CHAPTER 4

RESULTS

The results for flexibility and bending stresses around ninety degree single mitered bends are as shown in table 4-1. to 4-6. as follows :

TABLE 4-1. DEFLECTIONS ALONG A LINE JOINING THE FREE ENDS OF THE PIPES.

Load	Deflection, Y		Load	Deflection, Y		Load	Deflection, Y	
kg	Pipe No.1a	Pipe No.1b	kg	Pipe No.2a	Pipe No.2b	kg	Pipe No.3a	Pipe No.3b
0	0	0	0	0	0	0	0	0
22.0	0.07750	0.11500	37.0	0.11200	0.14300	52.0	0.18950	0.29400
44.5	0.14600	0.23700	74.0	0.24050	0.28850	101.5	0.37550	0.55750
55.0	0.18500	0.29000	110.0	0.35050	0.41650	151.0	0.55300	0.82500
67.0	0.21650	0.35050	144.5	0.45150	0.55700	197.0	0.71050	1.07400
88.5	0.29400	0.47450	160.0	0.50500	0.62000	219.5	0.80150	1.19900
110.0	0.26500	0.57800	177.0	0.55800	0.69100	242.0	0.89300	1.32400
120.0	0.39900	0.63500	190.0	0.60000	0.73700	265.0	0.98450	1.44900

TABLE 4-1. (CONTINUED)

Load kg	Deflection, Y		Load kg	Deflection, Y		Load kg	Deflection, Y	
	Pipe No.4a	Pipe No.4b		Pipe No.5a	Pipe No.5b		Pipe No.6a	Pipe No.6b
0	0	0	0	0	0	0	0	0
52.0	0.01810	0.02900	24.8	0.01000	0.01525	49.6	0.01525	0.02740
66.5	0.02560	0.04020	62.0	0.02695	0.04230	80.6	0.02855	0.04695
131.0	0.04630	0.07280	124.0	0.05345	0.08055	160.2	0.05815	0.09055
190.5	0.06575	0.10310	186.0	0.07855	0.11960	241.8	0.08730	0.13990
248.0	0.08485	0.13310	248.0	0.10555	0.15800	320.4	0.11670	0.18400
302.5	0.10580	0.16410	310.0	0.13150	0.19650	403.0	0.14590	0.23190
354.0	0.12520	0.19475	372.0	0.15810	0.23570	483.6	0.17455	0.27595

TABLE 4-1. (CONTINUED)

Load kg	Deflection, Y		Load kg	Deflection	Load kg	Deflection	Load kg	Deflection	Load kg	Deflection
	Pipe No.7a	Pipe No.7b		Pipe No.8a		Pipe No.8b		Pipe No.9a		Pipe No.9b
0	0	0	0	0	0	0	0	0	0	0
74.4	0.03505	0.06865	384.4	0.17810	335.7	0.39750	388.8	0.18660	331.3	0.42520
111.6	0.04560	0.10060	497.0	0.23200	437.4	0.52020	530.1	0.25450	402.0	0.52280
223.2	0.08110	0.19435	567.7	0.26390	512.5	0.60920	684.7	0.32820	459.4	0.59750
334.8	0.12405	0.28990	640.6	0.29670	580.9	0.68300	740.0	0.35520	508.0	0.67390
446.4	0.16550	0.38295	713.5	0.33310	673.7	0.79490	799.6	0.38420	574.3	0.75080
558.0	0.20575	0.47930	795.2	0.36840	740.0	0.86910	868.1	0.41620	689.2	0.89570
669.6	0.24795	0.57710	876.9	0.40780	801.8	0.94190	927.7	0.44320	724.5	0.93810

TABLE 4-2. FLEXIBILITIES OF PIPE BENDS.

