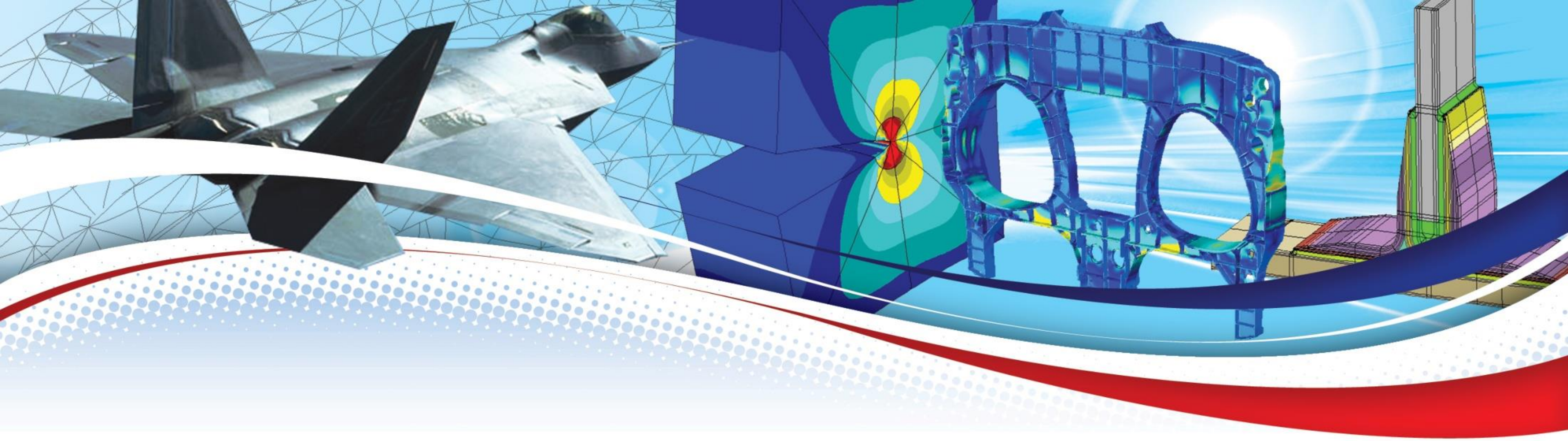
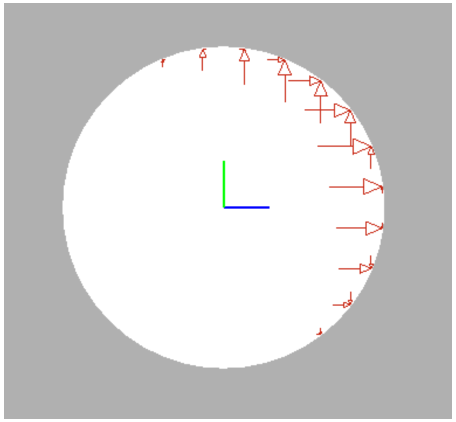


Formulae for Directional Components of Bearing Traction Load

Andrew Ledbetter
ESRD
2019



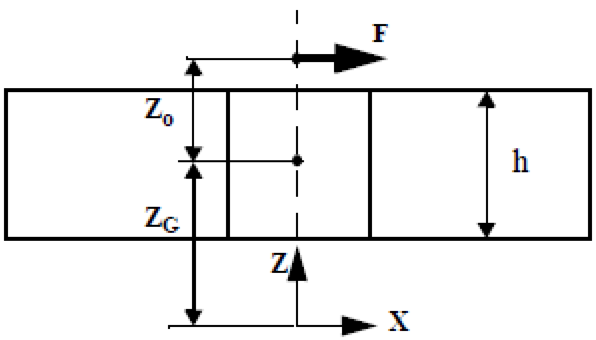
esrd

StressCheck

In-Plane Bearing Load Formula

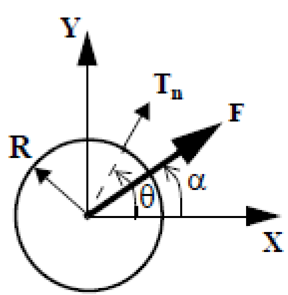
STRESSCHECK®

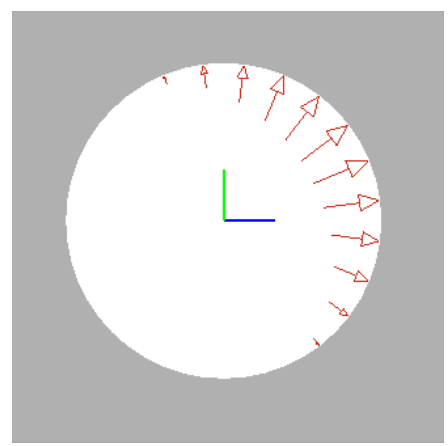
- The bearing load is defined as a cosine traction distribution oriented <u>normal</u> to the bore surface of a hole.
  - In 3D, the formula is defined as follows:



$$T_n = -\frac{2F}{\pi R h}\cos(\theta-\alpha)\left[1+\frac{12}{h^2}Z_o(Z-Z_G)\right] \text{ if } (T_n<0)$$

