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AUSTRALIAN ATOMIC ENERGY COMMISSION

RESEARCH ESTABLISHMENT

LUCAS HEIGHTS RESEARCH LABORATORIES

RESULTS OF PIPE BEND ANALYSIS
PART XII: STRESSES IN ELBOWS WITH LONG TANGENTS UNDER OUT-OF-PLANE BENDING

by

J.F. WHATHAM

MAY 1985

ISBN 0 642 59803 7

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ABSTRACT

Graphs of outside surface stress distributions are presented and numerical values of stresses on inside and outside surfaces tabulated for a wide range of 90° pipe bends with long tangent pipes subjected to out-of-plane bending; calculations are based on linear thin shell theory.

National Library of Australia card number and ISBN 0 642 59803 7

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ANALYTICAL SOLUTION; BENDING; EXPERIMENTAL DATA; PIPES; SPATIAL DISTRIBUTION; STRESSES

CONTENTS

1. INTRODUCTION

The objective of this report is to present the surface stress distributions for a range of 90° pipe bends terminated by long tangent pipes and subjected to an out-of-plane bending moment, to assist pipework design engineers and to provide analytic solutions for checking numerical solution methods. Wall thicknesses vary from one to ten per cent of the pipe radius with bend radii two, three and five times the pipe radius.

Stresses were calculated by the thin shell theory of Novozhilov [1970] and details of the analysis have been published [Whatham 1981, 1982]. The assumptions were that:

(i) the pipe wall is thin ($t/r < 0.3$),

(ii) normal stresses through the wall are negligible, and

(iii) normals through the wall remain normal to it and unchanged in length,

2. STRESS DERIVATION

The pipe bend configuration is shown in Figure 1, and a segment of a curved pipe middle surface, an imaginary surface mid-way between the inner and outer surfaces, is shown in Figure 2 with one end joined to a tangent pipe at least one pipe circumference long. An element of the middle surface in Figure 3 is supposed to have forces T_θ, T_η, $T_{\theta\eta}$, $T_{\eta\theta}$, N_θ, N_η and moments M_θ, M_η, $M_{\eta\theta}$, $M_{\theta\eta}$ per unit length acting on its edges and the solution was obtained by thin shell theory in terms of these forces and moments; the stresses presented in this report were then derived as follows:

$$\begin{aligned} \text{Hoop stress: } \sigma_{\theta\theta} &= T_\theta/t + 12zM_\theta/t^3 \quad , \\ \text{Axial stress: } \sigma_{\eta\eta} &= T_\eta/t + 12zM_\eta/t^3 \quad , \\ \text{Shear stress: } \sigma_{\eta\theta} &= S/t + z(12H/t^3 - S/rt) \quad , \end{aligned} \tag{1}$$

where $S = T_{\theta\eta} - M_{\eta\theta}/r_\eta = T_{\eta\theta} - M_{\theta\eta}/r$, and $H = M_{\theta\eta} = M_{\eta\theta}$.

These stresses were close to those derived from beam theory when considering a straight pipe subjected to bending or torsion; if a moment M is applied to a straight pipe, Novozhilov's theory [see Whatham 1981] gives

$$T_\eta = \frac{12M\cos\theta}{(12+\gamma)\pi r^2} \quad ,$$

$$M_\eta = \frac{\gamma M\cos\theta}{(12+\gamma)\pi r} \quad , \tag{2}$$

$$T_\theta = M_\theta = S = H = 0 \quad ,$$

where $\gamma = (t/r)^2$.

Substituting in Equations (1), the axial stress distribution approximates that from beam theory, which is

$$\sigma_{\eta\eta} = \frac{M(r+z)\cos\theta}{\pi r^3 t(1+\gamma/4)} \quad . \tag{3}$$

If torque T is applied to a straight pipe, Novozhilov's theory gives

$$S = \frac{3T}{2(3+\gamma)\pi r^2} \quad ,$$

$$H = \frac{\gamma T}{4(3+\gamma)\pi r} \quad , \tag{4}$$

$$T_\eta = M_\eta = T_\theta = M_\theta = 0 \quad .$$

Substituting in Equations (1), the shear stress distribution approximates that from beam theory, which is

$$\sigma_{\eta\theta} = \frac{T(r+z)}{2\pi r^3 t(1+\gamma/4)} \quad . \tag{5}$$

Equations (1) assume that the strains are linearly distributed through the pipe wall; this is not true for curved shells and the stresses $\sigma'_{\theta\theta}$, $\sigma'_{\eta\eta}$, $\sigma'_{\eta\theta}$ derived by the following equations are theoretically more accurate, even though the results do not agree with beam theory in the case of straight pipes:

$$\sigma'_{\theta\theta} = \sigma_{\theta\theta} - z(A+\nu B)/(1-\nu^2) \quad ,$$

$$\sigma'_{\eta\eta} = \sigma_{\eta\eta} - z(B+\nu A)/(1-\nu^2) \quad , \tag{6}$$

$$\sigma'_{\eta\theta} = \sigma_{\eta\theta} - \frac{z}{2r}\left[(r/(r+z)+r/(r_\eta+z))\sigma_{\eta\theta} - (r_\eta-r)\bar{\sigma}_{\eta\theta}/(r_\eta+z)\right] \quad ,$$

where

$$r_\eta = r + R/\cos\theta \ ,$$

$$A = (\sigma_{\theta\theta} - \nu\sigma_{\eta\eta})/(r+z) \ ,$$

$$B = (\sigma_{\eta\eta} - \nu\sigma_{\theta\theta})/(r_\eta+z) \ , \quad \text{and}$$

$$\bar{\sigma}_{\eta\theta} = \tfrac{1}{2}\sigma_{\eta\theta}\,(\text{inside}) + \tfrac{1}{2}\sigma_{\eta\theta}(\text{outside}).$$

3. ELBOW CONFIGURATION AND RESULTS

Stresses were calculated for one side of the bend in Figure 1 (θ = 0 to 180°), those for negative θ having the same magnitude but with the hoop and axial stress signs changed; note that a pure out-of-plane bending moment acting on one tangent of a 90° bend produces a reaction of pure torsion at the other tangent. Hoop and axial stresses on the outside surface are plotted in Appendix A, together with the stresses on theoretically unterminated pipe bends. The latter stresses vary as $\sin\phi$ while the shear stresses without end effects vary as $\cos\phi$.

The two graphs for each pipe bend are accompanied by tabulated stresses from which the graphs were constructed. In addition, since shear stresses and inside surface stresses are also given and a linear variation through the wall is assumed, the complete stress state in each pipe bend is provided.

A computer program package BENDPAC, written in FORTRAN IV and Assembler for an IBM3033 computer and designed to calculate the stresses in and the flexibility of pipe bends with tangents under in-plane or out-of-plane bending, or flanged pipe bends under any loading, is available from the Australian Atomic Energy Commission, the Risley Nuclear Power Development Establishment, Cheshire, UK, or the National Energy Software Center, Argonne National Laboratory, USA.

4. ACKNOWLEDGEMENT

The author acknowledges the advice and encouragement of Professor J.J. Thompson of the School of Nuclear Engineering, University of New South Wales.

5. REFERENCES

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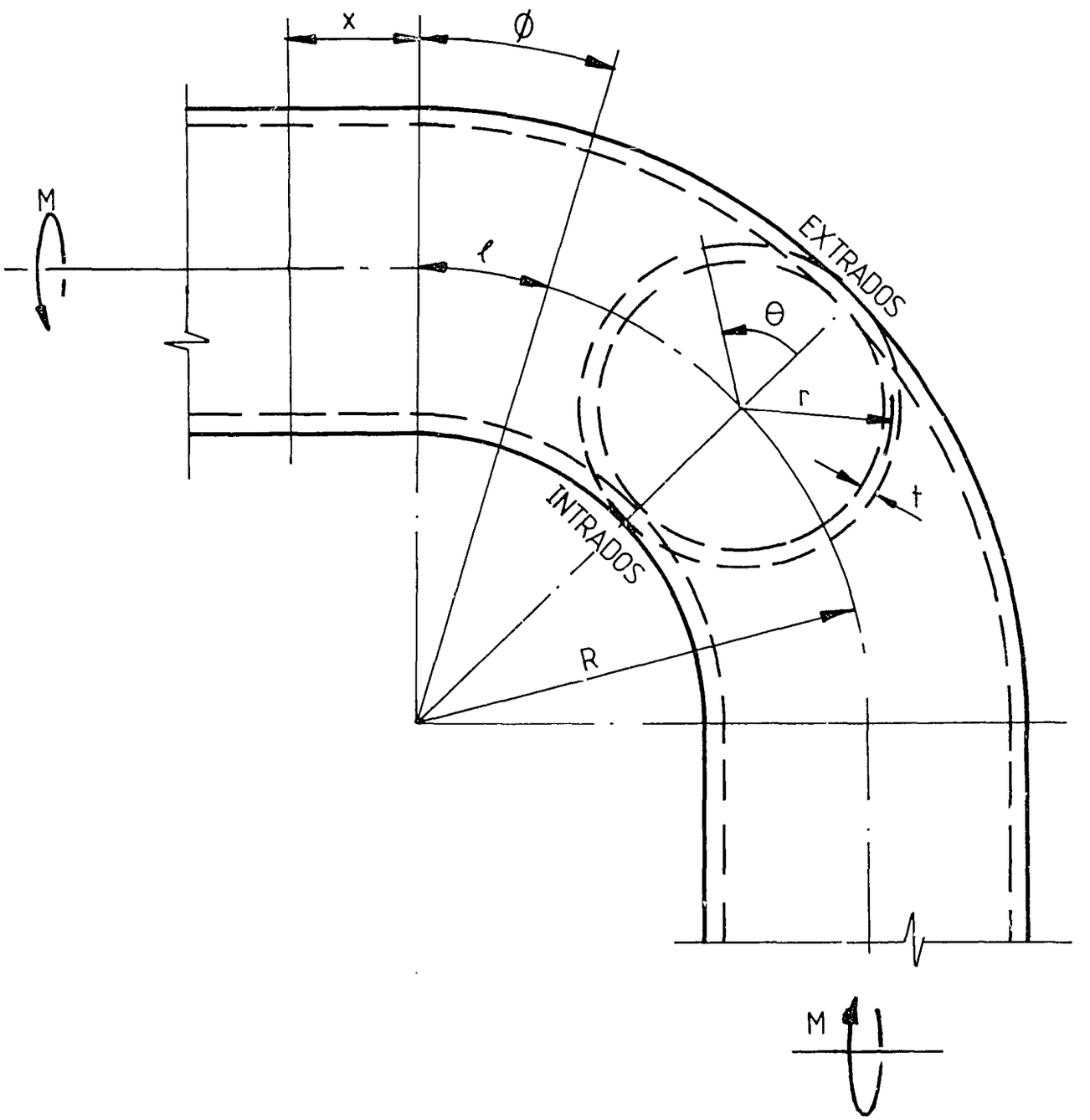


