm length. CAESAR II does not have a separate element to define a concentrated mass and hence the Translator simulates the CMASS as a Rigid Element in CAESAR II. The following is the algorithm used for transferring the CMASS to CAESAR II.

a. Since CMASS in CAEPIPE is defined as a nodal property and does not have physical length the Translator assumes the length as 0.1mm for the simulated Rigid Element in CAESAR II.

b. The length thus assumed is then adjusted by reducing the length of the preceding element by 0.1mm.

c. Translator will not transfer the CMASS information to CAESAR II, if the preceding element is a Bend and will be reported to .log file.

d. Translator will not transfer the CMASS details to CAESAR II, if there is no preceding element (i.e. CMASS placed at the disconnected “From” node) and will be reported to the .log file.

Constant Support

Transfers Constant Support as Hanger to CAESAR II by specifying a very small allowable travel. (i.e. 0.1 in) as stated in Chapter 3, Restraints of CAESAR II – Applications Guide.

Flange

Transfers Flange as Rigid Element to CAESAR II. The following is the algorithm used to transfer the flange details to CAESAR II.

a. Since Flange in CAEPIPE is defined as a nodal property and does not have physical length, Translator assumes the length as 0.1mm for the simulated Rigid Element in CAESAR II.

b. The length thus assumed is then adjusted by reducing the length of preceding element by 0.1mm.

c. Translator will not transfer the flange details to CAESAR II, if the preceding element is a Bend and will be reported to .log file.

d. Translator will not transfer the flange details to CAESAR II, if there is no preceding element (i.e. flange placed at the disconnected “From” node) and will be reported to the .log file.

Force

Transfers Force as Force/Moment to CAESAR II. Translator writes the Force information to CII as follows.

a. If the number of thermal loads in CAEPIPE is less than 4 and the Force/Moment is defined as part of Sustained load, then Translator writes the Force/Moment information to vector 4 of CAESAR II input with Temperature 4 as Reference temperature of CAPIPE and Pressure 4 as maximum pressure among P1, P2 and P3 of CAEPIPE.

b. On the other hand, if the force is defined as part of Expansion Load, then it will be written to the corresponding vector of Force/Moment input of CAESAR II. **User has to create a separate load combination to view the results along with Force/Moment load in CAESAR II. Refer CAESAR II documentation for more info on creating load combinations**.

Force Spectrum Load

Translator will not transfer the force spectrum load to CAESAR II, as its batch input does not support this feature.

Guide

Transfers Guide as Guide/Restraints to CAESAR II. The following is the algorithm used for transferring the Guide details to CAESAR II.

a. Transfer as double-acting restraints with or without specified gap.

b. Guide placed in the horizontal or skewed pipe will be transferred as two restraints orthogonal to pipe axis.

c. Guide placed in the vertical pipe will be transferred as “Guide” in CAESAR II.

Generic Support

Generic Support from CAEPIPE will not be transferred to CAESAR II as CAESAR II does not have an equivalent element. Accordingly, Translator writes them in log file to notify the users.

Hanger

Transfers Hanger as Hanger to CAESAR II. Since the hanger selection algorithm of CAEPIPE is slightly different from the CAESAR II, it was observed during the Verification and Validation of the Translator (see Section 7.0) that the results produced by CAEPIPE and CAESAR II is different (i.e., for the test problems reported in Section 7.0, CAESAR II selected the smallest single spring that satisfies all design requirements, whereas CAEPIPE selected the larger spring to be on more conservative side, if two or more spring options are feasible). Hence, at this time, in order to obtain almost identical results from CAEPIPE and CAESAR II for a typical piping problem with hangers, we recommend the user of this Translator to manually model the "hanger" (i.e., the internally selected variable spring hanger) of CAEPIPE as a "User-defined hanger" in CAESAR II input file with the values for "Hot Load" and "Spring Rate" as those reported in the Hanger Report of CAEPIPE. Refer Appendix D for details on entering the "Hot Load" and "Spring Rate" manually to CAESAR II.

Hangers in CAEPIPE	Hangers in CAESAR II	Internal Ref. Number
ABB-PBS	Not Available	
Basic Engineers	Basic Engineers	10
Bergen-Paterson	Bergen Power	2
Bergen-Paterson (L)	Bergen Power	2
BHEL Hyderabad	BHEL	14
BHEL Trichy	BHEL	14
Borrello	Not Available	
Carpenter & Paterson	Carpenter & Paterson	16
Comet	Comet	17
Corner & Lada	Not Available	
Dynax	Not Available	
Elcen	Not Available	
Fee & Mason	Not Available	
Flexider	Flexider	15
Fronek	Fronek	6
Grinnell	PSS-Grinnell	1
Hydra	Hydra	18
Lisega	Lisega	5
Mitsubishi	Not Available	
Myricks	Myricks	20
NHK	Not Available	
Nordon	Not Available	
Piping Services	Piping Services	9
Piping Tech & Products	Piping Technology	7
Sanwa Tekki	Not Available	
Sarathi	Sarathi	19
Spring Supports	Not Available	
SSG	Not Available	

Please note, if the corresponding Hanger Catalog for CAESAR II is not available, the Translator replaces the same with CAESAR II Hanger selected from the list through "Options->Default CII Hangers and Materials" of the KP2CII Translator.

Harmonic Load

Translator will not transfer the harmonic load to CAESAR II as the batch input does not support this feature.

Jacketed End Cap

At this time, Translator will not transfer the Jacketed End Cap to CAESAR II.

Limit Stop

Transfers Limit Stop as Single/Double acting Restraint to CAESAR II. The following is the algorithm used in transferring the Limit Stop to CAESAR II. For clarity, assume the direction of Limit Stop as Global Y (i.e., 0,1,0)

a. If the Upper Limit is "NONE" and the Lower Limit >= 0 in CAEPIPE, then the Translator will transfer as "+Y" Restraint in CAESAR II with gap as specified in Lower Limit of CAEPIPE.

b. If the Upper Limit >=0 and the Lower Limit is "NONE" in CAEPIPE, then the Translator will transfer as "-Y" Restraint in CAESAR II with gap value as specified in Upper Limit of CAEPIPE.

c. If the Upper Limit > 0 and Lower Limit < 0, then the Translator will transfer as "+Y" restraint with gap as absolute value specified in Lower Limit and "-Y" restraint with gap as absolute value specified in Upper Limit.

d. If the Upper Limit >0 and the Lower Limit > 0, then the Translator will transfer as "Y" restraint without gap and the same will be reported to the .log file.

e. If the Upper Limit < 0 and Lower Limit < 0, then the Translator will transfer as "Y" restraint without gap and the same will be reported to the .log file.

Nozzle

Transfers Nozzle as Nozzle to CAESAR II. Transfers both WRC – 297 and API 650 Nozzle from CAEPIPE to CAESAR II.

Restraint

Transfers restraint as double-acting Restraint to CAESAR II. The types of restraint transferred from CAEPIPE to CAESAR II are listed below.

a. Transfers "X" restraint as "X" restraint in CAESAR II with stiffness as rigid.

b. Transfers "Y" restraint as "Y" restraint in CAESAR II with stiffness as rigid.

c. Transfers "Z" restraint as "Z" restraint in CAESAR II with stiffness as rigid.

Rod Hanger

Transfers Rod Hanger as single-acting Restraint to CAESAR II. If "Y" axis is vertical in CAEPIPE, then the Translator will transfer the Rod Hanger as "+Y" restraint to CAESAR II. If the "Z" axis is vertical in CAEPIPE, then the Translator will transfer the Rod Hanger as "+Z" restraint to CAESAR II.

Skewed Restraint

Transfers Skewed Restraint as double-acting Restraints to CAESAR II with stiffnesses identical to CAEPIPE stiffnesses.

The following are the restraint type used for transferring from CAEPIPE to CAESAR II.

a. Transfers as "X" restraint, if the direction is (1,0,0) and the type="Translational"

b. Transfers as "Y" restraint, if the direction is (0,1,0) and the type="Translational"

c. Transfers as "Z" restraint, if the direction is (0,0,1) and the type="Translational"

d. Transfers as "X(Xcomp,Ycomp,Zcomp), if the direction is skewed and the type = "Translational"

e. Transfers as "RX" restraint, if the direction is (1,0,0) and the type="Rotational"

f. Transfers as “RY” restraint, if the direction is (0,1,0) and the type=”Rotational”

g. Transfers as “RZ” restraint, if the direction is (0,0,1) and the type=”Rotational”

h. Transfers as “RX(Xcomp,Ycomp,Zcomp), if the direction is skewed and the type = “Rotational”

Snubber

Transfers Snubber as Directional Snubber (Restraint) to CAESAR II.

a. Transfers as “XSNB(1,0,0)” restraint, if the direction is 1,0,0

b. Transfers as “XSNB(0,1,0)” restraint, if the direction is 0,1,0

c. Transfers as “XSNB(0,0,1)” restraint, if the direction is 0,0,1

d. Transfers as “XSNB(Xcomp,Ycomp,Zcomp), if the direction is skewed.

Spider

Transfers Spider as Spider to CAESAR II.

Threaded Joint and Weld

Transfers Threaded Joint and Weld as SIF & TEES to CAESAR II. The following are the types of Threaded Joint and Weld in CAEPIPE and the corresponding SIF & TEES in CAESAR II.

Threaded Joint and Weld n CAEPIPE	SIF & TEES in CAESAR II
Threaded Joint	Threaded Joint
Buttweld	Buttweld
Fillet Weld	Double weld
Tapered	Tapered
Concave	Lap Joint

User SIF

Transfers User SIF as SIF & TEES to CAESAR II. Transfers the value of Inplane SIF and Outplant SIF to CAESAR II with intersection type code as “Null”.

Material

Translator checks the description of the material entered in CAEPIPE with the field “CAEPIPEmat” of table “material” from the Material Mapping DB (material.mdb) supplied along with the software to identify the corresponding CAESAR II material. Please note, if the CAESAR II material corresponding to the material description entered in CAEPIPE is not available in the mapping DB, then by default, the Translator will transfer the CAESAR II material selected from the list through “Options->Default CII Hanger and Material” from KP2CII. User can add new description to this table, to enable the transfer of user-defined material from CAEPIPE to CAESAR II. Refer Appendix A for details on modifying the Material Mapping DB and Hanger Mapping DB.

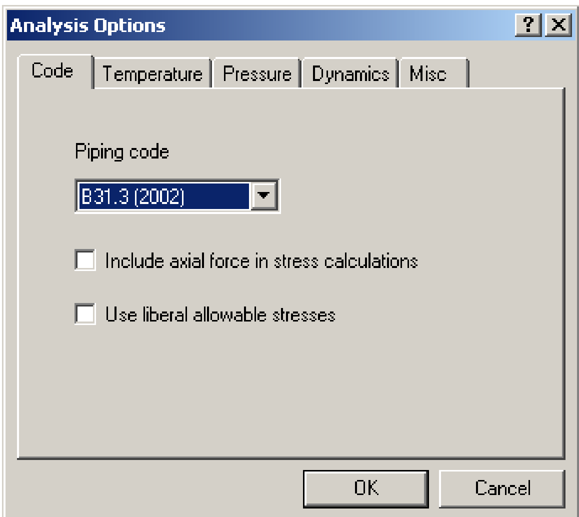
6.0 Points to be considered while comparing results

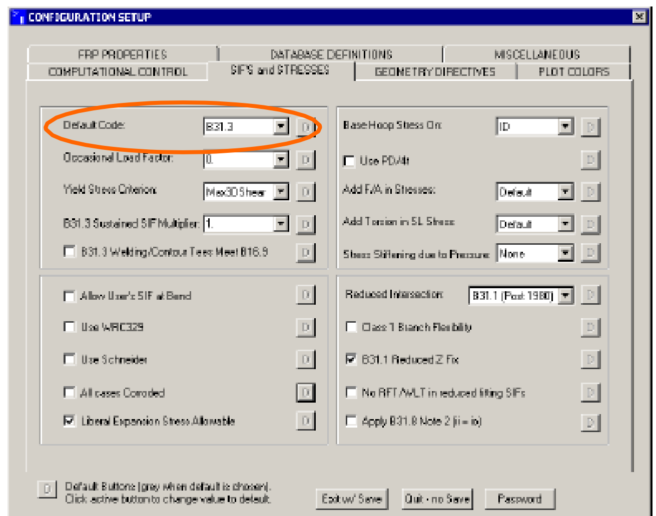
The most important task to be performed for producing identical results between CAEPIPE and CAESAR II is to configure manually in CAESAR II the analysis option inline with CAEPIPE analysis option. Since CAESAR II batch input does not have the provision to store this information, the Translator cannot transfer these options electronically. This section describes in detail about setting the analysis options in CAESAR II configuration file identical to those options set in CAEPIPE.

The following are the steps to be followed to set the analysis options in CAESAR II corresponding to CAEPIPE analysis options.

6.1 Code

On this tab you can choose the piping code and also set options for that piping code.



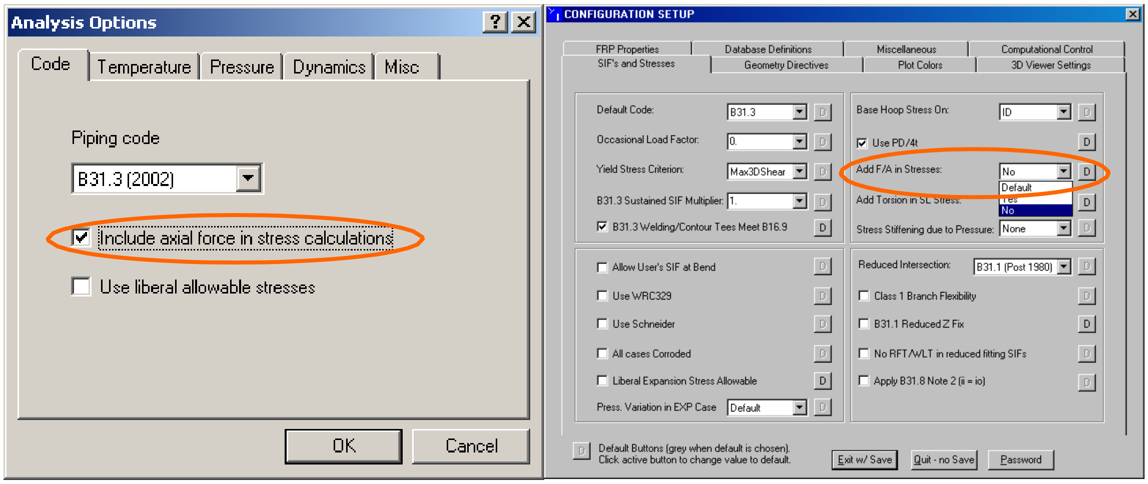


a. The left figure above shows the analyses option related to code. The piping code to be used for performing analysis can be selected from the "Piping code" drop-down combo box of CAEPIPE. The following is the procedure in CAESAR II to select the Piping Code corresponding to CAEPIPE.

   1. From the “Tools” menu, select “Configure/Setup”
   2. Select the tab “SIF’s and Stresses”
   3. From the “Default Code” drop-down combo box, select the Piping Code corresponding to CAEPIPE Piping Code.

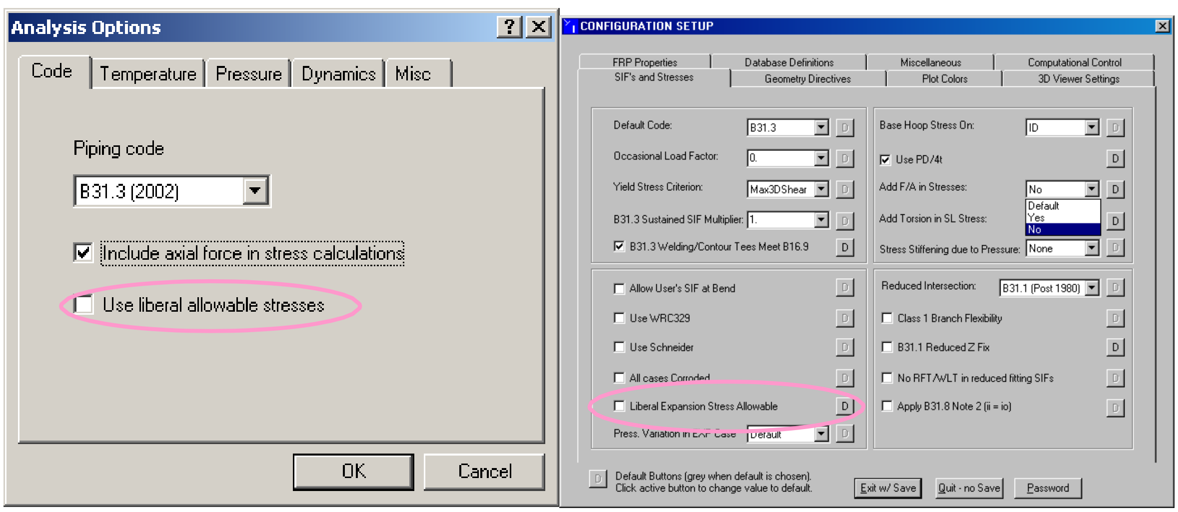
b. The analysis option in CAESAR II corresponding to CAEPIPE “Include axial force in stress calculations” as shown in left figure below can be set as follows

   1. From the “Tools” menu, select “Configure/Setup”
   2. Select the tab “SIF’s and Stresses”
   3. From the “ADD F/A in Stresses” drop-down combo box, select the option “No” if it is turned off in CAEPIPE and select the option “Yes” if it is turned on in CAEPIPE as shown in right figure below.



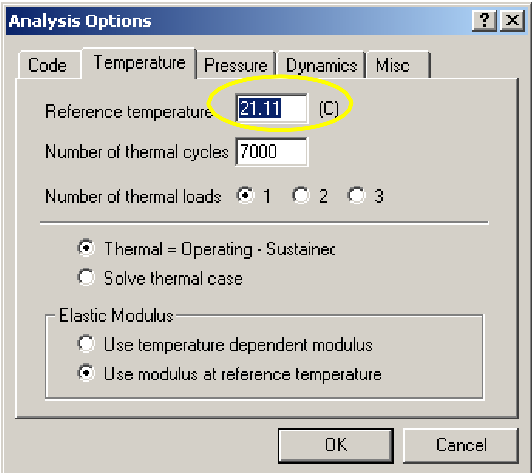
c. The analysis option in CAESAR II corresponding to CAEPIPE “Use liberal allowable stresses” as shown in left figure below can be set as follows

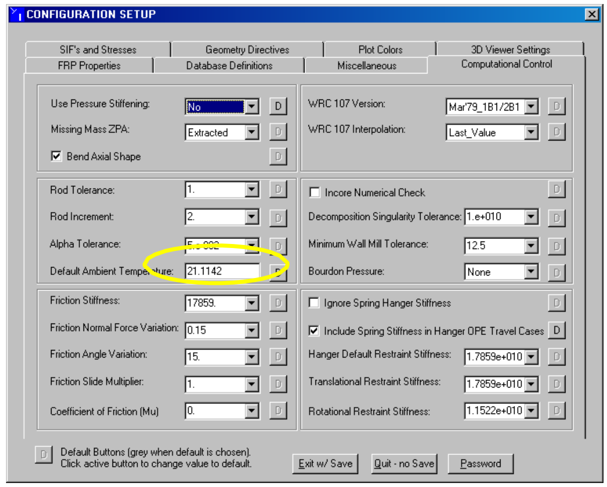
1. From the “Tools” menu, select “Configure/Setup”
2. Select the tab “SIF’s and Stresses”
3. “Uncheck” the option “Liberal Expansion Stress Allowable”, if it is turned off in CAEPIPE and “Check” the option, if it is turned on in CAEPIPE.



