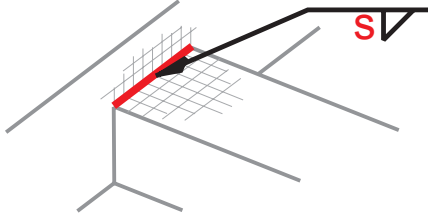
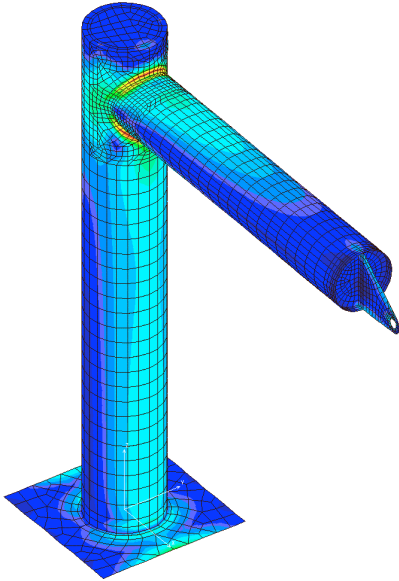


# FEWeld



Weld Calculations from FEA



# FEWeld

With most fabricated machinery and equipment, the welds play a critical role in the structural resistance to failure. Often, the welds comprise the critical points that determine the capacity of the structure.

FEWeld is a general mathematical tool for calculating weld parameters to meet performance criteria from the results of finite element analysis with shell elements, including your existing solved FEA models. FEWeld calculates and organizes weld size requirements and other design parameters. A database driven GUI manages multiple weldment configurations (corresponding to multiple FEA Models), welds, load cases, and evaluation criteria simply and effectively. The program comes with a standard library formulations for most combinations of Single and Double Sided Fillet and Partial Joint Penetration welds. The formulation library is user extensible with a 'C' like formulation language that will optimize weld design parameters given an objective such as minimizing weld volume and constraints such as allowable throat stress. The formulation is evaluated at each node of a weld for each load case with the local load and stress data available in the local weld joint coordinate system. The calculation results are easily browsed as plots along the joint length for each configuration-weld-load case, or as the worst case across all load cases. Professional summary reports are also generated. FEWeld is fast and easy to use.

FEWeld is implemented for Ansys and Cosmos on Windows NT, 95, 98, 2000, XP, VISTA, and 7 - 32 and 64 Bit.

FEWeld E:\WORK\91-011\pipe\_lug\_wld

Set Name: Pipe\_Lug\_04  
Set Description: Mapped Shell9 Elements around Joints, Refined Mesh at Pipe - to pipe Joint

Welds: 7 Welds Entered with 7 Defined

Weld Number	Weld Type	Allowsables Set	Weld Joint Description
01	S	5356	Weld Between Base Plate and Post-Pipe
02	S	4043	Weld Between Post-Pipe and Post-Pipe End Cap
03	S	4043	Weld Between Post-Pipe and Stand-Off Pipe
04	S	4043	Weld between Stand-Off Pipe and Lug-Plug
05a	S	4043	Weld between Stand-Off Pipe and Lug - Top
05b	S	4043	Weld between Stand-Off Pipe and Lug - Bottom
06	S	4043	Weld Between Lug-Plug and Lug

Stress Allowable Sets: 2 Allowables Sets

Set ID	Description
4043	4043 Electrode
5356	5356 Electrode

Load Cases: 7 Load Cases

Load Case	Description	4043	5356
01	Lug-Load 0 Degrees (Vertical)	5000	8000
02	Lug-Load 15 Degrees	5000	8000
03	Lug-Load 30 Degrees	5000	8000
04	Lug-Load 45 Degrees	5000	8000
05	Lug-Load 60 Degrees	5000	8000
06	Lug-Load 75 Degrees	5000	8000
07	Lug-Load 90 Degrees (Horizontal)	5000	8000

Detail Results Control Panel

Set: Pipe\_Lug\_04 | Load Case: byNode | Weld: 03

Detail Results

December 10, 1999  
E:\WORK\91-011\pipe\_lug\_wld

Set	Weld	Weld Description
Pipe_Lug_04	03	Weld Between Post-Pipe and Stand-Off Pipe

Load Case: byNode For each node, Max Signed [tw, Weld Throat] for all load cases.

Weld Type: S Single Sided Weld based on throat shear.

Pipe\_Lug\_04, Weld: 03, LC: byNode

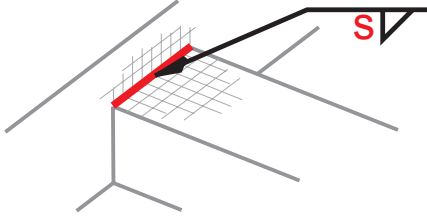
seam dist, s	x	y	z	tw	Tj	Tw	Ts	Twss	Mw	THK	f_Tj	Load Case
0.00	2.00	0.00	2.50	0.215820	-644.418	-0.60851	-512.515	512.5155	-115.017	0.25	-2985.91	01
0.31	2.00	8.82	2.48	0.220703	-718.998	-110.784	-479.307	491.9433	-117.792	0.25	-3257.76	01
0.62	2.01	17.50	2.43	0.225586	-769.065	-220.527	-563.247	604.8793	-121.931	0.25	-3409.19	01
0.91	2.00											
1.20	2.00											
1.49	2.00											
1.77	2.00											
2.05	2.00											
2.33	1.99											
2.60	1.99											

WeldType Plot Variables

Select Formulation Output Variables for Plotting

Weld_Type	Variable	Plotting
DF	Weld Throat	<input checked="" type="checkbox"/>
S	Joint Norman Traction (Load)	<input type="checkbox"/>
Tj	Weld Axis Traction (Longitudinal Shear)	<input type="checkbox"/>
Tw	Out of Plane Traction (Load)	<input type="checkbox"/>
Ts	Magnitude of Traction in ws Plane	<input type="checkbox"/>
Twss	Bending Load	<input type="checkbox"/>
Mw	Local Terminated Part Thickness	<input type="checkbox"/>
THK	Calculated Throat Stress from Tj	<input type="checkbox"/>
f_Tj	Calculated Throat Stress from Twss	<input type="checkbox"/>
f_Twss	Summary Variable	<input type="checkbox"/>