FIGURE 1. PIPE BEND CONFIGURATION

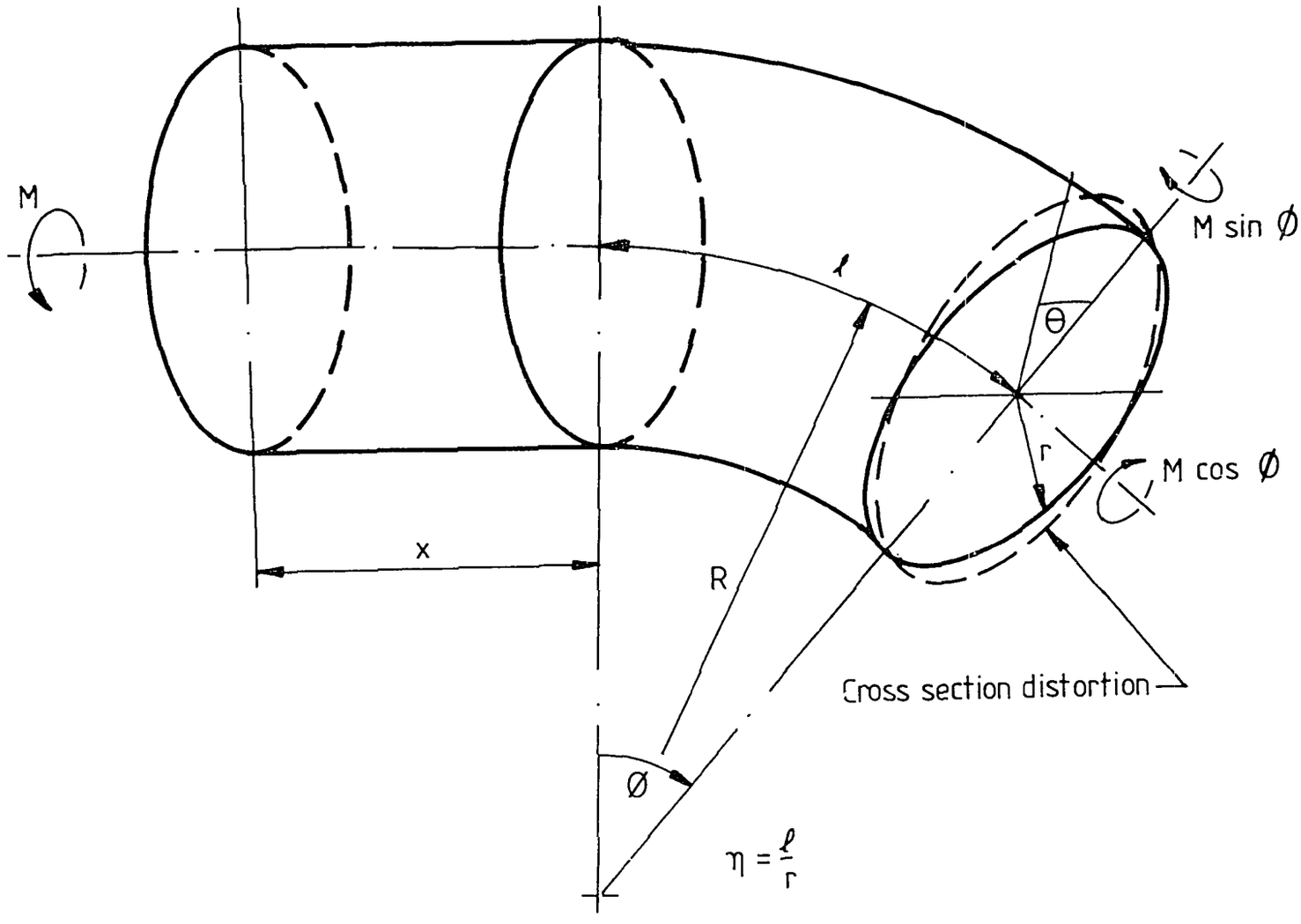


FIGURE 2. PIPE MIDDLE SURFACE

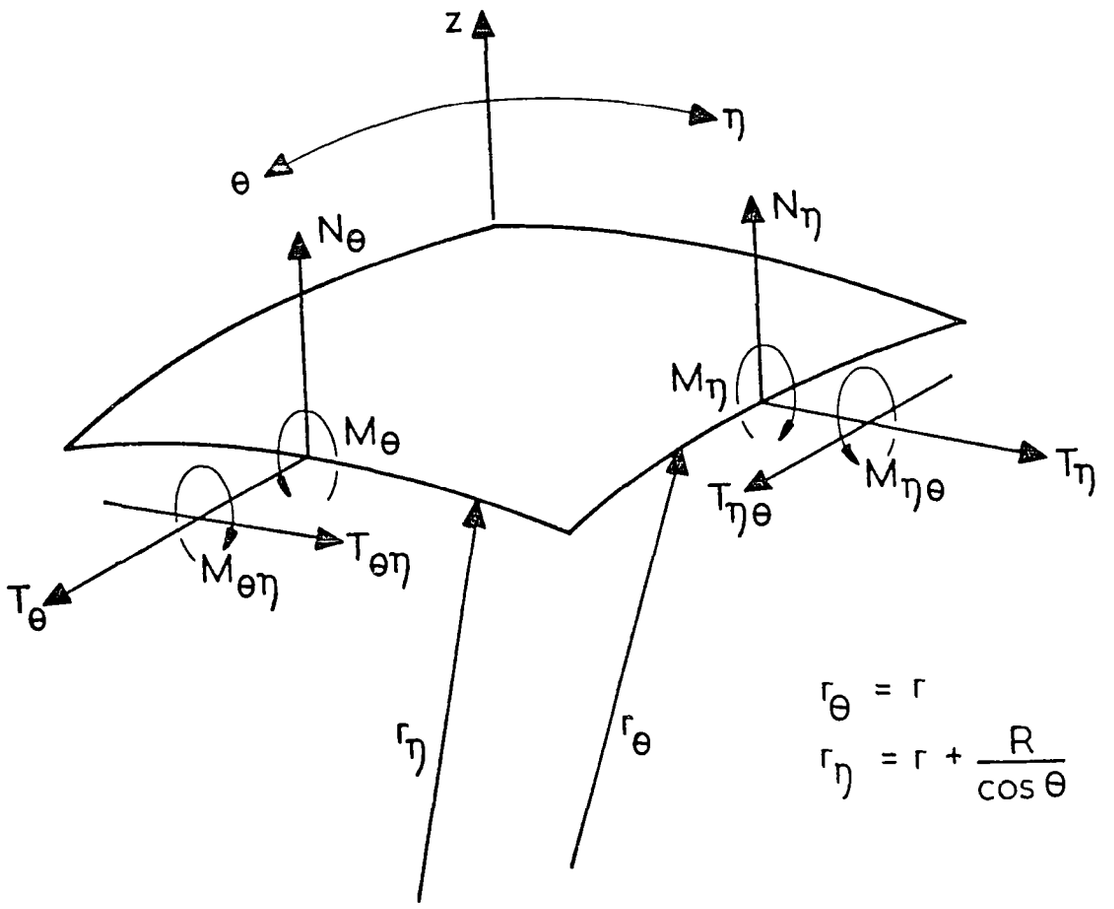


FIGURE 3. ELEMENT OF PIPE MIDDLE SURFACE

APPENDIX A

STRESSES IN PIPE ELBOWS WITH LONG TANGENTS UNDER OUT-OF-PLANE BENDING

Parameters of pipe elbows considered:

R/r = 2, 3, 5

t/r = 0.01, 0.02, 0.05, 0.1

ν = 0.3

Stress factor (S) = stress . $\pi r^2 t/M$

For unflanged pipe bends:

$\left.\begin{matrix} x \sin \\ x \cos \end{matrix}\right\}$ = multiply stress factors by $\left\{\begin{matrix} \sin\phi \\ \cos\phi \end{matrix}\right.$