6.2 Temperature

On this tab you can set the options related to thermal loads



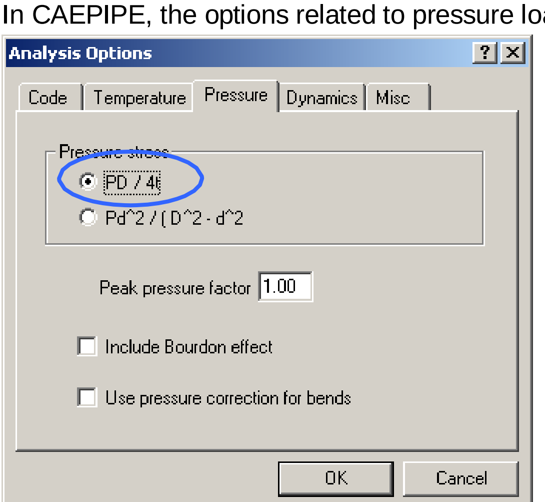


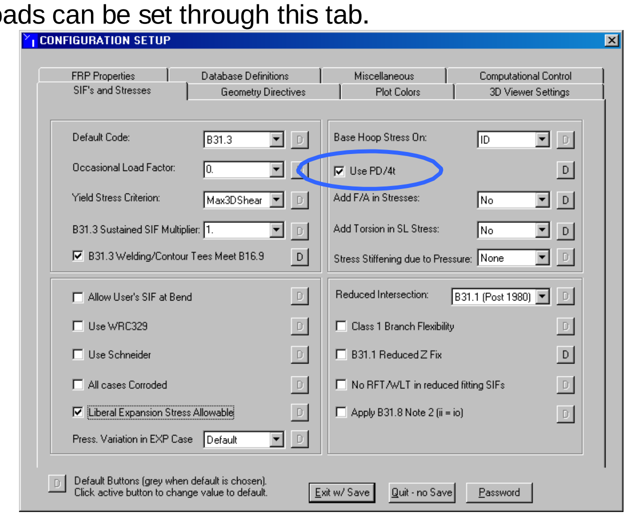
a. The analysis option in CAESAR II corresponding to CAEPIPE "Reference temperature" as shown in left figure above can be set as follows

1. From the "Tools" menu, select "Configure/Setup"
2. Select the tab "Computational Control"
3. Enter the "Reference temperature" of CAEPIPE at the "Default Ambient Temperature" as shown in right figure above.

6.3 Pressure

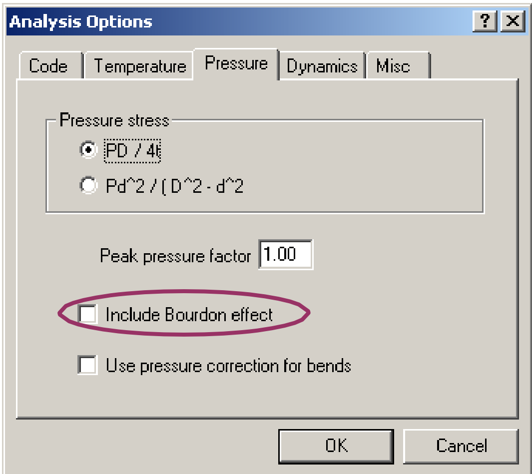
In CAEPIPE, the options related to pressure loads can be set through this tab.

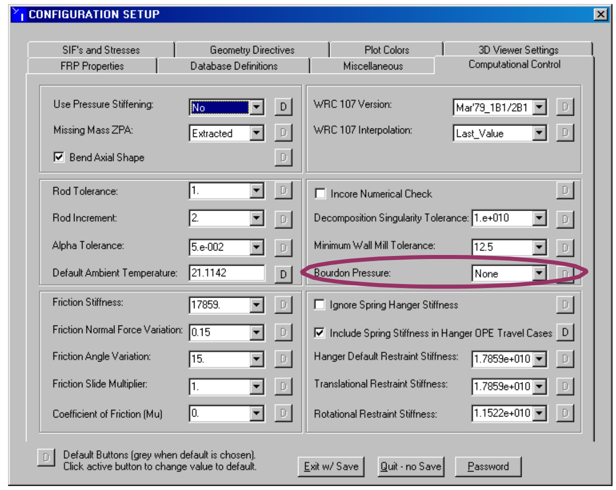




a. The analysis option in CAESAR II corresponding to CAEPIPE "PD/4T" as shown in left figure above can be set as follows

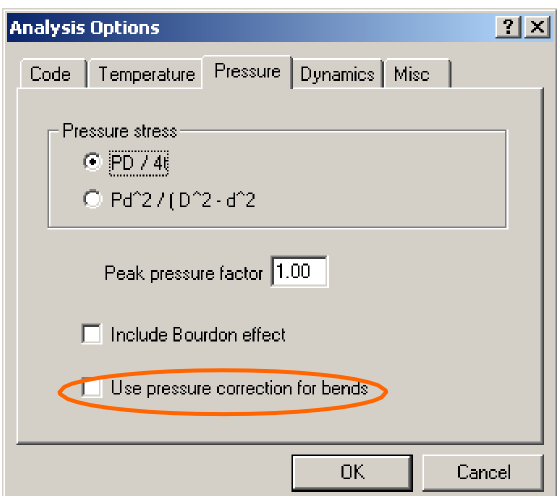
1. From the "Tools" menu, select "Configure/Setup"
2. Select the tab "SIF's and Stresses"
3. "Check" the option "Use PD.4t" as shown in right figure above, if the radio button "PD/4T" is selected in CAEPIPE.

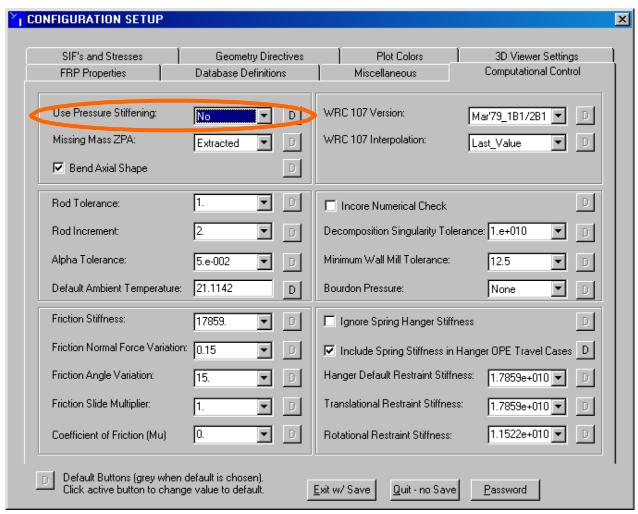




b. The analysis option in CAESAR II corresponding to CAEPIPE "Include Bourdon Effect" as shown in left figure above can be set as follows

1. From the "Tools" menu, select "Configure/Setup"
2. Select the tab "Computational Control"
3. Select the option "None" from "Bourdon Pressure" as shown in right figure above, if it is "Unchecked" in CAEPIPE and select the option "Trans + Rot", if it is "Checked" in CAEPIPE.



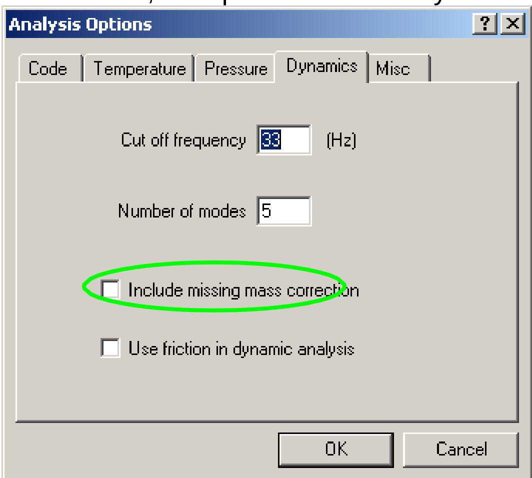


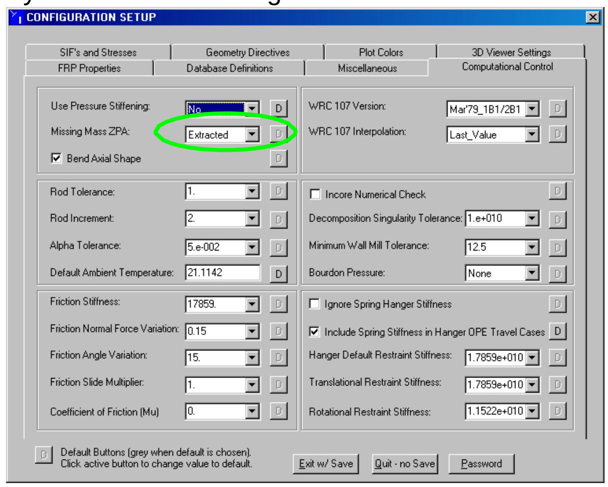
c. The analysis option in CAESAR II corresponding to CAEPIPE "Use pressure correction for bends" as shown in left figure above can be set as follows

4. From the "Tools" menu, select "Configure/Setup"
5. Select the tab "Computational Control"
6. Select the option "No" from "Use Pressure Stiffening" as shown in right figure above, if it is "Unchecked" in CAEPIPE and select the option "Yes", if it is "Checked" in CAEPIPE.

6.4 Dynamics

In CAEPIPE, the options related to dynamic analysis can be set through this tab.



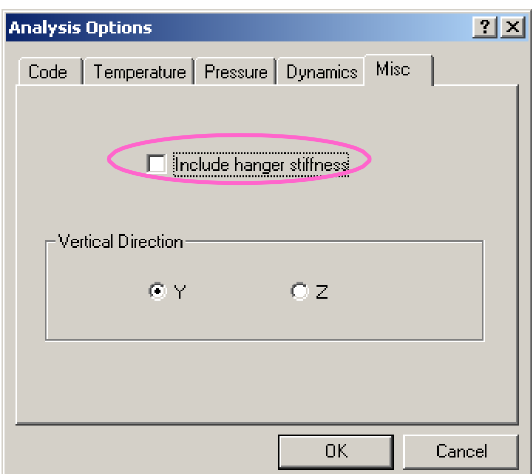


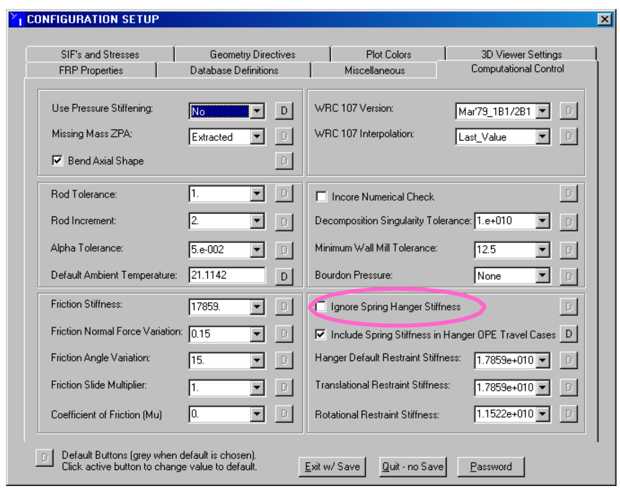
a. The analysis option in CAESAR II corresponding to CAEPIPE "Include missing mass correction" as shown in left figure above can be set as follows

1. From the "Tools" menu, select "Configure/Setup"
2. Select the tab "Computational Control"
3. Select the option "Extracted" from "Missing Mass ZPA" as shown in right figure above, if it is "Checked" in CAEPIPE and select "Spectrum", if it is unchecked in CAEPIPE.

6.5 Miscellaneous

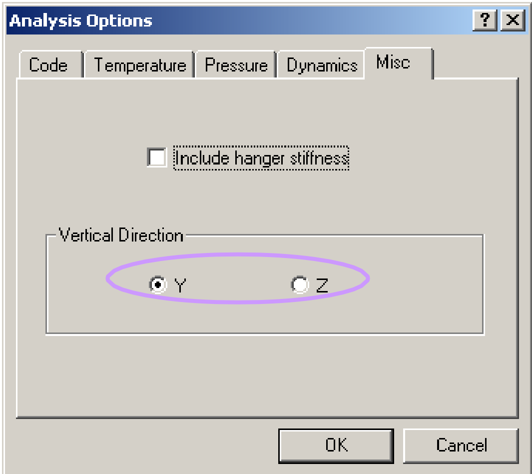
In CAEPIPE, the miscellaneous options can be set through this tab.

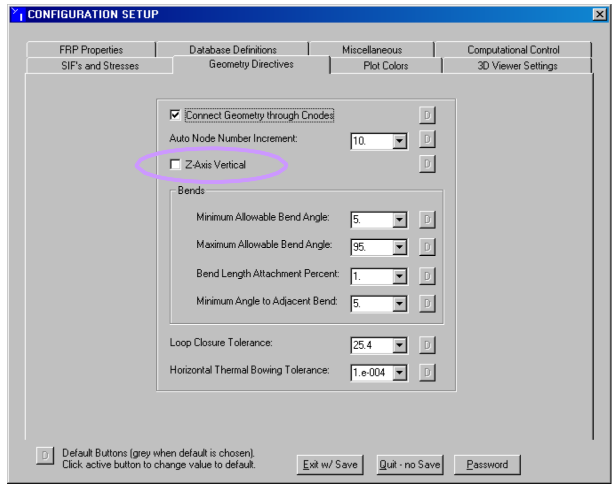




a. The analysis option in CAESAR II corresponding to CAEPIPE "Include hanger stiffness" as shown in left figure above can be set as follows

1. From the "Tools" menu, select "Configure/Setup"
2. Select the tab "Computational Control"
3. "Uncheck" the option "Ignore Spring Hanger Stiffness" as shown in right figure above, if it is "Checked" in CAEPIPE and "Check" in CAESAR II, if it is "Unchecked" in CAEPIPE.





b. The analysis option in CAESAR II corresponding to CAEPIPE "Vertical Direction" as shown in left figure above can be set as follows

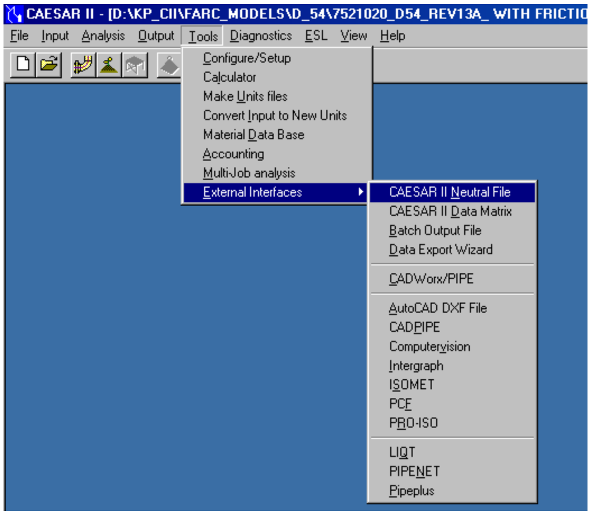
1. From the "Tools" menu, select "Configure/Setup"
2. Select the tab "Geometry Directives"
3. "Uncheck" the option "Z-Axis Vertical" as shown in right figure above, if the radio button "Y" is selected in CAEPIPE and "Check" in CAESAR II, if the radio button "Z" is selected in CAEPIPE.

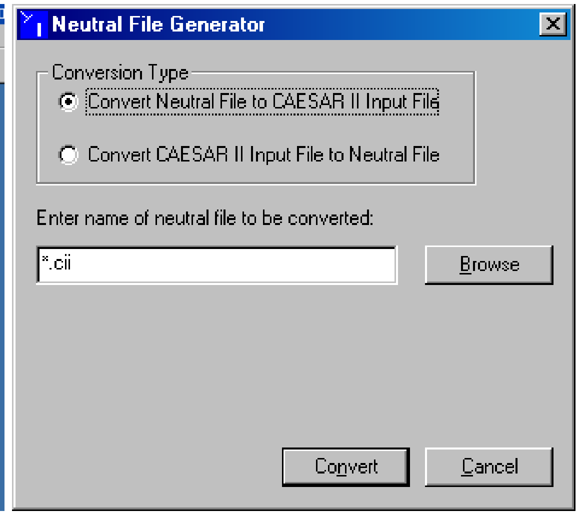
6.6 Adding missing information to CAESAR II

To produce identical results between CAEPIPE and CAESAR II, additional information may need to be input into CAESAR II model before analysis. During the transfer of CAEPIPE model file to CAESAR II, the Translator will clearly report the missing items/information to ".log" file. The primary name of the log file is identical to primary name of the batch input file ".cii" entered during the transfer. In addition, the log file will be stored in the same directory, where the path of the batch input file ".cii" is entered during the transfer. The information stored in this log file should be read carefully by the user of the Translator and should be added to the CAESAR II input. Failing to do so will affect the results and will lead to mismatch in the results between the software.

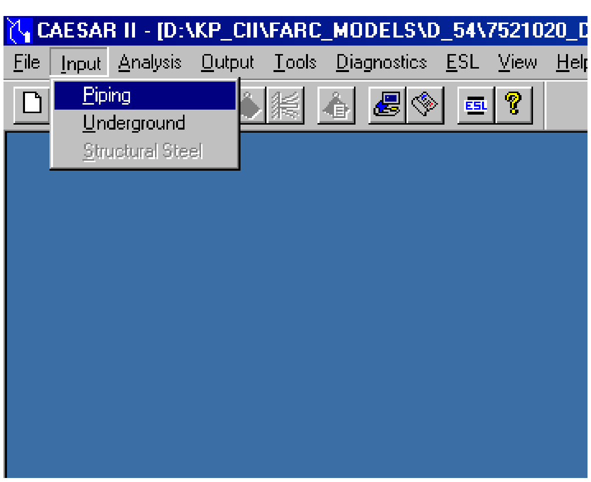
The following is the procedure to add the missing items, if the user finds a message in log file as "FLANGE at Node 10 with mass 55.000 kg is not transferred".

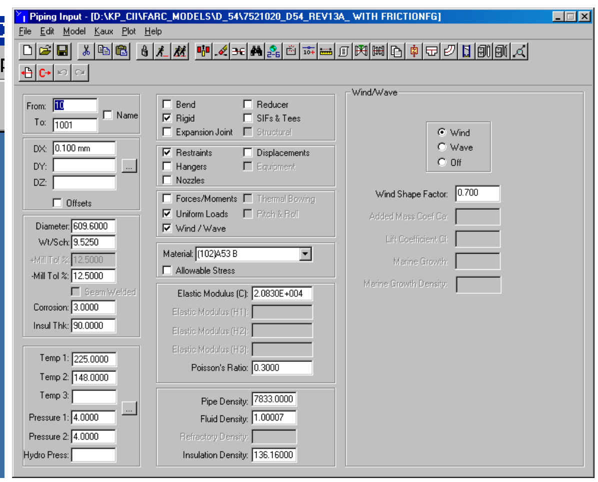
1. Import and convert the batch input file ".cii" created using the Translator into CAESAR II binary format through "Tools->External Translators->CAESAR II Neutral File" as shown in left figure below.
2. From the figure shown in right below, select the radio button "Convert Neutral File to CAESAR II Input File" and then press the button "Browse" and select the ".cii" file.



