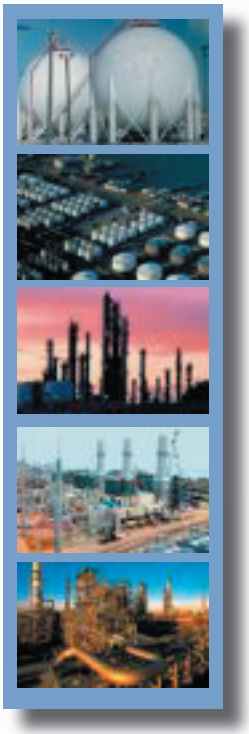
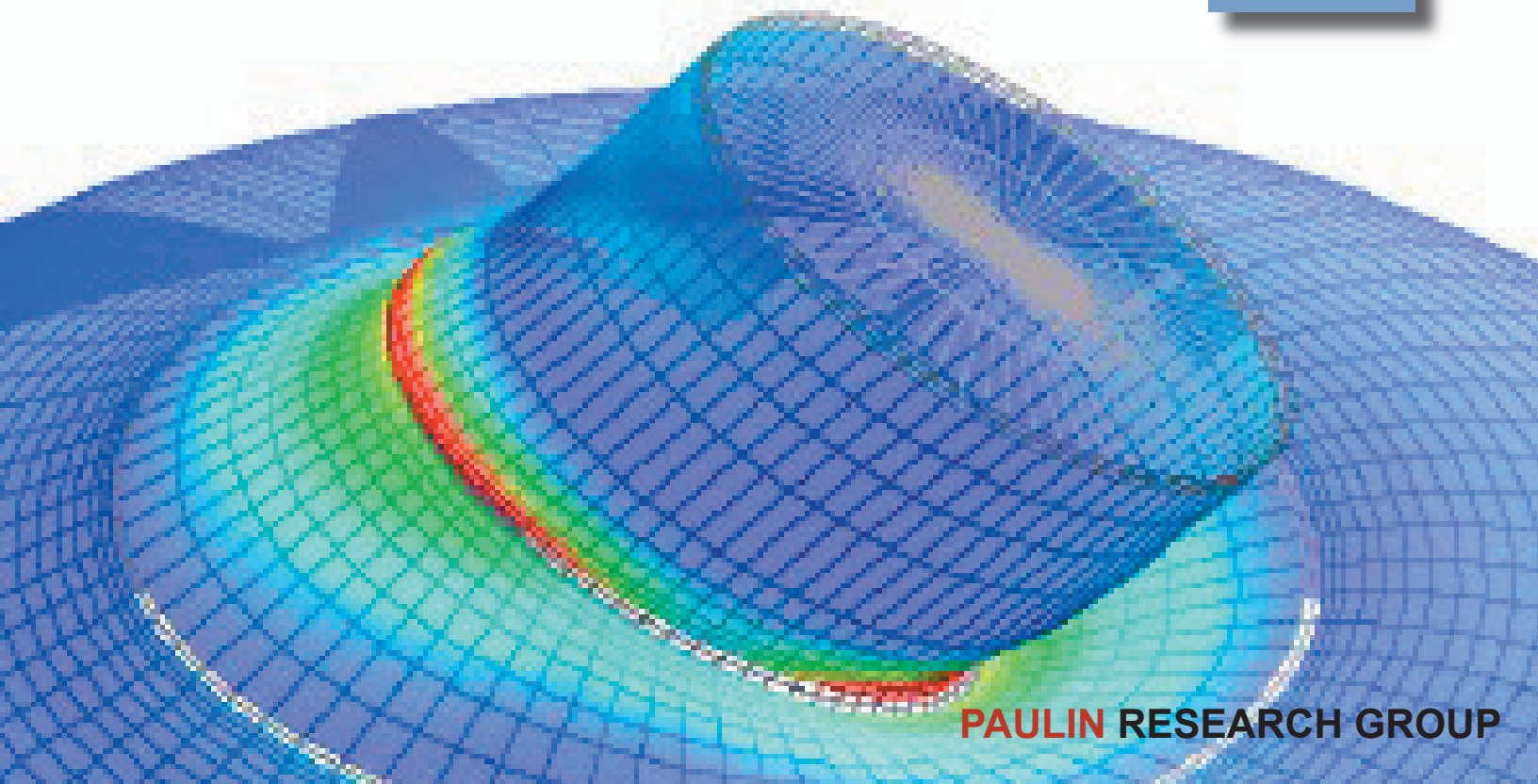
FE/Pipe