NT = no tangent effects

Diameter expansion factor = diameter expansion . $\pi rEt/M$

E = Young's modulus

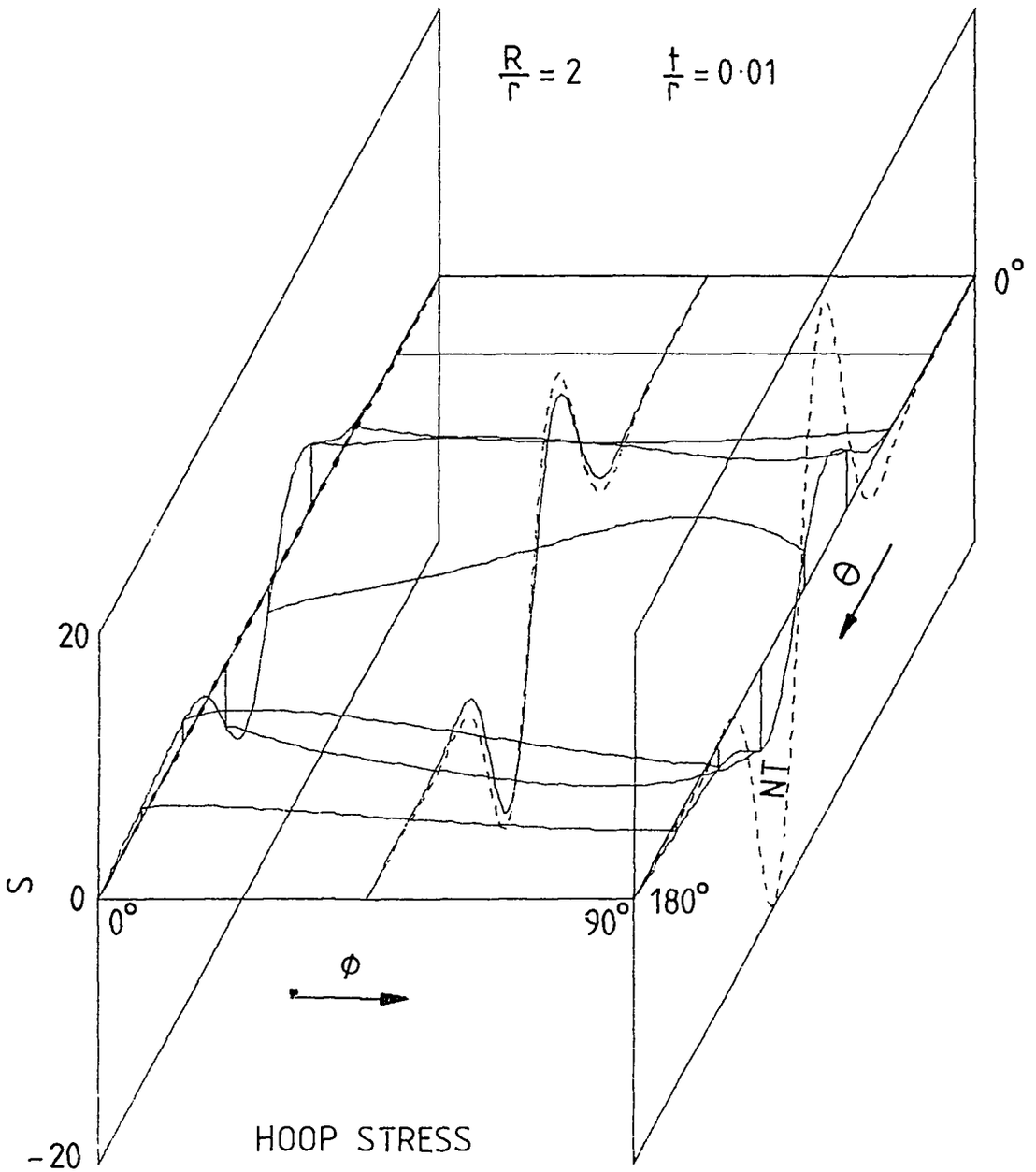


FIGURE A1

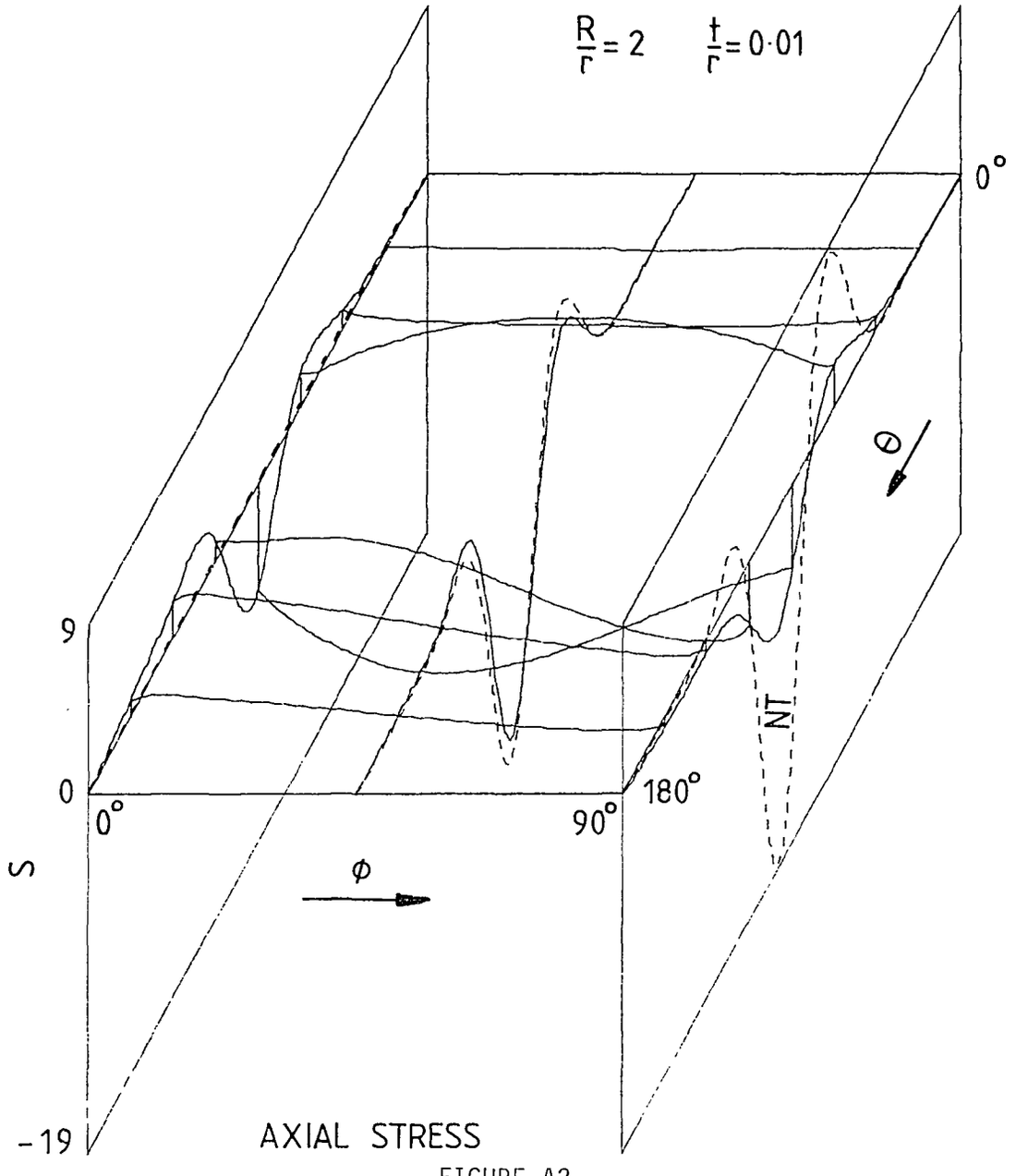


FIGURE A2

TABLE A1

R/r = 2.0 t/r = 0.01

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0132	0.0252	0.0351	0.0278	0.0161	0.0067	0.0024	0.0037	0.0095	0.0170	0.0204	0.0104	-0.0093	-0.1093
45.0	0.5114	-0.0713	-0.3983	-0.6370	-0.7928	-0.8767	-0.8976	-0.8616	-0.7710	-0.6261	-0.4283	-0.1376	0.1832	-1.8290
67.5	4.8454	4.9093	5.1772	5.3718	5.4170	5.2943	5.0237	4.6509	4.2404	3.8731	3.6500	3.7018	4.3975	5.8631
90.0	-1.8156	-0.8362	-0.1400	0.4842	1.1913	2.0258	2.9530	3.8792	4.6677	5.1498	5.1313	4.3825	2.6956	8.9887
112.5	-4.6651	-5.6126	-6.4570	-7.0696	-7.6000	-8.1010	-8.5726	-8.9715	-9.2223	-9.2266	-8.8728	-8.0414	-6.3494	-15.3619
135.0	1.7192	2.4299	2.4076	2.1876	1.8144	1.3414	0.8170	0.2789	-0.2446	-0.7339	-1.1808	-1.5397	-1.8338	0.2894
157.5	0.9045	1.0870	0.9631	0.7769	0.5588	0.3170	0.0667	-0.1761	-0.3968	-0.5837	-0.7292	-0.7894	-0.8328	-0.1728
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2604	0.1894	0.1423	0.1135	0.0971	0.0886	0.0850	0.0849	0.0880	0.0951	0.1070	0.1233	0.1318	0.1231
45.0	1.0065	0.5739	0.4016	0.3093	0.2538	0.2135	0.1796	0.1520	0.1377	0.1501	0.2095	0.3486	0.6480	0.0894
67.5	1.7926	2.5881	3.4614	4.0612	4.4478	4.6611	4.7261	4.6534	4.4415	4.0796	3.5512	2.8352	2.3120	8.0408
90.0	-5.6901	-7.6115	-8.9153	-9.7104	-10.0144	-9.8913	-9.4234	-8.6998	-7.8107	-6.8461	-5.8992	-5.0800	-4.4291	-12.1821
112.5	1.0841	1.0959	1.2883	1.1987	0.8045	0.1454	-0.7070	-1.6596	-2.6069	-3.4357	-4.0269	-4.2958	-3.3856	-3.9445
135.0	1.9563	2.2811	2.0206	1.7211	1.3558	0.9659	0.5793	0.2145	-0.1177	-0.4123	-0.6772	-0.9211	-0.6285	0.5014
157.5	0.8942	1.1280	0.9434	0.7617	0.5504	0.3181	0.0809	-0.1463	-0.3500	-0.5197	-0.6569	-0.7287	-0.4393	-0.0751
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4436	-0.3999	-0.3634	-0.3339	-0.3066	-0.2796	-0.2525	-0.2258	-0.2001	-0.1756	-0.1514	-0.1257	-0.1001	-0.5023
22.5	-0.4109	-0.3922	-0.3695	-0.3473	-0.3224	-0.2949	-0.2659	-0.2370	-0.2099	-0.1855	-0.1639	-0.1424	-0.1226	-0.5417
45.0	-0.2788	-0.3972	-0.4311	-0.4225	-0.3892	-0.3437	-0.2944	-0.2479	-0.2099	-0.1866	-0.1856	-0.2160	-0.3164	-0.7116
67.5	-1.6420	-1.3587	-1.1537	-0.9644	-0.7918	-0.6291	-0.4673	-0.2978	-0.1144	0.0854	0.2983	0.5117	0.7727	-1.5310
90.0	0.2495	0.0738	-0.1751	-0.4550	-0.7149	-0.9196	-1.0477	-1.0866	-1.0277	-0.8630	-0.5808	-0.1611	0.3323	0.4599
112.5	-0.0873	-0.1722	-0.1838	-0.0913	0.0452	0.1767	0.2664	0.2879	0.2239	0.0640	-0.1966	-0.5673	-0.9387	1.0720
135.0	-0.8268	-0.6666	-0.4689	-0.3073	-0.1707	-0.0582	0.0315	0.1001	0.1489	0.1803	0.1958	0.1956	0.1800	-0.5773
157.5	-0.5521	-0.5779	-0.5841	-0.5894	-0.5869	-0.5690	-0.5312	-0.4712	-0.3886	-0.2850	-0.1639	-0.0244	0.1027	-1.1926
180.0	-0.5249	-0.6093	-0.6839	-0.7474	-0.7973	-0.8214	-0.8096	-0.7551	-0.6546	-0.5098	-0.3253	-0.1047	0.0933	-1.5034

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	157.37	159.77	168.20	180.96	196.74	214.16	231.91	248.73	263.53	275.44	283.95	288.88	290.83	374.30

TABLE A2

R/r = 2.0 t/r = 0.01

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.1019	-0.1511	-0.1325	-0.1077	-0.0859	-0.0707	-0.0632	-0.0631	-0.0694	-0.0800	-0.0902	-0.0910	-0.0418	0.0255
45.0	-0.6043	-0.1858	0.2000	0.4661	0.6356	0.7275	0.7547	0.7241	0.6365	0.4887	0.2762	-0.0027	-0.2310	1.6232
67.5	-5.2359	-5.4477	-5.8638	-6.1634	-6.2681	-6.1636	-5.8752	-5.4544	-4.9707	-4.5105	-4.1810	-4.1259	-4.6294	-7.1961
90.0	1.8934	0.7551	-0.0323	-0.7301	-1.5225	-2.4645	-3.5177	-4.5739	-5.4736	-6.0194	-5.9830	-5.1040	-3.0601	-10.5240
112.5	5.4221	7.3746	8.3278	8.9691	9.4338	9.8053	10.1054	10.3046	10.3351	10.1012	9.4881	8.3965	6.5259	17.4862
135.0	-1.1928	-1.3987	-1.5354	-1.4605	-1.2007	-0.8141	-0.3493	0.1518	0.6552	1.1332	1.5646	1.9677	1.9857	0.7329
157.5	-0.6194	-0.5967	-0.5334	-0.4440	-0.2962	-0.1032	0.1204	0.3573	0.5887	0.7948	0.9627	1.0998	0.9621	0.7945
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

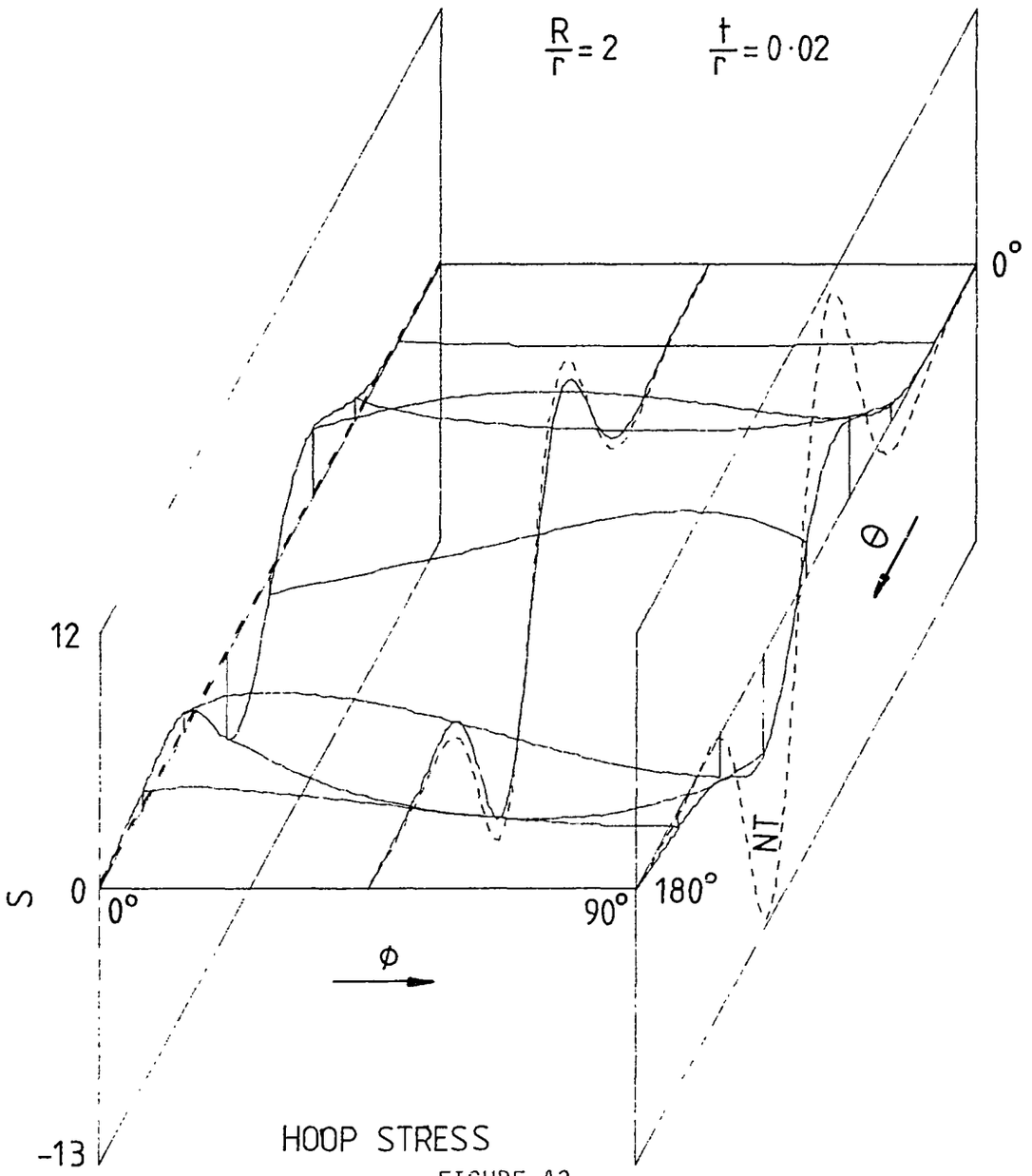
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2720	0.1922	0.1370	0.1023	0.0822	0.0715	0.0668	0.0666	0.0709	0.0807	0.0976	0.1216	0.1532	0.0837
45.0	0.7891	0.7307	0.6792	0.6647	0.6569	0.6406	0.6112	0.5709	0.5271	0.4920	0.4841	0.5296	0.6559	0.8400
67.5	-1.1907	-0.0558	0.3891	0.7096	0.9610	1.1715	1.3456	1.4690	1.5128	1.4367	1.1904	0.7168	-0.4937	3.4320
90.0	-3.0739	-4.5950	-5.7569	-6.5820	-7.1680	-7.5704	-7.8170	-7.9101	-7.8317	-7.5481	-7.0169	-6.1827	-5.0124	-12.8991
112.5	4.0218	5.4834	6.0975	6.3640	6.3707	6.1824	5.8503	5.4095	4.8803	4.2725	3.5882	2.8686	1.3424	8.4890
135.0	0.5123	-0.1962	-0.3123	-0.3446	-0.2344	-0.0145	0.2812	0.6191	0.9667	1.2936	1.5782	1.7965	1.4005	1.5605
157.5	-0.1241	-0.4928	-0.4268	-0.3493	-0.2239	-0.0548	0.1436	0.3555	0.5634	0.7500	0.9087	0.9963	0.7083	0.8044
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.5106	-0.4240	-0.3548	-0.3004	-0.2573	-0.2220	-0.1914	-0.1627	-0.1335	-0.1013	-0.0643	-0.0218	0.0251	-0.0743
22.5	-0.5184	-0.4209	-0.3508	-0.2986	-0.2587	-0.2264	-0.1985	-0.1723	-0.1451	-0.1141	-0.0760	-0.0275	0.0377	-0.0821
45.0	-0.2483	-0.2461	-0.2344	-0.2324	-0.2311	-0.2284	-0.2247	-0.2209	-0.2173	-0.2123	-0.2007	-0.1704	-0.1220	-0.0537
67.5	0.1396	-0.1511	-0.2704	-0.2792	-0.2306	-0.1628	-0.1033	-0.0729	-0.0877	-0.1619	-0.3109	-0.5550	-0.9420	-0.5177
90.0	-2.4547	-2.0521	-1.6940	-1.4151	-1.1823	-0.9664	-0.7405	-0.4821	-0.1753	0.1887	0.6112	1.0904	1.6094	-2.8612
112.5	0.6897	0.2394	-0.2875	-0.7294	-1.0712	-1.3021	-1.4233	-1.4426	-1.3700	-1.2147	-0.9829	-0.6766	-0.3313	-0.0824
135.0	-0.5073	-0.5435	-0.5588	-0.5368	-0.4926	-0.4368	-0.3763	-0.3167	-0.2633	-0.2215	-0.1955	-0.1960	-0.1994	-0.0503
157.5	-0.5474	-0.3904	-0.2238	-0.0872	0.0216	0.1000	0.1475	0.1651	0.1552	0.1208	0.0654	-0.0077	-0.0579	-0.1743
180.0	-0.5345	-0.3174	-0.0799	0.1127	0.2585	0.3547	0.4004	0.3984	0.3541	0.2752	0.1688	0.0489	-0.0346	-0.2245

