LOCAL STRESSES IN A SWIVEL OUTLET

ACCORDING TO BS5500 AND ASME

Date: Vr 05-Feb-2021

Time: 14:01:23

Project: VARIOUS CALCULATIONS

Jobnr: PV2021

ABSTRACT:

Due to some forces and moments on the swivel outlet stresses will occur at the interface of this nozzle and the header.

This calculation is performed according to BS5500 and ASME III/VIII.

This calculation is to proof that the configuration does not lie in the scope of these codes.
As indicated in the appropiate codes, the graph should not be extrapolated.
With more than 30% out of the defined area the results can not be considered to be reliable.

However the configuration lies well within the scope of Markle’s findings and can very well be performed with the help of a pipe stress analysis programme like Caesar II.

REFERENCES:

Stresses from local loadings in Cyl. Press. Vessels. P.P. Bijlaard, Ithaca
WRC Bulletin 107 K.R. Wichman, A.G. Hopper and J.L. Mershon
WRC Bulletin 297 J.L. Mershon, K. Mokhtarian, G.V. Ranjan and E.C. Rodabaugh (1984)
Revised WRC Bulletin 297 J.L. Mershon, K. Mokhtarian, G.V. Ranjan and E.C. Rodabaugh (1987)
BS5500
ASME VIII div.2
Nozzles- on ext. loads and int. press. C.J. Dekker & H.J. Bos Int.Journal Pres.Ves.& Piping ’72

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A Preliminary for information only B For review C Authorized for construction	**SP121008**	**0**	**B**

Description of the programme BYLA

The programme "BYLA" is used to calculate stresses in several types of cross sections of nozzles and shells due to external forces and moments on a loaded point.
A loaded point is connected to a cross section (to be investigated) for example by means of a pipe.

The cross section types are summarized as follows:

Type 1	solid square nozzle	-	spherical shell cross section
Type 2	solid cylindrical nozzle	-	spherical shell cross section
Type 3	hollow square nozzle	-	spherical shell cross section
Type 4	hollow cylindrical nozzle	-	spherical shell cross section
Type 5	cylindrical nozzle	-	spherical shell cross section
Type 6	square nozzle	-	spherical shell cross section
Type 7	rectangular nozzle	-	spherical shell cross section
Type 8	hollow cylindrical nozzle	-	spherical shell cross section

The stresses in type 1 thru 7 are calculated using the calculation methods of Prof. Bylaard, as described in WRC bulletin 107:
"Local stresses in spherical and cylindrical shells due to external loadings".

The stresses in type 8 are calculated using the method as described in WRC bulletin 297:
"Local stresses in cylindrical shells due to external loadings on nozzles.
Supplement to WRC bulletin No. 107."

WRC Bulletin 107 has been widely used since its initial publication in August 1965. This continued use despite advances in analysis methods and capabilities and increased experimental data made available during the ensuing years underscored the need for a "cook book" of the Bulletin 107 type.
The persistence of this need was the major motivation factor for preparation of the supplement WRC 297 that broadens the coverage of Bulletin 107 to two normally intersecting cylindrical shells.

Both WRC Bulletins present nondimensional curves and equations for determining the local stresses in the vicinity of nozzles in vessels based geometric parameters.
These parameters determine what graph and which equation to use.

The computer programme contains all graphs in digital form, chooses the correct graph and performs the calculation to go with it.
If the arguments are out of the defined curve range, lineair extrapolations are performed. There are no limits for this extrapolation in the programme.
When extrapolations were performed, they are listed on a separate sheet.
If the presented percentage is small, the answer is still reliable.

The local stresses are calculated in eight points:
Au AL Bu BL Cu CL Du DL.
The location of these points are shown on adjacent sheets.

STRESS CALCULATION FOR NOZZLES OF PRESSURE VESSELS SUBJECT TO INTERNAL PRESSURE AND EXTERNAL FORCES AND MOMENTS.

Determination whether a stress calculation for a nozzle is required.