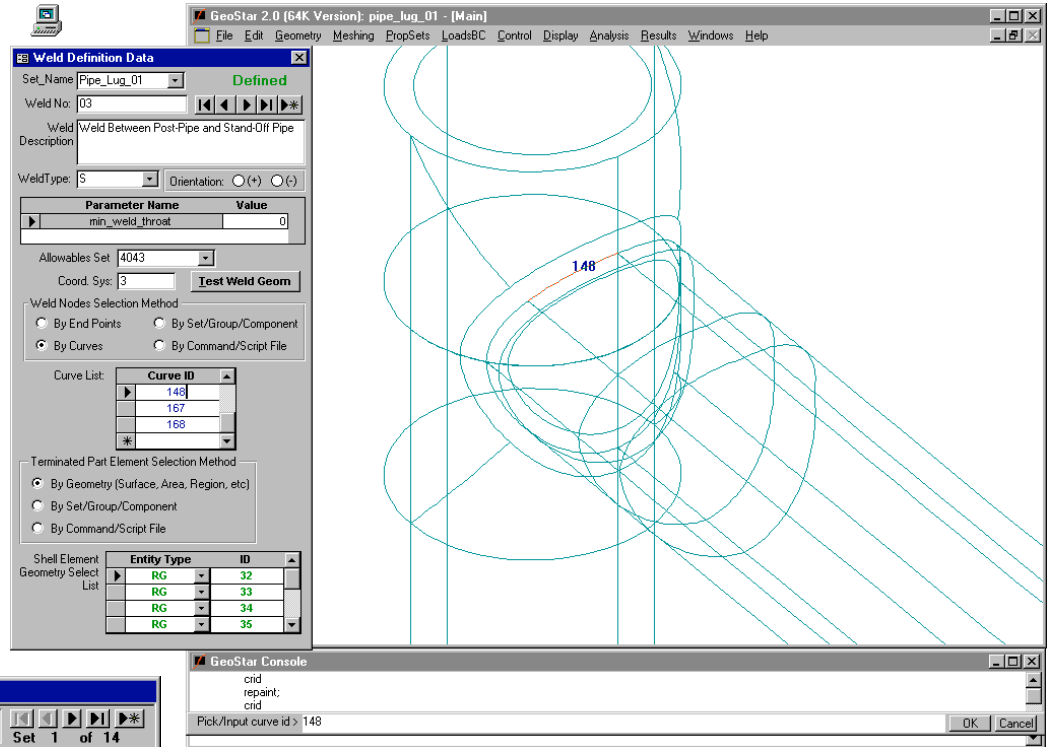




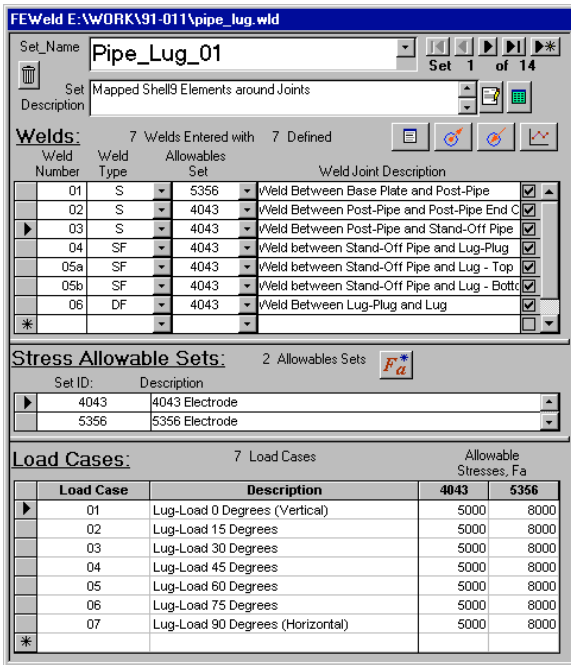
Weld Calculations from FEA

## Weld Configuration Definition

Each Weld Set within a FEWeld file contains the definition of the configuration: Welds, Load Cases, and Stress Allowables. The Weld Definitions include the Weld Number, a Weld Formulation, a Stress Allowable Set, and a specification for the weld in the FEA Model. This FEA Model definition includes the weld joint nodes, selectable by associated Curves|Lines or Component|Group|Selection Set; and terminated part element selection by associated Areas|Surface|Regions or Component|Group|Selection Set. The Load Case Definitions include Load Case Numbers and a stress allowable value for each stress allowable set.

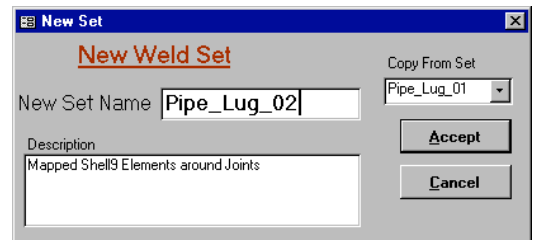


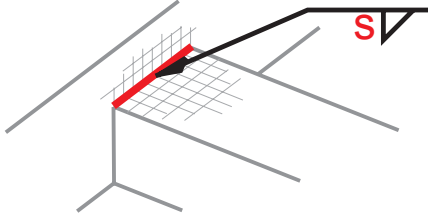
**Above:** Interactive specification of weld joint nodes and terminated part elements in Cosmos.



**Left:** The Weld Set Main Window. Contains the basic definition of the Weld Set: Welds, Load Cases, and Stress Allowables. Also displays definition status information.

**Below:** New weld sets can be defined as duplicates of existing weld sets to avoid effort duplication for definition of similar configurations.





Weld Calculations from FEA

FEWeld ships with a large selection of parametric weld definitions that embody most combinations of Fillet and Partial Joint Penetration Welds. The parameters of these definitions can be solved at each node of the weld joint or input for each weld as part of the weld definition. For example, on some welds, the amount of joint prep will be predefined and the definition will solve for the fillet reinforcement size, while for others both the prep depth and reinforcement size will be variables in the solution to minimize weld volume constrained by the allowable stress.

There are also formulations to apply notch stress concentration factors for bending and for membrane load stresses on both sides of the joint and take the worst case; formulations for principal stress output, etc.