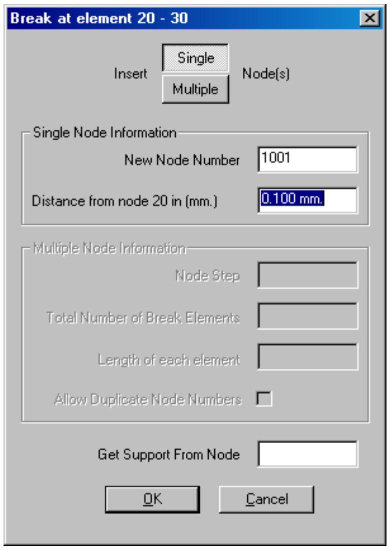


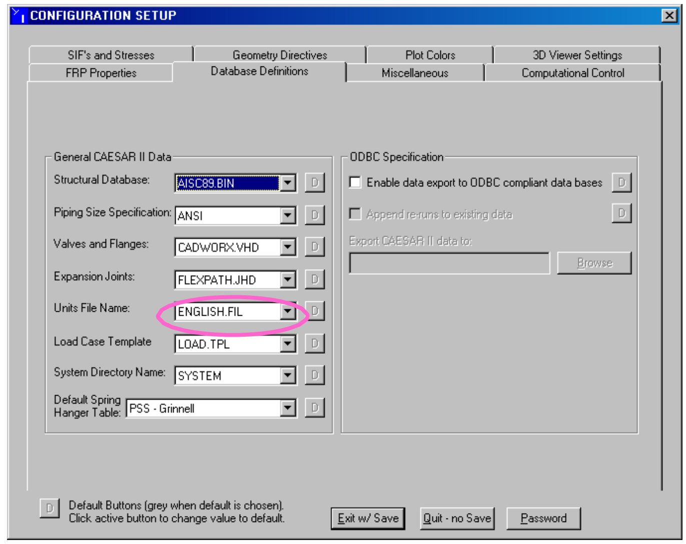
3. Upon successful conversion, the user will get a message “The conversion was completed successfully”.
4. Now, open the binary file (._A) through “File->Open”.
5. From the “Input” menu, select piping as shown in the figure below.





6. Navigate to the required element. In this case node number 10.
7. Press the icon “Break”. You will see a dialog box as shown in figure below.





8. Enter a unique node number at "New Node Number" field and enter the distance as 0.1mm as shown in figure above and press the button "OK".
9. Then from the spread sheet input, double click on "Rigid" check box and enter the weight of the Rigid Element as "55.000" kg as reported in the log file.
10. Similarly, follow the same steps 1 through 9, in case if you find a similar message for Concentrated Mass (CMASS).
11. For other elements/information, refer the CAESAR II – Technical Reference Manual, Applications Manual and User Guide for details on modeling and analysis of certain specific elements.

Note:

Translator transfers the model from CAEPIPE to CAESAR II batch input with UNITS setting corresponding to CAEPIPE units setting. However, for displaying the results, CAESAR II always uses the units setting defined in the unit file (.FIL) of CAESAR II configuration settings as shown in figure above. Hence, to have a identical units in CAESAR II, we recommend you to create a unit file corresponding to CAEPIPE units setting and assign them in the CAESAR II configuration or else change the CAEPIPE units corresponding to CAESAR II defaults units and before viewing/comparing the results.

Refer to Appendix C for details on, how CAESAR II units are mapped against with CAEPIPE units for transferring the model.

7.0 Verification and Validation of Translator

7.1 General

This section provides the comparison results between CAEPIPE and CAESAR II. To study and understand the intricate details of CAESAR II in certain analysis features in both CAEPIPE and CAESAR II and the way it performs the calculations, we categorized the models into two groups.

1. Study Models and
2. Live Project Models

7.2 Study Models

To study and understand the way CAESAR II performs analysis for different types of elements under different loading conditions, 27 problems were modeled manually in-house with an increasing complexity. (i.e., three Elements with simple load condition at the beginning and with a number of elements with complex loading conditions at the end).

The analyses were performed in both the software and the results thus obtained were compared against each other. Models in CAESAR II were fine-tuned to eliminate the mismatching of results and re-performed the analyses. The knowledge gathered from the above study was then used as the algorithm for developing the Translator.

To test the implemented algorithm, the models were then transferred electronically to CAESAR II and the analyses were performed again. The results thus obtained were compared against the manually modeled CAESAR II models and then with the CAEPIPE results. It was observed during the comparison that the results were identical between CAEPIPE and CAESAR II. The results are listed below for your reference.

Note:

The models chosen for testing and comparing the 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 "Hot Load" and the "Spring Rate" obtained from the hanger results report of CAEPIPE were entered manually at the "Cold Load" and "Spring Rate" fields of CAESAR II hanger input to get identical results between CAEPIPE and CAESAR II. Hence we recommend you to input the above said parameters manually to CAESAR II before performing the analysis, if you recreate the ".cii" file using the Translator for your testing. We also recommend you to add the missing items/information reported in the log file to the CAESAR II binary model before performing the analysis.

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.

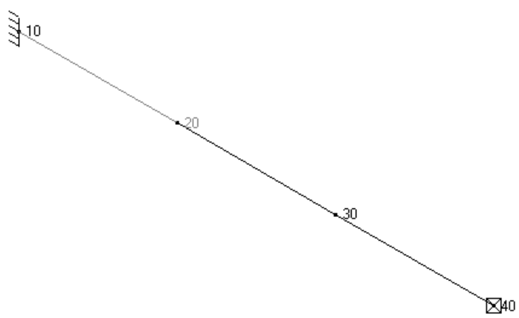
b. Rigid anchor at node 10.

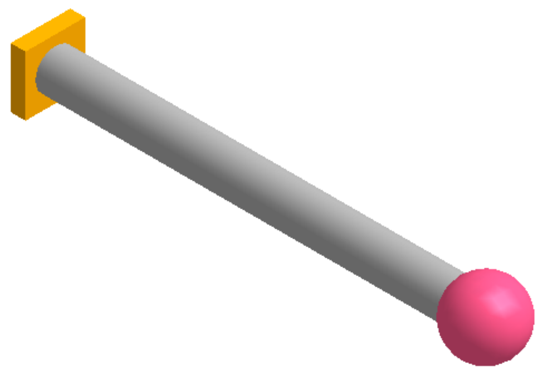
c. Concentrated mass of 1000 kg at node 40.

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 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^0c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

Total Weight (Kg)	
CAEPIPE	1000
CAESAR II	1000

Support Load (Sustained)

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-1000	0	0	0	-3000
CAESAR II	10	0	-1000	0	0	0	-2998.8

Operating Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-1000	0	0	0	-3000
CAESAR II	10	0	-1000	0	0	0	-2998.8

Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	7.586	7.584
2	7.586	7.584

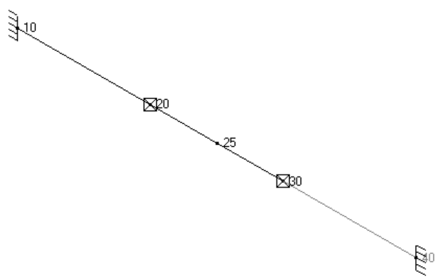
About Model-002

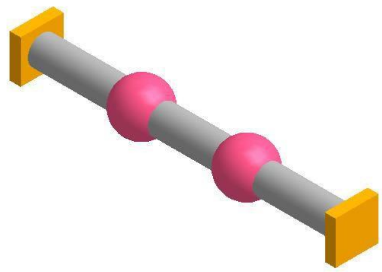
This model shown below is the same as Model-001 above, with the following modifications.

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 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^0c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	1000						
CAESAR II	1000						
Support Load (Sustained)							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-500	0	0	0	-333
CAESAR II	10	0	-500	0	0	0	-333.2
CAEPIPE	40	0	-500	0	0	0	333
CAESAR II	40	0	-500	0	0	0	333.2
Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-384383	-500	0	0	0	-333
CAESAR II	10	-384240	-500	0	0	0	-333.2
CAEPIPE	40	384383	-500	0	0	0	333
CAESAR II	40	384240	-500	0	0	0	333.2

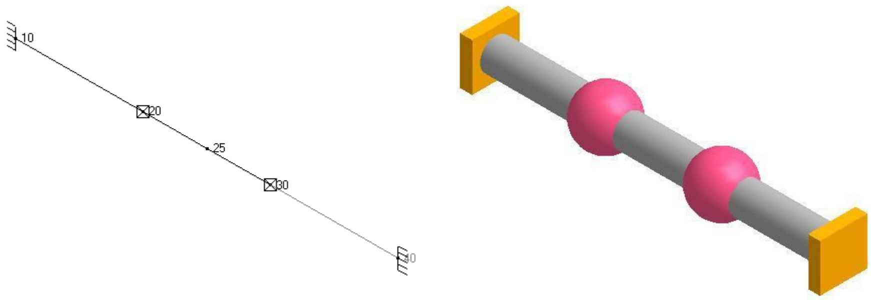
Frequencies (in Hz)

Mode Number	CAEPIPE	CAESAR II
1	70.777	70.764

About Model-003

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

d. 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.

e. 

Name of the Model	Model – 003

Analysis Options in CAEPIPE	
1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^{0}c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

Total Weight (Kg)	
CAEPIPE	1000
CAESAR II	1000

Support Load (Sustained)

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-500	0	0	0	-13
CAESAR II	10	0	-500	0	0	0	-13
CAEPIPE	40	0	-500	0	0	0	13
CAESAR II	40	0	-500	0	0	0	13

Operating Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-2264	-500	0	0	0	-13
CAESAR II	10	-2263	-500	0	0	0	-13
CAEPIPE	40	2264	-500	0	0	0	13
CAESAR II	40	2263	-500	0	0	0	13

Frequencies (in Hz)

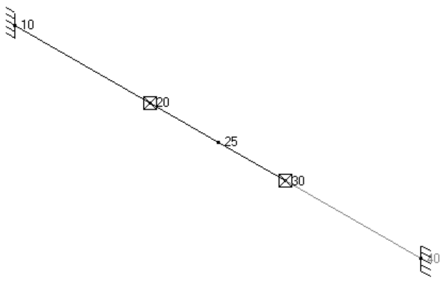
Mode Number	CAEPIPE	CAESAR II
1	18.83	18.823
2	18.83	18.823
3	22.254	22.245

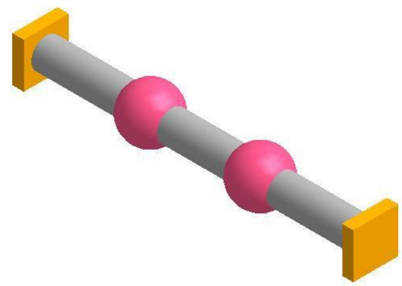
About Model-004

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.





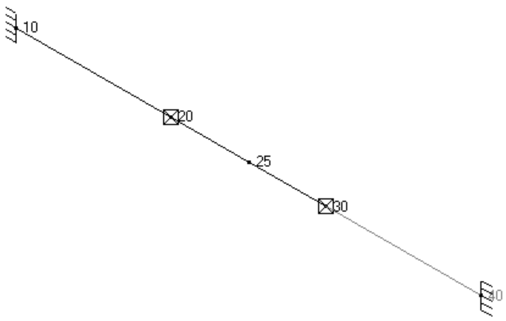
Name of the Model		Model – 004					
Analysis Options in CAEPIPE							
1	Code – B 31.3 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^{0}c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	1140.6						
CAESAR II	1140.6						
Support Load (Sustained)							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-570	0	0	0	-14
CAESAR II	10	0	-570	0	0	0	-14.4
CAEPIPE	40	0	-570	0	0	0	14
CAESAR II	40	0	-570	0	0	0	14.4
Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-2264	-570	0	0	0	-14
CAESAR II	10	-2263	-570	0	0	0	-14.4
CAEPIPE	40	2264	-570	0	0	0	14
CAESAR II	40	2263	-570	0	0	0	14.4

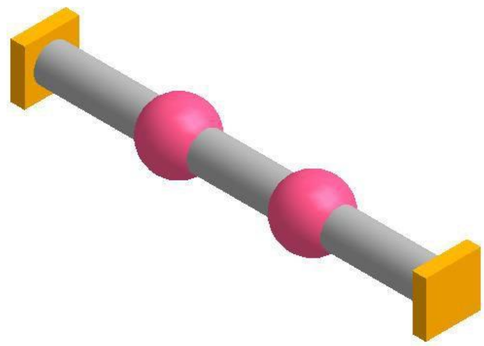
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	17.795	17.788
2	17.795	17.788
3	20.841	20.832

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.





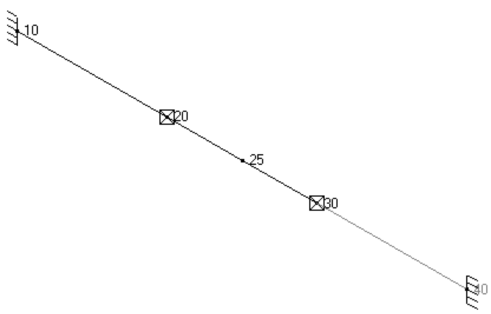
Name of the Model				**Model – 005**			
Analysis Options in CAEPIPE							
1	Code – B 31.3 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^0c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	1279.5						
CAESAR II	1279.7						
Support Load (Sustained)							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-640	0	0	0	-16
CAESAR II	10	0	-640	0	0	0	-15.7
CAEPIPE	40	0	-640	0	0	0	16
CAESAR II	40	0	-640	0	0	0	15.7
Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-2264	-640	0	0	0	-16
CAESAR II	10	-2263	-640	0	0	0	-15.7
CAEPIPE	40	2264	-640	0	0	0	16
CAESAR II	40	2263	-640	0	0	0	15.7

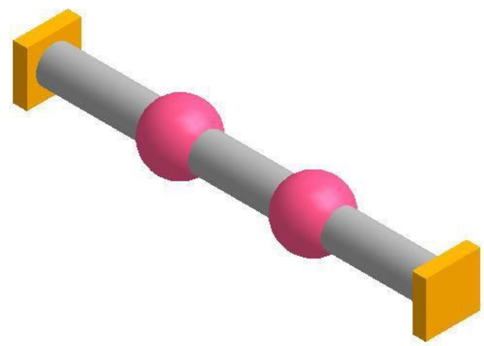
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	16.922	16.914
2	16.922	16.914
3	19.679	19.670

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 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^0c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

Total Weight (Kg)	
CAEPIPE	1566.4
CAESAR II	1566.5

Support Load (Sustained)

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-783	0	0	0	-19
CAESAR II	10	0	-783	0	0	0	-18.5
CAEPIPE	40	0	-783	0	0	0	19
CAESAR II	40	0	-783	0	0	0	18.5

Operating Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-2264	-783	0	0	0	-19
CAESAR II	10	-2263	-783	0	0	0	-18.5
CAEPIPE	40	2264	-783	0	0	0	19
CAESAR II	40	2263	-783	0	0	0	18.5

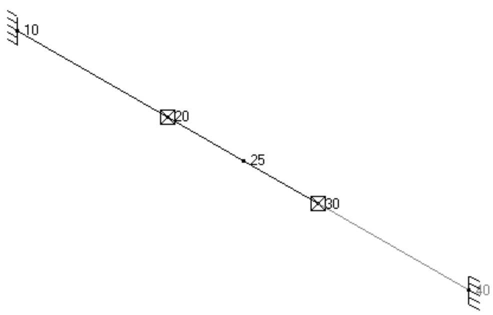
Frequencies (in Hz)

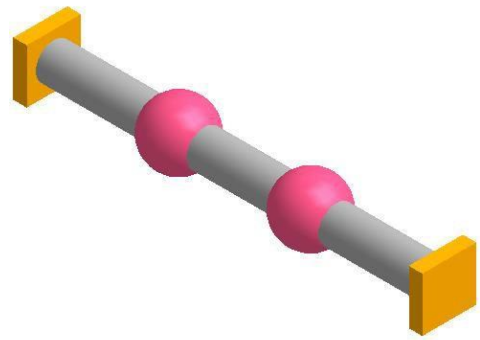
Mode Number	CAEPIPE	CAESAR II
1	15.458	15.452
2	15.458	15.452
3	17.789	17.784

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 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^0c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

Total Weight (Kg)

CAEPIPE	1566.4
CAESAR II	1566.5

Support Load (Sustained)

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-783	0	0	0	-19
CAESAR II	10	0	-783	0	0	0	-18.5
CAEPIPE	40	0	-783	0	0	0	19
CAESAR II	40	0	-783	0	0	0	18.5

Operating Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-2264	-783	0	0	0	-19
CAESAR II	10	-2263	-783	0	0	0	-18.5
CAEPIPE	40	2264	-783	0	0	0	19
CAESAR II	40	2263	-783	0	0	0	18.5

Frequencies (in Hz)

Mode Number	CAEPIPE	CAESAR II
1	15.458	15.452
2	15.458	15.452
3	17.789	17.781

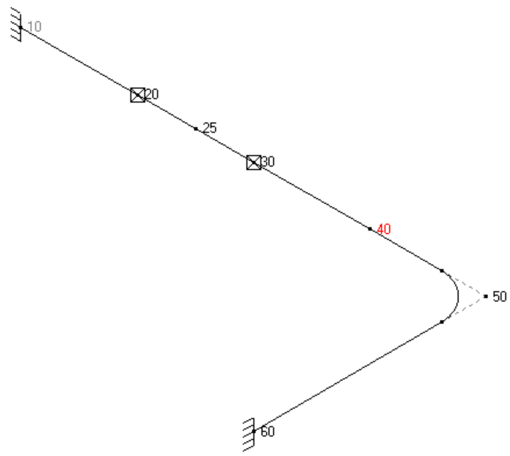
About Model-011

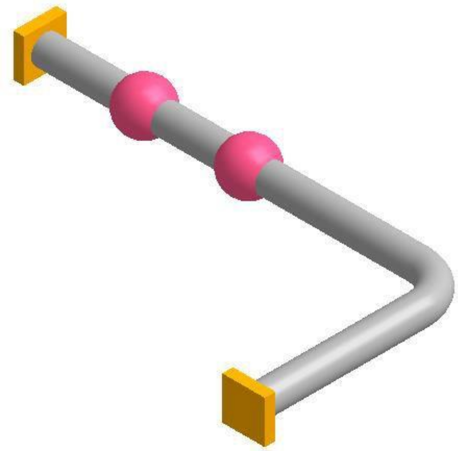
This model shown below is the same as Model-007 above with the following modifications.

a. Long radius bend at node 50.

b. Straight pipe of 2m lengths 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 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^{0}c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	2101.9						
CAESAR II	2101.2						
Support Load (Sustained)							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-1185	0	-669	0	-421
CAESAR II	10	0	-1185	0	-669.3	0	-421
CAEPIPE	60	0	-917	0	-784	0	-308
CAESAR II	60	0	-916	0	-784	0	-308
Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-866	-1185	-413	-669	61	-421
CAESAR II	10	-866	-1185	-413	-669.3	60.9	-421

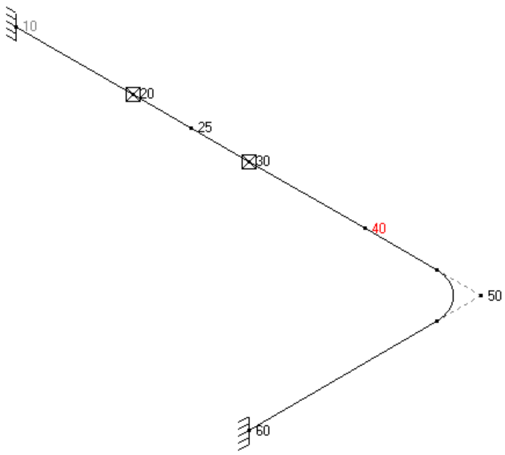
CAEPIPE	60	866	-917	413	-784	-141	-308
CAESAR II	60	866	-916	413	-784	-140.8	-308