$$T_n = 0 \text{ if } (T_n>0)$$

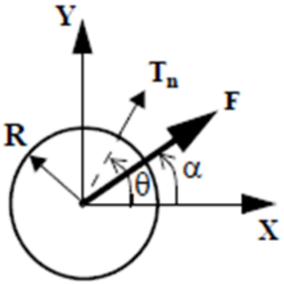


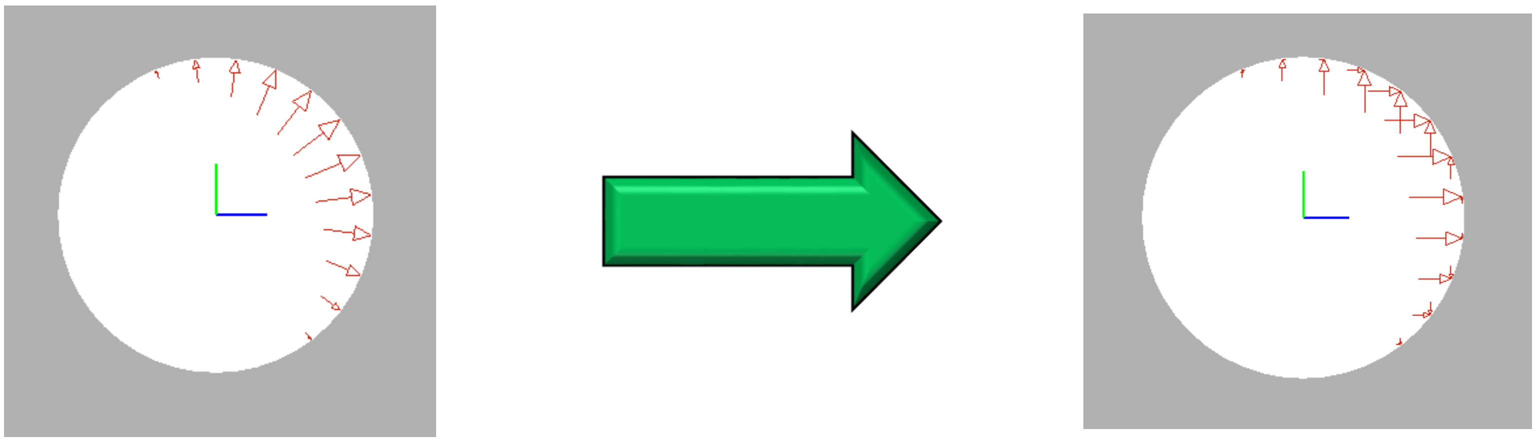


Directional Components

- We would like to represent this normal traction as a combination of its directional components:

$$\boldsymbol{T_n} = T_x\,\widehat{\boldsymbol{x}} + T_y\,\widehat{\boldsymbol{y}}$$





Bearing Load and Hole Parameters

- We can introduce the following parameters to control aspects of the bearing load and hole:

StressCheck Model Information

Model Info | Parameters | Rules

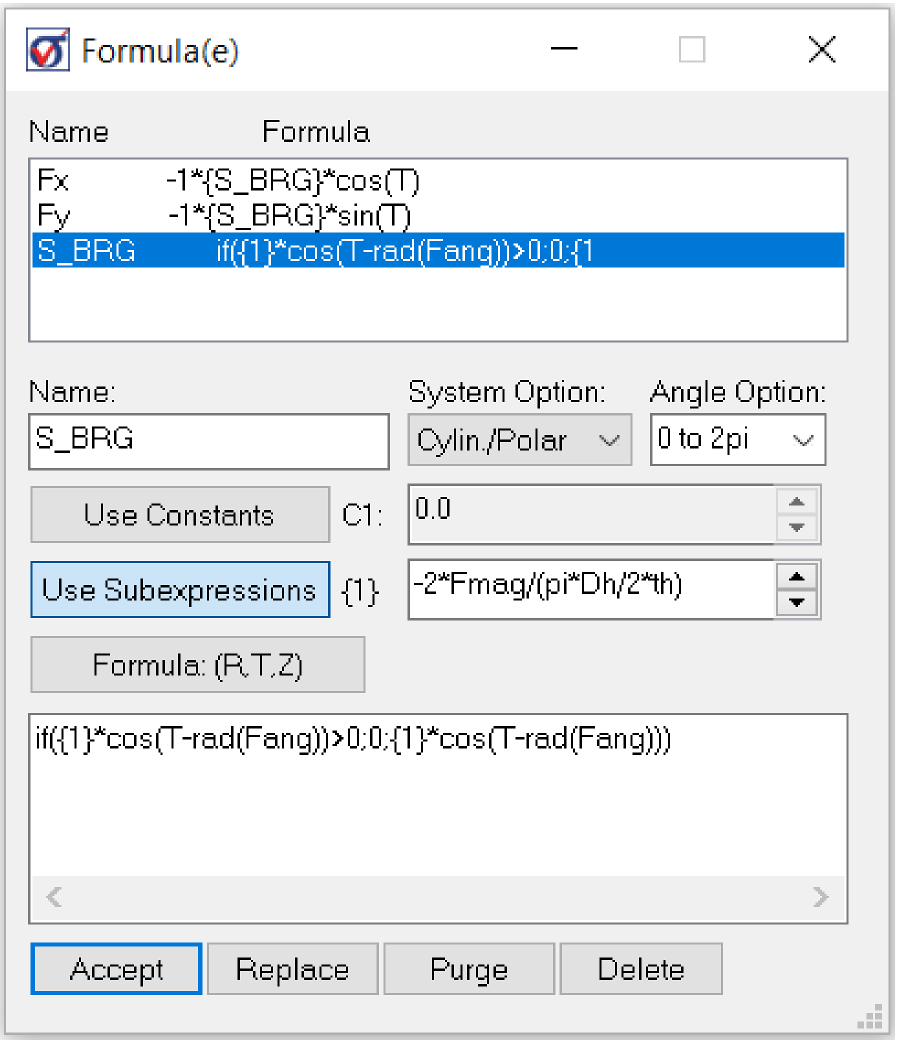
Name	Description	Expression	Value	Limit	Class	Sort
L	plate length		6.0000e+000		General	001
W	plate width		3.0000e+000		General	002
th	plate thickness		2.0000e-001		General	003
Dh	hole dia		6.2500e-001		General	004
Em	elastic modulus (psi)		1.0300e+007		General	005
nu	Poisson's ratio		3.3000e-001		General	006
Fmag	load magnitude (lbs)		1.2500e+003		General	007
Fang	load angle (deg)		1.3500e+002		General	008