Following is a tentative calculation method to determine the level of the stresses in the vicinity of nozzles in vessels, subject to internal pressure and external forces and moments.

$$\sigma_1 = \frac{Q * F}{\pi * r}$$

$$\sigma_2 = \frac{2Q * F}{\pi * r^2}$$

$$\sigma_p = \frac{3.3 * pd * R}{T'} \quad \text{for a cylinder}$$

$$\sigma_p = \frac{1.1 * pd * R}{T'} \quad \text{for a sphere (head)}$$

$$Q = \frac{1}{T'} \quad \frac{R}{T'}$$

$$\sigma_3 = \frac{\sigma_1 * \sigma_2 * \sigma_p}{3 * f}$$

Where:

r	=	outer radius of nozzle.
R	=	mean radius of wall.
T'	=	formula wall thickness of shell plus thickness of flat reinforcing ring (if any) around the nozzle.
pd	=	design pressure.
F	=	absolute value of the resultant of the forces imposed on the nozzle by the connecting piping.
M	=	absolute value of the resultant of the moments imposed on the nozzle by the connecting piping.
f	=	design stress (See Stoomwezen rules)

In Case $\sigma_3 \geq 0.9$ a stress calculation in accordance with WRC is required.

Stress calculation of a nozzle

The stresses in the vicinity of a nozzle are caused by:
a. external forces and moments imposed on the nozzle.
b. internal pressure.

The secondary stresses σ_u may be determined with the aid of WRC bulletins.

This report enables to calculate the two primairy stresses and the secondary shear stress at eight points (single plain stress condition).

The maximum stress σ_{pmax} as a consequence of internal pressure is determined as follows:

for a cylinder: $$\sigma_{pmaxc} = \frac{2.5}{z} * \frac{pd*R}{T'}$$

for a sphere : $$\sigma_{pmaxb} = \frac{2}{z} * \frac{pd*R}{2*T'}$$

where :

z = strength reduction factor. Calculated in accordance with StW D0501.

The normal and the shear stresses caused by the various external forces and moments are determined in accordance with WRC bulletins at eight points. The stress direction taken into account here lie in the plain of the vessel wall and run radially or circumferentially to the nozzle.

At each of the eight points, the radial stresses are added. The same is done for the circumferential stresses and the shearing stresses. This gives σ_x , σ_y , σ_ϕ and τ.

We designate these stresses:

for spheres: $\sigma_{xu(i)}$ instead of σ_x

$\sigma_{yu(i)}$ instead of σ_y

for cylinders: $\sigma_{\phi u(i)}$ instead of σ_ϕ

$\sigma_{xu(i)}$ instead of σ_x

Where i refers to one of the eigth points:
i = Au, AL, Bu, BL, Cu, CL, Du or DL.

The corresponding stress components caused by the internal pressure are determined as follows:

for spheres :

$$\sigma_{xp(i)} = \sigma_{pmaxb} * \frac{C_{x(i)}}{2.2}$$

$$\sigma_{yp(i)} = \sigma_{pmaxb} * \frac{C_{y(i)}}{2.2}$$

for cylinders:

$$\sigma_{\phi p(i)} = \sigma_{pmaxc} * \frac{C_{\phi(i)}}{3.3}$$

$$\sigma_{xp(i)} = \sigma_{pmaxc} * \frac{C_{x(i)}}{3.3}$$

The values $C_{x(i)}$, $C_{y(i)}$ for spheres and $C_{\phi(i)}$, C_{x} for cylinders are given in the following tables:

SPHERES

	i							
	Au	AL	Bu	BL	Cu	CL	Du	Dl
$C_{x(i)}$	2	-0.2	2	-0.2	2	-0.2	2	-0.2
$C_{y(i)}$	2	2	2	2	2	2	2	2

CYLINDERS

	i							
	Au	AL	Bu	BL	Cu	CL	Du	Dl
$C_{\phi(i)}$	1.2	3.1	1.2	3.1	2.6	-0.2	2.6	-0.2
$C_{y(i)}$	1.0	-0.2	1.0	-0.2	2.1	1.0	2.1	1.0

The total stresses caused by external loads and internal pressure are determined as follows:

for a sphere:

$$\sigma_{x(i)} = \sigma_{xu(i)} + \sigma_{xp(i)}$$

$$\sigma_{y(i)} = \sigma_{yu(i)} + \sigma_{yp(i)}$$

for a cylinder:

$$\sigma_{x(i)} = \sigma_{xu(i)} + \sigma_{xp(i)}$$

$$\sigma_{\phi(i)} = \sigma_{\phi u(i)} + \sigma_{\phi p(i)}$$

Note:

Here vector components are added, each of wich has its own sign. (i.e. do not add up absolute values as inprevious section).