Pipe No.	Flexibility, $Zx10^3$
1a	0.331
2a	0.313
3a	0.369
4a	0.350
5a	0.427
6a	0.361
7a	0.370
8a	0.464
9a	0.480
1b	0.529
2b	0.388
3b	0.549
4b	0.550
5b	0.634
6b	0.572
7b	0.862
8b	1.178
9b	1.299

TABLE 4-3. THE COMPARISION OF CALCULATED AND THEORETICAL (VON KARMAN) FLEXIBILITY FACTORS AT EACH EQUIVALENT RADIUS. (at R = r)

Pipe No.	Equivalent Radius, R	Pipe Factor, $\lambda = tR/r^2$	Calculated Flexibility Factor, K	Karman Flexibility Factor, K
1a	0.9650	0.2073	- 0.2497	8.3708
2a	1.2225	0.1922	- 0.0093	9.0258
3a	1.5425	0.1718	0.3974	10.0956
4a	1.9775	0.1340	0.5501	12.9263
5a	2.2650	0.1280	1.2718	13.5266
6a	2.8500	0.1018	1.3566	17.0111
7a	3.6225	0.0897	1.6567	19.2836
8a	4.3075	0.0755	3.4099	22.8971
9a	5.5675	0.0656	5.6288	26.2786
1b	0.9650	0.2073	1.3336	8.3708
2b	1.2225	0.1922	1.1508	9.0258
3b	1.5425	0.1718	3.0611	10.0956
4b	1.9775	0.1340	3.2490	12.9263
5b	2.2650	0.1280	4.2786	13.5266
6b	2.8500	0.1018	4.9698	17.0111
7b	3.6225	0.0897	10.2025	19.2836
8b	4.3075	0.0755	16.3479	22.8971
9b	5.5675	0.0656	23.2600	26.2786

a = Reinforced Pipe Bend

b = Unreinforced Pipe Bend

TABLE 4-3. (CONTINUED)

(at R = 2r)

Pipe No.	Equivalent Radius, R	Pipe Factor, $\lambda = tR/r^2$	Calculated Flexibility Factor, K	Karman Flexibility Factor, K
1a	1.9300	0.4145	0.4890	4.0431
2a	2.4450	0.3845	0.6261	4.3894
3a	3.0850	0.3436	0.8557	4.9574
4a	3.9550	0.2680	0.9427	6.4435
5a	4.5300	0.2561	1.3462	6.7536
6a	5.7000	0.2035	1.3995	8.5256
7a	7.2450	0.1794	1.5658	9.6676
8a	8.6150	0.1509	2.5553	11.4860
9a	11.1350	0.1311	3.8209	13.2100
1b	1.9300	0.4145	1.3858	4.0431
2b	2.4450	0.3845	1.2858	4.3894
3b	3.0850	0.3436	2.3576	4.9574
4b	3.9550	0.2680	2.4655	6.4435
5b	4.5300	0.2561	3.0341	6.7536
6b	5.7000	0.2035	3.4458	8.5256
7b	7.2450	0.1794	6.3804	9.6676
8b	8.6150	0.1509	9.8574	11.4860
9b	11.1350	0.1311	13.8101	13.2100

a = Reinforced Pipe Bend

b = Unreinforced Pipe Bend

TABLE 4-3. (CONTINUED)

(at R = 3r)

Pipe No.	Equivalent Radius, R	Pipe Factor, $\lambda = tR/r^2$	Calculated Flexibility Factor, K	Karman Flexibility Factor, K
1a	2.8950	0.6218	0.7722	2.6104
2a	3.6675	0.5767	0.8766	2.8244
3a	4.6275	0.5154	1.0477	3.1862
4a	5.9325	0.4020	1.1157	4.1805
5a	6.7950	0.3841	1.4159	4.3936
6a	8.5500	0.3053	1.4638	5.6241
7a	10.8675	0.2692	1.5858	6.4152
8a	12.9225	0.2264	2.3362	7.6592
9a	16.7025	0.1967	3.3088	8.8217
1b	2.8950	0.6218	1.4524	2.6104
2b	3.6675	0.5767	1.3812	2.8244
3b	4.6275	0.5154	2.1853	3.1862
4b	5.9325	0.4020	2.2692	4.1805
5b	6.7950	0.3841	2.6877	4.3936
6b	8.5500	0.3053	3.0213	5.6241
7b	10.8675	0.2692	5.2286	6.4152
8b	12.9225	0.2264	7.7828	7.6592
9b	16.7025	0.1967	10.9153	8.8217

a = Reinforced Pipe Bend

b = Unreinforced Pipe Bend

TABLE 4-3. (CONTINUED)

(at R = 4r)