Finite Element Solutions

Pressure Vessels & Piping

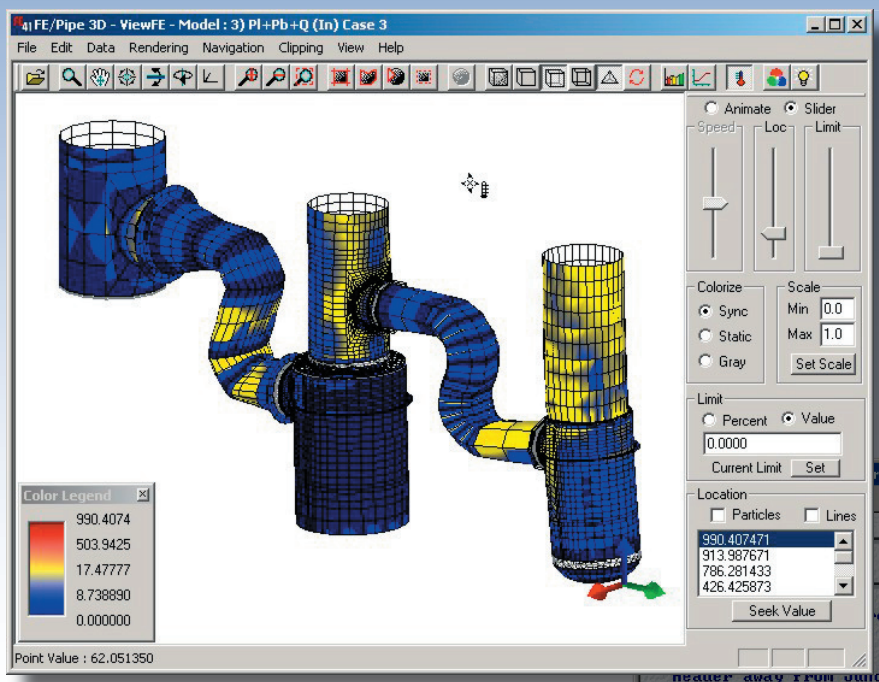




PAULIN RESEARCH GROUP

FE/Pipe - A Brief Overview

FE/Pipe is a template-driven Finite Element software package, specifically designed for the needs of the piping and pressure vessel industries. FE/Pipe (as well as all of its associated modules in the PRO series) generates automatic code compliance reports - comparisons to ASME Section VIII, Division 2, Appendix 4 and 5 rules and stress categories. Build models such as intersections, flanges, saddles, low tank settlement, structural steel and MORE - all in a matter of minutes. We bring engineering to the real world.