Case 1: Throat Terminates at Weld Face:  
Face\_Angle + 90 deg < Root\_Toe\_Angle  
Throat\_Angle = Face\_Angle + 90 deg

Case 1: Throat Terminates at Weld Face:  
Face\_Angle + 90 deg < Root\_Toe\_Angle  
Throat\_Angle = Face\_Angle + 90 deg

Joint Side 1  
Joint Side 2  
Weld Section n.a.  
throat\_angle = face\_angle + 90 deg

P1F1\_VF Formulation: Partial Joint Penetration on Side 1 with Fillet Reinforcement. Groove size & Fillet Face angle fixed (weld parameters), fillet size calculated (VF - Variable Fillet) to minimize weld volume and keep throat shear below allowable.

Joint Side 1  
Joint Side 2  
Terminated Part

Joint Side 1  
Joint Side 2  
Terminated Part

Joint Side 1  
Joint Side 2  
Terminated Part

throat\_ang = 90  
face\_ang = 0  
Tw = E  
Joint Side 1  
Joint Side 2  
Terminated Part

**Weld Definition Data**  
Set\_Name: Pipe\_Lug\_04 (Defined)  
Weld No: 03  
Weld Description: Weld Between Post-Pipe and Stand-Off Pipe  
WeldType: P1F1-VF  
Orientation: (+) (-)

Parameter Name	Value
restraint	1
E	0.25
face_angle_deg	30
min_leg_size	0

Allowables Set: 4043  
Coord. Sys: 3  
Weld Nodes Selection Method: By Curves (selected)  
Curve List:  

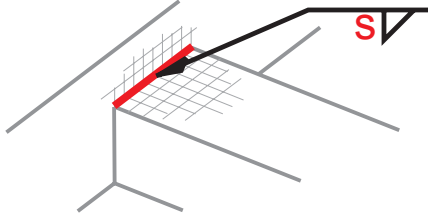
Curve ID
90
101
130
131

weld Formulation  
Parametric weld  
Definition Variables

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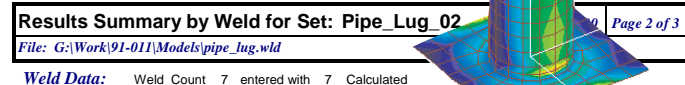
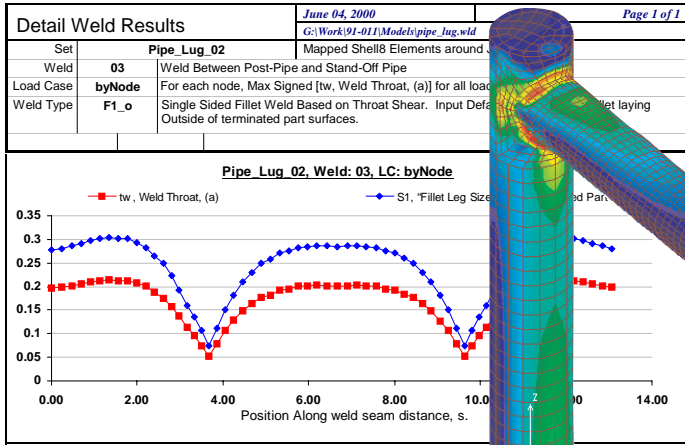
Tel: (+1) 206 612 6167 <http://www.weavereng.com>



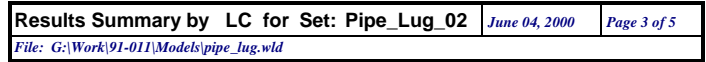
## Weld Calculations from FEA

# Results Presentation

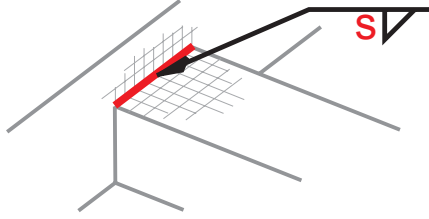
FEWeld provides a variety of result reports with varying degrees of detail. The most distilled is the 'Results By Weld' report that presents the single worst case nodal value for each summarized weld parameter across all nodes and evaluation conditions (load cases). The 'Results By Load Case' report provides the worst case nodal value for each load case of each weld for each summarized weld parameter, identifying the load case with the worst value. Finally, charting of nodal weld results traversing the weld is available.



Weld	Weld Description	Node	Case	Criteria	Value
<b>Weld 01</b>	Weld Between Base Plate and Post-Pipe				
F1_O	Single Sided Fillet Weld Based on Throat Shear. Input Defaults for 90 degree fillet laying Outside of terminated part surfaces.	Sa_Set_No: 5356			
	restraint 1 face_angle_deg 45 min_leg_size 0				
S1	"Fillet Leg Size (z) on Terminated P	8000	5631	04	Max Signed .218
tw	Weld Throat, (a)	8000	5631	04	Max Signed .154
<b>Weld 02</b>	Weld Between Post-Pipe and Post-Pipe End Cap				
F1_O	Single Sided Fillet Weld Based on Throat Shear. Input Defaults for 90 degree fillet laying Outside of terminated part surfaces.	Sa_Set_No: 4043			
	restraint 1 face_angle_deg 45 min_leg_size 0				
S1	"Fillet Leg Size (z) on Terminated P	5000	7147	01	Max Signed .146
tw	Weld Throat, (a)	5000	7147	01	Max Signed .104
<b>Weld 03</b>	Weld Between Post-Pipe and Stand-Off Pipe				
F1_O	Single Sided Fillet Weld Based on Throat Shear. Input Defaults for 90 degree fillet laying Outside of terminated part surfaces.	Sa_Set_No: 4043			
	restraint 1 face_angle_deg 45 min_leg_size 0				
S1	"Fillet Leg Size (z) on Terminated P	5000	8808	01	Max Signed .304
tw	Weld Throat, (a)	5000	8808	01	Max Signed .215
<b>Weld 04</b>	Weld between Stand-Off Pipe and Lug-Plug				
F1_O	Single Sided Fillet Weld Based on Throat Shear. Input Defaults for 90 degree fillet laying Outside of terminated part surfaces.	Sa_Set_No: 4043			
	restraint 1 face_angle_deg 45 min_leg_size 0				
S1	"Fillet Leg Size (z) on Terminated P	5000	868	02	Max Signed .12
tw	Weld Throat, (a)	5000	868	02	Max Signed .085