Pipe No.	Equivalent Radius, R	Pipe Factor, $\lambda = tR/r^2$	Calculated Flexibility Factor, K	Karman Flexibility Factor, K
1a	3.8600	0.8290	0.9508	1.9764
2a	4.8900	0.7689	1.0402	2.1165
3a	6.1700	0.6872	1.1820	2.3584
4a	7.9100	0.5360	1.2434	3.0538
5a	9.0600	0.5122	1.4939	3.2081
6a	11.4000	0.4070	1.5449	4.1247
7a	14.4900	0.3589	1.6446	4.7301
8a	17.2300	0.3018	2.2904	5.6920
9a	22.2700	0.2622	3.1411	6.5903
1b	3.8600	0.8290	1.5338	1.9764
2b	4.8900	0.7689	1.4789	2.1165
3b	6.1700	0.6872	2.1594	2.3584
4b	7.9100	0.5360	2.2340	3.0538
5b	9.0600	0.5122	2.5803	3.2081
6b	11.4000	0.4070	2.8906	4.1247
7b	14.4900	0.3589	4.7705	4.7301
8b	17.2300	0.3018	7.0532	5.6920
9b	22.2700	0.2622	9.7164	6.5903

a = Reinforced Pipe Bend

b = Unreinforced Pipe Bend

TABLE 4-3. (CONTINUED)

(at R = 5r)

Pipe No.	Equivalent Radius, R	Pipe Factor, λ $= tR/r^2$	Calculated Flexibility Factor, K	Karman Flexibility Factor, K
1a	4.8250	1.0363	1.0979	1.6490
2a	6.1125	0.9612	1.1798	1.7460
3a	7.7125	0.8590	1.3027	1.9158
4a	9.8875	0.6701	1.3638	2.4187
5a	11.3250	0.6402	1.5858	2.5330
6a	14.2500	0.5088	1.6456	3.2314
7a	18.1125	0.4486	1.7312	3.7075
8a	21.5375	0.3773	2.3299	4.4808
9a	27.8375	0.3278	3.1342	5.2140
1b	4.8250	1.0363	1.6336	1.6490
2b	6.1125	0.9612	1.5912	1.7460
3b	7.7125	0.8590	2.2072	1.9158
4b	9.8875	0.9701	2.2790	2.4187
5b	11.3250	0.6402	2.5839	2.5330
6b	14.2500	0.5088	2.9986	3.2314
7b	18.1125	0.4486	4.6186	3.7075
8b	21.5375	0.3773	6.7422	4.4808
9b	27.8375	0.3278	9.2596	5.2140

a = Reinforced Pipe Bend

b = Unreinforced Pipe Bend

TABLE 4-3. (CONTINUED)

(at R = 6r)

Pipe No.	Equivalent Radius, R	Pipe Factor, $\lambda = tR/r^2$	Calculated Flexibility Factor, K	Karman Flexibility Factor, K
1a	5.7900	1.2435	1.2421	1.4605
2a	7.3350	1.1534	1.3202	1.5310
3a	9.2550	1.0308	1.4280	1.6554
4a	11.8650	0.8041	1.4934	2.0312
5a	13.5900	0.7682	1.6966	2.1182
6a	17.1000	0.6105	1.7714	2.6603
7a	21.7350	0.5383	1.8460	3.0399
8a	25.8450	0.4527	2.4307	3.6707
9a	33.4050	0.3934	3.2351	4.2812
1b	5.7900	1.2435	1.7575	1.4605
2b	7.3350	1.1534	1.7274	1.5310
3b	9.2550	1.0308	2.3093	1.6554
4b	11.8650	0.8041	2.3828	2.0312
5b	13.5900	0.7682	2.6610	2.1182
6b	17.1000	0.6105	3.0010	2.6603
7b	21.7350	0.5383	4.6533	3.0399
8b	25.8450	0.4527	6.7355	3.6707
9b	33.4050	0.3934	9.2493	4.2812

a = Reinforced Pipe Bend

b = Unreinforced Pipe Bend

TABLE 4-3. (CONTINUED)

(at R = 7r)