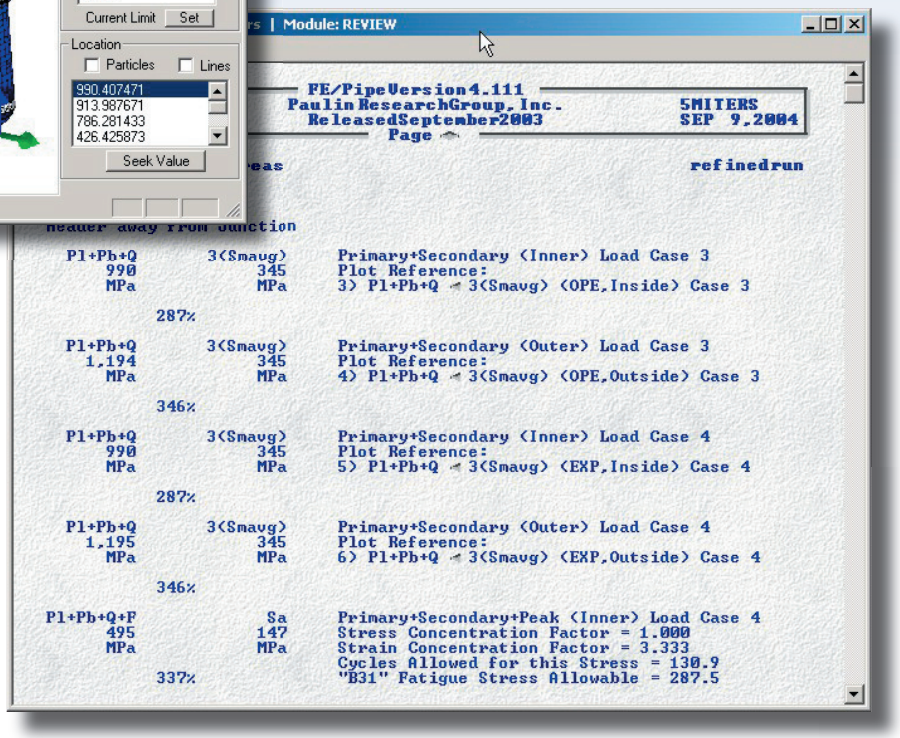


Direct X

3d graphical results offer ease of viewing and full Windows functionality.

Creating Systems

Parent-Child database functions allow the user to join together individual models into one large system for analysis. The geometry to the left was generated out of nine (9) individual models. Approximate solution time was five (5) minutes. Triangular elements eliminate the need for all model sections to have the same element density patterns. Include more elements only where you need them.



Buckling & Plasticity*

Buckling is a concern in piping and pressure vessel geometries with large D/t ratios and/or external pressure. FE/Pipe includes the ability to analyze buckling using traditional bifurcation buckling and elastic-plastic collapse analysis. In addition, FE/Pipe also provides full capabilities for elastic-plastic analysis with kinematic hardening. The elastic-plastic solver can also be used to generate lower bound collapse loads.

Thermal Solutions

In some systems, thru-the-wall thermal gradients can cause significant stresses. FE/Pipe can be used to analyze steady state and transient thermal stresses in both solid and axisymmetric elements. Applications might include hot-box design verification for skirt supported vessels, catalyst bed support rings, and other discontinuities.

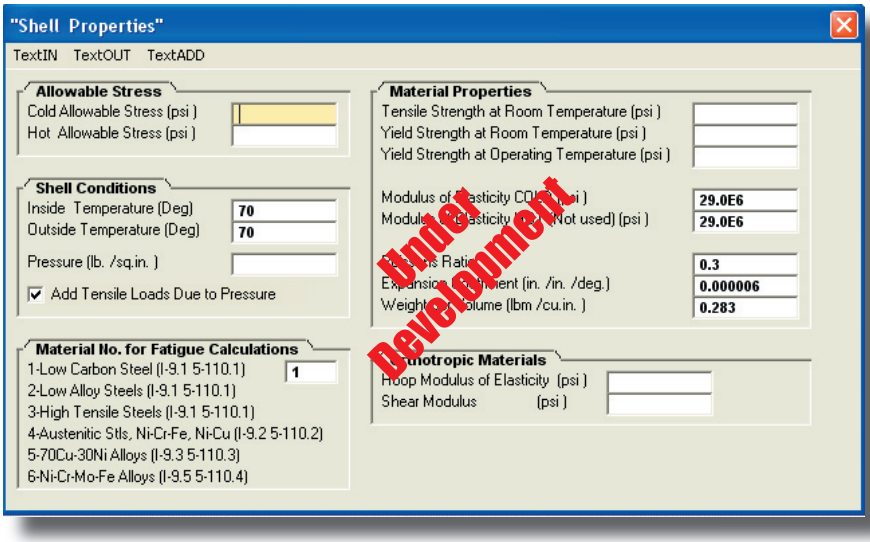
When You Should Use FE/Pipe

- To analyze any nozzle loads (WRC 107/297 are not comprehensive and often inaccurate).
- To analyze large branch/shell intersections (d/D>0.50)
- Piping or pressure vessels wtih D/t rations greater than 100.
- Flange analysis - get the REAL operating bolt load, not a psuedo “code” load and estimate flange leakage.
- Calculate accurate SIFs and flexibilites for your piping analysis.
- External loads on saddle supported vessels.