The value S(i) has to be determined in accordance with WRC bulletin 107:

where: $\tau = 0 \Rightarrow S_{(i)}$ is the highest value, in absolute terms, of:

$$\sigma_{x(i)} , \sigma_{y(i)} \text{ and } \left[\sigma_{x(i)} - \sigma_{y(i)} \right]$$

where: $\tau \neq 0 \Rightarrow S_{(i)}$ is the highest value, in absolute terms, of:

$$\left[\sigma_{x(i)} - \sigma_{y(i)} \right]^2 + 4 * \tau^2$$

and

$$\left[\sigma_{x(i)} + \sigma_{y(i)} \pm \left[\sigma_{x(i)} - \sigma_{y(i)} \right]^2 + 4 * \tau^2 \right]$$

The above definition of $S_{(i)}$ applies to spheres. For cylinders, index y is to be replaced by index ϕ throughout.

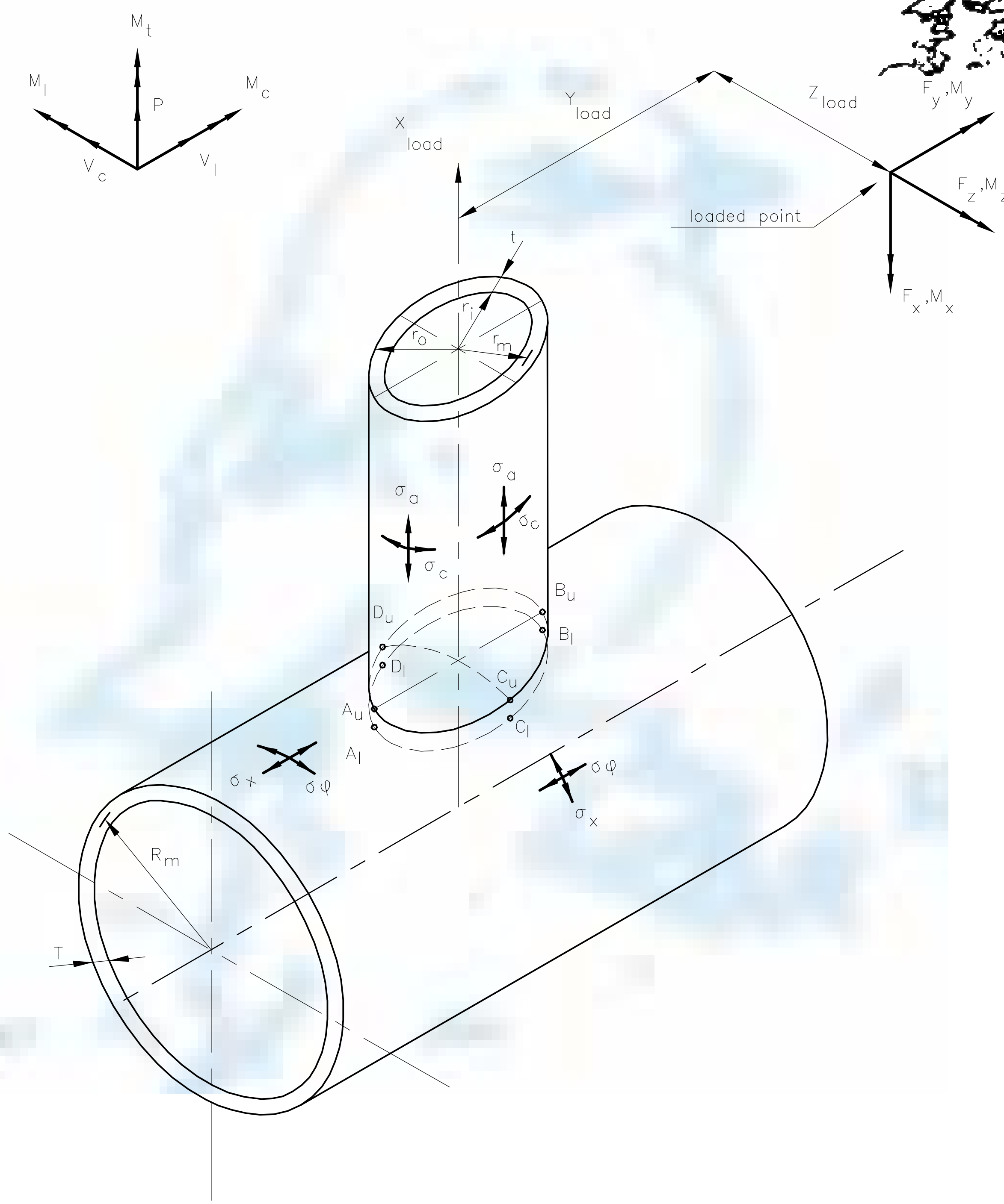
$S_{(i)}$ must satisfy the requirement:

$S_{(i)} \leq 3*f$ (where i= Au, AL...DL).

f = design stress.