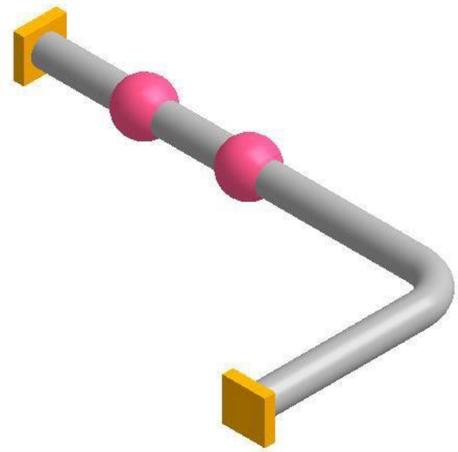
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	3.79	3.784
2	11.819	11.812
3	13.073	13.068
4	19.189	19.151
5	25.437	25.408

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 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^0c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	2101.9						
CAESAR II	2101.2						
Support Load (Sustained)							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	0	-943	0	-47	0	-36
CAESAR II	10	0	-943	0	-47.4	0	-36.2
CAEPIPE	60	0	-1159	0	-1890	0	276
CAESAR II	60	0	-1158	0	-1890	0	275.6
Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-3403	-943	-457	-47	69	-36
CAESAR II	10	-3402	-943	-457	-47.4	69	-36.2
CAEPIPE	60	3403	-1159	457	-1890	-5045	276
CAESAR II	60	3402	-1158	457	-1890	-5044.1	275.6

Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	12.556	12.55
2	14.430	14.422
3	18.485	18.474
4	29.96	29.884

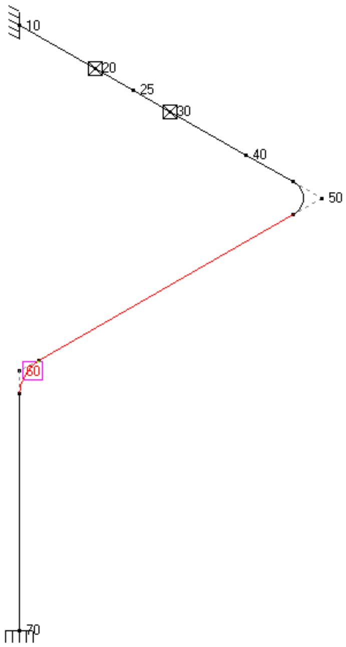
About Model-013

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 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^{0}c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

Total Weight (Kg)	
CAEPIPE	3025.4
CAESAR II	3025.9

Support Load (Sustained)

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	10	-1397	-86	-350	75	-432
CAESAR II	10	10	-1397	-86	-350.4	75.1	-431.8
CAEPIPE	70	-10	-1628	86	-2210	309	-1114
CAESAR II	70	-10	-1628	86	-2209.5	308.8	-1113.7

Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-441	-1297	-419	-381	169	-386
CAESAR II	10	-440	-1297	-419	-380.8	169.4	-385.7
CAEPIPE	70	441	-1728	419	-1580	-255	-2112
CAESAR II	70	440	-1728	419	-1579.7	-255.1	-2111.3

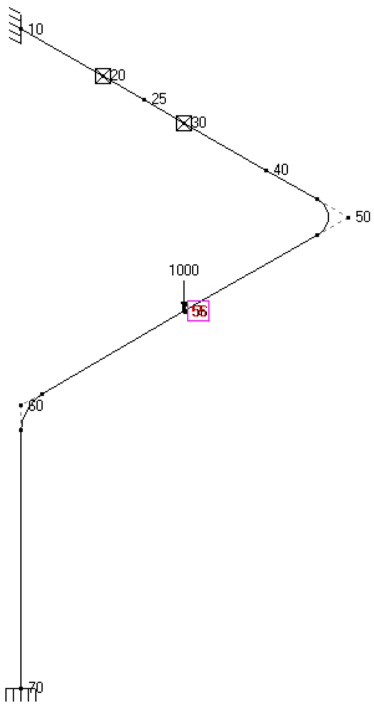
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	3.489	3.482
2	8.133	8.128
3	10.827	10.823
4	12.38	12.354
5	18.177	18.155

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 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^{0}c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	3025.6						
CAESAR II	3026.1						
Support Load (Sustained)							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	16	-1576	-125	-478	110	-602
CAESAR II	10	16	-1576	-125	-477.5	110.2	-601.9
CAEPIPE	70	-16	-2449	125	-3247	457	-1643
CAESAR II	70	-16	-2448	125	-3246.1	456.4	-1642.4

Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-434	-1476	-459	-508	205	-556
CAESAR II	10	-434	-1476	-459	-508	204.6	-555.8
CAEPIPE	70	434	-2549	459	-2617	-107	-2641
CAESAR II	70	434	-2548	459	-2616.3	-107.4	-2640

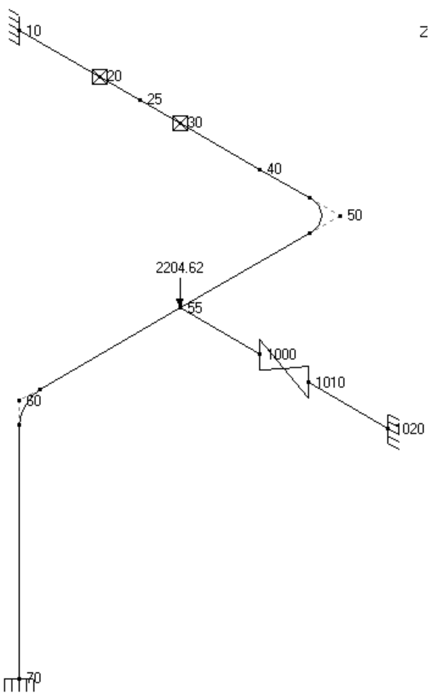
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	3.628	3.623
2	8.172	8.167
3	10.767	10.762
4	13.196	13.182
5	18.395	18.375

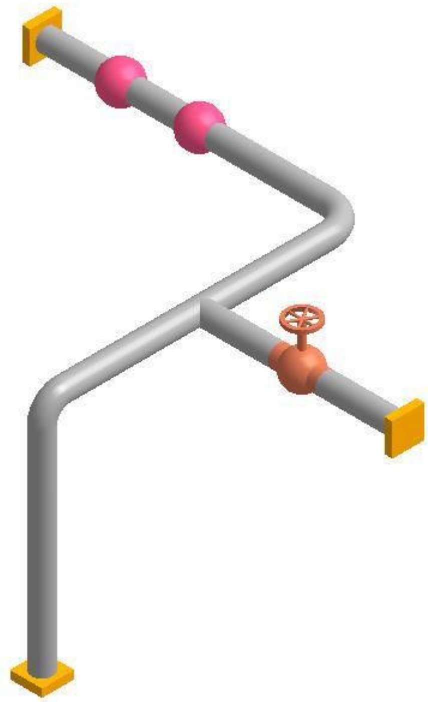
About Model-015

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

a. Two horizontal pipes of length 1m and

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





Name of the Model			Model – 015			
Analysis Options in CAEPIPE						
1	Code – B 31.3 (2016)					
2	Do not Include axial Force in Stress Calculations					
3	Do not use liberal allowable stress					
4	Reference Temperature = 20^{0}c					
5	Number of Thermal Cycles = 7000					
6	Use pd/4t					
7	Do not include bourdon effect					
8	Do not use pressure correction for bends					
9	Do not include missing mass correction					
10	Do not use friction in dynamic analysis					
11	Y – Vertical					
Total Weight (Kg)						
CAEPIPE	3580					
CAESAR II	3579.6					
Support Load (Sustained)						
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	276	-2722	-38	-654	51	-928
CAESAR II	10	276	-2723	-38	-654	51	-928
CAEPIPE	70	311	-2463	659	864	-1064	294
CAESAR II	70	311	-2464	659	864	-1064	293

CAEPIPE	1020	-587	-4912	-622	-9063	-4031	27555
CAESAR II	1020	-587	-4913	-622	-9065	-4032	27564
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-8877	-2744	-1755	-1140	922	-1072
CAESAR II	10	-8877	-2745	-1755	-1140	922	-1075
CAEPIPE	70	-3869	-5363	2575	9779	380	31130
CAESAR II	70	-3869	-5364	2576	9782	380	31134
CAEPIPE	1020	12747	-1990	-820	-17519	-18132	12794
CAESAR II	1020	12747	-1991	-821	-17522	-18135	12801

Frequencies (in Hz)

Mode Number	CAEPIPE	CAESAR II
1	8.030	8.023
2	11.139	11.132
3	16.276	16.264
4	19.010	18.988
5	21.909	21.869

About Model-017

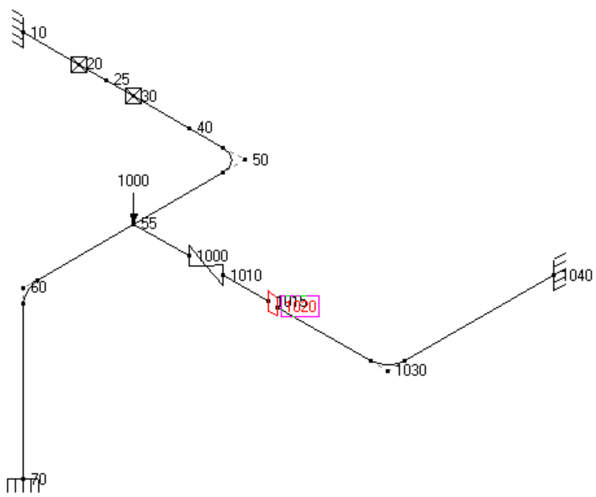
This model shown below is the same as Model-015 above with the following modifications.

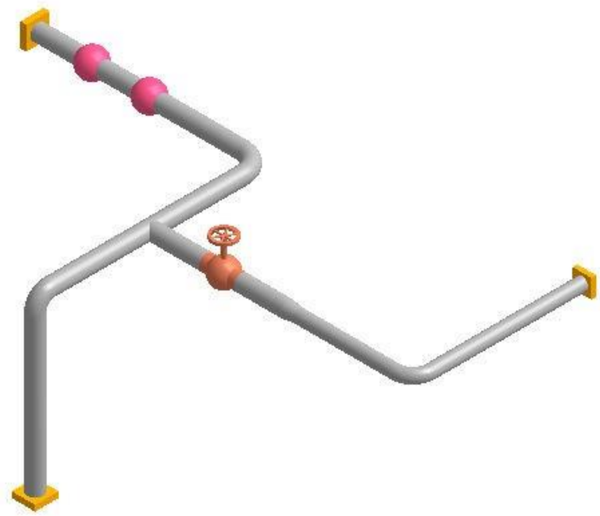
a. Long radius bend at node 1030.

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 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^{0}c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

Total Weight (Kg)	
CAEPIPE	4227.4
CAESAR II	4233.4

Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	30	-3493	-292	-1717	402	-2532
CAESAR II	10	30	-3494	-293	-1718	402	-2533
CAEPIPE	70	-352	-5181	858	-8336	-350	3019
CAESAR II	70	-352	-5182	858	-8340	-349	3019
CAEPIPE	1040	322	-2850	-565	14069	926	4277
CAESAR II	1040	322	-2851	-566	14079	928	4280

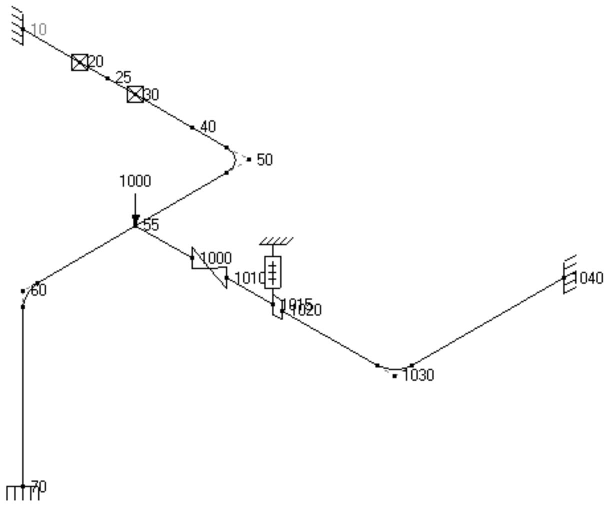
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-2637	-3264	-1233	-1974	996	-2215
CAESAR II	10	-2636	-3264	-1233	-1975	996	-2216
CAEPIPE	70	-1280	-5799	2738	4474	-3080	10017
CAESAR II	70	-1282	-5800	2738	4474	-3080	10022
CAEPIPE	1040	3918	-2461	-1505	10624	25214	3256
CAESAR II	1040	3918	-2462	-1506	10633	25216	3258

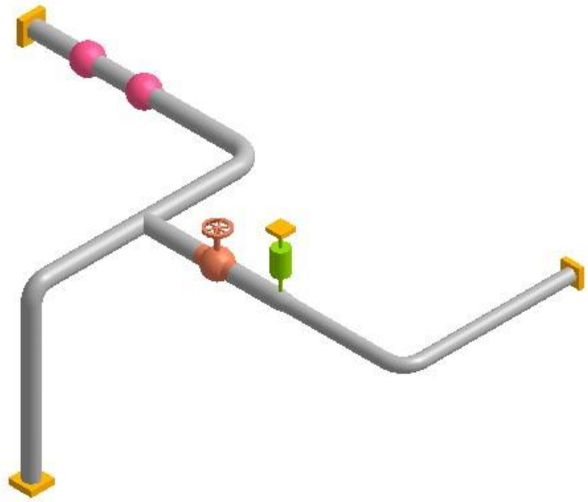
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	4.857	4.849
2	7.941	7.932
3	9.659	9.642
4	10.692	10.663
5	14.637	14.611

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 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^{0}c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	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
CAESAR II	4233.3

Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-190	-3359	-228	-1084	251	-1710
CAESAR II	10	-191	-3360	-228	-1085	251	-1711
CAEPIPE	70	195	-2666	382	-5424	-1465	2928
CAESAR II	70	195	-2667	382	-5426	-1466	2929
CAEPIPE	1040	-5	-141	-154	-5204	-690	1620
CAESAR II	1040	-5	-142	-154	-5195	-690	1617

Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-2857	-3129	-1168	-1342	845	-1394
CAESAR II	10	-2857	-3130	-1168	-1342	845	-1395
CAEPIPE	70	-734	-3285	2262	7387	-4196	9926
CAESAR II	70	-735	-3286	2262	7388	-4197	9932
CAEPIPE	1040	3592	248	-1094	-8649	23598	599
CAESAR II	1040	3591	247	-1094	-8641	23597	595

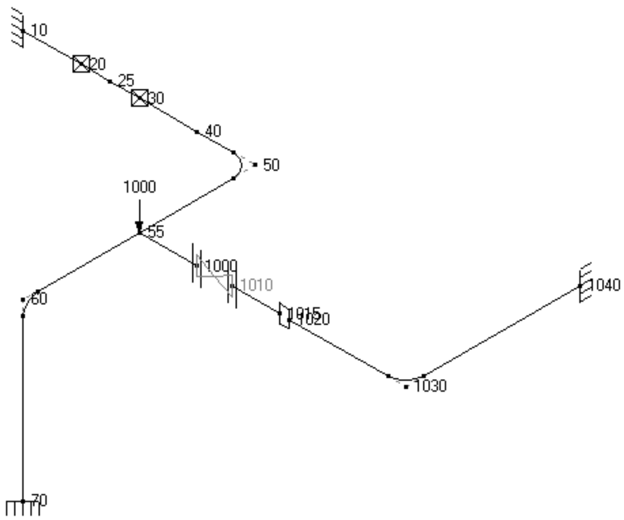
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	4.857	4.9
2	7.941	7.935
3	9.659	9.684
4	10.692	10.801
5	14.637	14.611

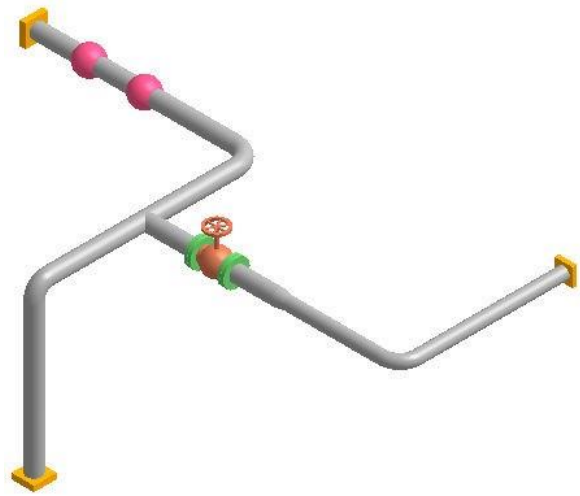
About Model-019

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 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^{0}c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	5218.1						
CAESAR II	5224*						
* Refer Appendix E for details							
Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	84	-3693	-345	-2016	489	-2990
CAESAR II	10	84	-3694	-345	-2017	489	-2991
CAEPIPE	70	-522	-6410	1077	-10081	-141	3431
CAESAR II	70	-523	-6411	1078	-10086	-139	3431
CAEPIPE	1040	438	-3605	-732	18951	1415	5452
CAESAR II	1040	439	-3606	-733	18962	1418	5457

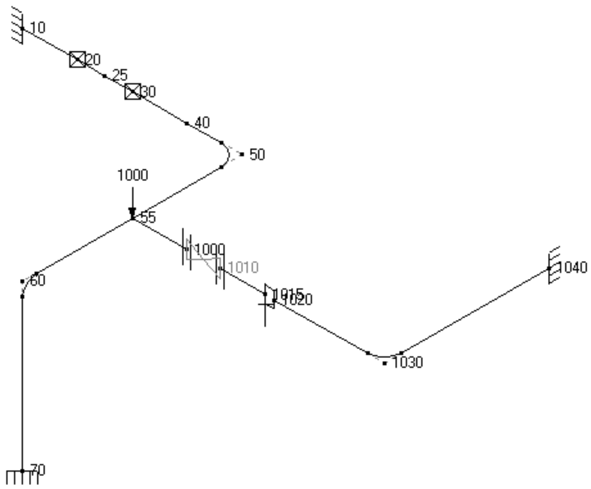
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-2583	-3464	-1285	-2273	1083	-2674
CAESAR II	10	-2582	-3464	-1285	-2274	1083	-2675
CAEPIPE	70	-1452	-7029	2959	2729	-2871	10429
CAESAR II	70	-1453	-7030	2958	2728	-2870	10434
CAEPIPE	1040	4035	-3216	-1672	15506	25703	4432
CAESAR II	1040	4035	-3217	-1673	15516	25705	4435

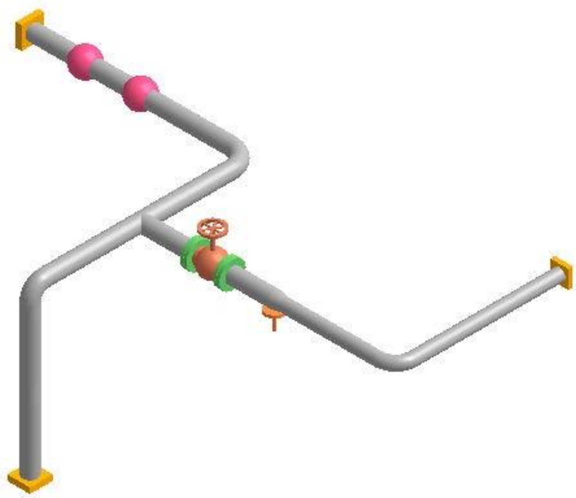
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	4.403	4.396
2	6.978	6.971
3	8.342	8.331
4	9.626	9.65
5	13.51	13.492

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 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^{0}c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