When You *REALLY* Should Use FE/Pipe

- Satisfy code requirements for buckling in complex systems.
- Get realistic stresses for nozzles with external loads.
- When your piping systems exceeds D/t>100. Piping code rules are not meant for large D/t systems.
- Perform accurate fatigue analysis for nozzles or attachments.
- When your design isn’t covered by code rules - large angle cones, rectangular openings, etc).

*Plasticity will be available in the next release: Winter 2004



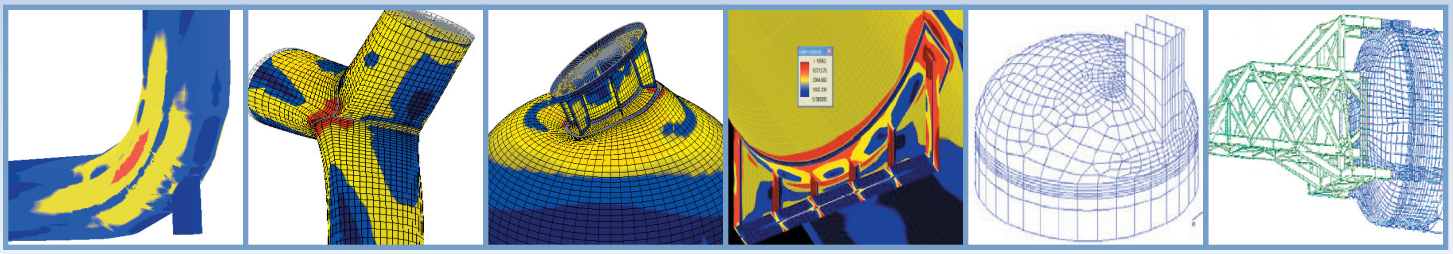
Standard Templates

FE/Pipe includes many standardized templates that allow the designer to quickly and easily build finite element geomeries that had previously taken days and weeks. Changes to geometry and loads are instantaneous - no need to completely rebuild the model. The following list details the standard templates currently available for use with FE/Pipe.

Unreinforced Fabricated Tee
Pad Reinforced Fabricated Tee
Welding Tee
Hillside Tee
General Nozzles, Plates & Shells
Beam Models
Cylindrical Strings

Symmetric Geometries (2d & Brick)
Axisymmetric Flange
Low Tank Nozzle
FCC Wye Fitting
Singular Nozzle Large Sizes
Head Structures
Wye Intersection

Tank Settlement
Plate Heat Exchanger
Simple Pipe Supports
Tangential Nozzle
Shell-to-Head Nozzle
Olet-Type Fitting (Brick)
UFT or RFT (Brick)

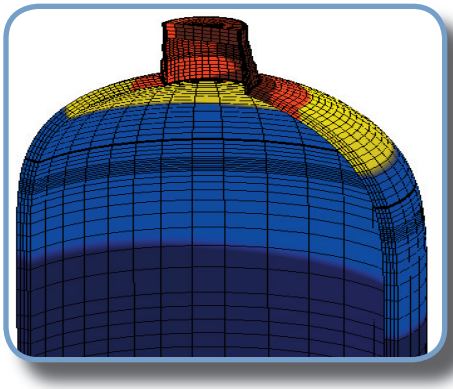


Specialized Modules

In addition to the templates listed above, FE/Pipe includes several stand-alone modules that can be purchased individually. These modules are part of our PRO series that bring specialized attention to the most common problems encountered by engineers and designers today.