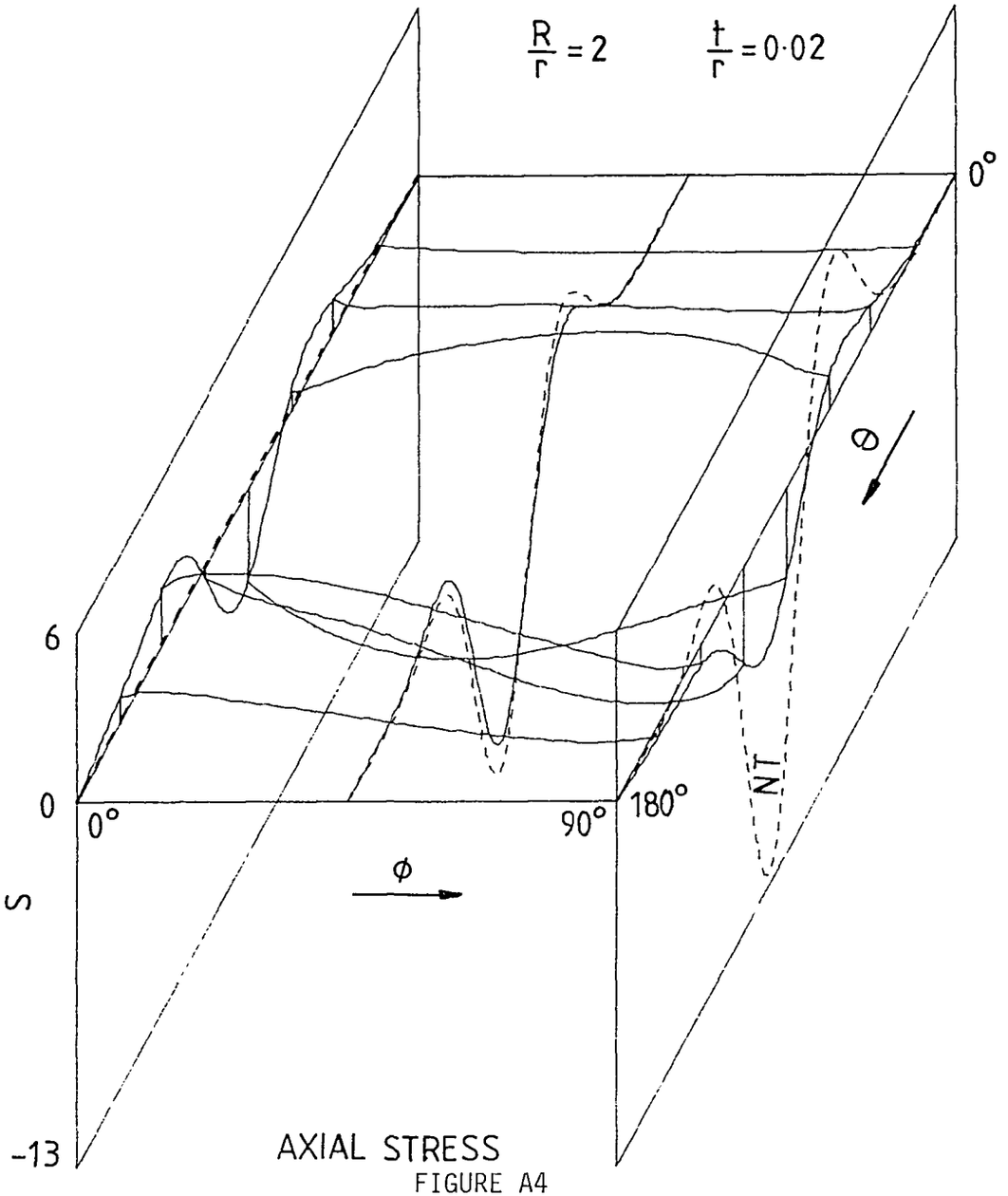
DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-157.37	-159.77	-168.20	-180.96	-196.74	-214.16	-231.91	-248.73	-263.53	-275.44	-283.95	-288.88	-290.83	-374.30



HOOP STRESS

FIGURE A3



AXIAL STRESS

FIGURE A4

TABLE A3

R/r = 2.0 t/r = 0.02

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0569	-0.0438	-0.0950	-0.1445	-0.1796	-0.1976	-0.1987	-0.1841	-0.1555	-0.1158	-0.0700	-0.0316	0.0162	-0.4231
45.0	1.0443	0.3918	0.0734	-0.1554	-0.3181	-0.4311	-0.5001	-0.5220	-0.4864	-0.3766	-0.1695	0.1576	0.8225	-1.3965
67.5	3.2289	3.8337	4.3288	4.6950	4.9197	5.0083	4.9750	4.8395	4.6259	4.3625	4.0835	3.8360	3.7136	7.2402
90.0	-0.8624	-0.3316	0.1068	0.5310	0.9837	1.4767	1.9863	2.4636	2.8412	3.0379	2.9584	2.4927	1.5766	5.0188
112.5	-3.9900	-5.0466	-5.9972	-6.6703	-7.1576	-7.4927	-7.6865	-7.7352	-7.6224	-7.3227	-6.8086	-5.9993	-4.6711	-12.4339
135.0	0.9252	1.7106	1.8337	1.7167	1.4255	0.9914	0.4609	-0.1171	-0.6972	-1.2398	-1.7021	-1.9886	-2.2053	-0.3627
157.5	0.8800	1.0634	0.9826	0.7954	0.5731	0.3321	0.0861	-0.1499	-0.3639	-0.5464	-0.6805	-0.7339	-0.8151	-0.1386
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2985	0.1451	0.0663	0.0195	-0.0074	-0.0225	-0.0299	-0.0310	-0.0250	-0.0090	0.0219	0.0743	0.1530	-0.0683
45.0	1.1029	0.8413	0.8659	0.8927	0.9075	0.9003	0.8694	0.8187	0.7558	0.6923	0.6455	0.6330	0.8824	1.2836
67.5	0.6531	1.1165	1.6524	2.0431	2.3395	2.5593	2.7050	2.7670	2.7260	2.5546	2.2179	1.6581	1.1370	5.1079
90.0	-3.3555	-4.5270	-5.3107	-5.8226	-6.0787	-6.1060	-5.9422	-5.6289	-5.2095	-4.7269	-4.2249	-3.7662	-3.2693	-8.2386
112.5	-0.4298	-1.1349	-1.5684	-1.9848	-2.4638	-2.9954	-3.5488	-4.0770	-4.5200	-4.8092	-4.8813	-4.6692	-3.5321	-6.8733
135.0	2.0051	2.5259	2.4727	2.3251	2.0509	1.6771	1.2441	0.7849	0.3251	-0.1203	-0.5499	-0.8778	-0.7174	1.3404
157.5	0.9115	1.1159	0.9295	0.7175	0.4965	0.2623	0.0281	-0.1910	-0.3837	-0.5458	-0.6723	-0.6882	-0.4510	-0.1306
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4063	-0.3803	-0.3525	-0.3307	-0.3090	-0.2860	-0.2622	-0.2389	-0.2175	-0.1989	-0.1826	-0.1654	-0.1520	-0.5015
22.5	-0.3394	-0.3641	-0.3580	-0.3446	-0.3241	-0.2990	-0.2721	-0.2461	-0.2236	-0.2073	-0.1991	-0.1988	-0.2282	-0.5371
45.0	-0.5247	-0.5427	-0.5346	-0.4928	-0.4351	-0.3702	-0.3040	-0.2407	-0.1843	-0.1396	-0.1140	-0.1211	-0.1626	-0.8059
67.5	-1.3973	-1.1751	-1.0218	-0.8906	-0.7708	-0.6506	-0.5200	-0.3707	-0.1963	0.0077	0.2444	0.5139	0.8609	-1.2764
90.0	-0.0508	-0.1662	-0.3159	-0.4679	-0.6026	-0.7032	-0.7573	-0.7568	-0.6956	-0.5685	-0.3684	-0.0922	0.2057	0.2366
112.5	0.2755	0.1612	0.0472	-0.0085	-0.0215	-0.0224	-0.0349	-0.0775	-0.1627	-0.2981	-0.4898	-0.7469	-0.9561	1.1056
135.0	-0.9266	-0.8065	-0.5938	-0.4023	-0.2296	-0.0793	0.0432	0.1352	0.1958	0.2250	0.2217	0.1993	0.1506	-0.5605
157.5	-0.5957	-0.6085	-0.6022	-0.5894	-0.5736	-0.5463	-0.5016	-0.4364	-0.3501	-0.2439	-0.1187	0.0257	0.1425	-1.1977
180.0	-0.5536	-0.6249	-0.6926	-0.7408	-0.7730	-0.7816	-0.7570	-0.6934	-0.5887	-0.4438	-0.2607	-0.0495	0.1260	-1.5064

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	78.74	81.94	87.64	94.88	103.00	111.41	119.52	126.80	132.77	137.08	139.54	140.18	139.73	192.73

TABLE A4

R/r = 2.0 t/r = 0.02

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.1088	-0.0759	0.0124	0.0792	0.1235	0.1464	0.1503	0.1370	0.1080	0.0648	0.0105	-0.0483	-0.0395	0.3471
45.0	-1.1333	-0.6144	-0.2643	-0.0259	0.1412	0.2592	0.3360	0.3686	0.3449	0.2449	0.0400	-0.3079	-0.8212	1.1333
67.5	-3.6285	-4.2955	-4.9422	-5.4060	-5.6917	-5.8085	-5.7740	-5.6103	-5.3424	-4.9986	-4.6129	-4.2222	-4.0081	-8.5820
90.0	0.8752	0.2729	-0.2675	-0.7656	-1.3004	-1.8851	-2.4913	-3.0602	-3.5096	-3.7406	-3.6408	-3.0633	-1.8969	-6.1803
112.5	4.6861	6.4307	7.4710	8.1800	8.6317	8.8673	8.9138	8.7811	8.4641	7.9450	7.2010	6.2390	4.8452	14.1262
135.0	-0.4379	-0.6332	-0.8083	-0.8298	-0.6532	-0.3148	0.1381	0.6555	1.1866	1.6827	2.1101	2.4430	2.3217	1.4920
157.5	-0.5856	-0.5877	-0.5123	-0.4214	-0.2799	-0.0937	0.1199	0.3433	0.5591	0.7537	0.9234	1.0475	0.9349	0.7584
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

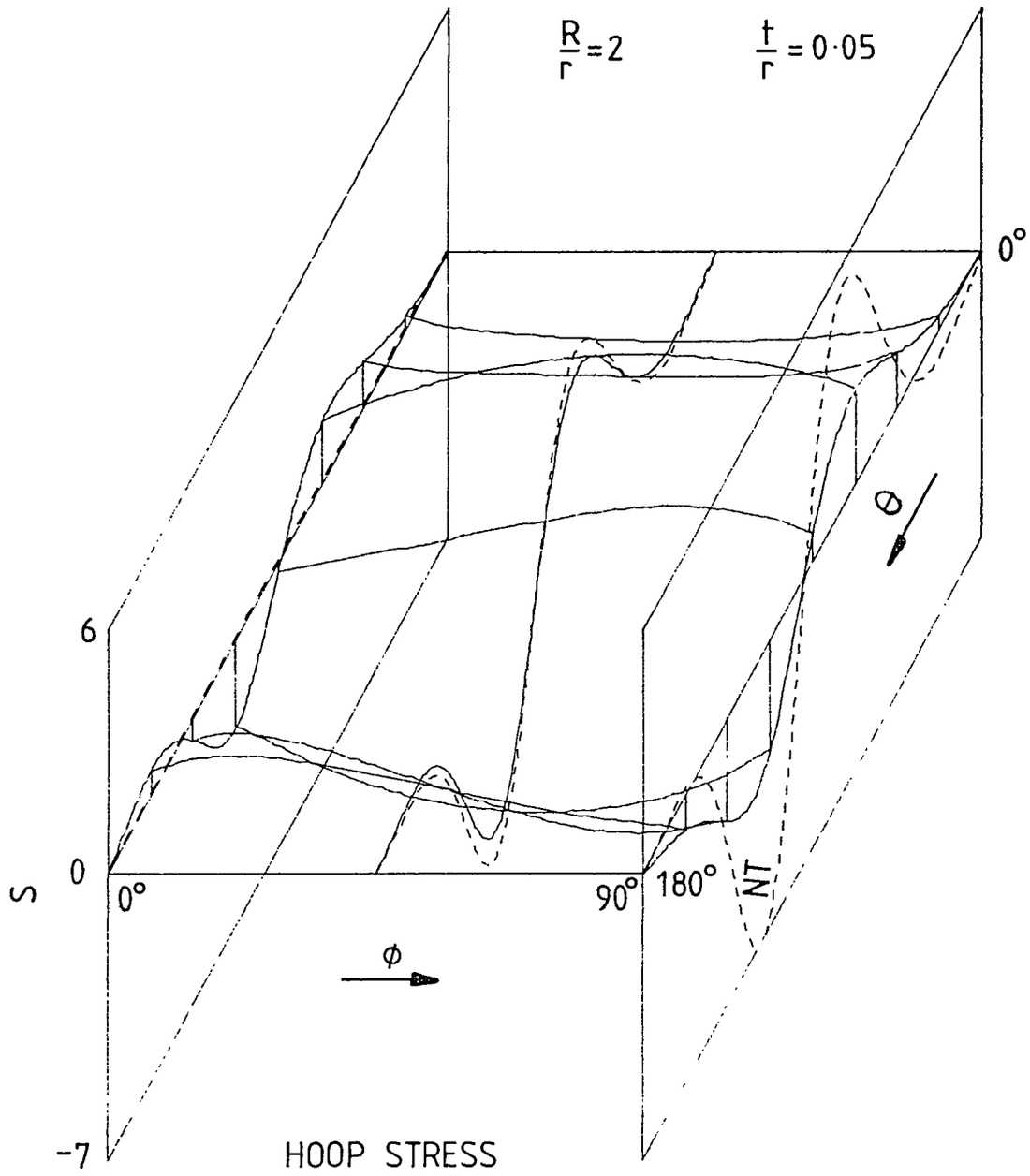
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3245	0.2188	0.1532	0.1163	0.0947	0.0806	0.0706	0.0640	0.0624	0.0693	0.0907	0.1342	0.2238	0.0789
45.0	0.4245	0.7292	0.8113	0.8924	0.9503	0.9809	0.9829	0.9572	0.9059	0.8326	0.7430	0.6574	0.4120	1.6529
67.5	-1.2343	-0.8009	-0.7167	-0.6362	-0.5483	-0.4473	-0.3400	-0.2420	-0.1754	-0.1680	-0.2543	-0.4639	-1.1983	0.2832
90.0	-1.6804	-2.4433	-3.1166	-3.6410	-4.0509	-4.3651	-4.5887	-4.7169	-4.7372	-4.6314	-4.3762	-3.9235	-3.3156	-7.5311
112.5	2.3186	3.1636	3.5031	3.6031	3.5539	3.3787	3.1040	2.7573	2.3642	1.9487	1.5443	1.1838	0.2664	4.3033
135.0	1.0841	0.6697	0.7054	0.7274	0.8184	0.9864	1.2091	1.4577	1.7004	1.9078	2.0591	2.0413	1.4584	2.7382
157.5	-0.0542	-0.4371	-0.4088	-0.3305	-0.2175	-0.0620	0.1239	0.3231	0.5199	0.7031	0.8580	0.8972	0.6720	0.7277
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.5290	-0.4235	-0.3493	-0.2947	-0.2541	-0.2224	-0.1957	-0.1703	-0.1434	-0.1114	-0.0711	-0.0200	0.0491	-0.0756
22.5	-0.4702	-0.3867	-0.3229	-0.2804	-0.2499	-0.2263	-0.2063	-0.1870	-0.1660	-0.1399	-0.1044	-0.0522	0.0194	-0.0681
45.0	-0.0660	-0.1610	-0.1883	-0.2038	-0.2096	-0.2109	-0.2122	-0.2172	-0.2286	-0.2480	-0.2753	-0.3051	-0.3857	-0.0411
67.5	-0.3737	-0.4636	-0.4838	-0.4374	-0.3594	-0.2726	-0.1933	-0.1337	-0.1035	-0.1121	-0.1710	-0.2981	-0.4864	-0.7768
90.0	-1.7741	-1.5983	-1.4121	-1.2432	-1.0792	-0.9056	-0.7110	-0.4863	-0.2256	0.0741	0.4138	0.7978	1.1916	-2.2646
112.5	0.0351	-0.2117	-0.5350	-0.8079	-1.0222	-1.1621	-1.2175	-1.1848	-1.0650	-0.8617	-0.5780	-0.2340	0.1159	-0.5737
135.0	-0.2112	-0.2983	-0.3997	-0.4660	-0.4914	-0.4889	-0.4687	-0.4400	-0.4111	-0.3886	-0.3796	-0.3959	-0.3759	0.0864
157.5	-0.5649	-0.4256	-0.2565	-0.1174	-0.0072	0.0731	0.1223	0.1412	0.1320	0.0973	0.0389	-0.0313	-0.0776	-0.1750
180.0	-0.5405	-0.3382	-0.1037	0.0903	0.2337	0.3266	0.3695	0.3654	0.3198	0.2393	0.1331	0.0246	-0.0511	-0.2184