Total Weight (Kg)	
CAEPIPE	5218.1
CAESAR II	5224.0*

* Refer Appendix E for details

Support Load (Sustained)

	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-208	-3515	-260	-1178	288	-1902
CAESAR II	10	-208	-3516	-260	-1178	288	-1902
CAEPIPE	70	203	-3077	447	-6222	-1619	3310
CAESAR II	70	203	-3079	447	-6225	-1619	3311
CAEPIPE	1040	5	-15	-187	-6591	-727	1932
CAESAR II	1040	5	-16	-187	-6580	-727	1928

Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-2797	-3333	-1223	-1660	936	-1878
CAESAR II	10	-2796	-3334	-1223	-1660	936	-1878
CAEPIPE	70	-921	-4591	2496	5552	-3952	10341
CAESAR II	70	-922	-4592	2497	5553	-3953	10347
CAEPIPE	1040	3718	-591	-1273	-3174	24137	1857
CAESAR II	1040	3718	-591	-1274	-3168	24136	1854

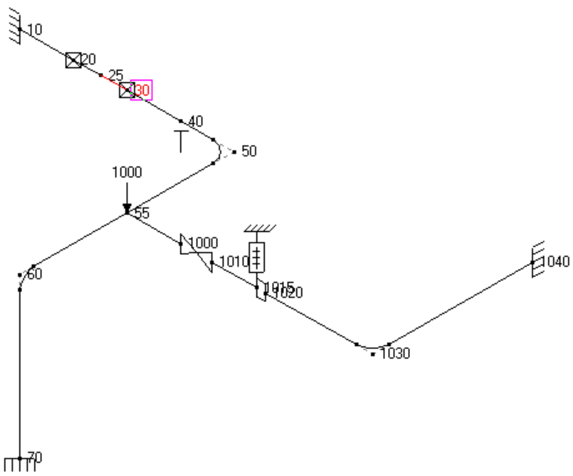
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	5.39	5.393
2	7.127	7.131
3	8.532	8.531
4	13.488	13.484
5	17.186	17.168

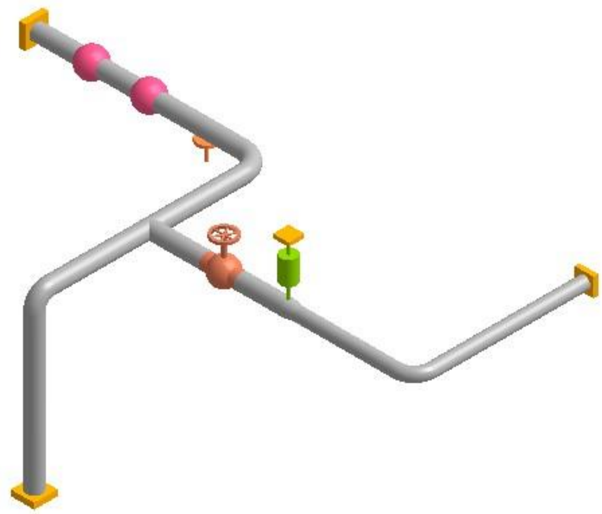
About Model-021

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 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^0c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
CAEPIPE	**Hanger Report**						
Node	Spring Rate	Hot Load					
1015	19.287	2430*					
Total Weight (Kg)							
CAEPIPE	4227.4						
CAESAR II	4233.4*						
* Refer Appendix D & E for details							
Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-166	-1847	-76	78	54	-215
CAESAR II	10	-166	-1848	-76	78	54	-215
CAEPIPE	70	290	-2017	-10	-1297	-1060	1252
CAESAR II	70	290	-2018	-10	-1298	-1061	1253

CAEPIPE	1040	-124	641	86	-8397	-907	-757
CAESAR II	1040	-124	640	86	-8394	-908	-762
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-2837	-1907	-1045	-402	685	-185
CAESAR II	10	-2837	-1907	-1045	-401	685	-185
CAEPIPE	70	-658	-2760	1945	10723	-3868	8571
CAESAR II	70	-658	-2761	1945	10726	-3870	8577
CAEPIPE	1040	3495	880	-900	-11230	23423	-1323
CAESAR II	1040	3495	879	-900	-11228	23421	-1328

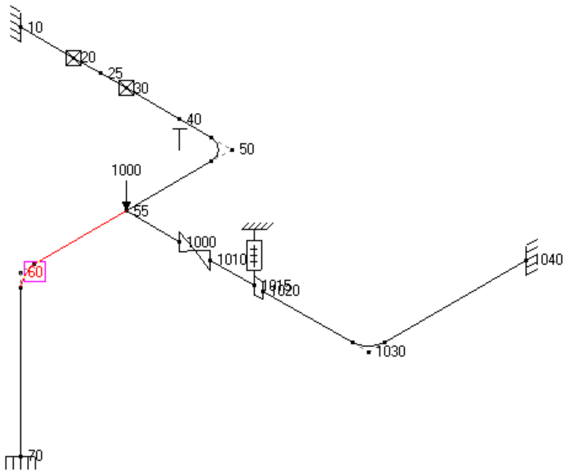
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	7.553	7.545
2	9.567	9.547
3	10.498	10.470
4	14.236	14.223
5	14.637	14.611

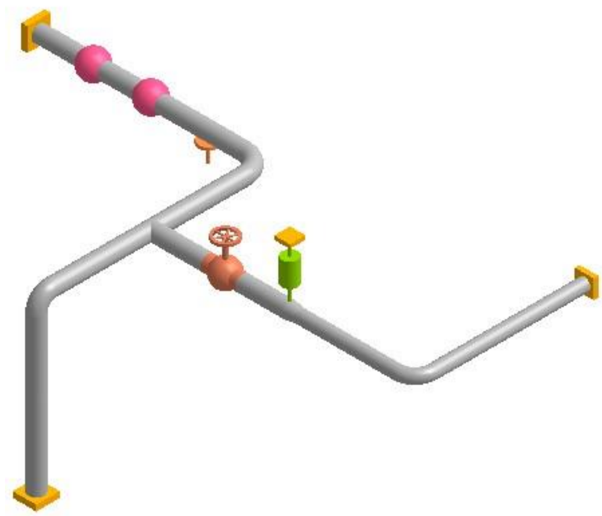
About Model-022a

This model shown below is the same as Model-021 above with the following modifications.

a. Hanger replaces user hanger at node 1015.

b. Flexible limit stop with stiffness=1000 kg/mm at node 40 in vertical direction with friction coefficient 0.35.





Name of the Model			**Model – 022a**				
Analysis Options in CAEPIPE							
1	Code – B 31.3 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^{0}c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
CAEPIPE	**Hanger Report**						
Node	Spring Rate	Hot Load					
1015	10.715	1191*					
Total Weight (Kg)							
CAEPIPE	4227.4						
CAESAR II	4233.4*						
* Refer Appendix D & E for details							
Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	0	-1526	109	47	-7	-236
CAESAR II	10	-6	-1526	104	47	-4	-236
CAEPIPE	70	131	-3208	576	1680	-386	88
CAESAR II	70	128	-3207	563	1574	-385	115

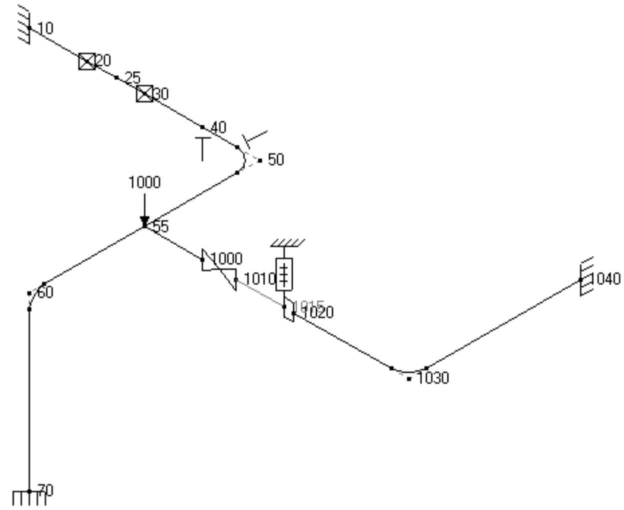
CAEPIPE	1040	-14	-532	25	571	-99	-53
CAESAR II	1040	-14	-533	22	575	-103	-54
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-3329	-1589	-798	-435	601	-205
CAESAR II	10	-3299	-1589	-809	-434	606	-205
CAEPIPE	70	-844	-3970	2629	14439	-3013	7612
CAESAR II	70	-848	-3967	2605	14252	-3023	7642
CAEPIPE	1040	3544	-287	-969	-2306	23798	-627
CAESAR II	1040	3548	-288	-973	-2299	23816	-628

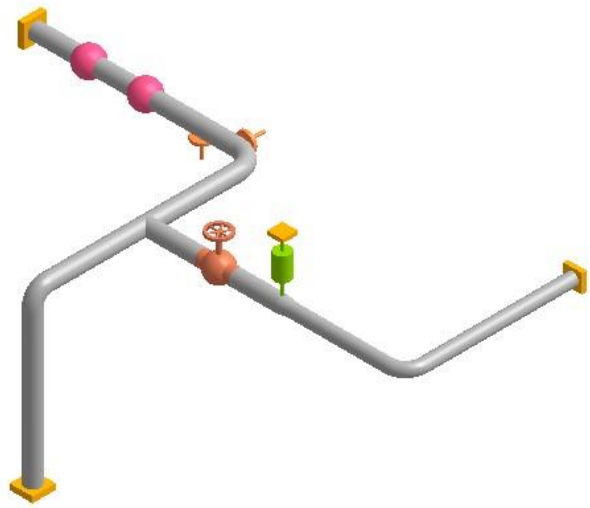
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	7.553	7.545
2	9.567	9.547
3	10.498	10.470
4	14.236	14.223
5	14.637	14.611

About Model-023a

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

a. Flexible limit stop in +Z direction with stiffness 1000 kg/mm without friction coefficient at node 50.





Name of the Model		Model – 023a
Analysis Options in CAEPIPE		
1	Code – B 31.3 (2016)	
2	Do not Include axial Force in Stress Calculations	
3	Do not use liberal allowable stress	
4	Reference Temperature = 20^{0}c	
5	Number of Thermal Cycles = 7000	
6	Use pd/4t	
7	Do not include bourdon effect	
8	Do not use pressure correction for bends	
9	Do not include missing mass correction	
10	Do not use friction in dynamic analysis	
11	Y – Vertical	

CAEPIPE	**Hanger Report**	
Node	Spring Rate	Hot Load
1015	10.715	1178*
Total Weight (Kg)		
CAEPIPE	4227.4	
CAESAR II	4233.4*	
* Refer Appendix D & E for details		

Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-70	-1521	-6	50	24	-237
CAESAR II	10	-69	-1521	-8	50	24	-236
CAEPIPE	70	90	-3202	475	894	-349	389
CAESAR II	70	90	-3203	477	912	-348	391
CAEPIPE	1040	-20	-543	4	655	-198	-41
CAESAR II	1040	-21	-544	5	660	-202	-42

Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-2915	-1626	-520	-509	260	-182
CAESAR II	10	-2906	-1627	-545	-509	264	-182
CAEPIPE	70	-448	-4389	4899	31572	-2947	4365
CAESAR II	70	-453	-4392	4908	31638	-2942	4402
CAEPIPE	1040	3363	-280	-505	-2358	23653	-749
CAESAR II	1040	3358	-280	-502	-2357	23627	-751

Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	9.563	9.543
2	10.374	10.346
3	12.406	12.369
4	14.262	14.246
5	14.761	14.758

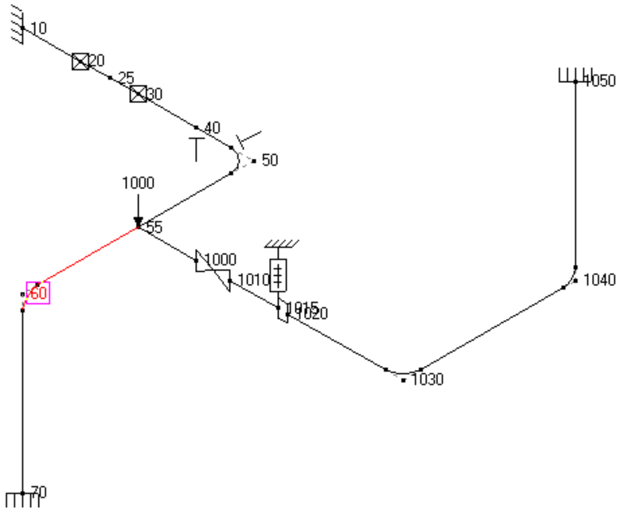
About Model-025

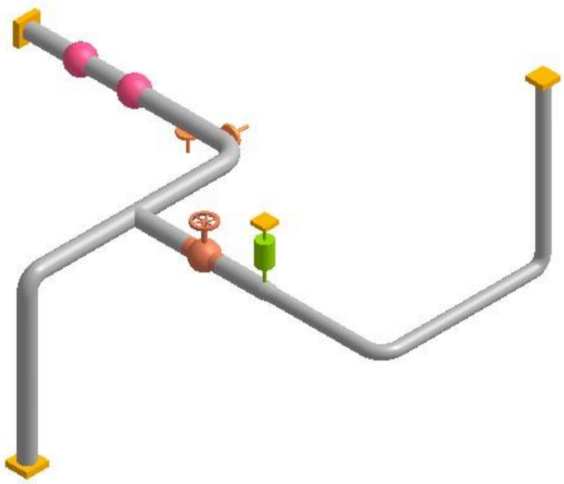
This model shown below is the same as Model-023a above with the following modifications.

a. Rigid limit stops without friction coefficient replaces flexible limit stops at node 40 and 50.

b. Short radius bend at node 1040 and

c. Vertical pipe of length 3m in Y direction





Name of the Model	Model – 025

Analysis Options in CAEPIPE	
1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^{0}c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

CAEPIPE	Hanger Report	
Node	Spring Rate	Hot Load
1015	8.036	1070*

Total Weight (Kg)	
CAEPIPE	4617.8
CAESAR II	4623.8*

* Refer Appendix D & E for details

Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-79	-1231	18	232	-2	2
CAESAR II	10	-78	-1231	15	232	-2	2
CAEPIPE	70	74	-3220	410	1386	-157	-16
CAESAR II	70	73	-3222	412	1397	-156	-11

CAEPIPE	1050	5	-1358	36	163	88	-265
CAESAR II	1050	5	-1358	36	162	88	-268
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-1597	-1300	-67	-447	9	-3
CAESAR II	10	-1585	-1301	-107	-447	15	-3
CAEPIPE	70	649	-4613	6085	41021	-3314	-5397
CAESAR II	70	639	-4615	6092	41077	-3307	-5314
CAEPIPE	1050	947	-1037	-152	-413	3808	6724
CAESAR II	1050	946	-1037	-150	-430	3803	6709

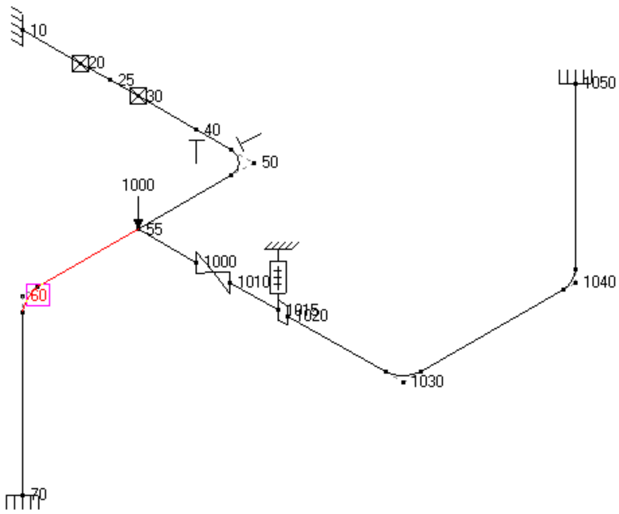
Frequencies (in Hz)

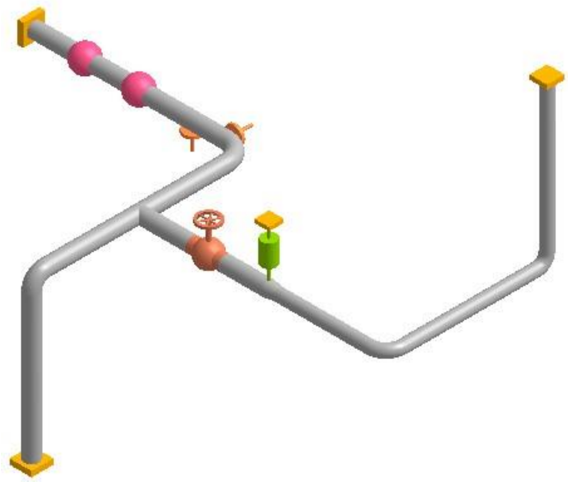
Mode Number	CAEPIPE	CAESAR II
1	5.859	5.841
2	9.001	8.989
3	9.542	9.520
4	11.467	11.447
5	15.077	15.001

About Model-026

This model shown below is the same as Model-025 above with the following modification.

a. Seismic coefficient of 0.3 in x direction.





Name of the Model			Model – 026			
Analysis Options in CAEPIPE						
1	Code – B 31.3 (2016)					
2	Do not Include axial Force in Stress Calculations					
3	Do not use liberal allowable stress					
4	Reference Temperature = 20^{0}c					
5	Number of Thermal Cycles = 7000					
6	Use pd/4t					
7	Do not include bourdon effect					
8	Do not use pressure correction for bends					
9	Do not include missing mass correction					
10	Do not use friction in dynamic analysis					
11	Y – Vertical					
CAEPIPE	**Hanger Report**					
Node	Spring Rate	Hot Load				
1015	8.036	1070*				
Total Weight (Kg)						
CAEPIPE	4617.8					
CAESAR II	4623.8*					
* Refer Appendix D & E for details						
Support Load (Sustained)						
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-79	-1231	18	232	-2	2
CAESAR II	10	-78	-1231	15	232	-2	2
CAEPIPE	70	74	-3220	410	1386	-157	-16
CAESAR II	70	73	-3222	412	1397	-156	-11
CAEPIPE	1050	5	-1358	36	163	88	-265
CAESAR II	1050	5	-1358	36	162	88	-268

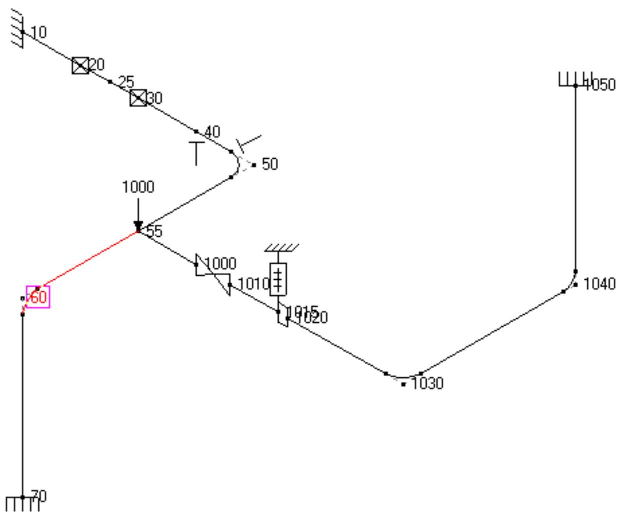
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-1597	-1300	-67	-447	9	-3
CAESAR II	10	-1585	-1301	-107	-447	15	-3
CAEPIPE	70	649	-4613	6085	41021	-3314	-5397
CAESAR II	70	639	-4615	6092	41076	-3307	-5314
CAEPIPE	1050	947	-1037	-152	-413	3808	6724
CAESAR II	1050	946	-1037	-150	-430	3802	6709
Seismic Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	1751	39	65	12	9	3
CAESAR II	10	1751	39	65	12	9	2
CAEPIPE	70	890	5	31	250	490	5780
CAESAR II	70	890	4	29	235	490	5783
CAEPIPE	1050	414	21	16	249	185	2385
CAESAR II	1050	414	21	16	247	185	2387

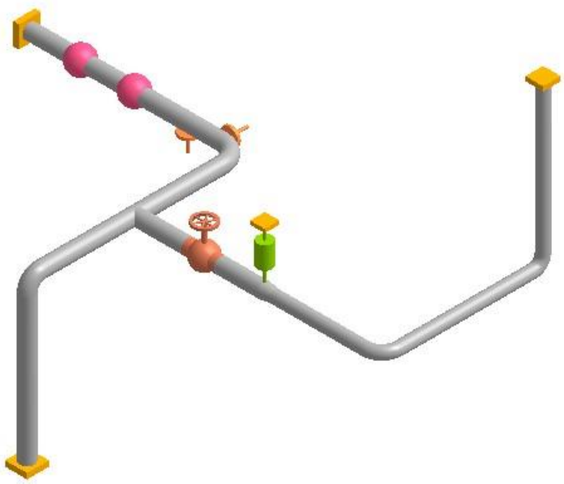
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	5.859	5.841
2	9.001	8.989
3	9.542	9.520
4	11.467	11.447
5	15.077	15.001

About Model-027

This model shown below is the same as Model-025 above with the following modification.

a. Wind in X direction.