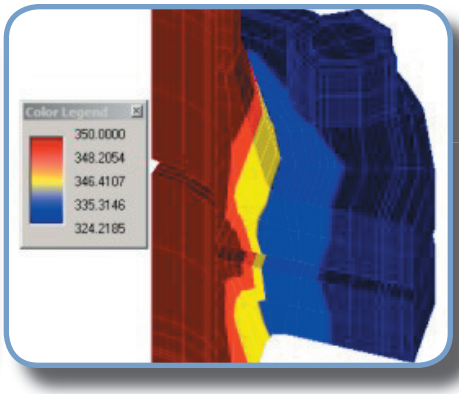
Nozzle/ PRO

Analyze individual nozzles, saddles, clips or pipe supports on a variety of head types.



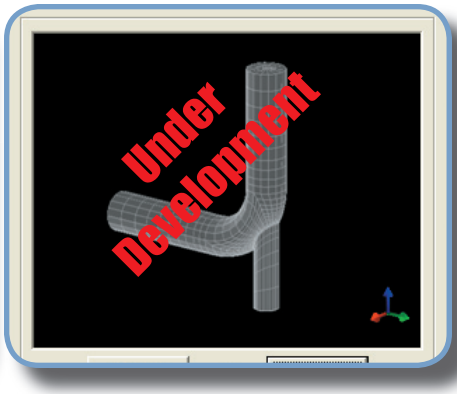
Axi/ PRO

An axisymmetric & brick FEA modeler, designed to analyze flanged joints & other axisymmetric geometries.



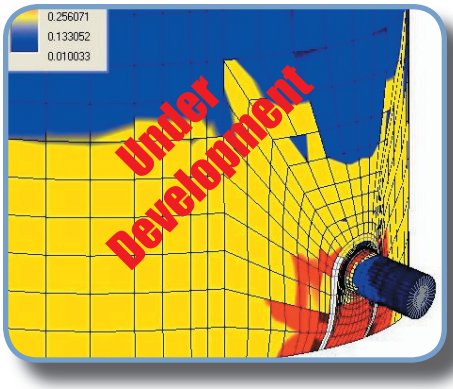
Bend/ PRO

Analyze individual Bends with staunchions or clips.



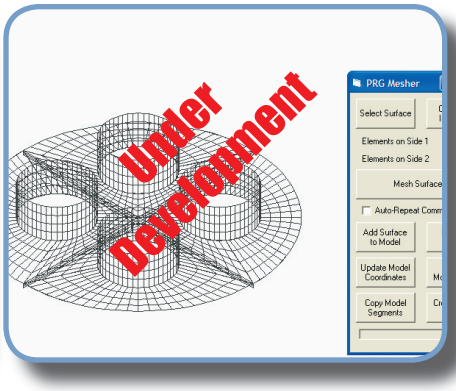
Tank/ PRO

Generate stresses, SIFs and flexibilities for low tank nozzles.



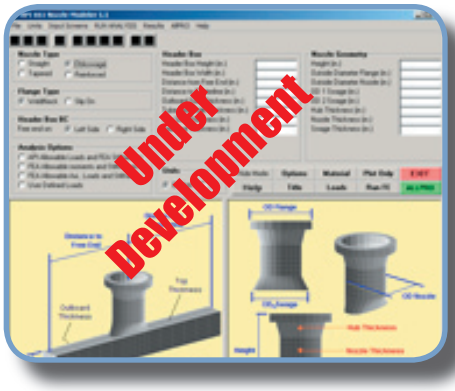
Mesh/ PRO

This interface allows the FE/Pipe user to import geometries into AutoCAD for editing and re-import back into FE/Pipe for code analysis.



661/ PRO

FEA analysis of header box nozzles for fin fan exchangers.

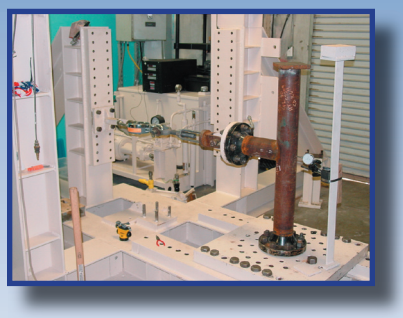


FE/Pipe Verified

Paulin Research Group verifies the accuracy of its software with real-world tests.