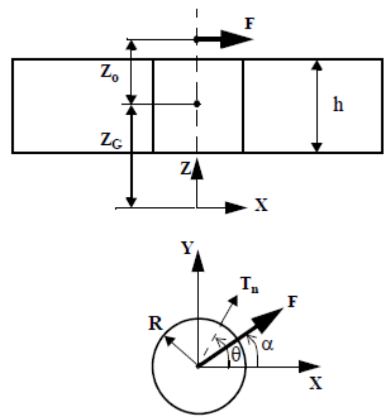
Accept | Delete | Auto Step: 0.2

Input | Settings

Normal Bearing Traction Formula

STRESSCHECK



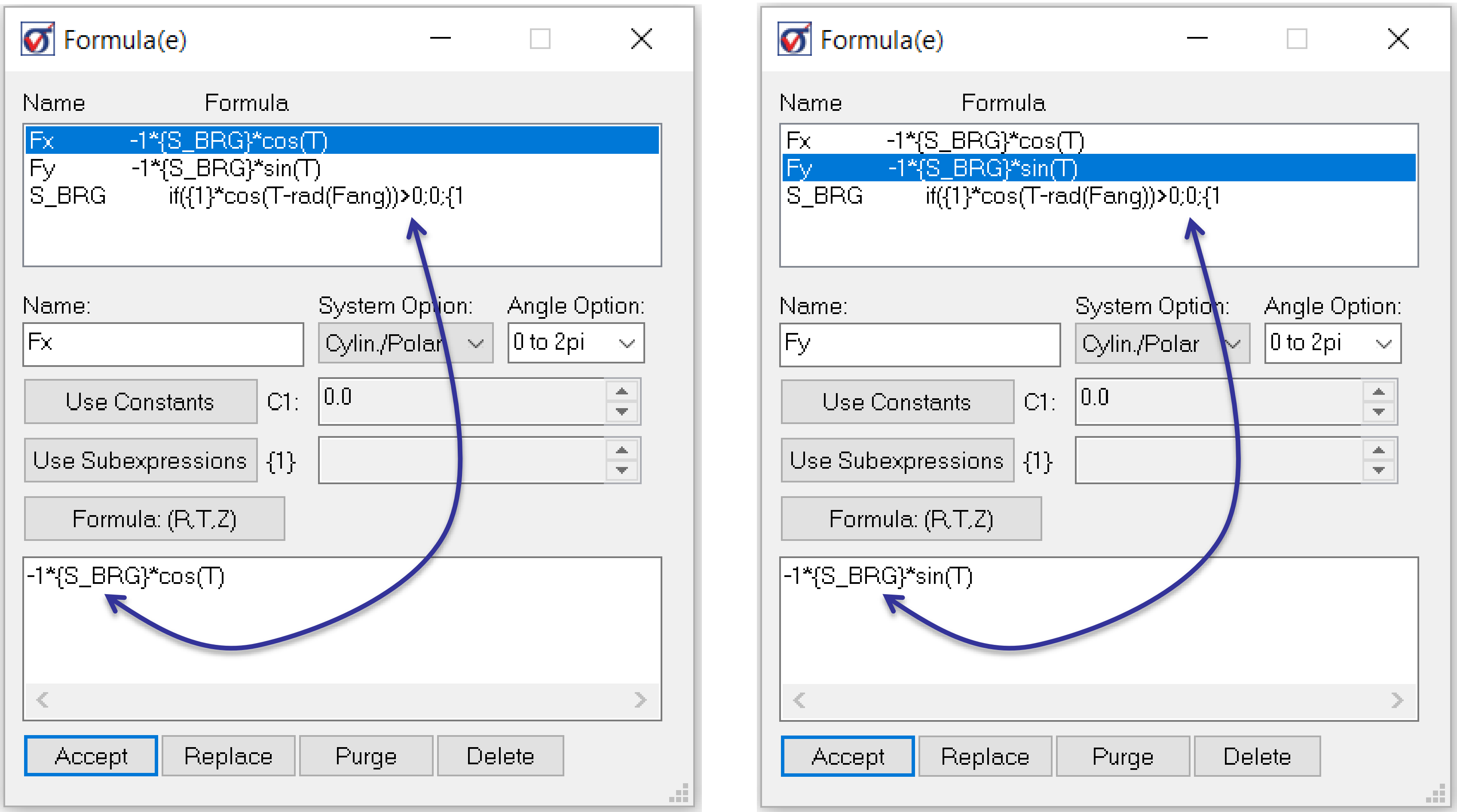


$$T_n = -\frac{2F}{\pi R h}\cos(\theta-\alpha)\left[1+\frac{12}{h^2}Z_o(Z-Z_G)\right] \text{ if } (T_n<0)$$

$$T_n = 0 \text{ if } (T_n>0)$$

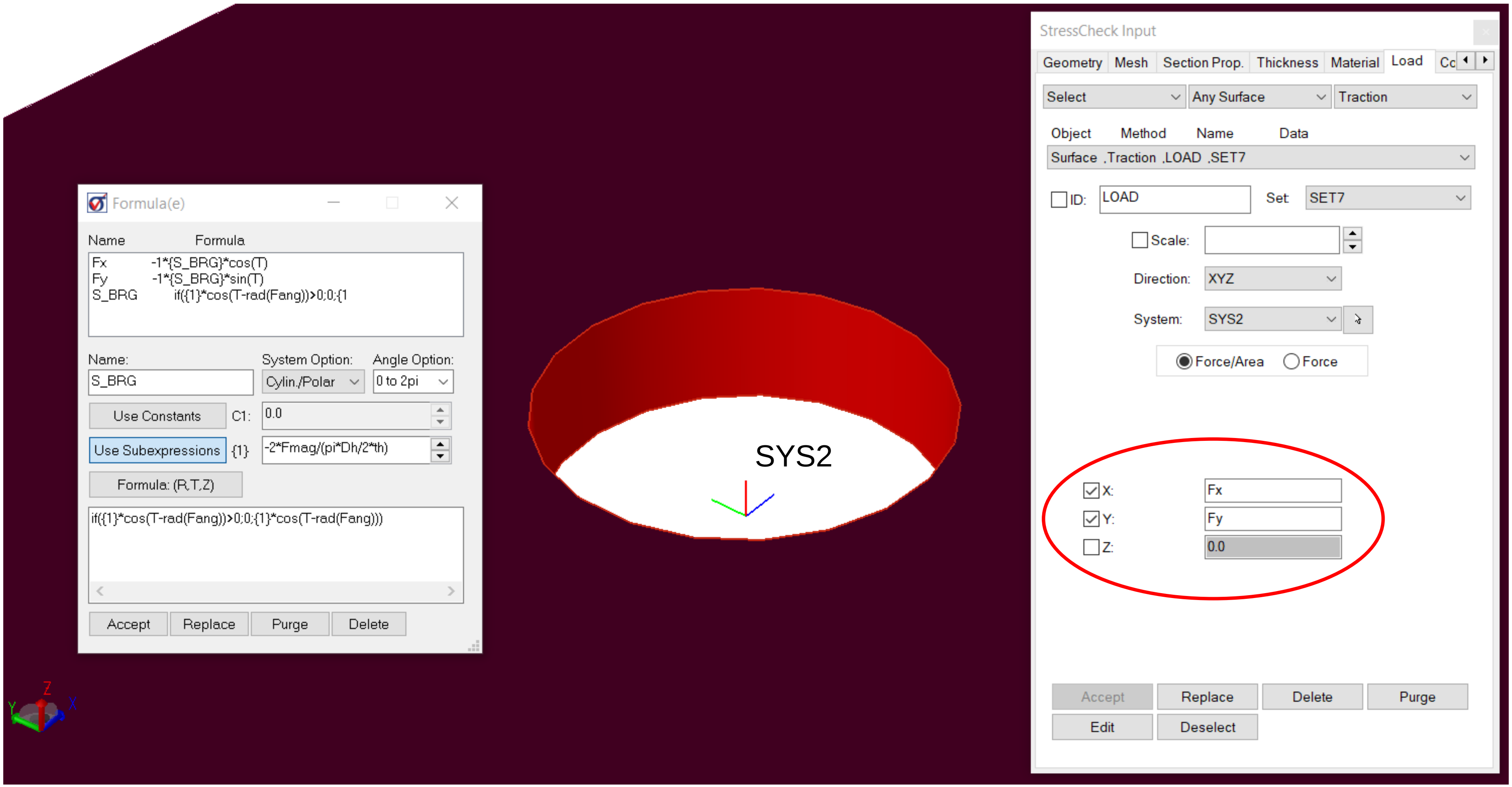
Note: The values of h and Z_G are computed automatically by StressCheck from the location of the nodes on the selected faces.

