Advanced FEA Insights

PCLGold™

Designed By Piping Engineers
For Piping Engineers

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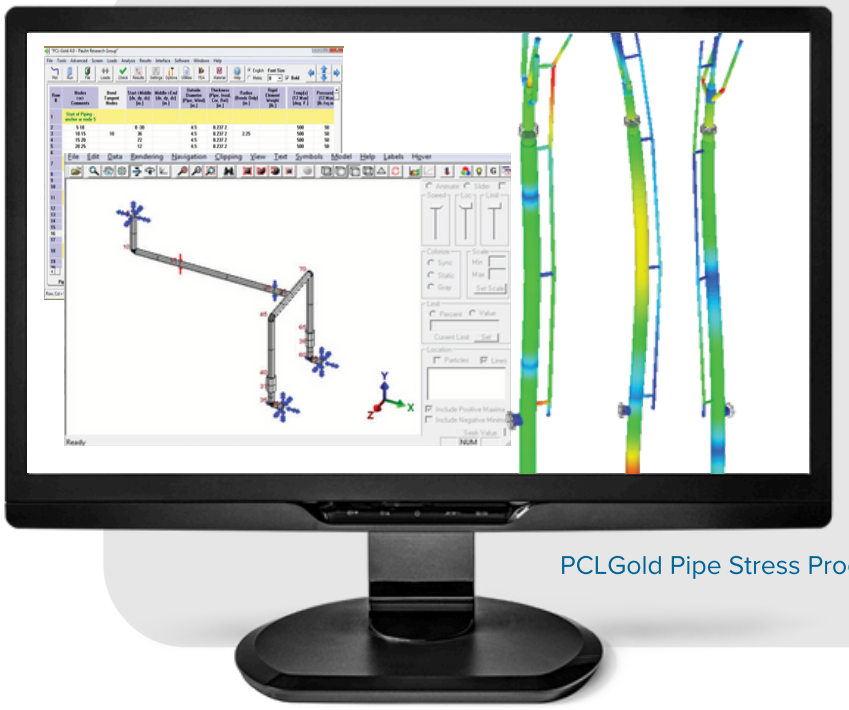
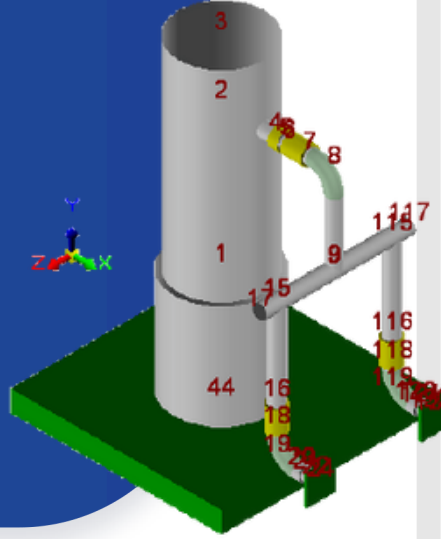


PCLGold Pipe Stress Program

PRG
PAULIN
Research Group
www.paulin.com
Sales: 281-920-9775

PCLGold™

The First Pipe Stress Program to Automatically Run FEA for Local Intersections



- Path Dependent Friction
- Thermal Bowing
- Hot Sustained Cases
- P-Δ Effects
- Large Rotations
- Stress Stiffening & Softening
- Pressure Cycling Calculations
- FEA-based i-factors & k-factors
- 18dof Refractory Line Pipe
- Rotating Equipment Reports
- High Frequency & Mode Estimates
- Structural Elements

What separates PCLGold from the rest of the general pipe stress tools?

PCLGold provides independent run/branch i-factors and k-factors for axial loads and pressure, which aren't adequately defined in the current version of B31.3.

It provides automatic FEA modeling of the actual industry variation observed in welding tees (considered the most dependable branch connection product on the market).

PCLGold provides B31.3 Eq. 1d for multiple load case fatigue equivalent cycle counting automatically. The program finds the worst fatigue range between load cases automatically.

PCLGold includes a path dependent friction solver that considers the order of loading in the stress analysis, and how the friction loads change directions depending on the loading conditions.

Why should I use PCLGold?