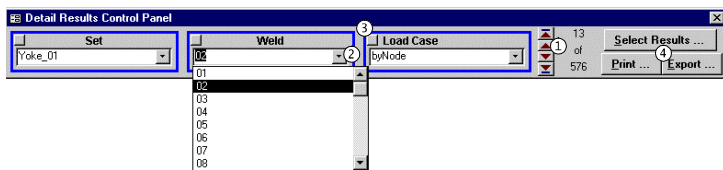
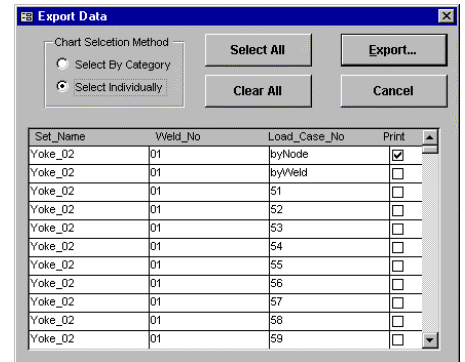
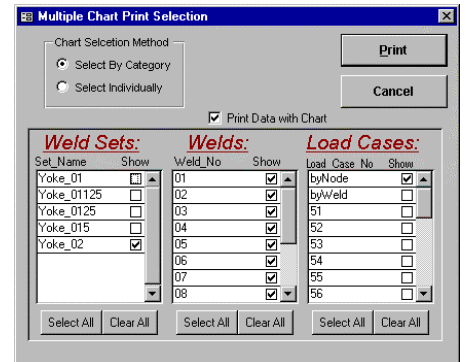
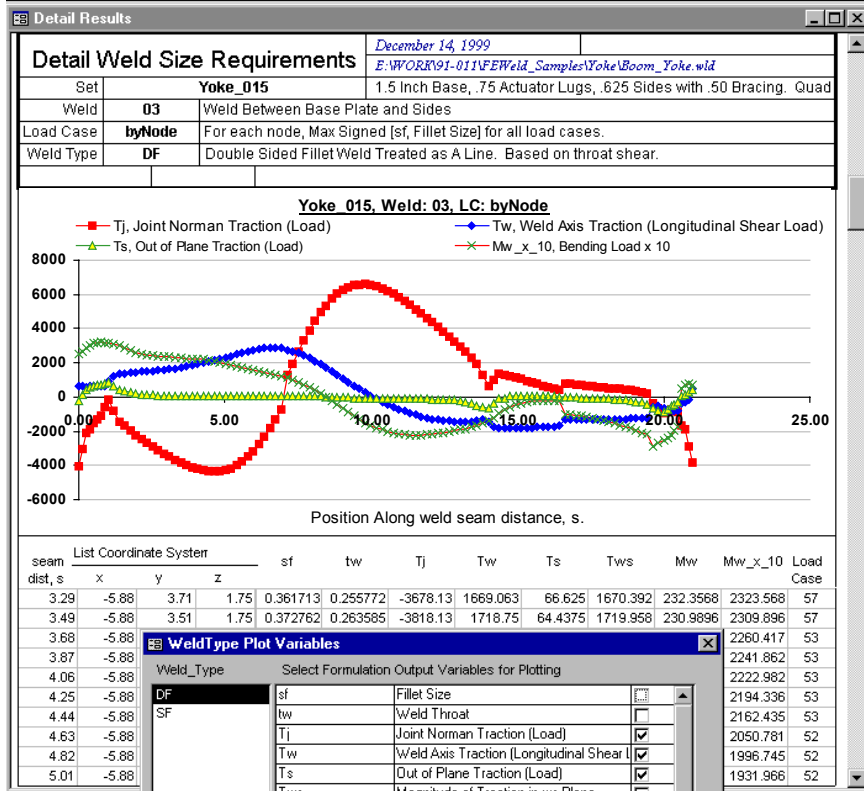
Weld	Weld Description	Node	Case	Criteria	Value
<b>Weld 03</b>	Weld Between Post-Pipe and Stand-Off Pipe				
F1_O	Single Sided Fillet Weld Based on Throat Shear. Input Defaults for 90 degree fillet laying Outside of terminated part surfaces.	Sa_Set_No: 4043			
	restraint 1 face_angle_deg 45 min_leg_size 0				
<b>Load Case: 01</b>	Lug-Load 0 Degrees (Vertical)				
S1	"Fillet Leg Size (z) on Terminated P	5000	8808	Max Signed	.304
tw	Weld Throat, (a)	5000	8808	Max Signed	.215
<b>Load Case: 02</b>	Lug-Load 15 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	8808	Max Signed	.294
tw	Weld Throat, (a)	5000	8808	Max Signed	.208
<b>Load Case: 03</b>	Lug-Load 30 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	8808	Max Signed	.272
tw	Weld Throat, (a)	5000	8808	Max Signed	.192
<b>Load Case: 04</b>	Lug-Load 45 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	8808	Max Signed	.238
tw	Weld Throat, (a)	5000	8808	Max Signed	.168
<b>Load Case: 05</b>	Lug-Load 60 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	7047	Max Signed	.193
tw	Weld Throat, (a)	5000	7047	Max Signed	.137
<b>Load Case: 06</b>	Lug-Load 75 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	7047	Max Signed	.134
tw	Weld Throat, (a)	5000	7047	Max Signed	.095
<b>Load Case: 07</b>	Lug-Load 90 Degrees (Horizontal)				
S1	"Fillet Leg Size (z) on Terminated P	5000	8791	Max Signed	.097
tw	Weld Throat, (a)	5000	8791	Max Signed	.068
<b>Weld 04</b>	Weld between Stand-Off Pipe and Lug-Plug				
F1_O	Single Sided Fillet Weld Based on Throat Shear. Input Defaults for 90 degree fillet laying Outside of terminated part surfaces.	Sa_Set_No: 4043			
	restraint 1 face_angle_deg 45 min_leg_size 0				
<b>Load Case: 01</b>	Lug-Load 0 Degrees (Vertical)				
S1	"Fillet Leg Size (z) on Terminated P	5000	868	Max Signed	.117
tw	Weld Throat, (a)	5000	868	Max Signed	.083
<b>Load Case: 02</b>	Lug-Load 15 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	868	Max Signed	.12
tw	Weld Throat, (a)	5000	868	Max Signed	.085
<b>Load Case: 03</b>	Lug-Load 30 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	868	Max Signed	.119
tw	Weld Throat, (a)	5000	868	Max Signed	.084
<b>Load Case: 04</b>	Lug-Load 45 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	868	Max Signed	.113
tw	Weld Throat, (a)	5000	868	Max Signed	.08
<b>Load Case: 05</b>	Lug-Load 60 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	868	Max Signed	.102
tw	Weld Throat, (a)	5000	868	Max Signed	.072
<b>Load Case: 06</b>	Lug-Load 75 Degrees				
S1	"Fillet Leg Size (z) on Terminated P	5000	8647	Max Signed	.095
tw	Weld Throat, (a)	5000	8647	Max Signed	.067
<b>Load Case: 07</b>	Lug-Load 90 Degrees (Horizontal)				
S1	"Fillet Leg Size (z) on Terminated P	5000	8647	Max Signed	.106
tw	Weld Throat, (a)	5000	8647	Max Signed	.075