Pipe No.	Equivalent Radius, R	Pipe Factor, $\lambda = tR/r^2$	Calculated Flexibility Factor, K	Karman Flexibility Factor, K
1a	6.7550	1.4508	1.4010	1.3429
2a	8.5575	1.3456	1.4774	1.3962
3a	10.7975	1.2026	1.5698	1.4907
4a	13.8425	0.9381	1.6442	1.7802
5a	15.8550	0.8963	1.8330	1.8479
6a	19.9500	0.7123	1.9306	2.2767
7a	25.3575	0.6280	1.9947	2.5835
8a	30.1525	0.5282	2.5897	3.1031
9a	38.9725	0.4559	3.4318	3.6163
1b	6.7550	1.4508	1.9135	1.3429
2b	8.5575	1.3456	1.8983	1.3962
3b	10.7975	1.2026	2.4641	1.4907
4b	13.8425	0.9381	2.5432	1.7802
5b	15.8550	0.8963	2.8020	1.8479
6b	19.9500	0.7123	3.1886	2.2767
7b	25.3575	0.6280	4.8355	2.5835
8b	30.1525	0.5282	6.9640	3.1031
9b	38.9725	0.4589	9.5884	3.6163

a = Reinforced Pipe Bend

b = Unreinforcde Pipe Bend

TABLE 4-4. THE COMPARISION OF KELLOGG'S, CALCULATED AND THEORETICAL (VON KARMAN) FLEXIBILITY FACTORS FOR EQUIVALENT SMOOTH BEND OF UNREINFORCED MITERED PIPE BEND.

Pipe No.	Kellogg's Flexibility Factor	Calculated Flexibility Factor	Karman Flexibility Factor	$K_{Kellogg}/K_{Karman}$	$\lambda \cdot K_{Karman}$
1b	5.6420	1.3336	8.3708	0.6740	1.7353
2b	6.0070	1.1508	9.0258	0.6655	1.7348
3b	6.5967	3.0611	10.0956	0.6534	1.7344
4b	8.1139	3.2490	12.9263	0.6277	1.7321
5b	8.4280	4.2786	13.5266	0.6231	1.7314
6b	10.2070	4.9698	17.0111	0.6000	1.7317
7b	11.3354	10.2025	19.2836	0.5878	1.7297
8b	13.0957	16.3479	22.8971	0.5719	1.7287
9b	14.7224	23.2600	26.2786	0.5602	1.7239

TABLE 4-5. PRINCIPAL STRAINS AND MAXIMUM SHEAR STRAINS AT ZERO DEGREE POSITION ON z-θ PLANE.

Load F	Maximum Strain, $e_1 \times 10^2$	Minimum Strain, $e_2 \times 10^2$	Maximum Shear Strain, $e_{z\theta\,max.} \times 10^2$
360.0	0.00325	-0.00800	0.01125
428.5	0.00405	-0.00950	0.01355
505.8	0.00470	-0.01120	0.01590
578.7	0.00545	-0.01265	0.01810
651.6	0.00620	-0.01445	0.02065
731.1	0.00690	-0.01600	0.02290
770.9	0.00725	-0.01700	0.02425
868.0	0.00820	-0.01905	0.02725
927.7	0.00875	-0.02045	0.02920

TABLE 4-6. STRESS-STRAIN DUE TO IN-PLANE BENDING MOMENT AROUND THE PIPE AT THE SAME CIRCULAR SECTION.

(at load, F = 360.0 kg.)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress, S_z(theo.)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.01020	-0.00455	203.0877	234.2440	- 5.0702	68.7521	0	0	0
+ 60	0.00900	-0.00475	173.2077	197.7384	- 25.3511	51.7162	22.7399	19.9384	19.9384
+ 30	0.00740	-0.00500	91.5746	149.2672	- 51.9190	29.2045	68.2198	34.5333	34.5333
0	-0.00240	-0.00240	- 19.9384	- 97.3482	- 97.3482	- 58.4089	90.9597	39.8768	39.8768
- 30	-0.00795	0.00220	-131.4515	-198.9553	- 34.2747	- 69.9690	68.2198	34.5333	34.5333
- 60	-0.01020	-0.00275	-213.0845	-323.0742	-202.2002	-157.5823	22.7399	19.9384	19.9384
- 90	-0.01080	-0.00250	-242.9646	-337.0680	-202.4030	-161.8413	0	0	0