For piping systems in which there are well-known weaknesses in code approaches, PCLGold provides an alternative method for determining if the weakness can cause a potential problem. Most noted areas are:

- The system suffers a significant number of thermal cycles
- Piping with large diameter to thickness ratio
- Pressure design
- Rotating equipment loads (automatic k-factors are generated to produce proper load distribution in the piping system)

When there is a critical piping system that has a chance for load estimate errors, PCLGold should be used as a backup calculation to verify that the full range of potential problem areas are considered ... (automatically).

How do I get PCLGold?

PCLGold is available as a part of an active FEPipe service plan. FEPipe users who are current on their SMS automatically receive access to PCLGold.

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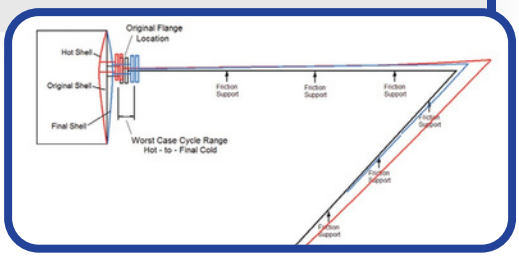
Path Dependent Friction

During startup, as the pipe heats it moves away from the nozzle. The friction supports located downstream react to the outward sliding and push back on the vessel nozzle putting the nozzle in an axial compressive load. When the pipe returns to ambient during a shutdown, the direction of the friction force changes (since friction acts against the direction of motion), and the friction load puts the nozzle in tension, pulling outward on the vessel.



Thermal Bowing

Thermal bowing may be used to consider the effects of liquid layers developed inside the pipe, such as those which occur due to furnace radiation, rain, or sun or when filling with LNG. Any of these effects can produce a circumferential varying temperature gradient along the axial length of the pipe. Depending on the source of these gradients, they may be found in horizontal or vertical pipe. PCLGold allows for thermal variation along the circumference, properly developing the bending moment in the pipe due to the temperature gradient.

Hot Sustained Cases

B31.3 includes the following:

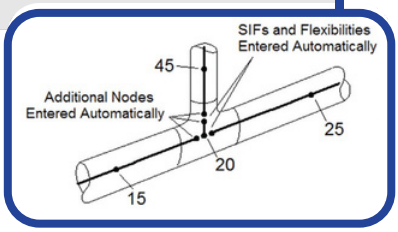
321.1.1 (g) addresses unintentional disengagement of piping.

B31.3 Appendix S, paragraph S302 addresses the potential intentional disengagement of piping. S302.6.2 states, “All anticipated sustained conditions utilizing all possible support scenarios should be considered and either evaluated or Approved By Inspection.”

The hot sustained load case is always the last load case analyzed. Note that if the highest SL is found in the hot sustained case, then this SL will be used to reduce the expansion case stress allowable.

Automated Intersection Models

One of the greatest difficulty in preparing a beam-type piping model for a finite element analysis is the conversion of the nodes at the intersection. PCLGold automatically inserts the additional nodes and inserts the FEA stiffnesses, Stress Intensification Factors and Sustained Stress Indices in the correct piping nodes at the broken down intersection.



P-Δ Effects, Large Rotation, Stress Stiffening & Softening

For pipe overhangs, considerable sag may occur if designers do not properly account for the increased flexibility along with the weight. Condensate can collect, further increasing the sag, ultimately resulting in a situation where unexpected slugging occurs in the line.

When vertical risers are permitted to move laterally, compressive axial loads can reduce the lateral strength of the line, permitting additional lateral displacement and greater offset, producing greater bending moments at the base of the riser.

When axial loads develop in long lines due to friction, the lateral load bearing capacity is reduced and large displacement can occur in the lateral direction as the pipe “conforms” to the axial load. Small axial displacements (thermal strains), can produce very large lateral displacements and binding or failure of supports.

GRE piping is particularly susceptible to the development of axial compressive stresses and so can be particularly likely to stress soften. When piping systems are subject to tensile loads, they may experience a lateral stiffening effect and so deflect less when subject to lateral loads such as wind, weight or developed loads due to attached piping. This is the well known “guitar- string” effect.

These stiffening effects may also alter natural frequencies and mode shapes.

Physical Testing To Verify Results

Paulin Research Group uses real-world tests to verify the accuracy of our software results. PRG has performed burst, fatigue, acoustic, and soil tests.