This requirement is derived from ASME VIII div.2.

Coordinates of loaded point and positive direction of loads



type 8

LOCAL STRESSES IN A SWIVEL OUTLET

ACCORDING TO BS5500 AND ASME

Date: Vr 05-Feb-2021
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Project: VARIOUS CALCULATIONS
Jobnr: PV2021

Swivel outlet calculation

1. Applied Loads

Radial Load	Fx =	7000.
Shear Load	Fy =	44000.
Shear Load	Fz =	8000.
Torsional Moment	Mx =	77000000.
Overturning Moment	My =	17000000.
Overturning Moment	Mz =	76000000.

2. Geometry

Vessel Thickness	T =	25.4
Vessel Mean Radius	Rm =	444.5
Nozzle Thickness	t =	17.5
Nozzle Mean Radius	rm =	296.0

3. Coordinates of Loaded Point

X-coordinate =	375.0
Y-coordinate =	0.0
Z-coordinate =	0.0

Internal pressure = 3.1

4. Geometric Parameters

gamma = T/t = 1.45
betha = d/t = 34.83
lambda= (d/D)*(D/T)**.5 = 4.057

5. Stress Concentration Factors.

due to :
Membrane Load Kn =1.00
Bending Load Kb =6.07

6. Dimensions

Loads in N
Moments in Nmm
Measures in mm
Stresses in N/mm**2

STRESSES - if load is opposite that shown, reverse sign shown

From Fig.	va- lue	Au	AL	Bu	BL	Cu	CL	Du	DL
10/11	.0356	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
5/ 6	.0633	-25.0	25.0	-25.0	25.0	-25.0	25.0	-25.0	25.0
29/30	.0775	-	-	-	-	-3.2	-3.2	3.2	3.2
24/25	.1799	-	-	-	-	-273.7	273.7	273.7	-273.7
47/48	.0293	-5.9	5.9	5.9	-5.9	-	-	-	-
42/43	.0581	-425.2	425.2	425.2	-425.2	-	-	-	-
sigX		-456.5	455.7	405.7	-406.5	-302.3	295.1	251.6	-245.8
SigX press.		121.9	121.9	121.9	121.9	243.7	243.7	243.7	243.7
Sum of sigX		-334.6	577.6	527.6	-284.6	-58.6	538.8	495.3	-2.1
20/21	.1275	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4
15/16	.0250	-9.9	9.9	-9.9	9.9	-9.9	9.9	-9.9	9.9
38/39	.1750	-	-	-	-	-7.3	-7.3	7.3	7.3
33/34	.0811	-	-	-	-	-123.4	123.4	123.4	-123.4
56/57	.1696	-34.1	-34.1	34.1	34.1	-	-	-	-
51/52	.0228	-167.0	167.0	167.0	-167.0	-	-	-	-
sigfi		-212.4	141.4	189.8	-124.4	-141.9	124.5	119.4	-107.6
Sigfi press		243.7	243.7	243.7	243.7	121.9	121.9	121.9	121.9
Sum of sigfi		31.4	385.2	433.6	119.3	-20.1	246.4	241.3	14.3
tauFy		-	-	-	-	1.8	1.8	-1.8	-1.8
tauFz		0.3	0.3	-0.3	-0.3	-	-	-	-
tauMx		-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2
tau		-4.9	-4.9	-5.5	-5.5	-3.4	-3.4	-7.0	-7.0
Comb. stress		456.7	455.9	405.9	406.7	302.7	295.4	251.9	246.2
S:load/press		366.3	577.9	528.1	404.2	59.8	539.0	495.5	21.6

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Swivel outlet calculation

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Radial Load	Fx =	7000.
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Shear Load	Fz =	8000.
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Overturning Moment	My =	17000000.
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2. Geometry

Vessel Thickness	T =	25.4
Vessel Mean Radius	Rm =	444.5
Nozzle Thickness	t =	17.5
Nozzle Mean Radius	rm =	296.0