Name of the Model	**Model – 027**
Analysis Options in CAEPIPE	
1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^0c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Do not include missing mass correction
10	Do not use friction in dynamic analysis
11	Y – Vertical

CAEPIPE	**Hanger Report**	
Node	Spring Rate	Hot Load
1015	8.036	1070*
Total Weight (Kg)		
CAEPIPE	4617.8	
CAESAR II	4623.8	
* Refer Appendix D & E for details		

Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-79	-1231	18	232	-2	2
CAESAR II	10	-78	-1231	15	232	-2	2
CAEPIPE	70	74	-3220	410	1386	-157	-16
CAESAR II	70	73	-3222	412	1397	-156	-11
CAEPIPE	1050	5	-1358	36	163	88	-265
CAESAR II	1050	5	-1358	36	162	88	-268

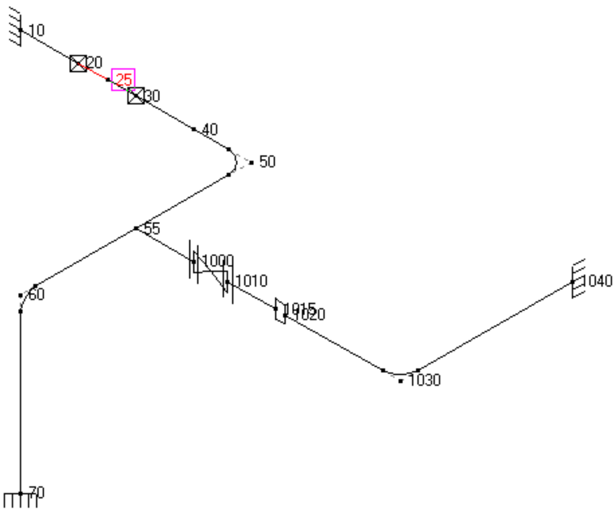
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-1597	-1300	-67	-447	9	-3
CAESAR II	10	-1585	-1301	-107	-447	15	-3
CAEPIPE	70	649	-4613	6085	41021	-3314	-5397
CAESAR II	70	639	-4615	6092	41077	-3307	-5314
CAEPIPE	1050	947	-1037	-152	-413	3808	6724
CAESAR II	1050	946	-1037	-150	-430	3803	6709
Wind Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	2268	122	291	-29	-38	8
CAESAR II	10	2301	119	298	-29	-40	8
CAEPIPE	70	3051	22	-142	-1140	-96	-17089
CAESAR II	70	3203	22	-138	-1106	-274	-18756
CAEPIPE	1050	2256	-22	-27	400	-694	11875
CAESAR II	1050	2331	-15	-91	911	-358	12803

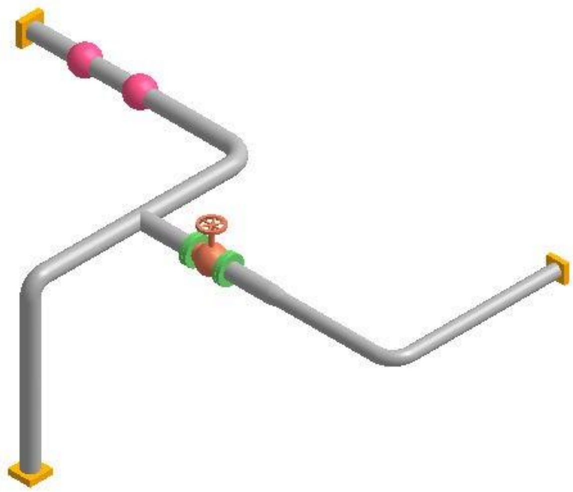
Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	5.859	5.841
2	9.001	8.989
3	9.542	9.520
4	11.467	11.447
5	15.077	15.001

About Model-050

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

a. Seismic in both x and z directions.





Name of the Model				**Model – 050**			
Analysis Options in CAEPIPE							
1	Code – B 31.3 (2016)						
2	Do not Include axial Force in Stress Calculations						
3	Do not use liberal allowable stress						
4	Reference Temperature = 20^0c						
5	Number of Thermal Cycles = 7000						
6	Use pd/4t						
7	Do not include bourdon effect						
8	Do not use pressure correction for bends						
9	Do not include missing mass correction						
10	Do not use friction in dynamic analysis						
11	Y – Vertical						
Total Weight (Kg)							
CAEPIPE	5218.1						
CAESAR II	5224*						
* Refer Appendix E for details							
Support Load (Sustained)							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	91	-3310	-260	-1706	377	-2419
CAESAR II	10	91	-3310	-260	-1702	376	-2412
CAEPIPE	70	-454	-4976	849	-7741	47	2514
CAESAR II	70	-454	-4977	850	-7749	47	2516
CAEPIPE	1040	363	-3218	-589	17134	1248	4319
CAESAR II	1040	364	-3219	-590	17144	1251	4324

Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-2576	-3080	-1200	-1963	971	-2103
CAESAR II	10	-2575	-3080	-1200	-1964	971	-2104
CAEPIPE	70	-1383	-5595	2729	5069	-2684	9513
CAESAR II	70	-1384	-5596	2730	5069	-2683	9517
CAEPIPE	1040	3960	-2829	-1529	13689	25536	3298
CAESAR II	1040	3960	-2829	-1530	13697	25538	3301
Seismic Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	1918	122	778	65	284	161
CAESAR II	10	1918	122	779	65	284	161
CAEPIPE	70	949	214	1743	12599	607	6226
CAESAR II	70	949	214	1744	12603	607	6227
CAEPIPE	1040	652	112	944	655	3521	323
CAESAR II	1040	652	112	944	655	3522	323

Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	4.403	4.396
2	6.978	6.971
3	8.342	8.331
4	9.626	9.605
5	13.51	13.492

7.3 Live Project Models

To test the functionality of the Translator, 7 live analysis models with more complexity was chosen and transferred electronically using the Translator. Then the missing items/information were added manually to the transferred CAESAR II model. The analyses were then performed and the results between CAEPIPE and CAESAR II were compared and found identical. The results are tabulated below for all the models.

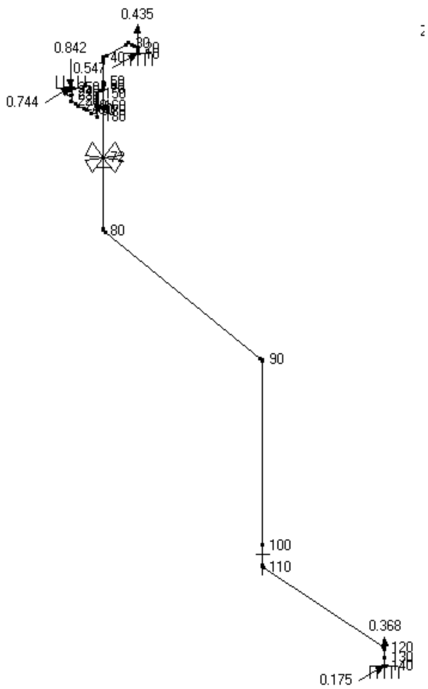
Note:

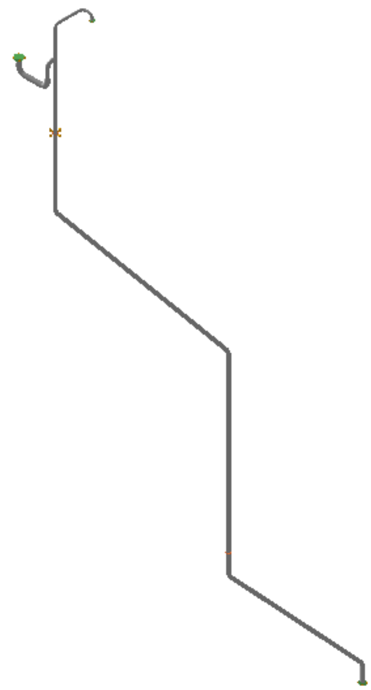
The models chosen for testing and comparing the results are included with the distribution CD for reference. Due to space constraints in listing the results for all nodes, the table listed below shows values for Total weight, Support loads under different loading conditions and frequencies.

During the verification, the “Hot Load” and the “Spring Rate” obtained from the hanger results report of CAEPIPE were entered manually at the “Cold Load” and “Spring Rate” fields of CAESAR II hanger input to get identical results between CAEPIPE and CAESAR II. Hence we recommend you to input the above said parameters manually to CAESAR II before performing the analysis, if you recreate the “.cii” file using the Translator for your testing. We also recommend you to add the missing items/information reported in the log file to the CAESAR II binary model before performing the analysis.

About 7522029_D105_rev14a_ friction

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.





Name of the Model	7522029_D105_rev14a_ friction.mod

Analysis Options in CAEPIPE	
1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Use pd/4t
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

Total Weight (Kg)	
CAEPIPE	309.65
CAESAR II	309.30

Support Load (Sustained)

	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	-1	-129	1	1	0	3
CAESAR II	10	-1	-129	1	1	0	3
CAEPIPE	140	1	-84	-1	50	5	21
CAESAR II	140	1	-84	-1	50	5	21

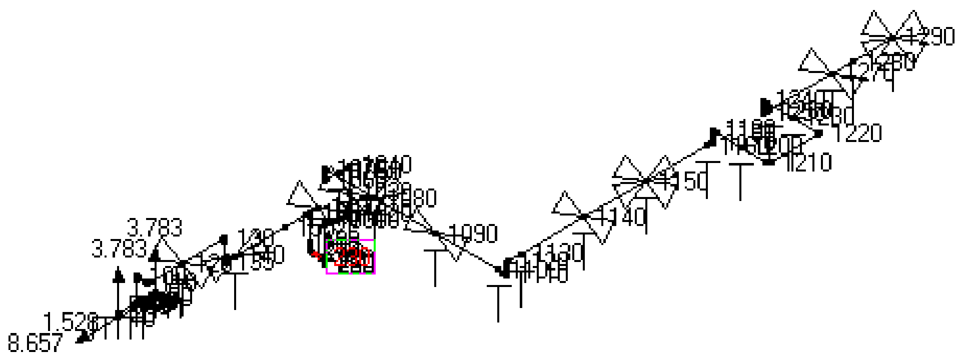
CAEPIPE	250	9	-57	-7	6	13	1
CAESAR II	250	9	-58	-8	6	13	1

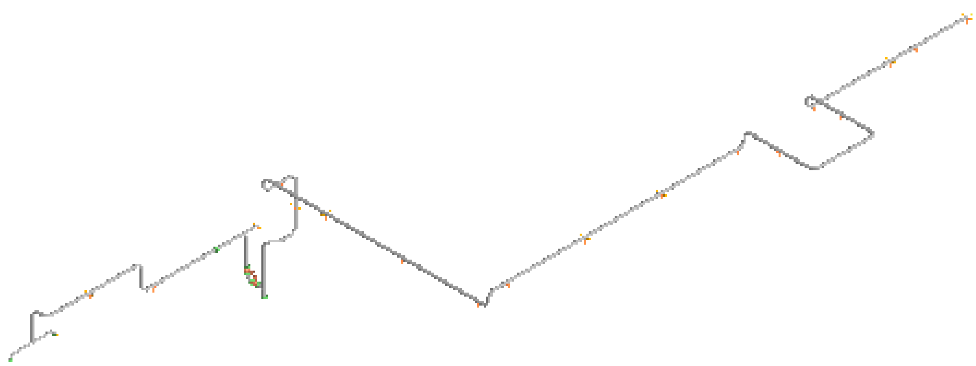
Operating Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	63	361	-232	-623	-94	-246
CAESAR II	10	60	355	-230	-615	-96	-243
CAEPIPE	140	133	-609	-169	958	267	-142
CAESAR II	140	131	-602	-167	948	265	-140
CAEPIPE	250	-294	1131	323	340	-652	2121
CAESAR II	250	-287	1151	323	344	-661	2178
Seismic Case							
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	38	6	33	4	5	5
CAESAR II	10	38	6	34	4	5	5
CAEPIPE	140	44	61	58	113	181	334
CAESAR II	140	44	61	58	113	181	334
CAEPIPE	250	49	18	18	4	33	52
CAESAR II	250	49	18	18	4	34	54

Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	1.991	1.993
2	3.662	3.665
3	6.041	6.051
4	8.686	8.688

About 7513306_D157_rev13a_friction

This model is a 6” and 8” nominal diameter carbon steel (A53 Grade B) 300 lb class insulated piping system connected to Residue MP steam generators in a Oil Refinery Expansion Project. Operating temperature is 232^0 C. The model consists of straight pipes, elbows, reducers, tees and flanges. The system is of welded construction and has 18 limit stops, 10 lateral restraints and 2 valves. Cases considered for analysis are sustained, operating and seismic. Cut-off frequency is 33 Hz. Friction at supports is considered in the dynamic analysis. Piping code used is ASME B31.3.





Name of the Model	7513306_D157_rev13a_friction.mod

Analysis Options in CAEPIPE	
1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Use pd/4t
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

Total Weight (Kg)	
CAEPIPE	5495.2
CAESAR II	5495.2

Support Load (Sustained)

	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	0	-397	565	144	31	-67
CAESAR II	10	1	-396	574	151	31	-71
CAEPIPE	90	-47	-429	-635	-158	-75	-37
CAESAR II	90	-48	-432	-646	-165	-76	-40

Operating Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-151	-509	400	-13	41	109
CAESAR II	10	-148	-503	141	-76	39.9	107.7
CAEPIPE	90	25	99	76	11	9	75
CAESAR II	90	23	93	324	73.8	8.9	74.2

Seismic Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	14	103	41	10	35	141
CAESAR II	10	14	104	41	10.6	35.3	141.5
CAEPIPE	90	89	144	120	4	59	124
CAESAR II	90	89	145	122	3.5	58.7	125.4

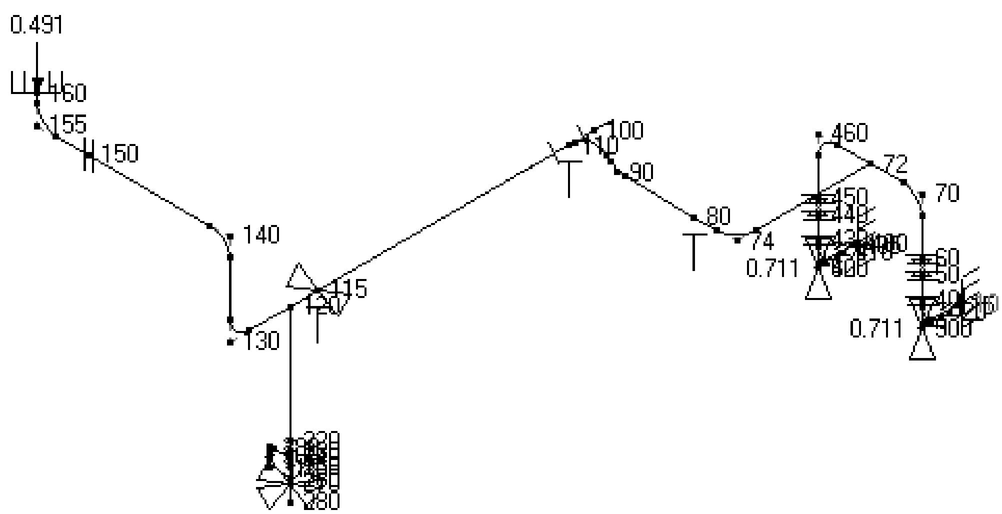
Frequencies (in Hz)

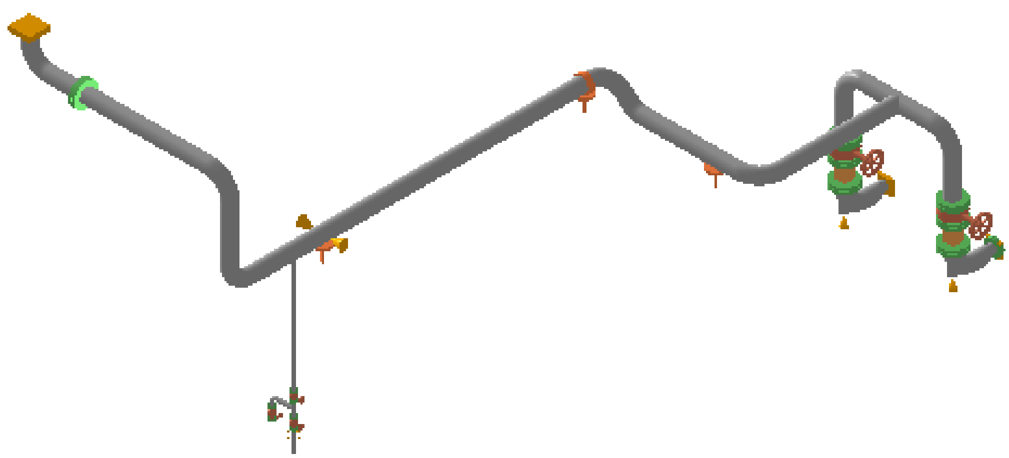
Mode Number	CAEPIPE	CAESAR II
1	1.423	1.444
2	1.631	1.633
3	1.745	1.775
4	2.160	2.160

About 522002_d221-rev323_fg_02_ope_friction_r01

This model is a 12" nominal diameter insulated carbon steel (A53 Grade B), 150 lb class suction piping to Gas oil Product Pumps in an Oil Refinery Expansion Project. Operating temperature is 120^0 C. The model consists of straight pipes, elbows, tees and flanges. There are valves, limit stops and lateral restraints.

