Use SIFs and Flexibilities in CAESAR II®

The following methods are recommended for pipe intersections when the stress intensification factors (SIFs) need to be considered per ASME B31.3 Appendix D Note 12. Simple and comprehensive methods are described below for using SIFs and flexibilities in a pipe stress analysis.

Simple Method

1. Insert in-plane and out-plane SIFs for the branch element as shown in the diagram below.
2. Specify the general intersection type on any of the elements framing into the intersection. CAESAR II will provide header SIFs.
3. Model the intersection using three pipe elements. Do not enter stiffnesses and do not use any rigid elements to define the intersection.

Notes:

Use the typical intersection model with three beam elements (not rigid elements) framing into the common intersection point.

1. *The SIF should be specified on the intersection node of the branch element (node 10120 on the element 10110 to 10120 in the example below).*

2. *Specify the intersection type and any other data that is applicable in CAESAR II. CAESAR II will automatically calculate B31 SIFs for the header elements.*

3. *Always check the CAESAR stress reports to be sure that entered SIFs are used properly. (Input values for ii and io override the effective section modulus calculation. Stresses (even at intersections) are calculated using (i)(M/Z) when the SIF is entered.*

4. *CAESAR II will properly orient the SIFs providing all three elements that frame into the intersection are pipe elements.*

5. *Users can override CAESAR calculated header SIFs also. FESIF calculates SIFs for header elements. These SIFs are often considerably lower than Code calculated values when branch to header diameter ratio (d/D) is much less than 0.5.*