Directional Components

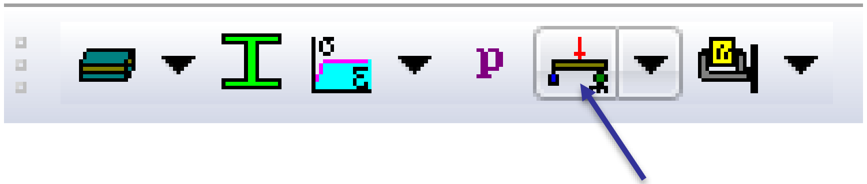


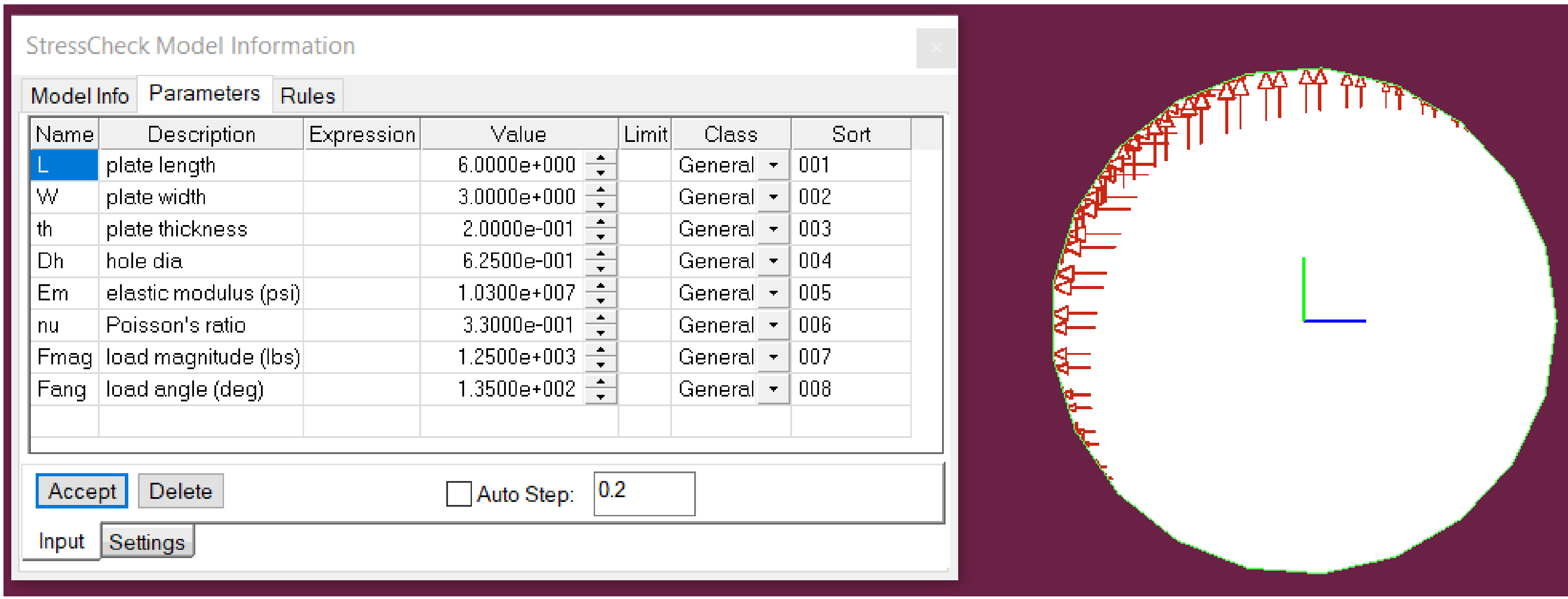
Note: Use curly brackets { } when referencing other formulae within a formula expression