The system is of welded construction. Cases considered for analyses are sustained, operating and seismic. Cut-off frequency is 33 Hz; friction at supports is considered in dynamic analysis. Piping code used is ASME B31.3





Name of the Model	7522002_d221-rev323_fg_02_ope_friction_r01.mod

Analysis Options in CAEPIPE	
1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Reference Temperature = 20^{0}c
5	Number of Thermal Cycles = 7000
6	Use pd/4t
7	Do not include bourdon effect
8	Do not use pressure correction for bends
9	Include missing mass correction
10	Do not use friction in dynamic analysis
11	Include hanger stiffness
12	Y – Vertical

Total Weight (Kg)	
CAEPIPE	6327.9
CAESAR II	6316.4

Support Load (Sustained)

	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	59	-285	-1	146	119	-63
CAESAR II	10	59	-283	-1	141	118	-62
CAEPIPE	160	44	-1140	107	661	-1381	-1825
CAESAR II	160	44	-1141	108	664	-1389	-1842
CAEPIPE	400	-60	-288	-3	150	-123	78
CAESAR II	400	-60	-286	-3	145	-123	77

Operating Case

	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	616	-3573	-411	8270	487	-2995
CAESAR II	10	614	-3479	-410	7888	478	-2960
CAEPIPE	160	-896	-616	733	-2193	-5914	-1098
CAESAR II	160	-902	-612	741	-2218	-5979	-1095
CAEPIPE	400	-279	-3642	-422	8289	-171	1269
CAESAR II	400	-280	-3532	-427	7946	-180	1261

Seismic Case

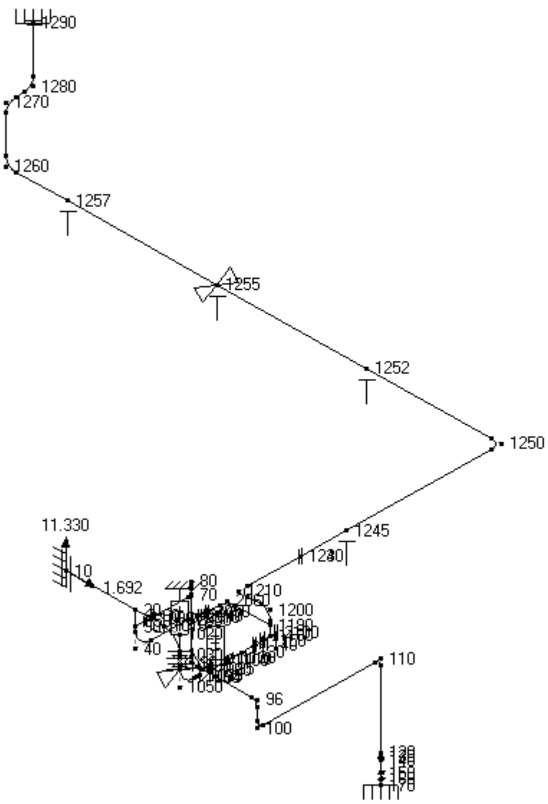
	Node	Fx (lb)	Fy (lb)	Fz (lb)	Mx (ft-lb)	My (ft-lb)	Mz (ft-lb)
CAEPIPE	10	1033	1844	938	2603	2836	2845
CAESAR II	10	1033	1795	938	2833	2833	2822
CAEPIPE	160	285	58	314	281	1099	462
CAESAR II	160	285	59	315	281	1101	462
CAEPIPE	400	1027	1730	915	2425	2869	2803
CAESAR II	400	1027	1687	915	2296	2865	2780

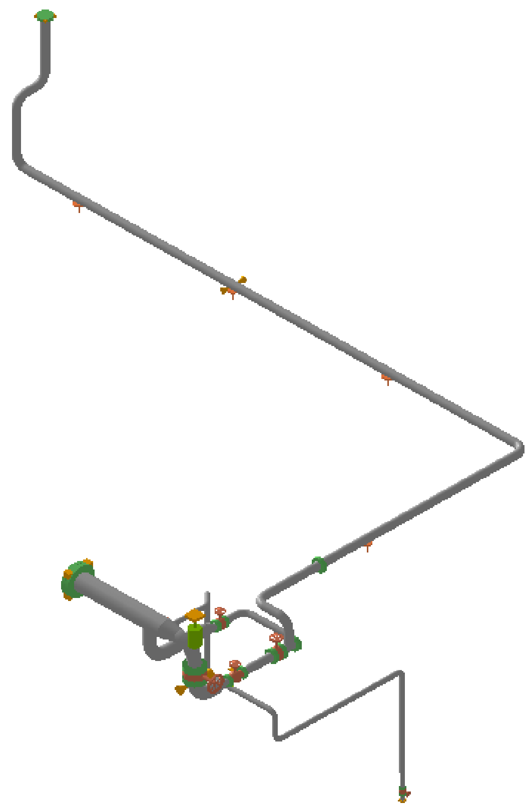
Frequencies (in Hz)

Mode Number	CAEPIPE	CAESAR II
1	3.592	3.597
2	7.161	7.165
3	8.369	8.364

About 7521020_d54_rev13a_ with frictionfg

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.





Name of the Model	7521020_d54_rev13a_ with frictionfg.mod
Analysis Options in CAEPIPE	
1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Use pd/4t
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

Node	CAEPIPE	
	Spring Rate (kg/mm)	Hot Load (kg)
94	13.593	586
1020B	54.384	3246
Refer Appendix D for details		

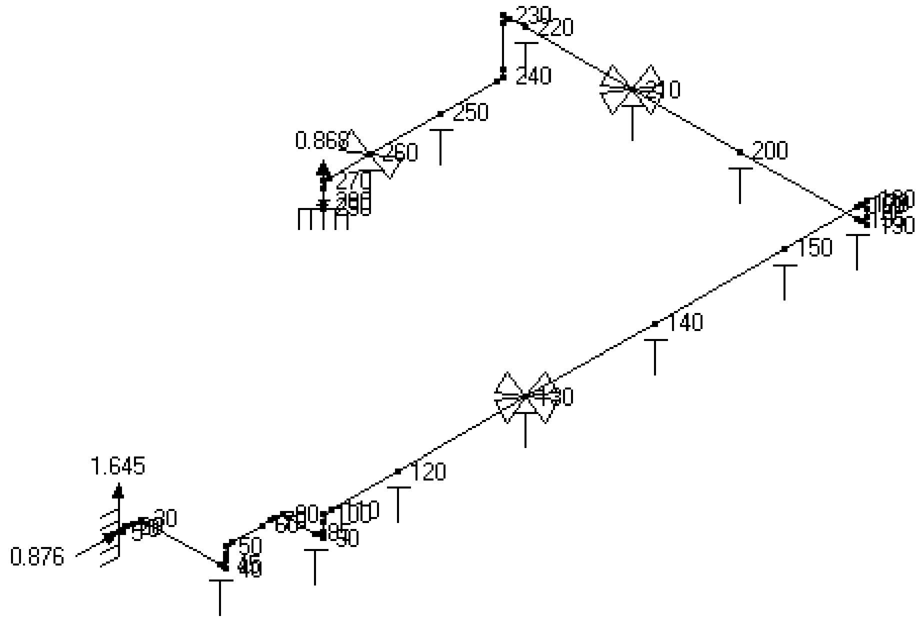
Total Weight (Kg)	
CAEPIPE	7606.7
CAESAR II	7643.8

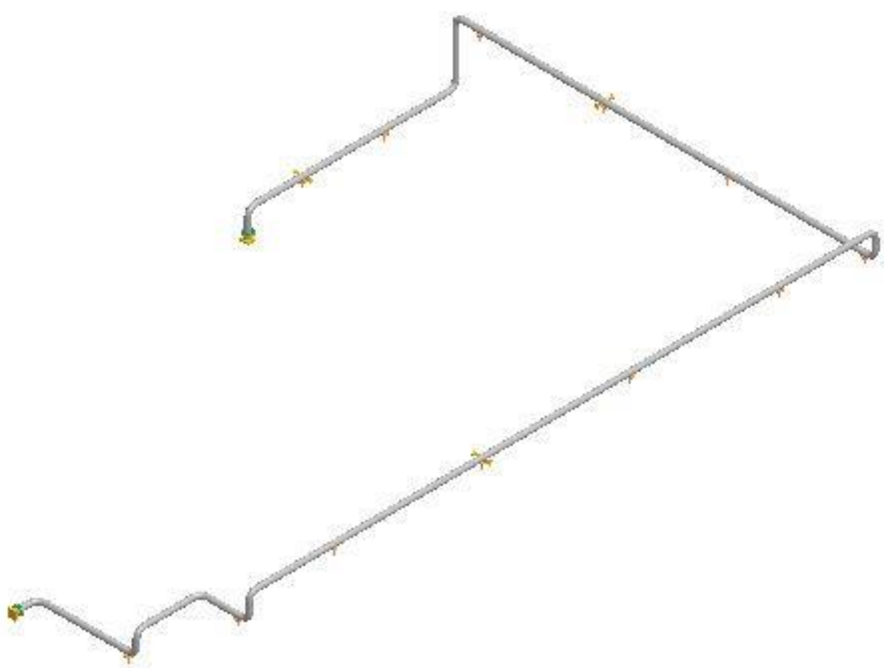
Support Load (Sustained)							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-15	-910	-46	-2121	77	816
CAESAR II	10	-10	-911	-47	-2128	82.2	818.3
CAEPIPE	170	2	-422	-6	-7	2	-13
CAESAR II	170	2	-423	-6	-7.8	1.9	-12.9
CAEPIPE	1290	-11	-277	0	49	-3	-22
CAESAR II	1290	-11	-277	0	48.9	-2.6	-22.4
Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-35	-1167	32	-2431	82	-360
CAESAR II	10	-26	-1169	16	-2397	87.1	-359.2
CAEPIPE	170	25	-473	-60	-115	30	-98
CAESAR II	170	24	-472	-59	-113.4	29.10	-96.2
CAEPIPE	1290	-471	697	-295	233	-249	-1140
CAESAR II	1290	-441	642	-249	112.4	-230	-1068.2
Seismic Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	1356	192	522	559	23	542
CAESAR II	10	1357	192	523	570.9	26.9	541.4
CAEPIPE	170	110	19	128	245	26	207
CAESAR II	170	110	19	128	244.3	26.1	206.3
CAEPIPE	1290	360	16	102	214	133	1151
CAESAR II	1290	360	16	102	213.2	133.2	1152.0

Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	2.342	2.334
2	2.574	2.567
3	2.750	2.77
4	3.194	3.18
5	3.463	3.79

About 7509002_D69_R12a_with_friction

This model is a 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	7509002_D69_R12a_with_friction.mod

Analysis Options in CAEPIPE

1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Use pd/4t
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	4463.5
CAESAR II	4465.8

Support Load (Sustained)

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	5	7	-238	-11	-195	-1	-15
CAESAR II	5	7	-241	-11	-197.9	-1.2	-16.8
CAEPIPE	290	6	-163	17	9	-2	-4
CAESAR II	290	6	-163	17	8.1	-2.1	-3.5

Operating Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	5	-226	-270	146	-150	-134	-100
CAESAR II	5	-227	-274	149	-156.2	-134.2	-101.1
CAEPIPE	290	111	-235	343	267	-50	-39
CAESAR II	290	110	-235	333	257.8	-49.6	-40.2

Seismic Case

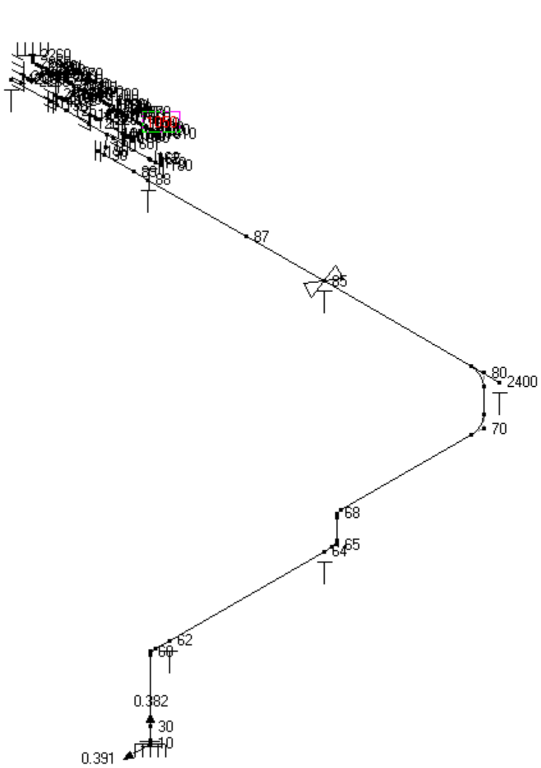
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	5	207	32	97	30	127	44
CAESAR II	5	207	32	97	30	127.4	44.5
CAEPIPE	290	30	3	203	227	6	94
CAESAR II	290	30	3	203	227.6	5.9	93.7

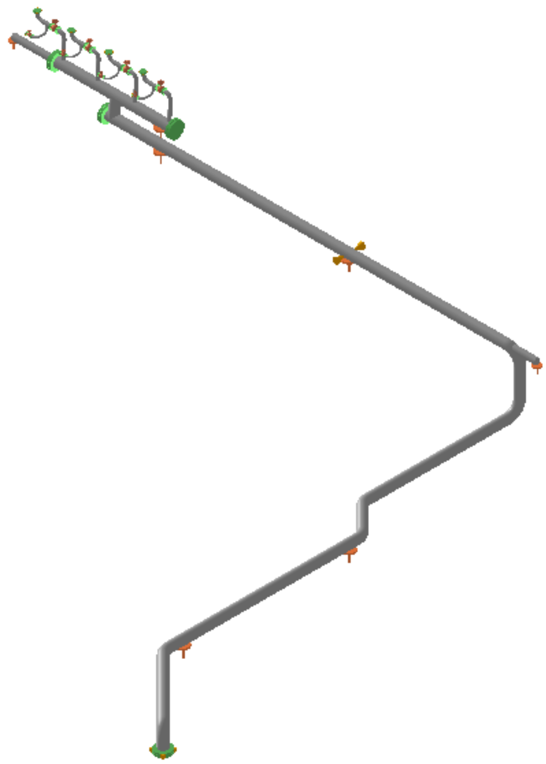
Frequencies (in Hz)

Mode Number	CAEPIPE	CAESAR II
1	2.297	2.294
2	3.283	3.279
3	4.043	4.041
4	5.258	5.256
5	5.294	5.284

About 7510004_D72_rev6a_fg_des_with_friction

This model is a 2”, 4”, 8” and 12” nominal diameter carbon steel (A106 Grade B) 150 lb class insulated piping system connected between MHC stripper Air condenser and MHC stripper Trim condenser in a Oil Refinery Expansion Project. Operating temperature of the system is 55^0 C. The model comprises of straight pipes, elbows, tees and flanges. The system is of welded construction and has 8 limit stops, 1 lateral restraint and 8 valves. Cases considered for analysis are sustained, operating and seismic. Cut-off frequency is 33Hz. Piping code used is ASME B31.3.





Name of the Model	7510004_D72_rev6a_fg_des_with_friction.mod
Analysis Options in CAEPIPE	
1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Use pd/4t
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

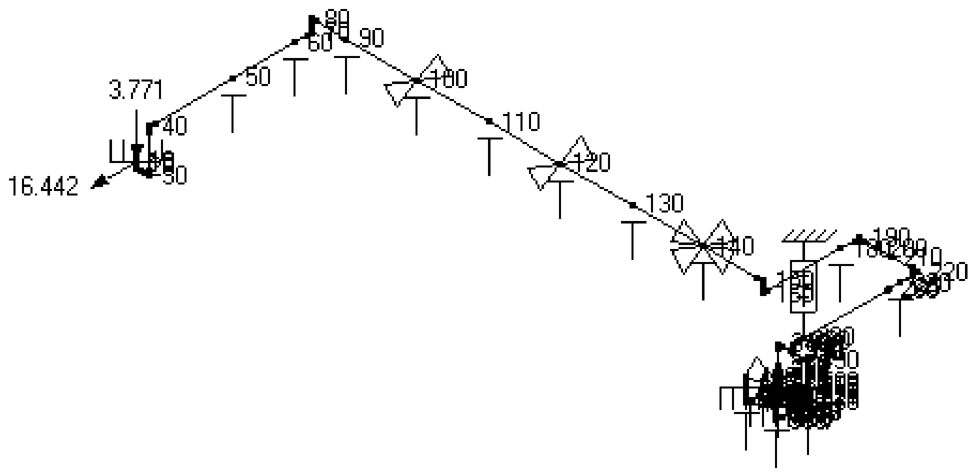
Total Weight (Kg)	
CAEPIPE	6905
CAESAR II	6908

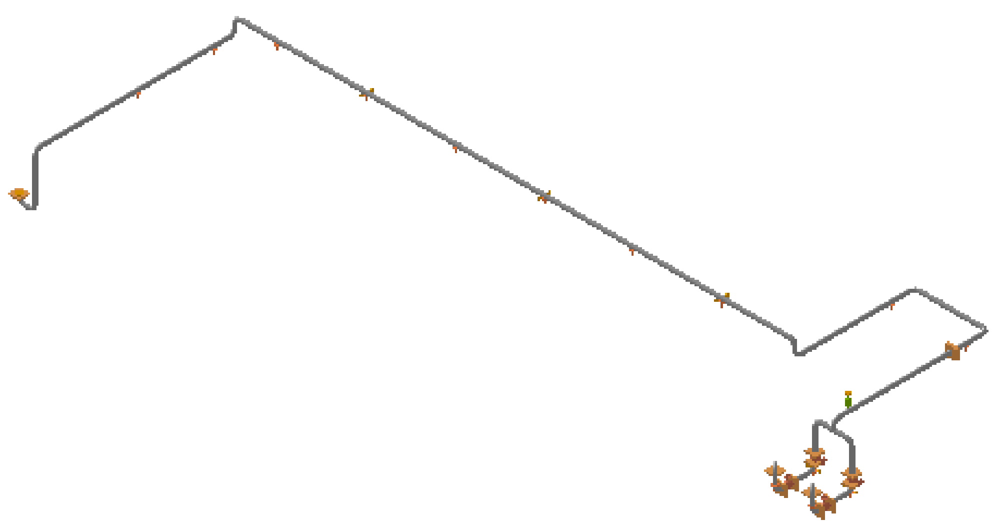
Support Load (Sustained)							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	46	-322	14	73	-62	67
CAESAR II	10	39	-322	6	70.1	-63.3	68.4
CAEPIPE	1070	-101	-24	-2	-1	1	-16
CAESAR II	1070	-99	-24	-2	-0.5	1.1	-15.9
CAEPIPE	2300	-32	-78	30	-9	-2	-19
CAESAR II	2300	-33	-79	30	-8.8	-2.1	-19.50
Operating Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	330	-460	1183	423	517	120
CAESAR II	10	325	-458	1166	417.9	506.4	119.8
CAEPIPE	1070	595	128	-401	120	10	222
CAESAR II	1070	601	122	-397	117.7	10.8	222.1
CAEPIPE	2300	89	-268	292	-36	-106	-68
CAESAR II	2300	87	-269	299	-35.9	-107.9	-68.3
Seismic Case							
	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	390	25	746	359	1347	73
CAESAR II	10	390	25	747	359.2	1347.3	72.6
CAEPIPE	1070	36	56	104	13	28	95
CAESAR II	1070	35	56	104	12.9	28.2	95
CAEPIPE	2300	29	24	213	2	63	6
CAESAR II	2300	29	25	214	1.9	63	5.7

Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	2.311	2.308
2	4.451	4.461
3	5.315	5.311
4	7.396	7.762
5	8.775	8.762

About 7510016_D77_rev32_fg_op..r01

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.