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-78.74	-81.94	-87.64	-94.88	-103.00	-111.41	-119.52	-126.80	-132.77	-137.08	-139.54	-140.18	-139.73	-192.73



HOOP STRESS

FIGURE A5

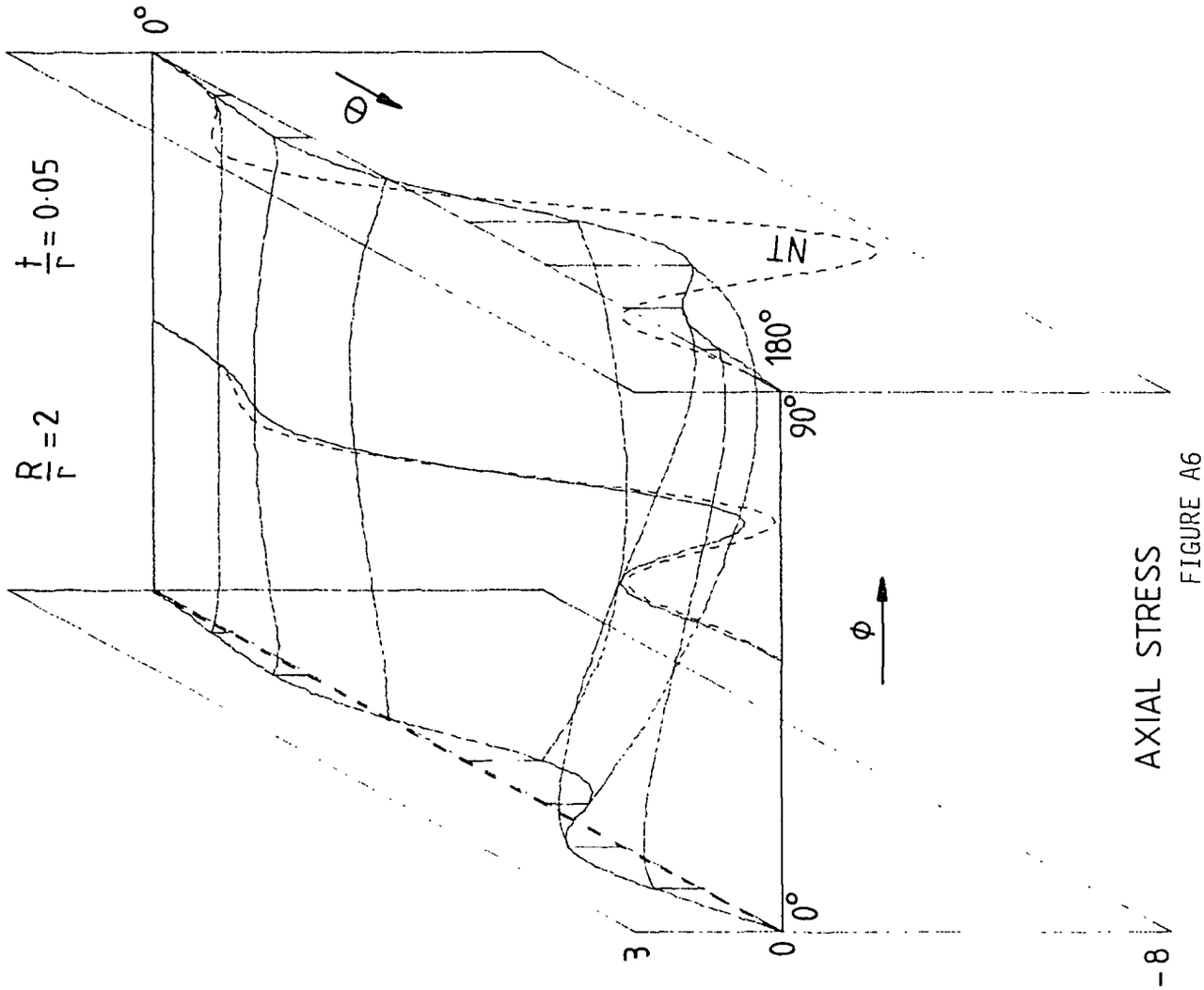


FIGURE A6

TABLE A5

R/r = 2.0 t/r = 0.05

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3536	0.0827	-0.0479	-0.1408	-0.2087	-0.2545	-0.2796	-0.2822	-0.2580	-0.1998	-0.0998	0.0582	0.3769	-0.6238
45.0	1.1371	0.9560	0.8847	0.8505	0.8222	0.7953	0.7701	0.7517	0.7500	0.7790	0.8563	1.0265	1.3702	0.9396
67.5	1.5625	2.0287	2.3704	2.6651	2.8978	3.0689	3.1779	3.2228	3.2011	3.1096	2.9446	2.7213	2.3458	5.0996
90.0	-0.2124	0.0268	0.2164	0.4203	0.6342	0.8500	1.0554	1.2313	1.3529	1.3898	1.3104	1.0970	0.7154	2.1334
112.5	-2.1238	-2.6259	-3.1419	-3.5514	-3.8558	-4.0666	-4.1874	-4.2177	-4.1564	-4.0000	-3.7317	-3.2956	-2.6471	-6.6493
135.0	-0.5475	-0.3696	-0.5246	-0.8080	-1.1461	-1.5129	-1.8856	-2.2367	-2.5355	-2.7458	-2.8192	-2.7099	-2.5248	-3.3757
157.5	0.6311	0.9121	0.9759	0.8963	0.7379	0.5336	0.3023	0.0606	-0.1750	-0.3855	-0.5516	-0.6742	-0.8317	0.2045
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.4332	0.2635	0.2619	0.2628	0.2637	0.2607	0.2520	0.2381	0.2208	0.2037	0.1915	0.1860	0.3413	0.4115
45.0	0.7532	0.7018	0.8475	0.9665	1.0560	1.1160	1.1442	1.1382	1.0953	1.0134	0.8864	0.7114	0.7184	1.9898
67.5	0.0377	0.0890	0.2313	0.3716	0.4998	0.6166	0.7139	0.7785	0.7935	0.7383	0.5837	0.3159	0.0416	1.5867
90.0	-1.5430	-2.1608	-2.6208	-2.9389	-3.1523	-3.2724	-3.3091	-3.2736	-3.1772	-3.0328	-2.8557	-2.6303	-2.2881	-4.9780
112.5	-0.8794	-1.5792	-2.1789	-2.6855	-3.1403	-3.5482	-3.8957	-4.1623	-4.3249	-4.3609	-4.2416	-3.8808	-3.0108	-6.3998
135.0	1.1677	1.3378	1.2108	1.0033	0.7272	0.3873	0.0053	-0.3910	-0.7759	-1.1261	-1.4013	-1.4891	-1.2054	-0.2702
157.5	1.0020	1.2150	1.1294	0.9610	0.7637	0.5467	0.3188	0.0916	-0.1238	-0.3150	-0.4539	-0.4843	-0.3854	0.3056
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.3101	-0.3388	-0.3407	-0.3311	-0.3153	-0.2951	-0.2735	-0.2540	-0.2399	-0.2347	-0.2414	-0.2662	-0.3287	-0.5022
22.5	-0.4026	-0.4089	-0.4046	-0.3841	-0.3558	-0.3229	-0.2884	-0.2555	-0.2272	-0.2072	-0.1994	-0.2138	-0.2457	-0.5921
45.0	-0.7427	-0.6705	-0.6229	-0.5650	-0.5006	-0.4312	-0.3574	-0.2795	-0.1984	-0.1154	-0.0335	0.0416	0.1506	-0.8515
67.5	-0.9644	-0.8703	-0.7952	-0.7308	-0.6630	-0.5857	-0.4933	-0.3810	-0.2448	-0.0809	0.1139	0.3478	0.6175	-0.8903
90.0	-0.3064	-0.3541	-0.4091	-0.4614	-0.4983	-0.5155	-0.5100	-0.4788	-0.4189	-0.3280	-0.2059	-0.0539	0.1043	0.0071
112.5	0.1338	0.0664	-0.0116	-0.0811	-0.1350	-0.1792	-0.2223	-0.2709	-0.3303	-0.4051	-0.5000	-0.6083	-0.6667	0.7478
135.0	-0.5838	-0.5561	-0.4595	-0.3601	-0.2667	-0.1818	-0.1107	-0.0591	-0.0316	-0.0308	-0.0526	-0.0796	-0.1187	-0.2596
157.5	-0.7530	-0.7549	-0.7197	-0.6638	-0.5998	-0.5282	-0.4461	-0.3517	-0.2445	-0.1243	0.0087	0.1441	0.2314	-1.2487
180.0	-0.6453	-0.6875	-0.7283	-0.7457	-0.7418	-0.7159	-0.6636	-0.5808	-0.4652	-0.3170	-0.1416	0.0410	0.1833	-1.5163

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	29.206	32.047	35.412	39.022	42.598	45.924	48.802	51.055	52.532	53.126	52.795	51.630	49.917	78.887

TABLE A6

R/r = 2.0 t/r = 0.05

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.3779	-0.1518	-0.0134	0.0895	0.1614	0.2102	0.2389	0.2460	0.2268	0.1732	0.0729	-0.0802	-0.3362	0.5407
45.0	-1.2988	-1.1280	-1.0938	-1.0705	-1.0507	-1.0265	-0.9966	-0.9660	-0.9447	-0.9481	-0.9968	-1.1074	-1.4220	-1.3483
67.5	-1.8904	-2.3495	-2.8114	-3.1789	-3.4639	-3.6703	-3.7966	-3.8390	-3.7927	-3.6518	-3.4062	-3.0360	-2.6535	-6.1898
90.0	0.1595	-0.0638	-0.3389	-0.6176	-0.9016	-1.1887	-1.4629	-1.6984	-1.8628	-1.9174	-1.9134	-1.4946	-0.9889	-2.9106
112.5	2.5919	3.4371	4.0076	4.4039	4.6668	4.8082	4.8345	4.7510	4.5627	4.2757	3.9008	3.4376	2.7669	7.6378
135.0	0.9985	1.3205	1.5645	1.7957	2.0566	2.3455	2.6402	2.9111	3.1279	3.2639	3.2956	3.1702	2.6900	4.6581
157.5	-0.3841	-0.4562	-0.4614	-0.4301	-0.3444	-0.2019	-0.0152	0.1978	0.4197	0.6364	0.8315	0.9616	0.9237	0.4339
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