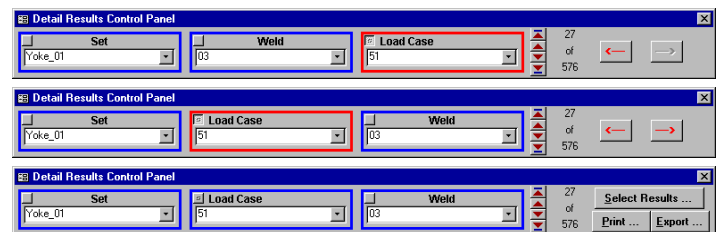
Weld Calculations from FEA

## Detail Results Review

All of the stored outputs from the weld formulation are available for plotting for each Weld\_Set, Weld\_No, Load\_Case combination, as well as plotting byNode. ByNode is a pseudo load case that plots, for a given weld in a given weld set, the maximum or minimum value across all load cases at each node for a selected formulation summary variable. The plots can be batch printed with or without data listings and the data can be batch exported. The plots themselves can be directly copied and pasted as a windows metafile, bitmap, or graph object into your favorite documentation application.

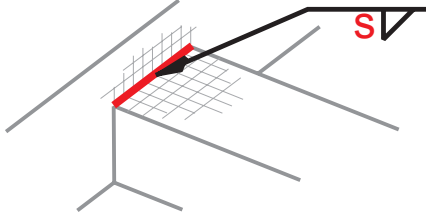


**The Detail Results Control Panel:** The Detail results control panel drives the Detail Results Plots. Specific Results Sets (Weld\_Set, Weld\_No, Load\_Case) can be directly accessed, or the results can be viewed sequentially.



**Rearranging the Display Sequence:** The plot sequence can be rearranged to sequence through Weld Sets, Welds, and Load Cases in any order.

# FEWeld

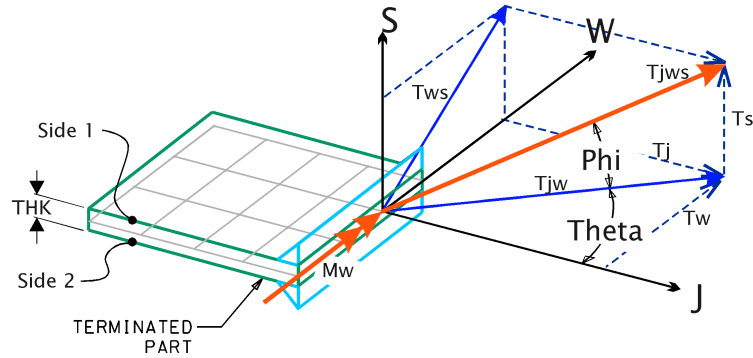


Weld Calculations from FEA

## User Weld Formulations

All weld calculations and results generation in FEWeld are defined in the *Weld Formulation*. The Weld Formulation is a mathematical algorithm that performs calculations at each node of each weld joint for each load case from the local loads and/or stresses in the local weld joint coordinate system, the local part thickness, and the evaluation criteria.

While FEWeld provides a library of formulations that will cover many design cases, additional formulations can be written for special situations or to modify the library formulations.



### Features

- Simplified 'C' like programming syntax with C and C++ style comments.
- Input variable definitions that are definition parameters for each weld using that formulation. For example, *min\_weld\_size* or *skew\_angle*.
- Iteration construct: Robust constrained goal searching with single and multiple independent variables.
- Outputs with descriptions for post processing.
- Optional summary data for Outputs: *ByNode* - worst case (max or min) load case for each node of each weld, used for xy-plots; *ByLC* - worst case node of each weld for each load case; and *ByWeld* - worst case nodal value for each weld across all load cases.
- Weld Orientation: Can account for weld elemental orientation to get load sense transformed into the weld joint coordinate system correctly.
- Wide variety of stress, load, criteria, and geometry data are available as global variables.
- Large set of arithmetic, trigonometric, and conditional functions built in.

**WELD FORMULATION EDITOR**

**Type List**

- 2P1F1-VF
- 3F
- DF
- DP
- DPP-VF
- DPP1-VF
- DPP45-VF
- F1\_1
- F1\_0
- L\_mat\_1
- L\_mat\_2
- Notch\_Trans
- P1
- P1Z1-VF
- P1F1-VF**
- P1F1-VF-CB
- P1F2-VF
- S
- SF
- Stress
- Weld\_Load

**Weld\_Type**

P1F1-VF

**Description**

Single Sided Partial Pen. Groove weld with Fillet Reinforcement, variable Fillet Size, Fixed Groove Size, based on throat shear.