Apply a Directional Traction



Display Load Arrows





StressCheck Model Information

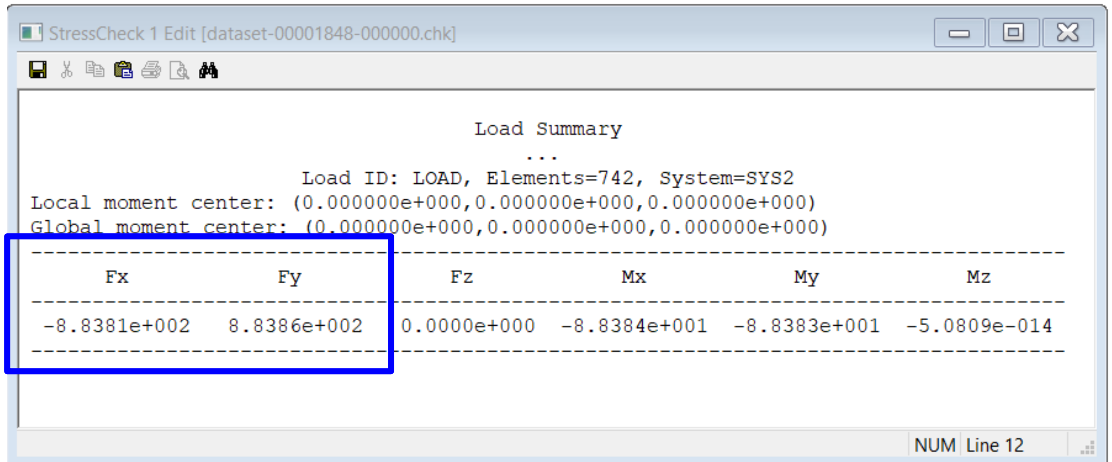
Model Info | Parameters | Rules

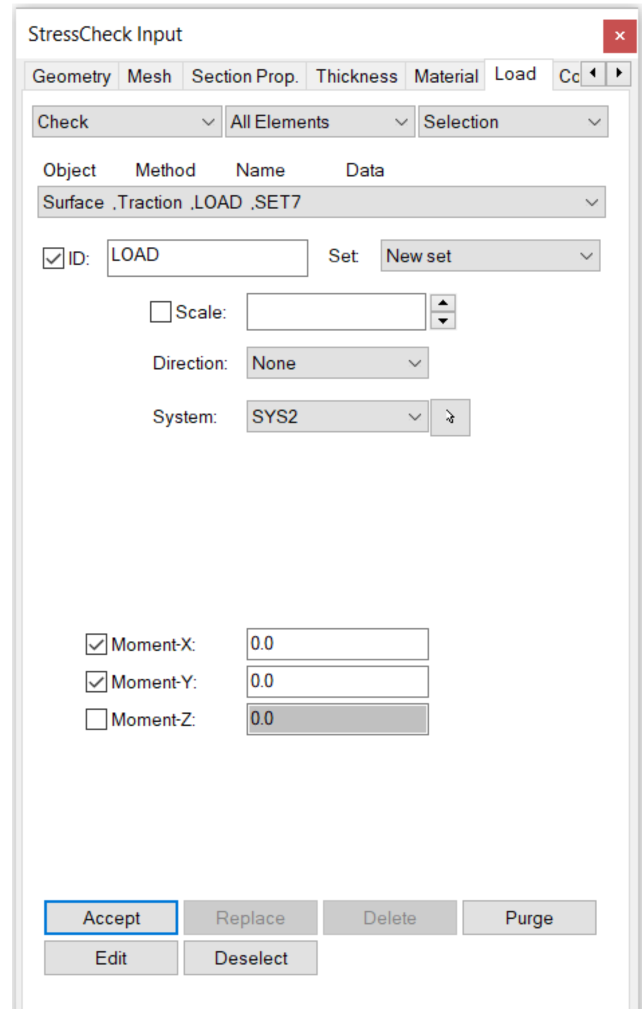
Name	Description	Expression	Value	Limit	Class	Sort
L	plate length		6.0000e+000		General	001
W	plate width		3.0000e+000		General	002
th	plate thickness		2.0000e-001		General	003
Dh	hole dia		6.2500e-001		General	004
Em	elastic modulus (psi)		1.0300e+007		General	005
nu	Poisson's ratio		3.3000e-001		General	006
Fmag	load magnitude (lbs)		1.2500e+003		General	007
Fang	load angle (deg)		1.3500e+002		General	008

Accept | Delete | Auto Step: 0.2

Input | Settings

Check Loads





$$F_x = F_b\cos(theta) = 1250\cos(135°)$$

$$\rightarrow \boldsymbol{F_x = -883.9\ lbs}$$

$$F_y = F_b\sin(theta) = 1250\sin(135°)$$

$$\rightarrow \boldsymbol{F_y = 883.9\ lbs}$$

Note: This method is applicable for any load angle

$$0° \le \theta \le 360°$$

BONUS: INCORPORATING BENDING MOMENT EFFECTS

Bending Component

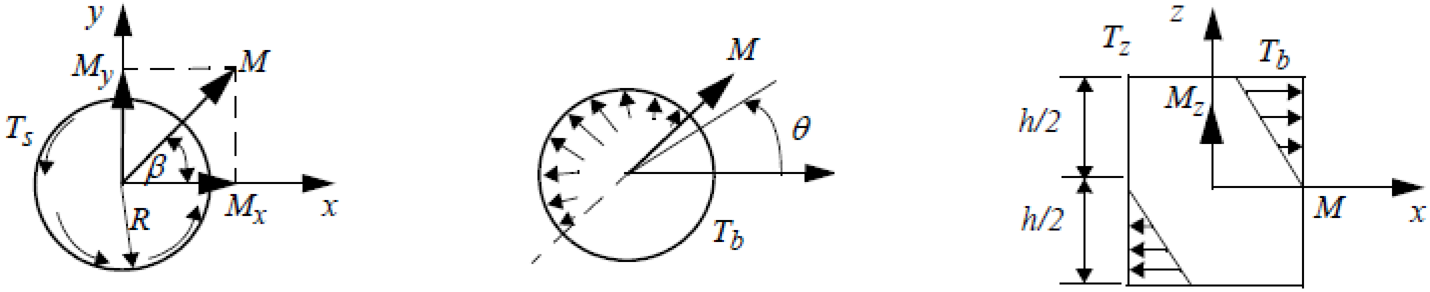
- A bending component can be included in the bearing normal traction formula for “heel and toe” effects