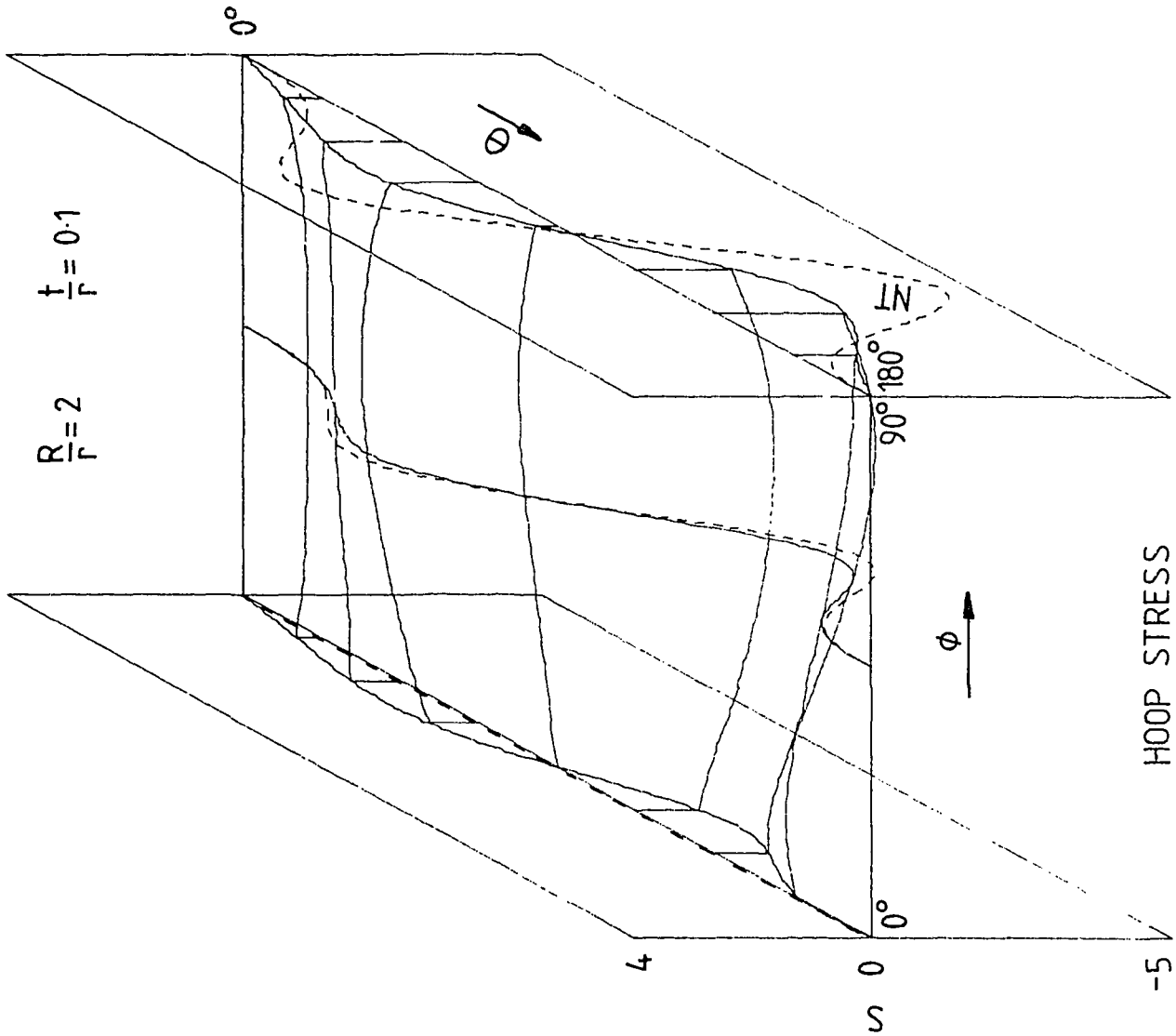
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.1754	0.2988	0.3031	0.3253	0.3452	0.3577	0.3612	0.3548	0.3386	0.3132	0.2821	0.2625	0.1219	0.6278
45.0	-0.0553	0.2452	0.3089	0.3717	0.4275	0.4701	0.4958	0.5005	0.4790	0.4256	0.3374	0.2100	-0.2196	0.9977
67.5	-0.7501	-0.7298	-0.8128	-0.8878	-0.9356	-0.9626	-0.9741	-0.9765	-0.9775	-0.9859	-1.0071	-1.0720	-1.3265	-1.2823
90.0	-0.6671	-0.9748	-1.2783	-1.5687	-1.8197	-2.0306	-2.2000	-2.3229	-2.3914	-2.3937	-2.3111	-2.1466	-1.9361	-3.5224
112.5	0.8636	1.0807	1.1577	1.1196	1.0258	0.9002	0.7530	0.5937	0.4343	0.2917	0.1804	0.0517	-0.3623	1.1265
135.0	1.2094	1.2437	1.4545	1.6146	1.7366	1.8443	1.9400	2.0156	2.0608	2.0632	1.9870	1.7156	1.0775	3.3502
157.5	0.2593	-0.0370	-0.0469	0.0210	0.1161	0.2358	0.3775	0.5314	0.6848	0.8190	0.8969	0.8558	0.6772	0.9204
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.3338	-0.3629	-0.2948	-0.2558	-0.2311	-0.2145	-0.2020	-0.1905	-0.1771	-0.1579	-0.1271	-0.0718	-0.0177	-0.0397
22.5	-0.3187	-0.2988	-0.2610	-0.2371	-0.2212	-0.2104	-0.2033	-0.1985	-0.1949	-0.1904	-0.1815	-0.1616	-0.1646	-0.0356
45.0	-0.2045	-0.2541	-0.2692	-0.2616	-0.2467	-0.2303	-0.2170	-0.2101	-0.2122	-0.2261	-0.2543	-0.3069	-0.3951	-0.1897
67.5	-0.6360	-0.6332	-0.6163	-0.5627	-0.4915	-0.4122	-0.3308	-0.2520	-0.1801	-0.1189	-0.0740	-0.0564	-0.0328	-0.8841
90.0	-1.1828	-1.1554	-1.1067	-1.0330	-0.9349	-0.8117	-0.6612	-0.4821	-0.2742	-0.0371	0.2281	0.5168	0.7923	-1.6513
112.5	-0.5400	-0.6488	-0.7857	-0.8876	-0.9420	-0.9450	-0.8935	-0.7859	-0.6227	-0.4065	-0.1469	0.1317	0.3980	-0.9664
135.0	-0.0687	-0.1417	-0.2595	-0.3722	-0.4561	-0.5091	-0.5348	-0.5376	-0.5228	-0.4978	-0.4730	-0.4491	-0.3708	0.0475
157.5	-0.4549	-0.3606	-0.2340	-0.1272	-0.0461	0.0099	0.0405	0.0451	0.0238	-0.0217	-0.0847	-0.1456	-0.1824	-0.0906
180.0	-0.5482	-0.3787	-0.1682	0.0184	0.1588	0.2492	0.2913	0.2886	0.2463	0.1727	0.0823	-0.0035	-0.0717	-0.2137

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-29.206	-32.047	-35.412	-39.022	-42.598	-45.924	-48.802	-51.055	-52.532	-53.126	-52.795	-51.630	-49.917	-78.887



HOOP STRESS
FIGURE A7

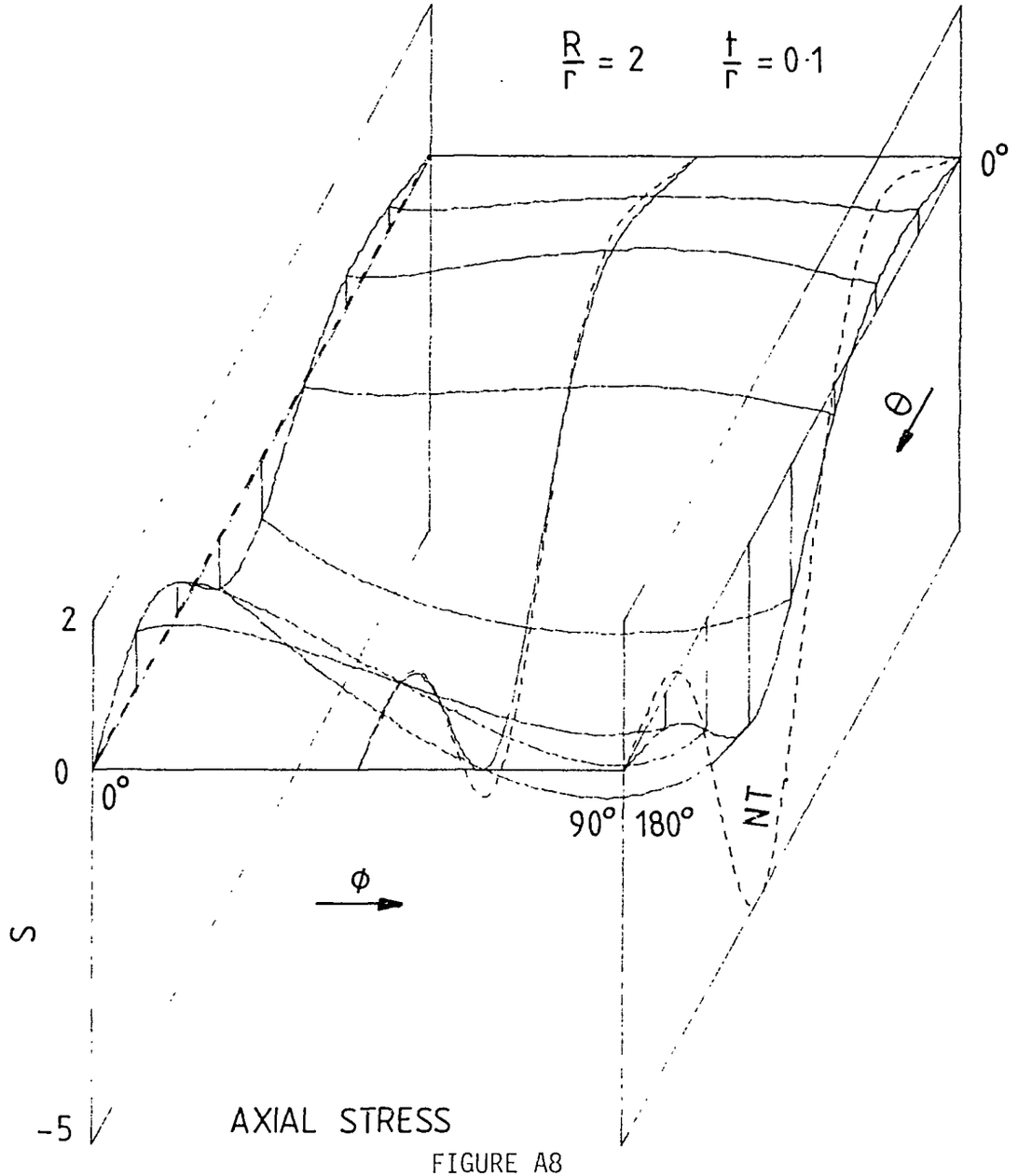


FIGURE A8

TABLE A7

R/r = 2.0 t/r = 0.1

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.4324	0.3381	0.2861	0.2658	0.2546	0.2468	0.2427	0.2444	0.2557	0.2827	0.3382	0.4535	0.6312	0.3227
45.0	0.8469	0.8852	0.9190	0.9778	1.0354	1.0824	1.1173	1.1408	1.1555	1.1666	1.1885	1.2523	1.3005	1.7440
67.5	0.8563	1.1229	1.3129	1.4949	1.6603	1.7990	1.9046	1.9714	1.9935	1.9659	1.8896	1.7644	1.4893	3.1096
90.0	0.0021	0.1342	0.2152	0.2972	0.3871	0.4773	0.5591	0.6232	0.6596	0.6592	0.6175	0.5282	0.3581	0.9763
112.5	-1.0659	-1.2703	-1.5263	-1.7678	-1.9710	-2.1300	-2.2428	-2.3069	-2.3181	-2.2681	-2.1413	-1.9169	-1.5966	-3.6251
135.0	-0.8858	-0.9504	-1.1750	-1.4659	-1.7710	-2.0625	-2.3213	-2.5293	-2.6667	-2.7103	-2.6362	-2.4360	-2.1707	-3.7593
157.5	-0.0346	0.1125	0.1184	0.0295	-0.1142	-0.2858	-0.4664	-0.6404	-0.7927	-0.9090	-0.9803	-1.0160	-1.0643	-0.7491
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3460	0.2975	0.3407	0.3925	0.4336	0.4627	0.4789	0.4805	0.4654	0.4304	0.3725	0.3098	0.3194	0.8353
45.0	0.4311	0.4131	0.4966	0.5960	0.6806	0.7459	0.7883	0.8024	0.7813	0.7154	0.5963	0.4477	0.3382	1.4152
67.5	-0.0276	-0.1144	-0.1380	-0.1179	-0.0860	-0.0523	-0.0240	-0.0095	-0.0193	-0.0663	-0.1583	-0.2722	-0.4046	0.1419
90.0	-0.7556	-1.1545	-1.4969	-1.7561	-1.9540	-2.1020	-2.2044	-2.2642	-2.2838	-2.2649	-2.1985	-2.0500	-1.8076	-3.4377
112.5	-0.6366	-1.1409	-1.6366	-2.0791	-2.4689	-2.8066	-3.0853	-3.2939	-3.4192	-3.4441	-3.3385	-3.0426	-2.4600	-4.8783
135.0	0.4574	0.3355	0.0704	-0.2379	-0.5619	-0.8897	-1.2080	-1.4999	-1.7466	-1.9241	-1.9936	-1.8885	-1.5246	-1.8125
157.5	0.8024	0.9128	0.8453	0.7037	0.5269	0.3301	0.1233	-0.0826	-0.2748	-0.4358	-0.5396	-0.5536	-0.4700	0.2133
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4028	-0.4019	-0.4053	-0.3894	-0.3630	-0.3316	-0.2983	-0.2664	-0.2396	-0.2224	-0.2233	-0.2549	-0.2886	-0.5818
22.5	-0.4948	-0.4739	-0.4630	-0.4381	-0.4036	-0.3635	-0.3202	-0.2761	-0.2340	-0.1975	-0.1731	-0.1677	-0.1522	-0.6461
45.0	-0.6913	-0.6372	-0.5954	-0.5525	-0.5025	-0.4448	-0.3797	-0.3072	-0.2278	-0.1422	-0.0516	0.0492	0.1733	-0.7599
67.5	-0.7342	-0.6915	-0.6462	-0.6069	-0.5620	-0.5063	-0.4374	-0.3533	-0.2522	-0.1323	0.0101	0.1829	0.3649	-0.6625
90.0	-0.4130	-0.4278	-0.4349	-0.4418	-0.4421	-0.4312	-0.4072	-0.3691	-0.3159	-0.2466	-0.1593	-0.0536	0.0575	-0.1240
112.5	-0.1092	-0.1432	-0.1743	-0.2036	-0.2301	-0.2535	-0.2754	-0.2977	-0.3225	-0.3510	-0.3817	-0.4078	-0.4027	0.3756
135.0	-0.3754	-0.3856	-0.3626	-0.3314	-0.2998	-0.2704	-0.2456	-0.2280	-0.2195	-0.2200	-0.2252	-0.2275	-0.2304	-0.1195
157.5	-0.7548	-0.7666	-0.7400	-0.6875	-0.6191	-0.5388	-0.4478	-0.3468	-0.2364	-0.1175	0.0062	0.1217	0.1923	-1.1652
180.0	-0.8238	-0.8466	-0.8487	-0.8217	-0.7690	-0.6933	-0.5951	-0.4738	-0.3301	-0.1672	0.0057	0.1677	0.2830	-1.5872