The PRG lab routinely performs piping fatigue / acoustic / flange leakage tests, as well as cryogenic studies.

The Ammonia Storage Vessel above was strain-gauged during hydro for verification of "Zick" type stresses predicted using Nozzle/PRO. PRG also load-tested the manway located in the elliptical head. Other testing included axial loading of the support saddles to verify saddle stresses predicted in Nozzle/PRO.



PRG lab generation of a load-deflection curve for use in "Markl" type fatigue testing. Loads and deflections were measured to generate a curve that describes the test components reaction to loading. During the fatigue test, a specified deflection was repeatedly applied. The actual load can then be estimated from the load-deflection curve.

The "Markl" test rig with a horizontal vessel is in place for an axial fatigue test of the support saddle and shell. An axial load is applied to the vessel to simulate sloshing or other events that would generate axial forces on the support saddles. This test was used to verify the Nozzle/PRO approach to saddle design.

The Codes

Output or code calculations are given directly for the following codes...

1. ASME Section 8, Division 2, Appendix 4
2. ASME Section 8, Division 2, Appendix 5
3. ASME Section 8, Division 1, Appendix 2
4. ASME Section 8, Division 1, Appendix BFJ (proposed)
5. AISC Manual of Steel Construction
6. ASME Section 8, Division 2, Article 4-9 Tubesheet stresses
7. NEAM Tube Buckling Calculations
8. ASME Section VIII, Division 1, Appendix A Tube and Tubesheet strength calculations.
9. TEMA

Other codes/methods are considered or used for comparative calculations...

1. SIFs and Flexibilities for B31.1, B31.3, and any other piping code
2. WRC 107/297 Nozzle Stress Calculations
3. N-318 Lug Calculations
4. N-392 Round Attachment Calculation
5. Code area replacement calculations at nozzles
6. Zick calculation for saddle supported vessels (satisfies new Division 2 and several existing foreign codes such as BS5500)
7. Nozzle Flexibilities per WRC 297 and NB 3685.

The primary code output is for ASME Section VIII, Division 2, Appendix 4 and 5. But, these results can be used to satisfy virtually any code in the world so long as the basis of the stress categorization is similar to that given in ASME.

Flange results are given for ASME Section VIII, Division 1, Appendix 2 and proposed Appendix BFJ. Flange results are also available for EN 13445.

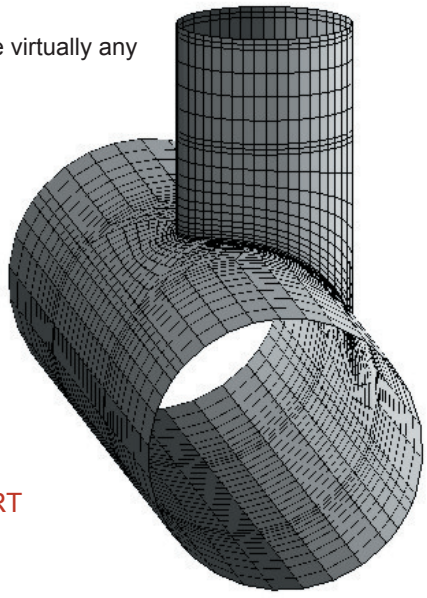
AISC output and code calcs are available for structural beam models.

The axisymmetric template can generate tube sheet models for heat exchangers. This extends upon the code rules provided in all codes with exchanger rules (TEMA, ASME, BS5000, etc).

Stress Intensification Factors generated in many of the templates can be used to improve virtually any piping code (B31.1, B31.3, etc).

API 653 can be satisfied using FE/Pipe's ***Tank Settlement*** template.

API 650 Appendix P can be satisfied using FE/Pipe's ***Low Wall Nozzle Tank*** template.



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