**Formulation**

```

@INPUT{
  restraint
  E
  face_angle_deg { // Groove Size
    default = 45
  }
  min_leg_size {
    default = 0
  }
}

@if(face_angle_deg > 180){
  face_ang = face_angle_deg - 360
}@ELSE{ face_ang = face_angle_deg }

// Perform calculations of constants
tan_face_ang = tan( face_ang )

@if( face_ang < 45 ){
  min_sl_leg = min_leg_size/tan_face_ang
}@ELSE{
  min_sl_leg = min_leg_size
}

@ITERATION{
  @INDEPENDENT_VARIABLES
  S1{
    to1 = .001
    start = THK/2
  }
  @ITERATE
  // PROPERTIES
  S2 = S1*tan_face_ang
  root_toe_ang = atan2(E, -S1)

  @if(root_toe_ang < face_ang + 90){
    throat_ang = root_toe_ang
    sin_throat_ang = sin(throat_ang)
    cos_throat_ang = cos(throat_ang)
    tw = E/sin_throat_ang;
  }@ELSE{
    throat_ang = face_ang + 90
    sin_throat_ang = sin(throat_ang)
    cos_throat_ang = cos(throat_ang)
    tw = (E + S2)*sin_throat_ang;
  }

  Area = tw
  Section_Mod = sqr(tw)/6

  // STRESS CALCULATIONS
  f_Tj = Tj/Area // Tj = Inplane Transverse Traction
  // f_Tj is throat stress due to Tj

  f_Tw = Tw/Area // Tw is the inplane joint shear (longitudinal shear)
  // f_Tw is throat stress due to Tw

  f_Ts = Ts/Area // Ts is the out-of-plane joint shear.
  // f_Ts is throat stress due to Ts

  // M accounts for bending due to load path offset from terminated part
  // center to throat center times the joint normal load.
  // Mw is the FEA bending load about the weld axis.

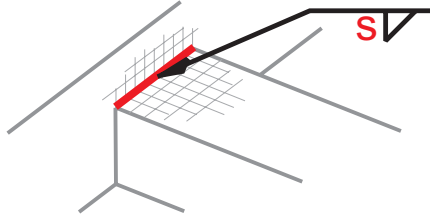
  Offset = .5*(THK + tw*sin_throat_ang) - E
  M = Mw - Tj*Offset*(1 - restraint)

```

**Weld Diagrams**

Weld\_Type: P1F1-VF Description: Single Sided Partial Pen. Groove Weld with Fillet Reinforcement Size, Fixed Groove Size, based on throat shear.

Case 1: Throat Terminates at Weld Face:  
Face\_Angle + 90 deg < Root\_Toe\_Angle  
Throat\_Angle = Face\_Angle + 90 deg

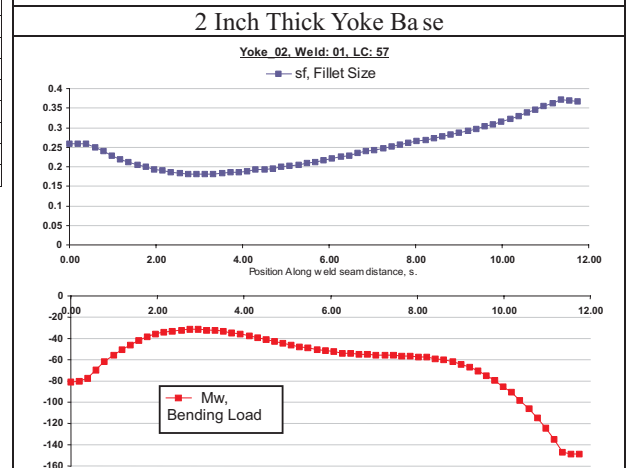
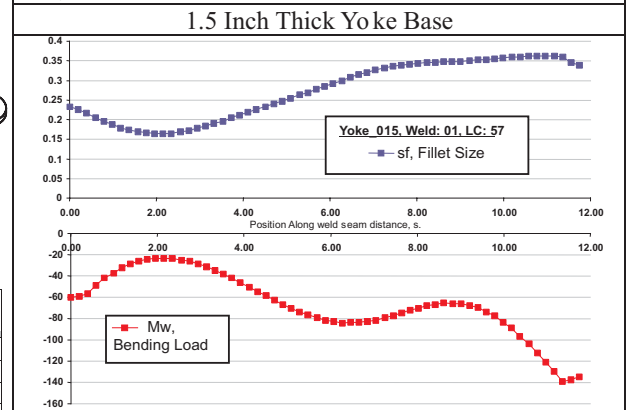
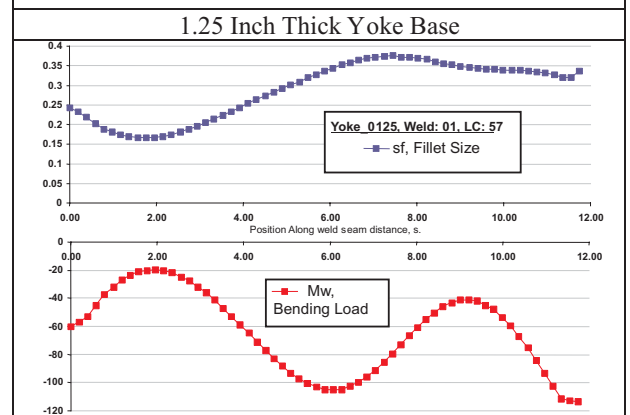
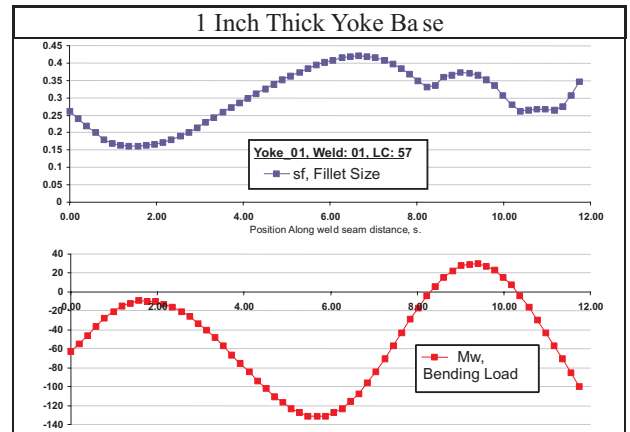
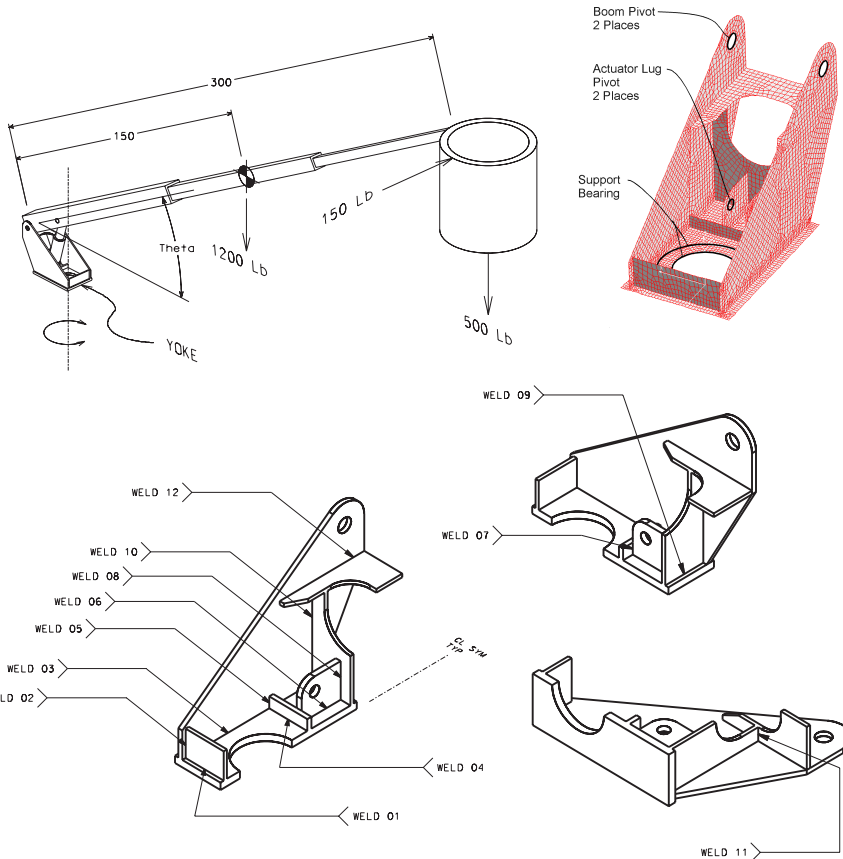