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	12.299	14.023	15.871	17.773	19.595	21.218	22.542	23.480	23.962	23.939	23.405	22.413	21.029	36.739

TABLE A8

R/r = 2.0 t/r = 0.1

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.5053	-0.3805	-0.3460	-0.3296	-0.3185	-0.3097	-0.3023	-0.2980	-0.3007	-0.3163	-0.3528	-0.4304	-0.6391	-0.4459
45.0	-1.0397	-1.0234	-1.1055	-1.1914	-1.2644	-1.3206	-1.3575	-1.3746	-1.3737	-1.3580	-1.3314	-1.3146	-1.4226	-2.1875
67.5	-1.1240	-1.3475	-1.6134	-1.8590	-2.0712	-2.2452	-2.3743	-2.4500	-2.4634	-2.4034	-2.2565	-2.0225	-1.7719	-3.9364
90.0	-0.0964	-0.1770	-0.3049	-0.4516	-0.6021	-0.7487	-0.8815	-0.9876	-1.0516	-1.0546	-0.9761	-0.8099	-0.5898	-1.5186
112.5	1.3220	1.7230	2.0233	2.2460	2.4082	2.5149	2.5664	2.5626	2.5047	2.3958	2.2369	2.0129	1.6689	4.2175
135.0	1.2385	1.6316	1.9645	2.2578	2.5260	2.7676	2.9708	3.1198	3.1990	3.1943	3.0890	2.8477	2.3842	4.9145
157.5	0.2121	0.2832	0.3638	0.4538	0.5629	0.6926	0.8359	0.9814	1.1168	1.2293	1.3017	1.3020	1.1722	1.4382
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

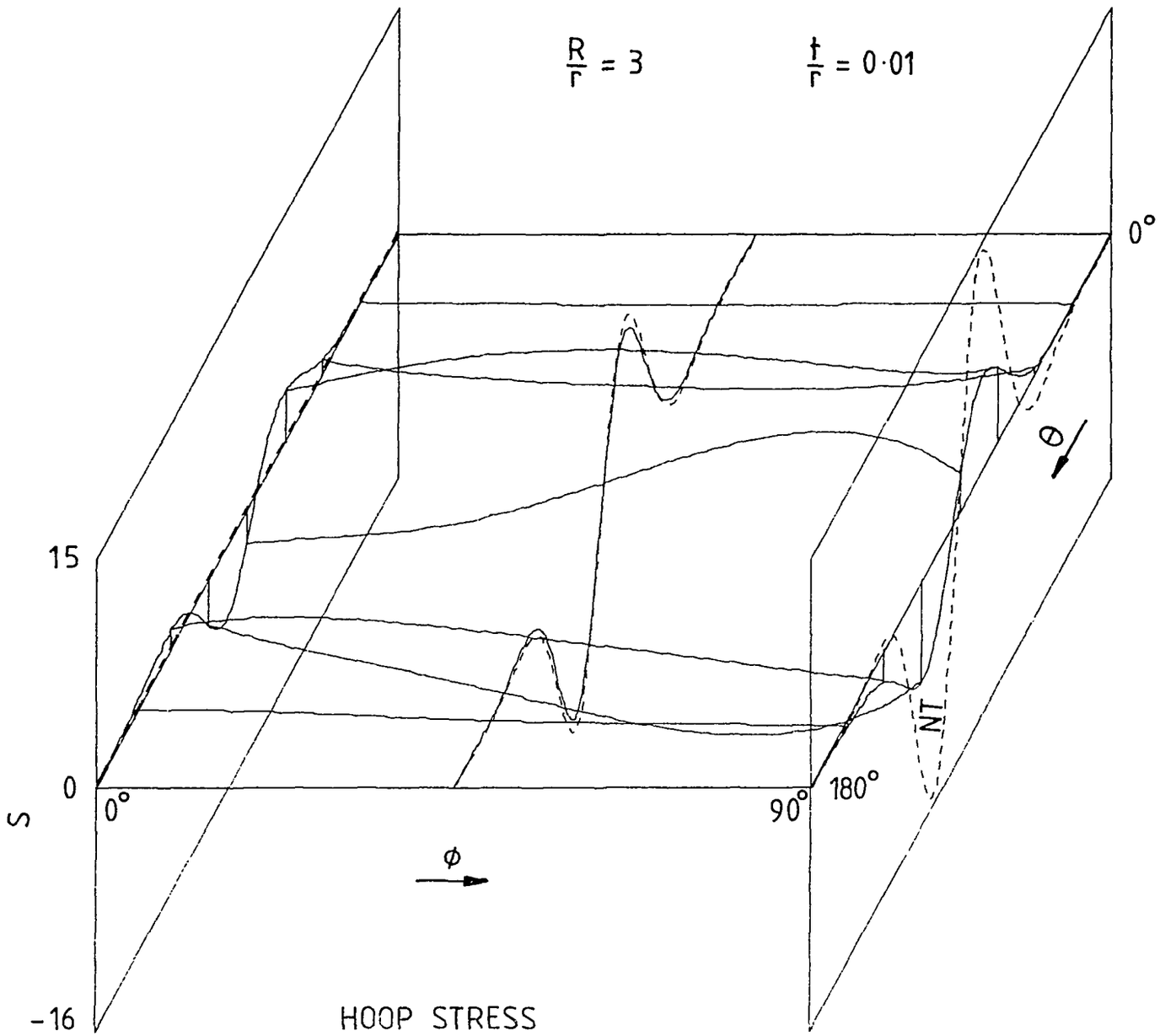
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.0148	0.1225	0.1594	0.1834	0.2069	0.2256	0.2363	0.2364	0.2235	0.1956	0.1510	0.0646	-0.1645	0.4515
45.0	-0.1817	-0.0395	-0.0127	-0.0095	-0.0032	0.0025	0.0026	-0.0073	-0.0315	-0.0730	-0.1381	-0.2723	-0.5754	0.1310
67.5	-0.4095	-0.4578	-0.5381	-0.6359	-0.7214	-0.7916	-0.8494	-0.8973	-0.9363	-0.9665	-0.9939	-1.0577	-1.1595	-1.2383
90.0	-0.2805	-0.4458	-0.6012	-0.7729	-0.9386	-1.0863	-1.2116	-1.3103	-1.3765	-1.4032	-1.3905	-1.3581	-1.2985	-1.8553
112.5	0.3777	0.4029	0.4105	0.3718	0.3032	0.2218	0.1377	0.0573	-0.0134	-0.0711	-0.1257	-0.2210	-0.4571	0.3228
135.0	0.8106	0.8912	1.0509	1.1892	1.2926	1.3680	1.4208	1.4508	1.4534	1.4150	1.3026	1.0516	0.5853	2.3904
157.5	0.4769	0.3975	0.4633	0.5696	0.6795	0.7843	0.8813	0.9655	1.0277	1.0512	1.0092	0.8712	0.6390	1.4732
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.2842	-0.2656	-0.2296	-0.2060	-0.1941	-0.1895	-0.1901	-0.1945	-0.2014	-0.2082	-0.2103	-0.2089	-0.2377	-0.0075
22.5	-0.2768	-0.2698	-0.2465	-0.2261	-0.2126	-0.2047	-0.2014	-0.2023	-0.2069	-0.2138	-0.2209	-0.2331	-0.2689	-0.0659
45.0	-0.3544	-0.3582	-0.3522	-0.3312	-0.3052	-0.2790	-0.2546	-0.2331	-0.2155	-0.2026	-0.1974	-0.2075	-0.2194	-0.3136
67.5	-0.6434	-0.6392	-0.6270	-0.5904	-0.5352	-0.4681	-0.3927	-0.3108	-0.2239	-0.1338	-0.0450	0.0403	0.1369	-0.8253
90.0	-0.9080	-0.9233	-0.9195	-0.8871	-0.8220	-0.7268	-0.6036	-0.4538	-0.2788	-0.0813	0.1343	0.3629	0.5757	-1.2883
112.5	-0.6816	-0.7451	-0.8090	-0.8453	-0.8415	-0.7947	-0.7059	-0.5771	-0.4122	-0.2176	-0.0034	0.2160	0.4198	-1.0205
135.0	-0.2589	-0.2947	-0.3555	-0.4157	-0.4593	-0.4800	-0.4775	-0.4545	-0.4159	-0.3681	-0.3170	-0.2597	-0.1682	-0.2154
157.5	-0.3016	-0.2340	-0.1558	-0.0944	-0.0551	-0.0373	-0.0397	-0.0614	-0.1007	-0.1539	-0.2123	-0.2594	-0.2777	0.0074
180.0	-0.4413	-0.3157	-0.1562	-0.0120	0.0959	0.1613	0.1846	0.1694	0.1219	0.0518	-0.0268	-0.0985	-0.1586	-0.1239

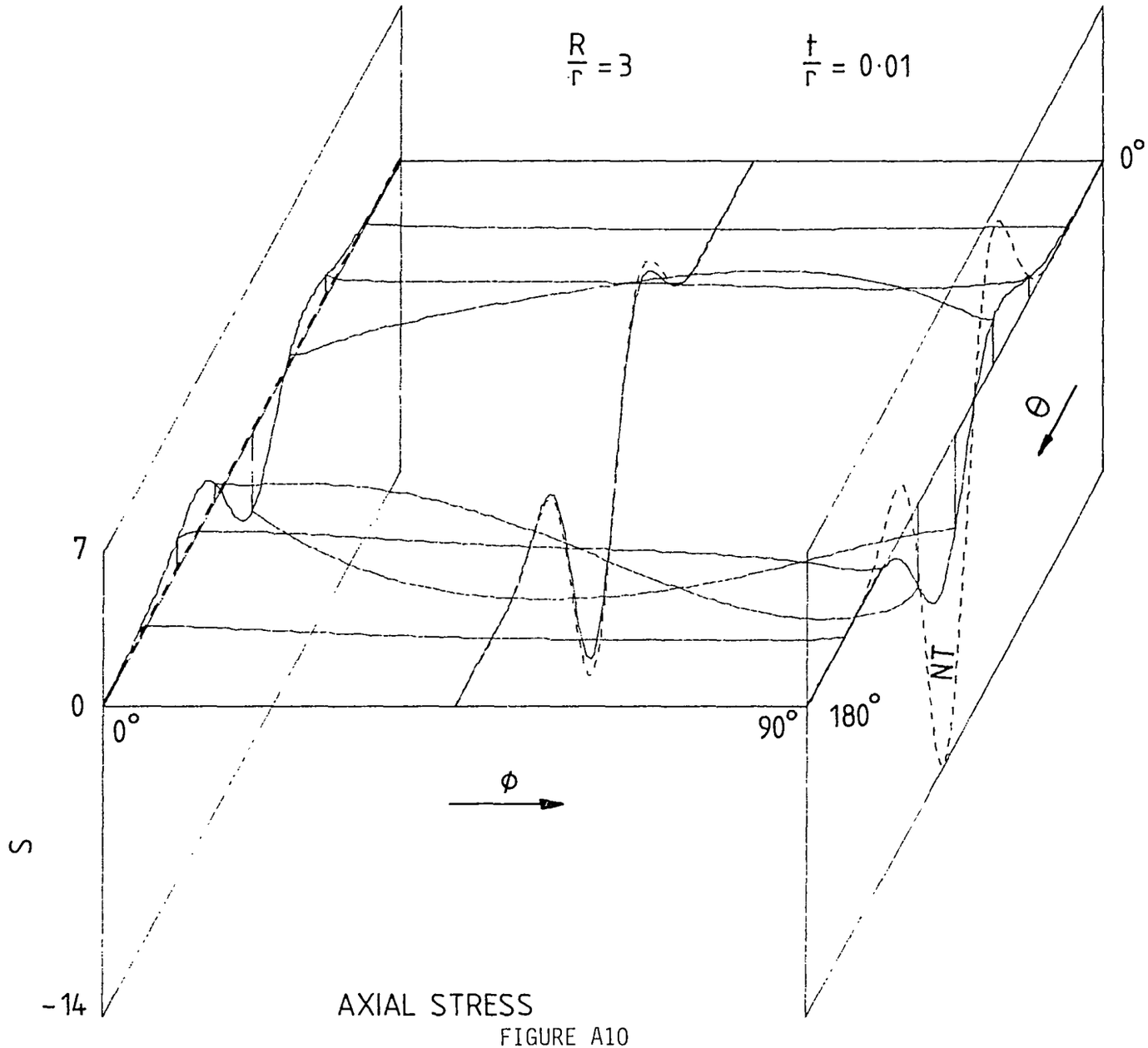
DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-12.299	-14.023	-15.871	-17.773	-19.595	-21.218	-22.542	-23.480	-23.962	-23.939	-23.405	-22.413	-21.029	-36.739