Name of the Model	7510016_D77_rev32_fg_op..r01.mod
Analysis Options in CAEPIPE	

1	Code – B 31.3 (2016)
2	Do not Include axial Force in Stress Calculations
3	Do not use liberal allowable stress
4	Use pd/4t
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

Node	Spring Rate (kg/mm)	Hot Load (kg)
280	8.0361	1058

Refer Appendix D for details

Total Weight (Kg)	
CAEPIPE	11569
CAESAR II	11574.3

Support Load (Sustained)

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-33	-797	41	10	20	-538
CAESAR II	10	-33	-797	42	10.3	20.3	-538.9
CAEPIPE	480	-17	-150	-53	-27	15	0
CAESAR II	480	-16	-150	-57	-29	16.9	0.2
CAEPIPE	630	-28	-151	-52	-26	11	6
CAESAR II	630	-27	-152	-56	-27.9	13.6	6.3

Operating Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	-177	-1024	451	422	713	-401
CAESAR II	10	-170	-1025	458	432.5	700.7	-413.9
CAEPIPE	480	-483	-27	102	-36	29	311
CAESAR II	480	-479	-45	106	-25.3	29.9	304.8
CAEPIPE	630	-407	624	-105	-416	-31	168
CAESAR II	630	-373	585	-61	-382.9	-33.4	141.4

Seismic Case

	Node	Fx (Kg)	Fy (Kg)	Fz (Kg)	Mx (Kg-m)	My (Kg-m)	Mz (Kg-m)
CAEPIPE	10	263	4	421	937	386	372
CAESAR II	10	263	4	421	939	386.3	373.2
CAEPIPE	480	221	652	605	309	256	102
CAESAR II	480	226	650	604	309.5	256.7	100.2
CAEPIPE	630	245	212	694	310	290	180
CAESAR II	630	233	217	697	311	293.2	177.2

Frequencies (in Hz)		
Mode Number	CAEPIPE	CAESAR II
1	1.658	1.661
2	2.784	2.785
3	2.977	2.982
4	3.429	3.442
5	3.65	3.644

Appendix A

Material Mapping DB

The Material Mapping DB supplied along with the software is used to map the CAEPIPE Material to the CAESAR II Materials. This Mapping DB basically has two tables viz, Material and CII_Material. The table "Material" is used to map the CAEPIPE Material with the CAESAR II Materials. To enable the effective transfer of material information from CAEPIPE, the description used in CAEPIPE Material Input is taken as a key value and is entered in the field 1 "CAEPIPEMat" of table "Material" and the corresponding material number in CAESAR II is then entered into the field 2 "CAESARMat" of table "Material" by referring the CAESAR II documentation.

Secondly, the table "CII_Material" is used to define the default CII material to be used during the transfer. The Translator collects all the CAESAR II materials listed in this table and displays them in a combo box, if the user selects the "Default CII Hanger and Material" from the "Option" menu. User is then allowed to specify the default CII material through this option. If the material corresponding to CAEPIPE material description is not available in the material mapping DB, then the Translator uses this information to transfer it to CAESAR II.

Hanger Mapping DB

The Hanger Mapping DB supplied along with the software is used to map the CAEPIPE Hanger with the CAESAR II Hanger. This Mapping DB basically has two tables viz, Hanger and CII_Hangers. The table "Hanger" is used to map the CAEPIPE Hanger with the CAESAR II Hanger. To enable the effective transfer of hanger information from CAEPIPE, the internal reference number used in CAEPIPE is taken as a key value and is entered in the field 1 (KP_Hanger) of table "Hanger" and the corresponding hanger number in CAESAR II is then entered into the field 2 (CII_Hanger) of table "Hanger" by referring the CAESAR II documentation.

Secondly, the table "CII_Hangers" is used to define the default CII hanger to be used during the transfer. The Translator collects all the CAESAR II hangers listed in this table and displays them in a combo box, if the user selects the "Default CII Hanger and Material" from the "Option" menu. User is then allowed to specify the default CII hanger through this option. If the hanger corresponding to CAEPIPE hanger is not available in the hanger mapping DB, then the Translator uses this information to transfer it to CAESAR II.

Appendix B

Errors and Descriptions

This Appendix presents the list of errors, their descriptions and the necessary actions to be taken.

a. “Enter all the Necessary Data and Proceed”

User has to enter the neutral file name, model batch file name and has to select hanger type from the hanger list.

b. “Not a valid CAEPIPE mod file”

The CAEPIPE model file selected is not a valid .mod file.

c. "Could not find a part of the path <path>”

Appears, If the user enters the wrong path and file name in the “CAESAR II File” text box.

Appendix C

Units Mapping

This sections lists, how the CAEPIPE units are transferred to CAESAR II.

Sl.No.	CAEPIPE Units	CAESAR II Units
1.	Length	Length
2.	Force	Force
3.	Weight	Force
4.	Moment	Moment Input
5.	Moment	Moment Output
6.	Stress	Stress
7.	Temperature	Temperature
8.	Pressure	Pressure
9.	Modulus	Elastic Modulus
10.	Density	Pipe Density
11.	Insulation Density	Insulation Density
12.	Density	Fluid Density
13.	Stiffness	Translational Stiffness
14.	Rotational Stiffness	Rotational Stiffness
15.	Additional Weight	Uniform Load
16.	G's	G Load
17.	Pressure	Wind Load
18.	Dimension	Elevation
19.	Dimension	Compound Length
20.	Dimension	Diameter
21.	Dimension	Thickness

Appendix D

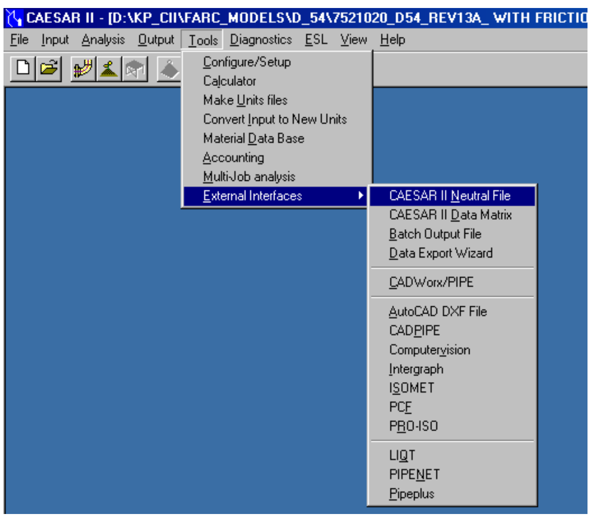
Hanger

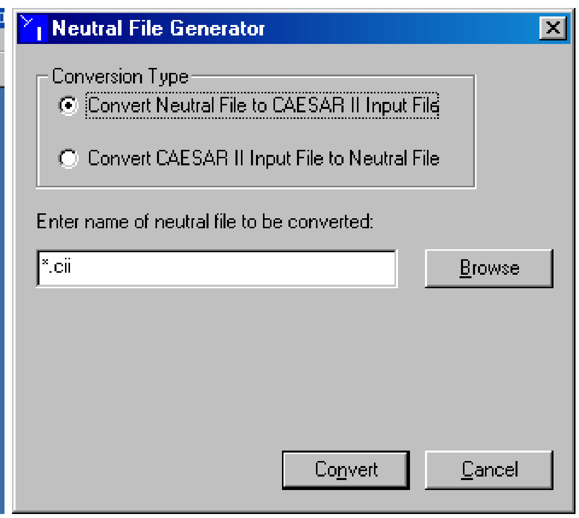
This section lists, how to model the Hanger manually in CAESAR II corresponding to CAEPIPE Hanger report results.

To get good comparison between CAEPIPE and CAESAR II results, the “Hot Load” and “Spring Rate” obtained from hanger report of CAEPIPE analysis results are entered manually at the hanger location of CAESAR II at the “Operating Load” and “Spring Rate” of hanger input in CAESAR II.

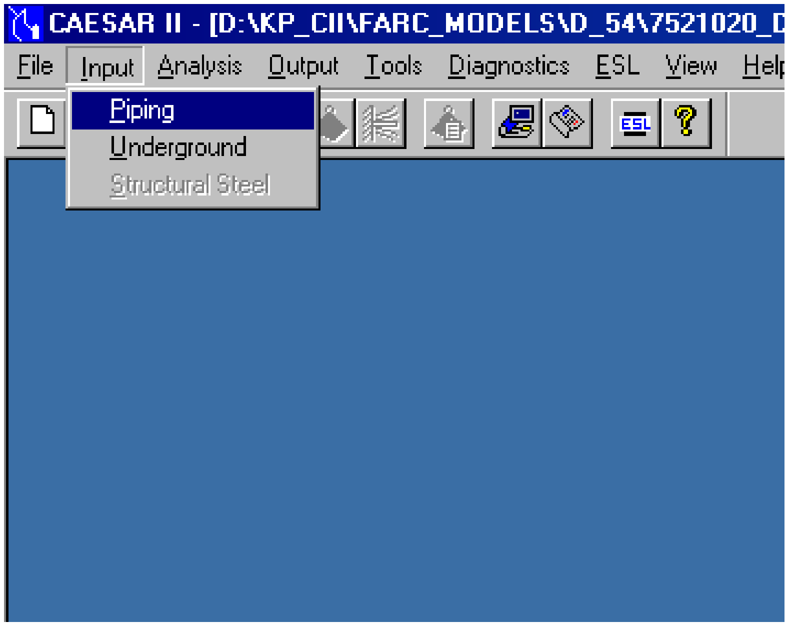
The procedure for entering the “Hot Load” and “Spring Rate” from CAEPIPE Hanger report to CAESAR II is given below.

1. Perform the Analysis in CAEPIPE and note down the “Hot Load” and “Spring Rate” from the Hanger Report for each hanger location.
2. Convert the CAEPIPE model file (.mod) to CAESAR II format (.cii) electronically using the KP2CII Translator.
3. Convert the batch input (.cii) file into binary file (._A) through CAESAR II->Tools->External Translator. Tools->External Interfaces->CAESAR II Neutral File” as shown in the left figure below.
4. From the figure shown in the right below, select the radio button “Convert Neutral File to CAESAR II Input File” and then press the button “Browse” and select the “.cii” file.

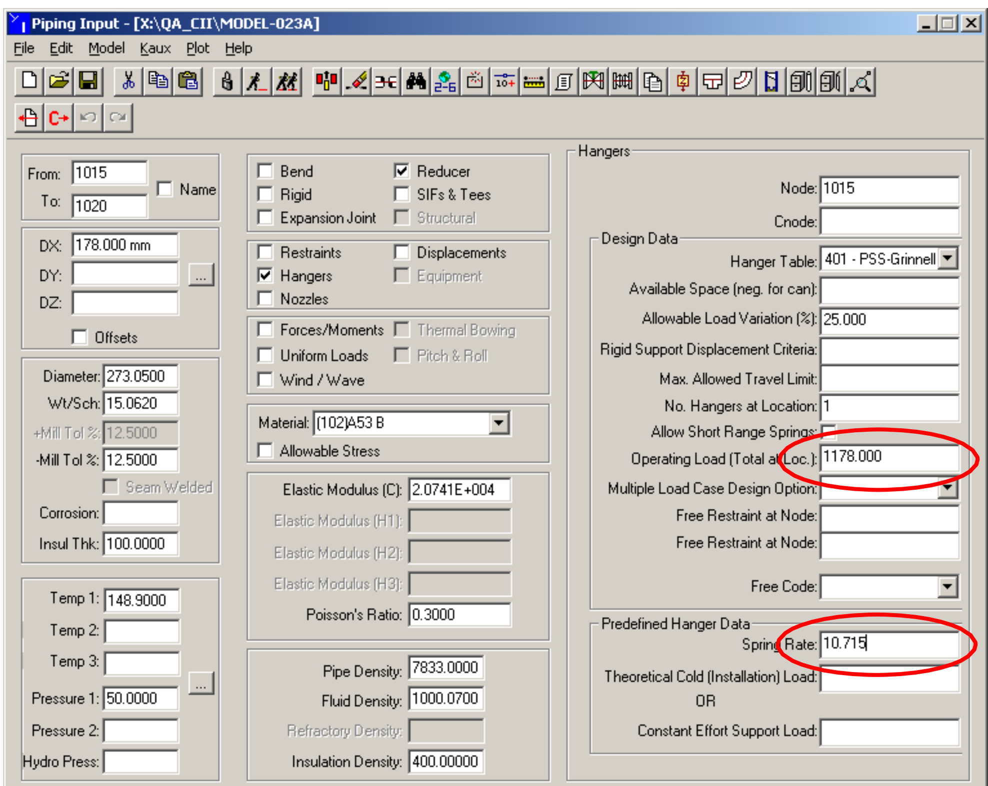




5. Upon successful conversion, the user will get a message “The conversion was completed successfully”.
6. Now, open the binary file (._A) through “File->Open”.
7. From the “Input” menu, select piping as shown in the figure below.



8. Navigate to the element where the hanger is placed and then enter the CAEPIPE-reported "Hot Load" and the "Spring Rate" at the marked fields in figure shown below.



Appendix E

Reducer Weight Calculation

During the Verification and Validation of the Translator, we observed a few kg differences in the total weight of the system between CAEPIPE and CAESAR II models. Further study in this regard concluded that the difference in weight between CAEPIPE and CAESAR II is only due to the presence of Reducer in the piping system.

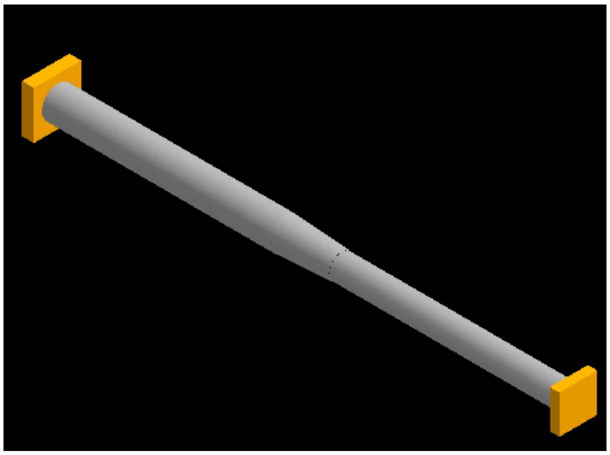
To verify the above said statement, the weight of the Reducer element was calculated manually as specified in the CAEPIPE and CAESAR II Technical Reference manual. The difference in the weight results between CAEPIPE and CAESAR II was minor in the hand calculations. But, the difference was significant between the results compared by KP and C-II.

To verify further, two piping systems were modeled in both CAEPIPE and CAESAR II with the following specifications.

Model-1: Reducer_Larger_to_Smaller

The first system was modeled with larger diameter pipe at the beginning and the smaller diameter pipe at the end with a reducer of larger diameter at the left end and smaller diameter at the right end placed in between two horizontal pipes. The model shown in figure below has the following.

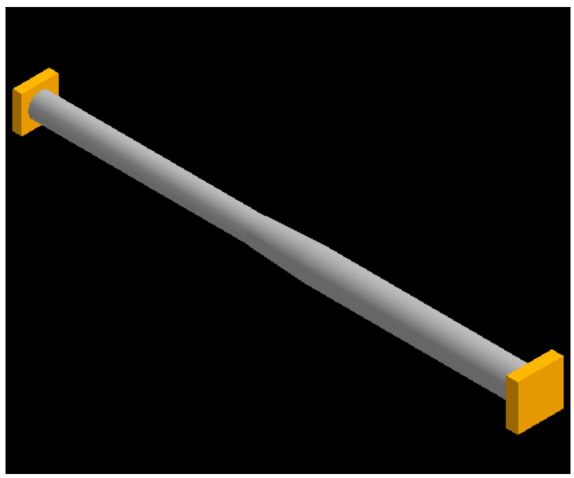
1. Two pipe element of lengths 2m each.
2. Reducer Element of 500 mm length in between the two pipes.
3. The outside diameter and the wall thickness of the first pipe are 273.05 mm and 15.062 mm respectively.
4. The OD1 and Thickness1 of the reducer element are 273.05 and 15.062 mm and OD2 and Thickness2 of the reducer element is 219.05 mm and 12.7 mm respectively.
5. The outside diameter and the wall thickness of the second pipe are 219.05 and 12.7 mm respectively and
6. The density of the material is 7833 kg/m3 and the density of the fluid is entered as 0 kg/m3.



Model-2: Reducer_Smaller_to_Larger

On the other hand, the second system was modeled with smaller diameter pipe at the beginning and the larger diameter pipe at the end with a reducer of smaller diameter at the left end and larger diameter at the right end placed in between the two horizontal pipes. The model shown in figure below has the following.

1. Two pipe element of lengths 2m each.
2. Reducer Element of 500 mm length in between the two pipes.
3. The outside diameter and the wall thickness of the first pipe are 219.05 mm and 12.7 mm respectively.
4. The OD1 and Thickness1 of the reducer element are 219.05 and 12.7 mm and OD2 and Thickness2 of the reducer element is 273.05 mm and 15.062 mm respectively.
5. The outside diameter and the wall thickness of the second pipe are 273.05 and 15.062 mm respectively and
6. The density of the material is 7833 kg/m3 and the density of the fluid is entered as 0 kg/m3.



The analyses were then performed in both CAEPIPE and CAESAR II for both models and total weight obtained in both the software for each model was then compared with the hand calculation and observed the following. CAESAR II calculates the reducer weight as the weight of a pipe with its OD and Thickness as OD1 and Thk1 of the reducer. This is contrary to the statement given in Chapter 3 "Piping Screen Reference" of Technical Reference Manual of CAESAR II which states "CAESAR II will construct a concentric reducer element made of ten pipe cylinders, each of a successively larger (or smaller) diameter and wall thickness over the element length". Hence you may experience in increase/decrease in total weight of the system between CAEPIPE and CAESAR II depending upon the number of reducer element the system has.

The details of observation are listed below for reference.

CAEPIPE						
Reducer_Larger_to_Smaller.mod						
Element	**Length (mm)**	**OD/Avg. OD (mm)**	**Thk/Avg.Tk (mm)**	**Density (kg/m3)**	**Hand Calculated Weight (Kg)**	**Weight from Analysis Report**
Pipe1	2000	273.05	15.062	7833	191.245024	
Reducer	500	246.06	13.881	7833	39.6544284	
Pipe2	2000	219.05	12.7	7833	128.978164	
					359.877616	359.91 (kg)
CAESAR II - 4.50						
Reducer_Larger_to_Smaller.mod						
Element	**Length (mm)**	**OD (mm)**	**Thk (mm)**	**Density (kg/m3)**	**Hand Calculated Weight (Kg)**	**Weight from Analysis Report**
Pipe1	2000	273.05	15.062	7833	191.245024	
Reducer	500	273.05	15.062	7833	47.811256	
Pipe2	2000	219.05	12.7	7833	128.978164	
					368.034443	368.04 (kg)
CAEPIPE						
Reducer_Smaller_to_Larger.mod						
Element	**Length (mm)**	**OD/Avg. OD (mm)**	**Thk/Avg.Tk (mm)**	**Density (kg/m3)**	**Hand Calculated Weight (Kg)**	**Weight from Analysis Report**
Pipe1	2000	219.05	12.7	7833	128.978164	
Reducer	500	246.06	13.881	7833	39.6544284	
Pipe2	2000	273.05	15.062	7833	191.245024	
					359.877616	359.91 (kg)
CAESAR II - 4.50						
Reducer_Smaller_to_Larger.mod						
Element	**Length (mm)**	**OD/Avg. OD (mm)**	**Thk/Avg.Tk (mm)**	**Density (kg/m3)**	**Hand Calculated Weight (Kg)**	**Weight from Analysis Report**
Pipe1	2000	219.05	12.7	7833	128.978164	
Reducer	500	219.05	12.7	7833	32.2445409	
Pipe2	2000	273.05	15.062	7833	191.245024	
					352.467728	352.5 (kng)

The above tabulated comparison results for CAESAR II between the hand calculation and the results computed by CAESAR II software clearly shows that the CAESAR II uses the OD1 and Thk1 for weight calculation.

Note: The models chosen for testing and comparing the results are included with the distribution inside the folder “Reducer_Verification” for reference.