## Weld Calculations from FEA

Evaluation of effect of baseplate thickness on weld loads and size requirements for boom yoke

# Evaluation of Welds with FEA

Finite element analysis (FEA) has become a practical method of Predicting stresses and deflection for loaded structures. FEA accurately Identifies the load path, which can be difficult using classical analysis with Complex structures. FEA shell element models are effective for predicting Loads in weldments fabricated from plate, sheet, structural shapes, and tube.

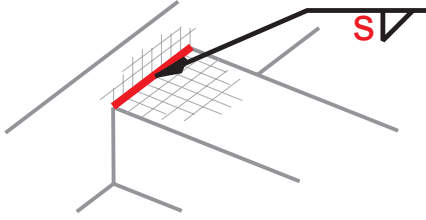


## WeldSizeResults

Weld_No	WeldType	Sa_Set	Description	1Inch Base	1.5Inch Base	2Inch Base
01	SF	Class2	Weld Between Front Stiffener and Base Plate	.421	.366	.402
02	DF	Class1	Weld Between Front Stiffener and LeftSide	.604	.388	.274
03	DF	Class1	Weld Between Base Plate and Sides	.84	.543	.468
04	DF	Class1	Weld between Base Plate and Middle Stiffener	.402	.309	.245
05	DF	Class1	Weld Between Middle Stiffener and Side Plate	1.117	.736	.534
06	DF&SF	Class2	Weld Between Actuator Lug and Base Plate	.25(DF)	.186(DF)	.485(SF)
07	DF	Class1	Weld Between Actuator Lug and Middle Stiffener	.584	.414	.328
08	DF	Class1	Weld Between Actuator Lug and Back Stiffener	.672	.431	.306
09	DF	Class1	Weld Between Back Stiffener and Base Plate	.11	.125	.115
10	DF	Class1	Weld Between Back Stiffener and Side Plate	.122	.091	.08
11	DF	Class1	Weld Between Back Stiffener and Upper Stiffener	.108	.105	.103
12	DF	Class1	Weld Between Upper Stiffener and Side Plate	.399	.258	.196



# FEWeld

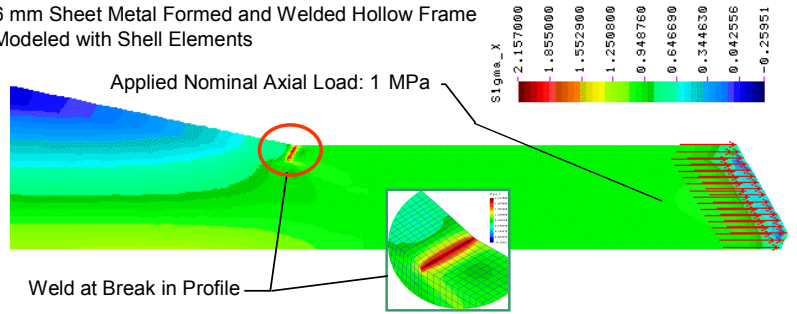


Weld Calculations from FEA

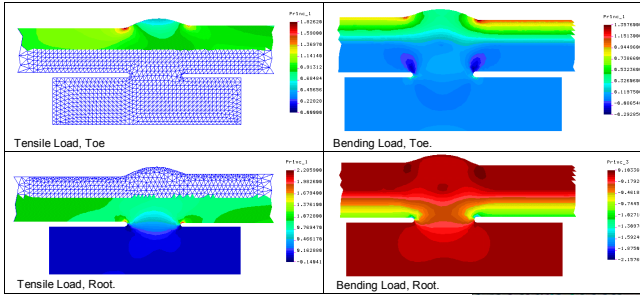
## Notch Stress Example

The following example demonstrates combination of geometric weld joint loads with effective notch stress concentration factors to predict the effective notch stress in the structure from the FEA shell element results. The example also illustrates the ease with which new weld formulations are incorporated into the FEWeld environment.