3. Coordinates of Loaded Point

X-coordinate	=	375.0
Y-coordinate	=	0.0
Z-coordinate	=	0.0

Internal pressure = 3.1

4. Geometric Parameters

gamma = T/t = 1.45
betha = d/t = 34.83
lambda= (d/D)*(D/T)**.5 = 4.057

5. Stress Concentration Factors.

due to :
Membrane Load Kn =1.00
Bending Load Kb =6.07

6. Dimensions

Loads in N
Moments in Nmm
Measures in mm
Stresses in N/mm**2

d = 2 * rm + t
di = d - 2 * t
pi = 3.141593
CSA = pi / 4 * (d^2 - di^2)
S = pi /(32*d) * (d^4 - di^4)

STRESSES - if load is opposite that shown, reverse sign shown

From/ For/Fig	va- lue	Au	AL	Bu	BL	Cu	CL	Du	DL
1/CSA	.000	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
10/11	.0356	2.4	-2.4	2.4	-2.4	2.4	-2.4	2.4	-2.4
5/ 6	.0633	-52.7	52.7	-52.7	52.7	-52.7	52.7	-52.7	52.7
1/ S	.0000	-	-	-	-	-3.5	-3.5	3.5	3.5
29/30	.0775	-	-	-	-	20.5	-20.5	-20.5	20.5
24/25	.1799	-	-	-	-	-576.6	576.6	576.6	-576.6
1/ S	.000	-16.9	-16.9	16.9	16.9	-	-	-	-
47/48	.0293	37.2	-37.2	-37.2	37.2	-	-	-	-
42/43	.0581	-895.8	895.8	895.8	-895.8	-	-	-	-
sigX		-925.9	891.7	824.9	-791.6	-610.1	602.6	509.2	-502.6
20/21	.1275	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4
38/39	.1750	-	-	-	-	-7.3	-7.3	7.3	7.3
56/57	.1696	-34.1	-34.1	34.1	34.1	-	-	-	-
sigfi		-35.5	-35.5	32.7	32.7	-8.7	-8.7	5.9	5.9
tauFy		-	-	-	-	2.6	2.6	-2.6	-2.6
tauFz		0.5	0.5	-0.5	-0.5	-	-	-	-
tauMx		-7.5	-7.5	-7.5	-7.5	-7.5	-7.5	-7.5	-7.5
tau		-7.1	-7.1	-8.0	-8.0	-4.9	-4.9	-10.2	-10.2
Comb. stress		926.0	927.4	825.1	824.6	610.3	611.7	509.4	508.9

DURING THE CALCULATION THE FOLLOWING EXTRAPOLATIONS WERE NEEDED

While reading figure 20/21 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.1275

While reading figure 15/16 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.0250

While reading figure 38/39 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.1750

While reading figure 33/34 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.0811

While reading figure 56/57 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.1696

While reading figure 51/52 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.0228

While reading figure 10/11 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(30.41% out of defined area)
Calculated value is : 0.0356

While reading figure 5/ 6 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.0633

While reading figure 29/30 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.0775

While reading figure 24/25 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.1799

While reading figure 47/48 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.0293

While reading figure 42/43 with geometric parameters
GAMMA(1.45)and LAMBDA(4.057)extrapolation used(13.35% out of defined area)
Calculated value is : 0.0581

LOCAL STRESSES IN A SWIVEL OUTLET

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SAKHI-M-842-CA-1004

1. Applied Loads

Radial Load	Fx	=	7000.
Shear Load	Fy	=	44000.
Shear Load	Fz	=	8000.
Torsional Moment	Mx	=	77000000.
Overturning Moment	My	=	17000000.
Overturning Moment	Mz	=	76000000.