TABLE 4-6. (CONTINUED)

(at load, F = 428.5 kg)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress, S_z(theo.)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.01250	-0.00405	241.7107	305.6326	37.1140	102.8240	0	0	0
+ 60	0.01050	-0.00555	206.1480	230.5934	- 29.8129	60.2342	27.3890	23.7303	23.7303
+ 30	0.00945	-0.00610	108.9902	194.0879	- 58.2061	40.7645	82.1669	41.1009	41.1009
0	-0.00285	-0.00280	- 23.7303	-114.9925	-114.1813	- 68.7521	109.5559	47.4606	47.4606
- 30	-0.01050	0.00305	-156.4508	-261.0147	- 41.1702	- 90.6555	82.1669	41.1009	41.1009
- 60	-0.01255	-0.00310	-253.6086	-394.0572	-240.7339	-190.4373	27.3890	23.7303	23.7303
- 90	-0.01350	-0.00335	-289.1713	-424.0729	-259.3923	-205.0396	0	0	0

TABLE 4-6. (CONTINUED)

(at load, F = 505.8 kg)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress, S_z(theo)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.01450	-0.00580	285.3201	341.1242	11.7629	105.8661	0	0	0
+ 60	0.01250	-0.00660	243.3413	274.6029	- 35.2887	71.7943	32.1391	28.0117	28.0117
+ 30	0.00975	-0.00720	128.6542	189.2205	- 85.7881	31.0297	96.4173	48.5163	48.5163
0	-0.00340	-0.00330	- 28.0117	-136.6930	-135.0706	- 81.5291	128.5564	56.0234	56.0234
- 30	-0.01185	0.00330	-184.6776	-296.3034	- 50.4994	-104.0408	96.4173	48.5163	48.5163
- 60	-0.01505	-0.00380	-299.3647	-473.5582	-291.0304	-229.3766	32.1391	28.0117	28.0117
- 90	-0.01545	-0.00400	-341.3436	-487.3492	-301.5765	-236.6777	0	0	0

TABLE 4-6. (CONTINUED)

(at load,F 578.7 kg)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress, S_z(theo.)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.01705	-0.00730	326.4307	395.2741	0.2028	118.6431	0	0	0
+ 60	0.01415	-0.00750	278.4033	310.5001	- 40.7645	80.9207	36.5860	32.0478	32.0478
+ 30	0.01175	-0.00820	147.1914	233.8384	- 89.8442	43.1982	109.7580	55.5068	55.5068
0	-0.00380	-0.00380	- 32.0478	-154.1346	-154.1346	- 92.4808	146.3440	64.0956	64.0956
- 30	-0.01345	0.00410	-211.2871	-331.9978	- 47.2544	-113.7757	109.7580	55.5068	55.5068
- 60	-0.01720	-0.00395	-342.4989	-536.4289	-321.4517	-257.3642	36.5860	32.0478	32.0478
- 90	-0.01785	-0.00450	-390.5263	-561.5772	-344.9775	-271.9664	0	0	0

TABLE 4-6. (CONTINUED)

(at load, F = 651.6 kg)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress S_z(theo.)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.01990	-0.00760	367.5469	472.5442	26.3651	149.6728	0	0	0
+ 60	0.01605	-0.00850	313.4701	352.2786	- 46.0376	91.8723	41.7404	36.0844	36.0844
+ 30	0.01375	-0.00940	165.7312	276.0226	- 99.5791	52.9331	125.2212	62.4982	62.4982
0	-0.00425	-0.00435	- 36.0845	-173.6042	-175.2267	-104.6493	166.9616	72.1689	72.1689
- 30	-0.01470	0.00435	-237.9001	-364.4472	- 55.3668	-125.9442	125.2212	62.4982	62.4982
- 60	-0.01855	-0.00485	-385.6390	-585.7114	-363.4331	-284.7434	41.7404	36.0844	36.0844
- 90	-0.01980	-0.00485	-439.7158	-621.2029	-378.6438	-299.9540	0	0	0

TABLE 4-6. (CONTINUED)