Bending moment

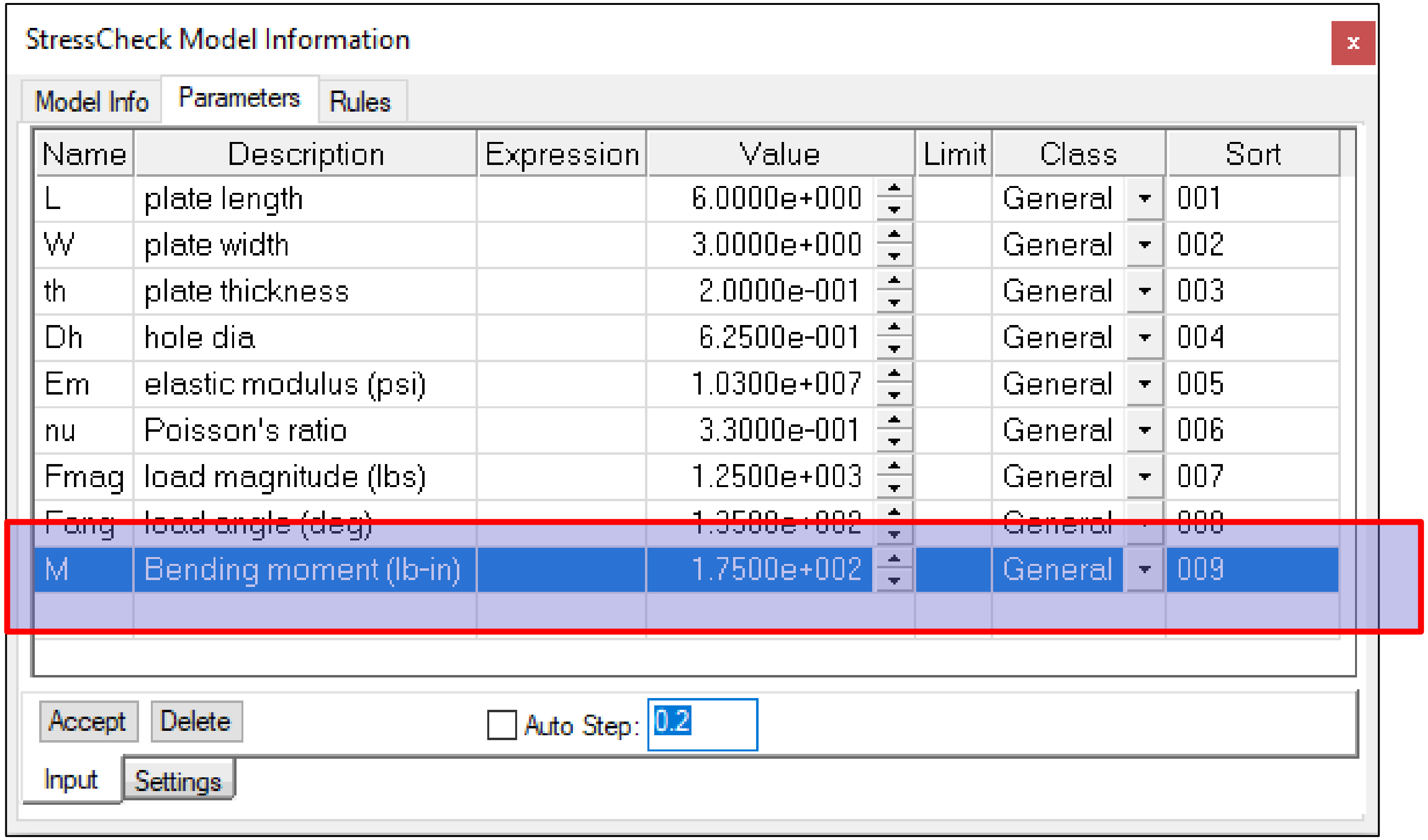
$$T_b = \frac{24M}{\pi R h^3} Z \sin(\theta - \beta)$$

Twisting moment
(not used in this example)

$$T_s = -\frac{M_z}{2\pi R^2 h}$$



Bending Moment Parameter (M)



Name	Description	Expression	Value	Limit	Class	Sort
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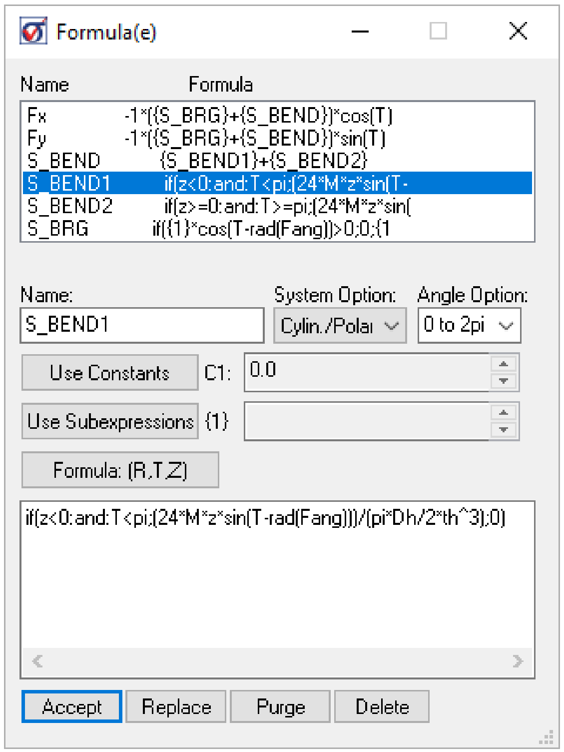
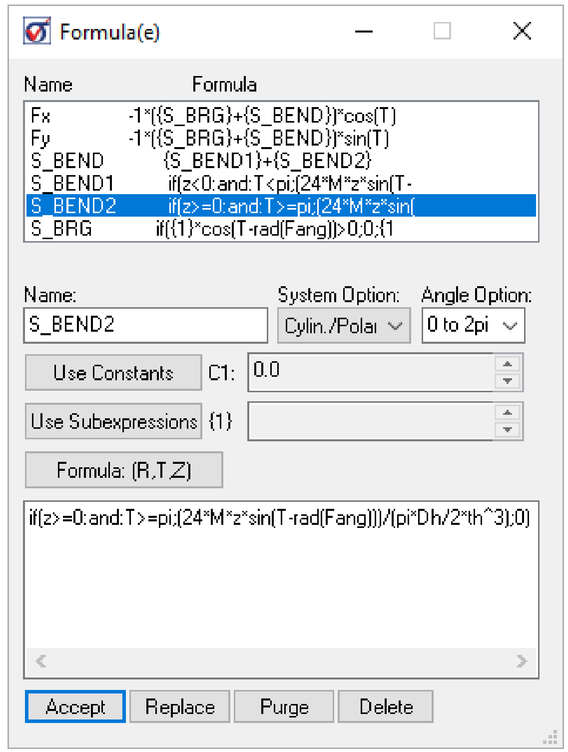
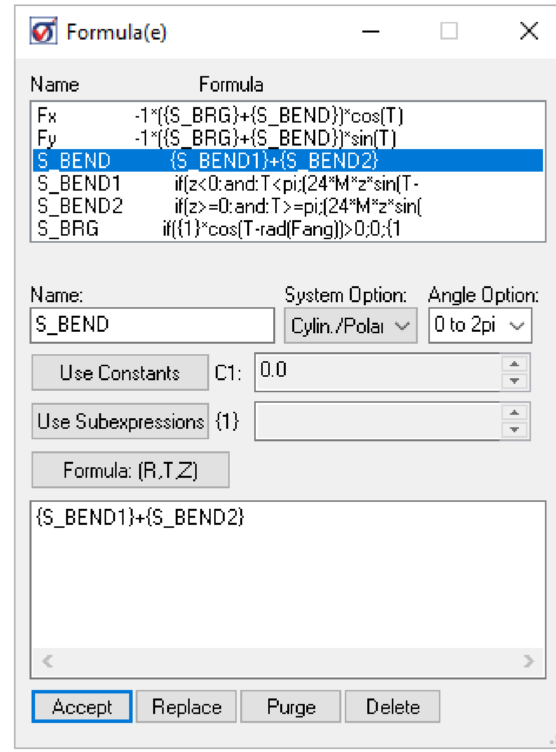
W	plate width		3.0000e+000		General	002
th	plate thickness		2.0000e-001		General	003
Dh	hole dia		6.2500e-001		General	004
Em	elastic modulus (psi)		1.0300e+007		General	005
nu	Poisson's ratio		3.3000e-001		General	006
Fmag	load magnitude (lbs)		1.2500e+003		General	007
Fang	load angle (deg)		1.3500e+002		General	008
M	Bending moment (lb-in)		1.7500e+002		General	009