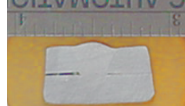
6 mm Sheet Metal Formed and Welded Hollow Frame Modeled with Shell Elements



Above is a FEA shell element model of a welded sheet metal structure with applied loading such that the nominal stress is 1.0 Mpa. The predicted structural (geometric effects, not counting the weld notch effect.) stress is 2.16 Mpa at the weld on the outside surface

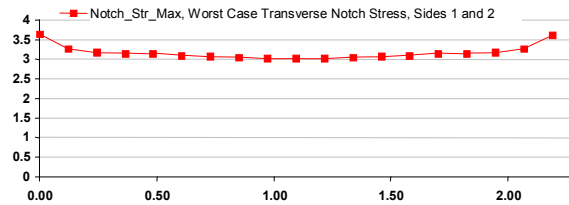


	$K_{TENSION}$	$K_{BENDING}$
TOE	1.59	1.36
ROOT	2.45	-2.16

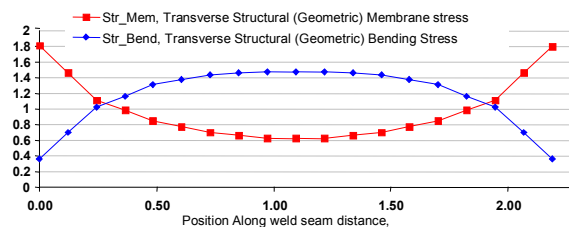
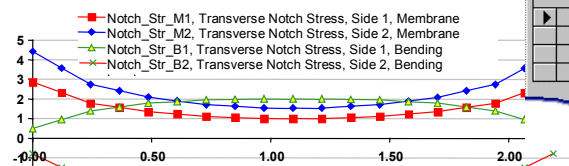
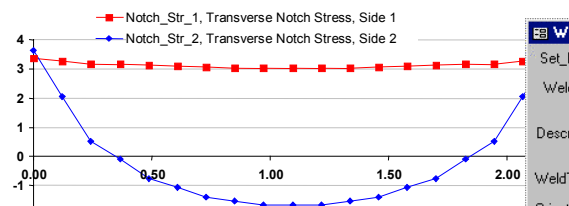


Left is a plane strain FEA model

used to estimate the effective notch stress concentration factors on each side of the joint for both Membrane and Bending Loading. The loading applied was such that the nominal stress in the material without the notch would be 1 MPa.



The combined notch and geometric stresses are shown to the left. To the right is the formulation used for the calculation.



**Weld Definition Data**

Set\_Name: Config00 Defined

Weld No: 03

Weld Description: Weld at Profile Break

Weld Type: Notch\_Trans

Orientation: (+) (-)

Parameter Name	Value
K1_1_Membrane	1.59
K1_2_Membrane	2.45
K1_1_Bending	1.36
K1_2_Bending	-2.16

Coord. Sys: 0

Test Weld Geom

Above shows the match-up between the weld formulation input parameters and weld definitions.

```

/***** COMMENT BLOCK *****/
Name: Notch_Trans
Weld Side 1 and 2 Stress Concentration Factors for Membrane
and Bending Applied to Transverse Geometric Stresses and Added.
Criteria:
None, Stress Result with Notch Factors Applied and Returned.
User Inputs:
K1_1_Membrane: Transverse Notch Stress Concentration
Factor for Membrane Stresses on Joint Side 1
K1_2_Membrane: Transverse Notch Stress Concentration
Factor for Membrane Stresses on Joint Side 2
K1_1_Bending: Transverse Notch Stress Concentration
Factor for Bending Stresses on Joint Side 1
K1_2_Bending: Transverse Notch Stress Concentration
Factor for Bending Stresses on Joint Side 2
Calculated Variables:
Notch_Str_1 - The total Notch Stress on Side 1 due to
Transverse Membrane and Bending Loads
Notch_Str_2 - The total Notch Stress on Side 2 due to
Transverse Membrane and Bending Loads
Notch_Str_Max - The Maximum of Snotch_1 and Snotch_2
Notch_Str_M1 - The Notch Stress Due to Transverse
Membrane Stresses on Side 1
Notch_Str_M2 - The Notch Stress Due to Transverse
Membrane Stresses on Side 2
Notch_Str_B1 - The Notch Stress Due to Transverse
Bending Stresses on Side 1
Notch_Str_B2 - The Notch Stress Due to Transverse
Bending Stresses on Side 2
Str_Mem - The Transverse Membrane Stress
Str_Bend - The Transverse Stress Due to Bending
Joint Types: Any
*****/
***** END COMMENT BLOCK *****/

@INPUT{
K1_1_Membrane
K1_2_Membrane
K1_1_Bending
K1_2_Bending
}

Str_Mem = (Sjj_1 + Sjj_2)/2
Str_Bend = Sjj_1 - Str_Mem
Notch_Str_M1 = Str_Mem*K1_1_Membrane
Notch_Str_M2 = Str_Mem*K1_2_Membrane
Notch_Str_B1 = Str_Bend*K1_1_Bending
Notch_Str_B2 = Str_Bend*K1_2_Bending
Notch_Str_1 = Notch_Str_M1 + Notch_Str_B1
Notch_Str_2 = Notch_Str_M2 + Notch_Str_B2
@if(Notch_Str_1 >= Notch_Str_2){
Notch_Str_Max = Notch_Str_1
}else{
Notch_Str_Max = Notch_Str_2
}

@store{
Notch_Str_Max{
description = "worst Case Transverse Notch Stress, Sides 1 and 2"
plot
summarize max unsigned
}
Notch_Str_1{
description = "Transverse Notch Stress, Side 1"
summarize max unsigned
}
Notch_Str_2{
description = "Transverse Notch Stress, Side 2"
summarize max unsigned
}
Notch_Str_M1{ "Transverse Notch Stress, Side 1, Membrane Load" }
Notch_Str_M2{ "Transverse Notch Stress, Side 2, Membrane Load" }
Notch_Str_B1{ "Transverse Notch Stress, Side 1, Bending Load" }
Notch_Str_B2{ "Transverse Notch Stress, Side 2, Bending Load" }
Str_Mem{ "Transverse Structural (Geometric) Membrane Stress" }
Str_Bend{ "Transverse Structural (Geometric) Bending Stress" }
}
    
```