2. Geometry

Vessel Thickness	T	=	25.4
Vessel Mean Radius	Rm	=	444.5
Nozzle Thickness	t	=	17.5
Nozzle Mean Radius	rm	=	296.5
Nozzle outs. Radius	ro	=	304.8

3. Coordinates of Loaded Point

X-coordinate = 375.0
Y-coordinate = 0.0
Z-coordinate = 0.0

Internal pressure = 3.1

4. Geometric Parameters

gamma = rm/t = 16.94
rho = T/t = 1.45
U = ro/(Rm*T)** .5= 2.869

5. Stress Concentration Factors.

due to :
Membrane Load Kn =1.00
Bending Load Kb =6.07

6. Dimensions

Loads in N
Moments in Nmm
Measures in mm
Stresses in N/mm**2

7. Interpolation for gamma and rho

Fig. SP/SM 5 Fig. SP/SM 6
Fig. SP/SM 9

From Fig.	va- lue	Au	AL	Bu	BL	Cu	CL	Du	DL
		STRESSES - if load is opposite that shown, reverse sign shown							
SP 0	.0091	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
SP 0	.0067	-2.6	2.6	-2.6	2.6	-2.6	2.6	-2.6	2.6
SM 0	.0062	-	-	-	-	1.5	1.5	-1.5	-1.5
SM 0	.0051	-	-	-	-	44.4	-44.4	-44.4	44.4
SM 0	.0062	7.1	7.1	-7.1	-7.1	-	-	-	-
SM 0	.0051	213.7	-213.7	-213.7	213.7	-	-	-	-
sigX		218.1	-204.0	-223.6	209.1	43.2	-40.4	-48.7	45.5
SigX press.		150.8	150.8	150.8	150.8	150.8	150.8	150.8	150.8
Sum of sigX		368.9	-53.3	-72.8	359.9	194.0	110.3	102.1	196.3
SP 0	.0339	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
SP 0	.0024	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0
SM 0	.0216	-	-	-	-	5.2	5.2	-5.2	-5.2
SM 0	.0019	-	-	-	-	16.6	-16.6	-16.6	16.6
SM 0	.0216	24.9	24.9	-24.9	-24.9	-	-	-	-
SM 0	.0019	79.7	-79.7	-79.7	79.7	-	-	-	-
sigY		103.2	-54.1	-105.9	55.3	20.4	-10.8	-23.1	12.0
SigY press.		150.8	150.8	150.8	150.8	150.8	150.8	150.8	150.8
Sum of sigY		254.0	96.6	44.9	206.1	171.2	140.0	127.7	162.8
tauFy		-	-	-	-	-1.8	-1.8	1.8	1.8
tauFz		-0.3	-0.3	0.3	0.3	-	-	-	-
tauMx		-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2
tau		-5.5	-5.5	-4.9	-4.9	-7.0	-7.0	-3.4	-3.4
Comb. stress		218.4	204.2	223.8	209.2	45.2	42.0	49.1	45.8
S:load/press		369.1	150.3	118.1	360.0	196.0	141.6	128.1	196.6

```
           DURING THE CALCULATION THE FOLLOWING EXTRAPOLATIONS WERE NEEDED


  While reading figure SP 5 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0018

  While reading figure SM 5 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0020

  While reading figure SP 5 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0088

  While reading figure SM 5 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0073

  While reading figure SP 5 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0265

  While reading figure SM 5 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0188

  While reading figure SP 5 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0053

  While reading figure SM 5 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0064

  While reading figure SP 6 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0032

  While reading figure SM 6 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0017

  While reading figure SP 6 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0046

  While reading figure SM 6 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0028

  While reading figure SP 6 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0405

  While reading figure SM 6 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0226

  While reading figure SP 6 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0141

  While reading figure SM 6 with geometric parameter
 U(  2.87)extrapolation used(31.095% out of defined area)
  Calculated value is :  0.0061
```

```
U(  2.87)extrapolation used(31.095% out of defined area)
 Calculated value is :  0.0026

 While reading figure SM 9 with geometric parameter
U(  2.87)extrapolation used(31.095% out of defined area)
 Calculated value is :  0.0025

 While reading figure SP 9 with geometric parameter
U(  2.87)extrapolation used(31.095% out of defined area)
 Calculated value is :  0.0028

 While reading figure SM 9 with geometric parameter
U(  2.87)extrapolation used(31.095% out of defined area)
 Calculated value is :  0.0013

 While reading figure SP 9 with geometric parameter
U(  2.87)extrapolation used(31.095% out of defined area)
 Calculated value is :  0.0529

 While reading figure SM 9 with geometric parameter
U(  2.87)extrapolation used(31.095% out of defined area)
 Calculated value is :  0.0405

 While reading figure SP 9 with geometric parameter
U(  2.87)extrapolation used(31.095% out of defined area)
 Calculated value is :  0.0064

 While reading figure SM 9 with geometric parameter
U(  2.87)extrapolation used(31.095% out of defined area)
 Calculated value is :  0.0048
```