(at load, F = 731.1 kg)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress S_z(theo.)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.02105	-0.00835	412.4030	496.0700	19.0640	154.5402	0	0	0
+ 60	0.01795	-0.00950	351.7266	394.0572	- 51.3106	102.8240	46.2884	40.4882	40.4882
+ 30	0.01400	-0.01050	185.9573	269.7355	-127.7695	42.5898	138.8651	70.1256	70.1256
0	-0.00470	-0.00480	- 40.4883	-191.8570	-193.4795	-115.6009	185.1535	80.9765	80.9765
- 30	-0.01745	0.00490	-266.9339	-435.8358	- 73.2139	-152.7149	138.8651	70.1256	70.1256
- 60	-0.02115	-0.00550	-432.7031	-667.4433	-413.5269	-324.2910	46.2884	40.4882	40.4882
- 90	-0.02225	-0.00545	-493.3795	-698.0674	-425.4926	-337.0680	0	0	0

TABLE 4-6. (CONTINUED)

(at load, F = 770.9 kg)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress S_z(theo.)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.02305	-0.00900	434.8310	544.9469	24.9455	170.9677	0	0	0
+ 60	0.01900	-0.01000	370.8548	417.7858	- 52.7303	109.5167	49.0172	42.6901	42.6901
+ 30	0.01535	-0.01105	196.0703	301.3737	-126.9582	52.3246	147.0515	73.9393	73.9393
0	-0.00505	-0.00500	- 42.6902	-204.2283	-203.4171	-122.2936	196.0687	85.3803	85.3803
- 30	-0.01800	0.00515	-281.4508	-448.4099	- 72.8083	-156.3655	147.0515	73.9393	73.9393
- 60	-0.02235	-0.00580	-456.2351	-705.1657	-436.6470	-342.5438	49.0172	42.6901	42.6901
- 90	-0.02355	-0.00590	-520.3795	-740.4544	-454.0886	-358.3629	0	0	0

TABLE 4-6. (CONTINUED)

(at load, F = 868.0 kg)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress, S_z(theo.)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.02595	-0.01075	489.6488	605.9923	10.5461	184.9615	0	0	0
+ 60	0.02140	-0.01130	417.6073	470.1105	- 60.4370	122.9020	55.0811	48.0720	48.0720
+ 30	0.01815	-0.01250	220.7884	363.2303	-134.0565	68.7521	165.2434	83.2606	83.2606
0	-0.00570	-0.00580	- 48.0720	-232.4187	-234.0412	-139.9380	220.3246	96.1439	96.1439
- 30	-0.02030	0.00575	-316.9324	-506.4132	- 83.7600	-177.0520	165.2434	83.2606	83.2606
- 60	-0.02535	-0.00665	-513.7513	-800.6886	-497.2868	-389.3926	55.0811	48.0720	48.0720
- 90	-0.02665	-0.00645	-585.7928	-835.1650	-507.4273	-402.7780	0	0	0

TABLE 4-6. (CONTINUED)

(at load, F = 927.7 kg)

Position, θ	Longitudinal Strain, $e_z \times 10^2$	Circumferential Strain, $e_\theta \times 10^2$	Theoretical Longitudinal Stress, S_z(theo.)	Longitudinal Stress, S_z	Circumferential Stress, S_θ	Radial Stress, S_r	Shear Stress in z-θ Plane $S_{z\theta}$	Shear Stress in θ-r Plane $S_{\theta r}$	Shear Stress in r-z Plane S_{rz}
+ 90	0.02705	-0.01095	523.2909	634.7911	18.2528	195.9132	0	0	0
+ 60	0.02285	-0.01205	446.2997	502.1542	- 64.0875	131.4200	59.0227	51.3748	51.3748
+ 30	0.01830	-0.01325	235.9580	358.3629	-153.5262	61.4510	177.0682	88.9812	88.9812
0	-0.00600	-0.00610	- 51.3749	-244.5872	-246.2097	-147.2391	236.0909	102.7496	102.7496
- 30	-0.02180	0.00620	-338.7077	-543.5272	- 89.2358	-189.8289	177.0682	88.9812	88.9812
- 60	-0.02700	-0.00685	-549.0494	-849.9711	-523.0435	-411.9044	59.0227	51.3748	51.3748
- 90	-0.02880	-0.00725	-626.0406	-905.9463	-556.3041	-438.6751	0	0	0