Bending Formulae

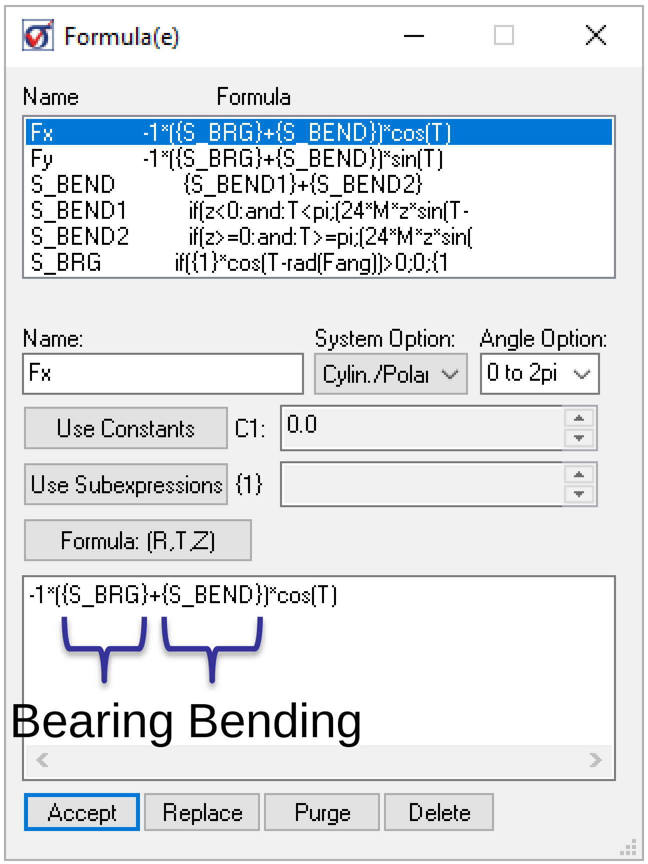


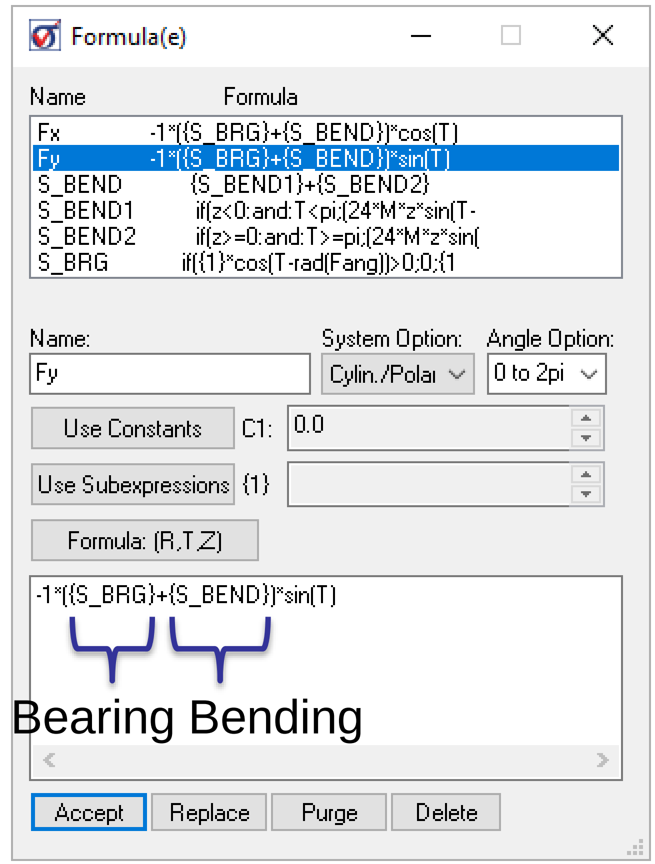




Total Bending Stress: $S_{BEND} = S_{BEND1} + S_{BEND2}$

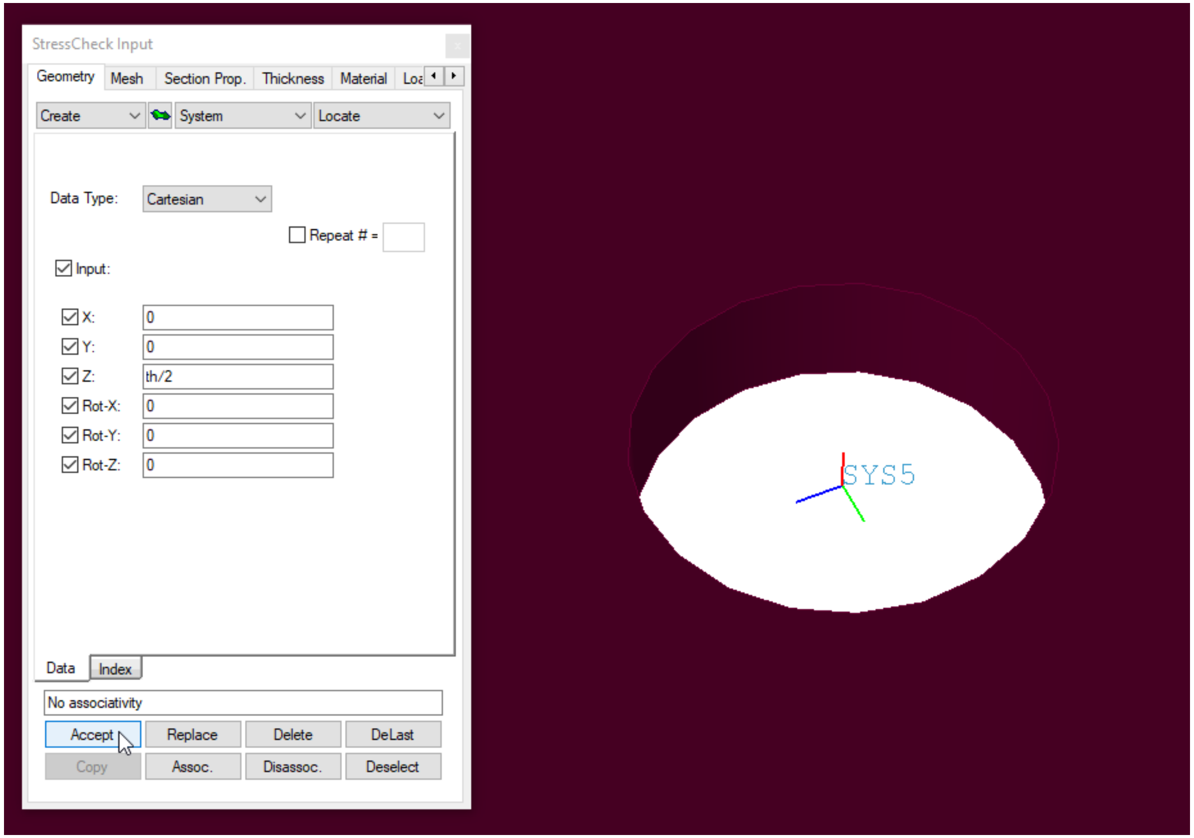
Directional Traction Formulae



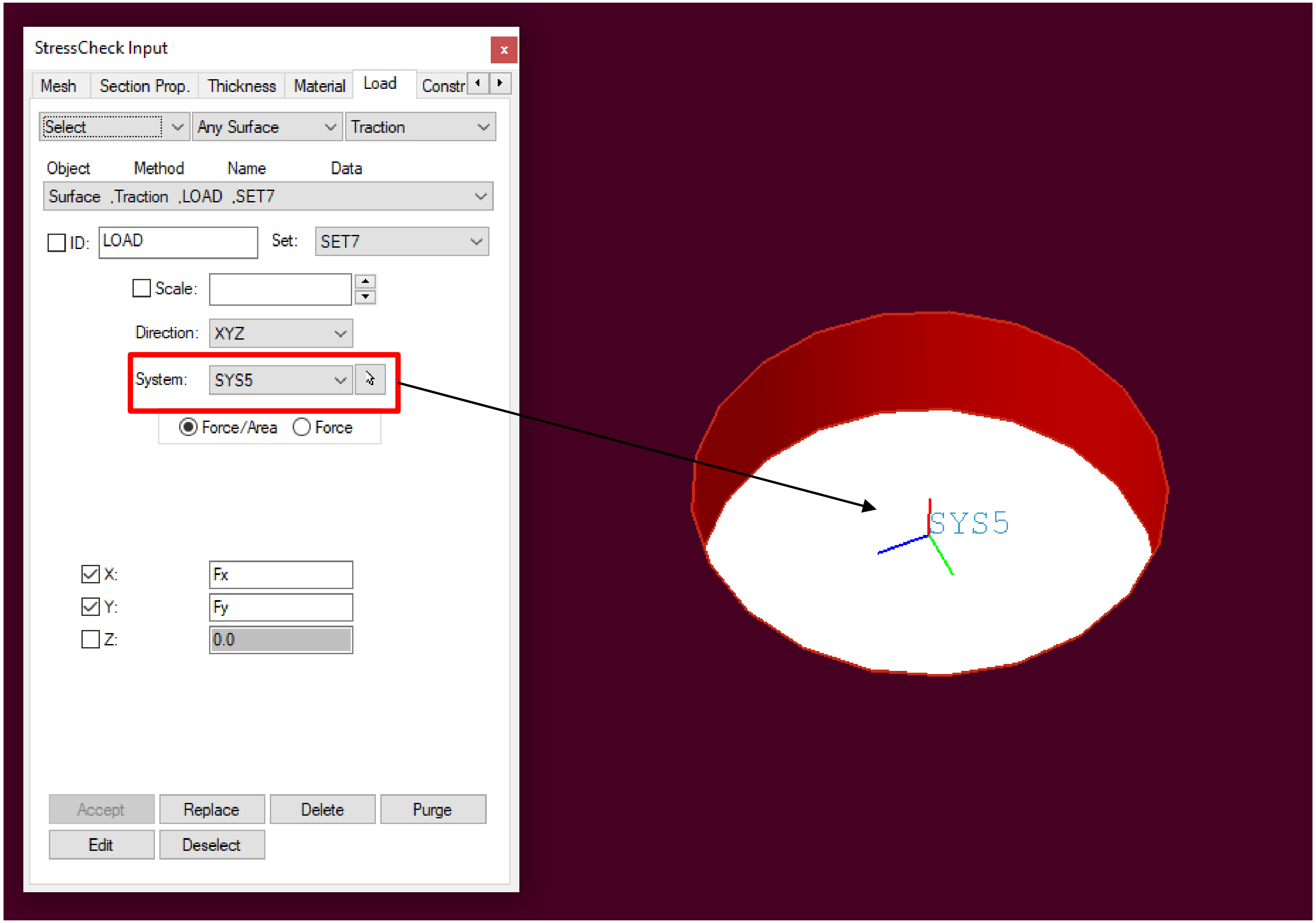


Create a Local System

- Create a Cartesian system in the middle (mid-height) of the hole, with the Z-axis parallel to the hole



Update the Traction Load Assignment



Check Loads

Load Summary

...

Load ID: LOAD, Elements=742, System=SYS5

Local moment center: (0.000000e+000,0.000000e+000,0.000000e+000)

Global moment center: (0.000000e+000,0.000000e+000,1.000000e-001)

Fx	Fy	Fz	Mx	My	Mz
-8.8599e+002	8.8391e+002	0.0000e+000	-1.2373e+002	1.2370e+002	-1.0281e-014

$$M_x = M\cos(theta) = 175\cos(135°)$$

$$\rightarrow \boldsymbol{M_x = -123.7\ lb - in}$$

$$M_y = M\sin(theta) = 175\sin(135°)$$

$$\rightarrow \boldsymbol{M_y = 123.7\ lb - in}$$