Applying SIFs at Pipe Intersection in CAESAR II

Comprehensive Method

1. Construct the intersection model using a rigid element from the centerline of header to the surface of the header where the branch pipe penetrates. This is illustrated in the example below. The end node of the branch element (41 in the example below), should be different from the end node of the rigid element (40 in the example below).
2. Insert the four calculated point stiffnesses from FESIF in between the node at the end of the rigid element and at the end of the branch element.
3. Insert two rigid stiffnesses for the translational stiffnesses that are rigid in between the node at the end of the rigid element and at the end of the branch element.
4. Determine the in-plane and out-plane directions for the branch and insert the SIFs calculated by FESIF. See below to know which direction is in-plane and which is out-plane for CAESAR.
5. Run FESIF with the option to calculate the header (run) SIFs.
6. Insert the in-plane and out-plane SIFs from FESIF on each header element framing into the intersection. Also include a CAESAR II intersection type (that is, RFT, UFT, etc.) for the node. CAESAR will determine the correct orientation (even with the rigid element used for the branch – but this is only true for the header SIF orientations).
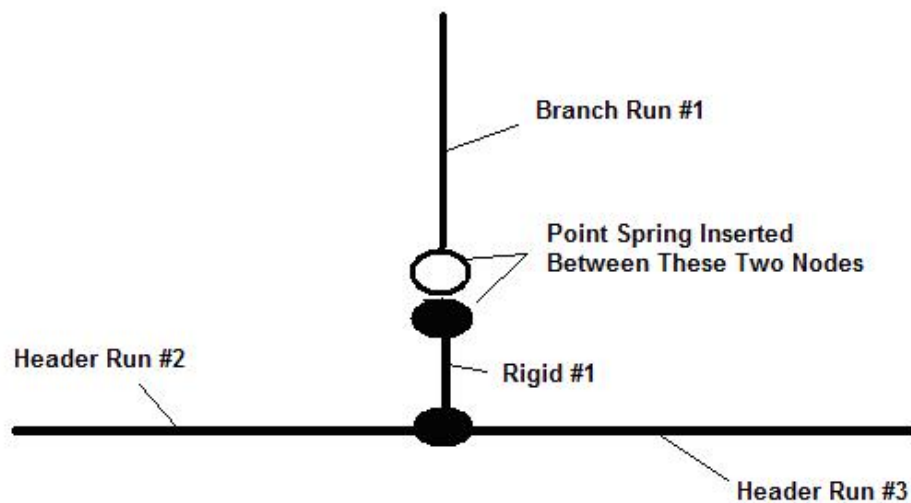
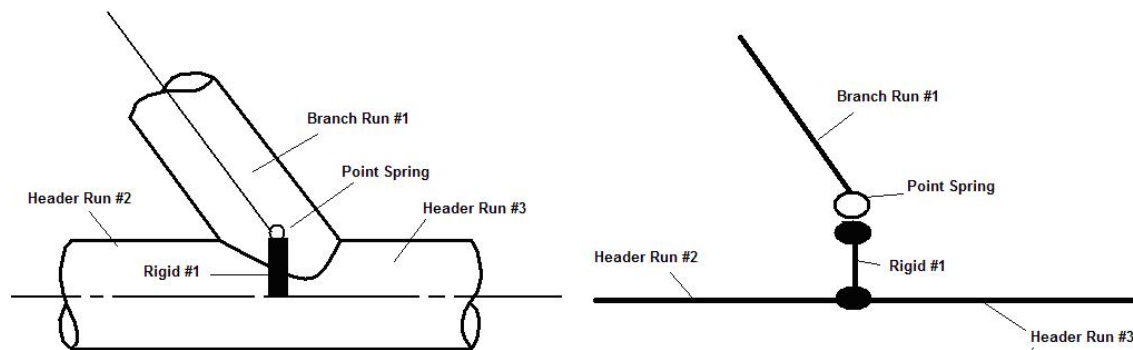**Conceptual Model of Piping Intersection**
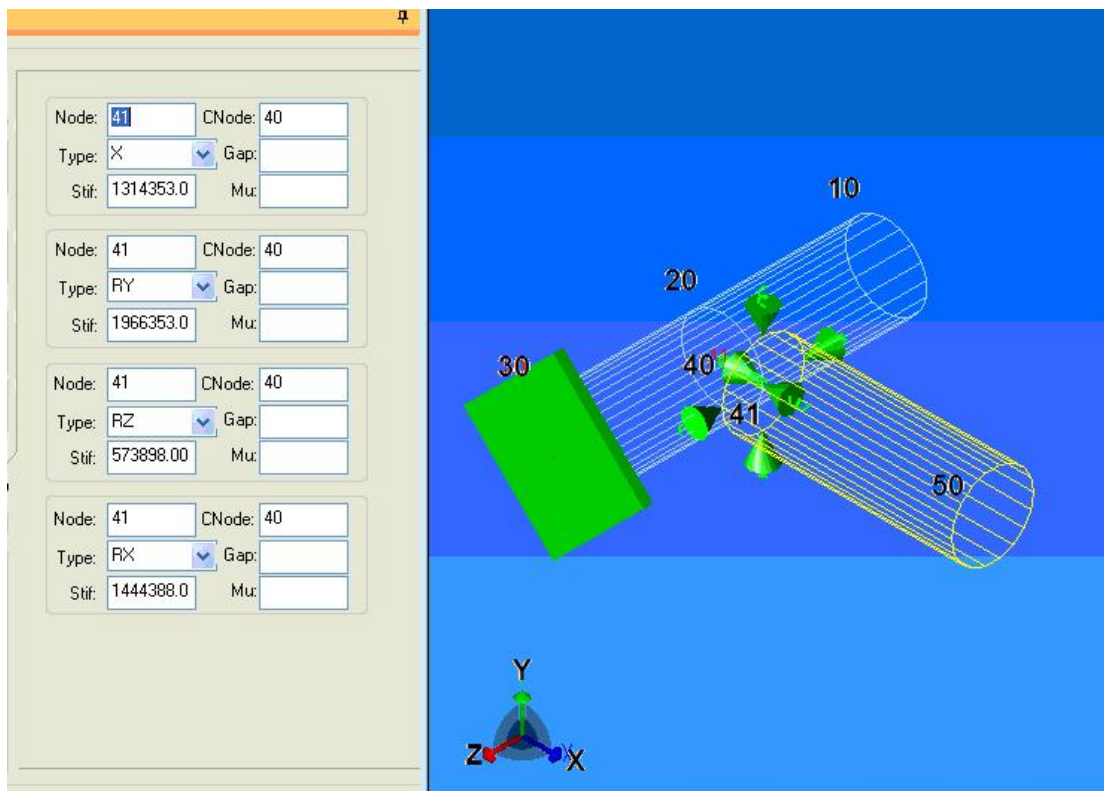
CAESAR II SIF Input Panel
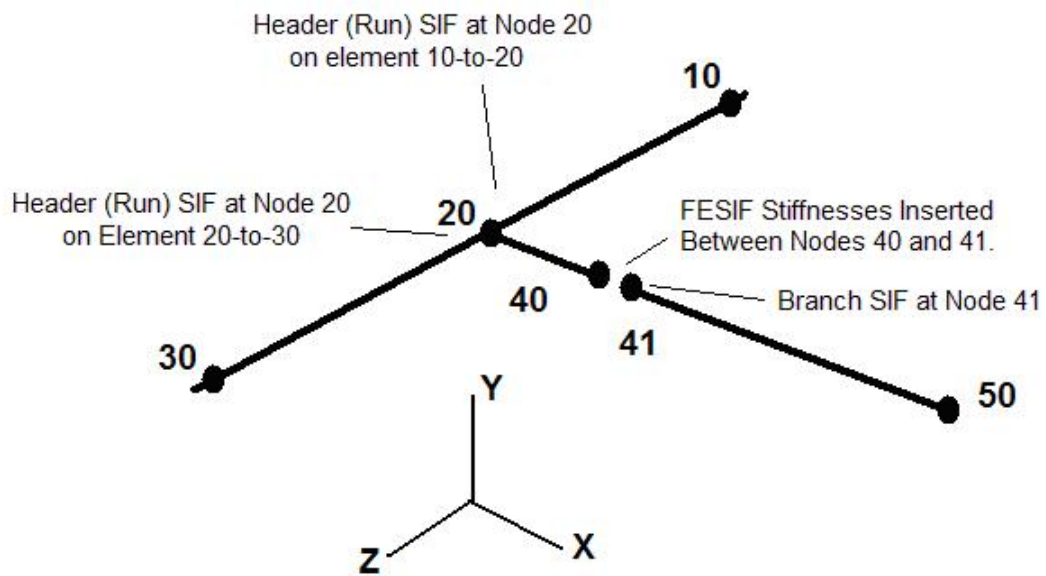
Piping Beam Elements

The rigid element approach is shown in more detail below.

Rigid Element Approach Detail

For laterals, the in-plane stiffness can be used for both the in-plane and out-plane directions, and the largest in-plane or out-plane SIF can be used. This is often a good idea for laterals since the torsional SIFs can be quite large and may contribute to fatigue failure.

There are four principle SIFs and stiffnesses associated with most intersections:

1. Axial translational
2. In-Plane Bending
3. Out-Plane Bending
4. Torsional Bending

The ASME B31.3 piping code only defines the in-plane and out-plane stress intensification factors although Welding Research Council Bulletin 329 discusses the magnitudes of the SIFs in the other directions.