HOOP STRESS

FIGURE A9



AXIAL STRESS

FIGURE A10

TABLE A9

R/r = 3.0 t/r = 0.01

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0772	0.0470	0.0124	-0.0254	-0.0532	-0.0675	-0.0682	-0.0566	-0.0352	-0.0086	0.0137	0.0116	-0.0332	-0.1702
45.0	0.9451	0.2586	-0.1350	-0.4148	-0.6278	-0.7987	-0.9321	-1.0152	-1.0222	-0.9193	-0.6707	-0.2495	0.4578	-1.7189
67.5	3.3984	4.2802	5.0465	5.6068	5.9450	6.0775	6.0312	5.8355	5.5247	5.1486	4.7915	4.6003	4.9291	8.7159
90.0	-2.1520	-1.8348	-1.5711	-1.1187	-0.3734	0.6549	1.8791	3.1573	4.3050	5.0984	5.2728	4.5172	2.4809	4.4266
112.5	-2.9757	-4.0642	-4.9430	-5.7308	-6.5510	-7.4422	-8.3682	-9.2315	-9.8864	-10.1541	-9.8420	-8.7716	-6.5819	-13.4215
135.0	1.3148	1.9614	2.0905	1.9654	1.6646	1.2594	0.8028	0.3273	-0.1534	-0.6379	-1.1256	-1.6047	-2.0607	0.7076
157.5	0.6265	0.6543	0.5334	0.3810	0.2166	0.0597	-0.0748	-0.1782	-0.2498	-0.2958	-0.3330	-0.3778	-0.4863	-0.1053
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2606	0.1455	0.0838	0.0506	0.0342	0.0270	0.0252	0.0277	0.0359	0.0526	0.0815	0.1241	0.1629	0.0396
45.0	0.9800	0.7089	0.6844	0.6910	0.6863	0.6545	0.5951	0.5177	0.4398	0.3879	0.4005	0.5355	0.9454	0.8418
67.5	0.4603	1.2601	1.9650	2.5195	3.0009	3.4407	3.8311	4.1319	4.2789	4.1938	3.7958	3.0151	2.0955	6.3149
90.0	-3.4868	-5.0964	-6.2329	-6.9667	-7.3579	-7.4728	-7.3649	-7.0698	-6.6107	-6.0140	-5.3332	-4.6741	-4.2001	-10.5093
112.5	0.8541	0.8319	0.8043	0.5015	-0.0863	-0.9170	-1.9135	-2.9753	-3.9833	-4.7973	-5.2519	-5.1556	-3.8454	-3.9508
135.0	1.4777	1.7342	1.6718	1.5190	1.3434	1.1864	1.0644	0.9721	0.8854	0.7651	0.5636	0.2283	0.0466	1.6324
157.5	0.4991	0.5158	0.3990	0.2776	0.1643	0.0705	0.0035	-0.0349	-0.0484	-0.0450	-0.0366	-0.0430	0.0491	0.1177
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4499	-0.4210	-0.3983	-0.3769	-0.3524	-0.3241	-0.2929	-0.2607	-0.2291	-0.1991	-0.1702	-0.1395	-0.1051	-0.5154
22.5	-0.4099	-0.4155	-0.4084	-0.3928	-0.3687	-0.3384	-0.3044	-0.2696	-0.2367	-0.2081	-0.1849	-0.1652	-0.1500	-0.5420
45.0	-0.4689	-0.5350	-0.5388	-0.5064	-0.4560	-0.3969	-0.3346	-0.2733	-0.2180	-0.1762	-0.1595	-0.1850	-0.2873	-0.7079
67.5	-1.2642	-1.0632	-0.9433	-0.8647	-0.8044	-0.7395	-0.6494	-0.5182	-0.3354	-0.0982	0.1871	0.5010	0.8503	-1.0807
90.0	0.1570	0.0158	-0.1588	-0.3276	-0.4645	-0.5613	-0.6187	-0.6387	-0.6184	-0.5441	-0.3878	-0.1040	0.3106	0.2661
112.5	-0.2131	-0.2467	-0.1767	-0.0286	0.1402	0.2856	0.3754	0.3862	0.3008	0.1067	-0.2034	-0.6294	-1.0940	0.4008
135.0	-0.8034	-0.6687	-0.5271	-0.4121	-0.3216	-0.2495	-0.1875	-0.1269	-0.0604	0.0156	0.0978	0.1724	0.2123	-0.6680
157.5	-0.5344	-0.5653	-0.5971	-0.6269	-0.6429	-0.6368	-0.6034	-0.5406	-0.4482	-0.3281	-0.1830	-0.0173	0.1471	-0.9159
180.0	-0.5168	-0.5935	-0.6676	-0.7329	-0.7742	-0.7807	-0.7465	-0.6710	-0.5577	-0.4127	-0.2432	-0.0550	0.1270	-1.0295

PARAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	115.49	121.87	136.91	158.50	184.62	213.05	241.59	268.07	290.60	307.70	318.46	322.71	321.37	378.28

TABLE A10

R/r = 3.0 t/r = 0.01

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.1276	-0.1243	-0.0714	-0.0254	0.0055	0.0207	0.0218	0.0104	-0.0117	-0.0414	-0.0709	-0.0821	-0.0111	0.0963
45.0	-1.0021	-0.4032	0.0051	0.2851	0.4957	0.6668	0.8046	0.8957	0.9117	0.8137	0.5587	0.1075	-0.4815	1.5154
67.5	-3.6265	-4.5850	-5.4826	-6.1363	-6.5380	-6.7099	-6.6816	-6.4818	-6.1420	-5.7090	-5.2659	-4.9644	-5.1547	-9.7353
90.0	2.3076	1.9720	1.6969	1.2068	0.3827	-0.7660	-2.1412	-3.5822	-4.8790	-5.7760	-5.9711	-5.1099	-2.7540	-5.0099
112.5	3.3160	4.8794	5.8559	6.6777	7.4946	8.3626	9.2538	10.0696	10.6563	10.8227	10.3643	9.0910	6.7941	14.7163
135.0	-1.1427	-1.5955	-1.8086	-1.7360	-1.4546	-1.0360	-0.5385	-0.0034	0.5441	1.0884	1.6126	2.0845	2.2325	-0.1539
157.5	-0.5410	-0.5196	-0.4477	-0.3211	-0.1619	0.0094	0.1739	0.3175	0.4328	0.5207	0.5895	0.6554	0.6219	0.3776
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

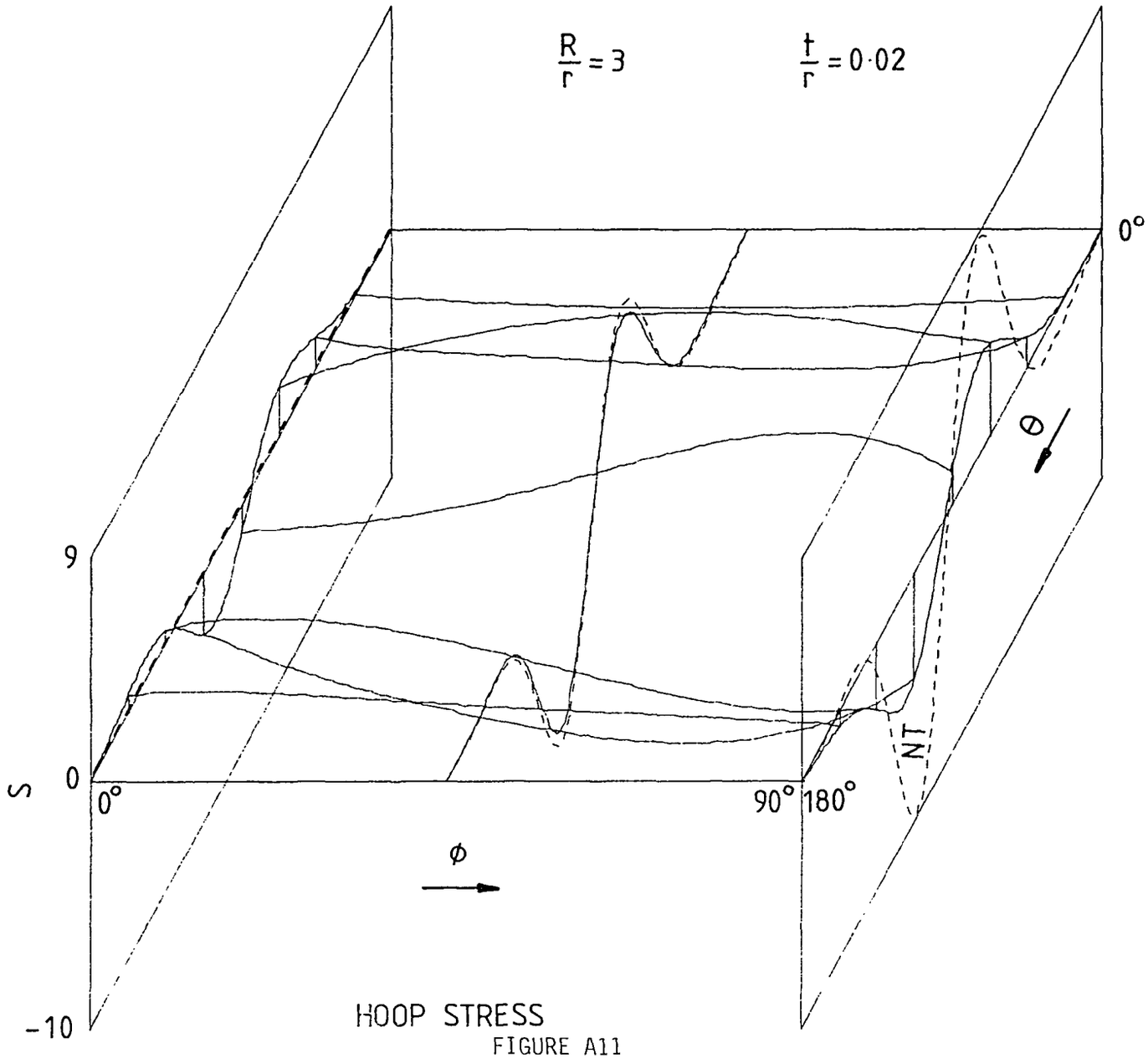
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2486	0.1527	0.0983	0.0722	0.0594	0.0517	0.0456	0.0411	0.0408	0.0498	0.0750	0.1242	0.2099	0.0752
45.0	0.4406	0.6508	0.7760	0.8880	0.9684	1.0124	1.0200	0.9937	0.9377	0.8610	0.7820	0.7371	0.7432	1.5993
67.5	-1.4788	-0.9984	-0.8434	-0.6886	-0.4779	-0.2005	0.1224	0.4466	0.7095	0.8322	0.7203	0.2613	-0.9930	0.7907
90.0	-1.4731	-2.6750	-3.6061	-4.3818	-5.0919	-5.7717	-6.4077	-6.9457	-7.3012	-7.3715	-7.0509	-6.2488	-4.8974	-10.1122
112.5	2.5691	3.5691	4.0478	4.2765	4.3267	4.2562	4.0987	3.8633	3.5408	3.1144	2.5763	1.9488	0.8259	5.9333
135.0	0.4723	0.0321	-0.1179	-0.1088	0.0473	0.3220	0.6780	1.0751	1.4717	1.8238	2.0819	2.1935	1.7786	1.5898
157.5	-0.0742	-0.2499	-0.2476	-0.1924	-0.0961	0.0257	0.1576	0.2861	0.4018	0.5010	0.5842	0.6595	0.5974	0.4209
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.5052	-0.4173	-0.3506	-0.3002	-0.2609	-0.2286	-0.2005	-0.1740	-0.1464	-0.1147	-0.0757	-0.0271	0.0303	-0.1920
22.5	-0.4949	-0.4048	-0.3423	-0.2977	-0.2631	-0.2344	-0.2090	-0.1850	-0.1600	-0.1305	-0.0912	-0.0354	0.0469	-0.2025
45.0	-0.2044	-0.2447	-0.2531	-0.2487	-0.2345	-0.2168	-0.2018	-0.1947	-0.1983	-0.2119	-0.2302	-0.2383	-0.2314	-0.1988
67.5	-0.4160	-0.5455	-0.5484	-0.4752	-0.3711	-0.2636	-0.1700	-0.1030	-0.0750	-0.1011	-0.2020	-0.4074	-0.7582	-0.7607
90.0	-1.5385	-1.3562	-1.2525	-1.2096	-1.1843	-1.1376	-1.0359	-0.8532	-0.5729	-0.1901	0.2861	0.8303	1.4024	-1.7926
112.5	0.2079	-0.0911	-0.3939	-0.6316	-0.7912	-0.8768	-0.9012	-0.8784	-0.8181	-0.7196	-0.5685	-0.3348	-0.0188	-0.2307
135.0	-0.4522	-0.4713	-0.4453	-0.3806	-0.2966	-0.2092	-0.1318	-0.0763	-0.0535	-0.0723	-0.1396	-0.2571	-0.3843	-0.1647
157.5	-0.5570	-0.4294	-0.3091	-0.2115	-0.1379	-0.0863	-0.0532	-0.0342	-0.0253	-0.0234	-0.0283	-0.0434	-0.0572	-0.3418
180.0	-0.5432	-0.3877	-0.2479	-0.1436	-0.0747	-0.0368	-0.0222	-0.0220	-0.0279	-0.0339	-0.0375	-0.0406	-0.0304	-0.3836

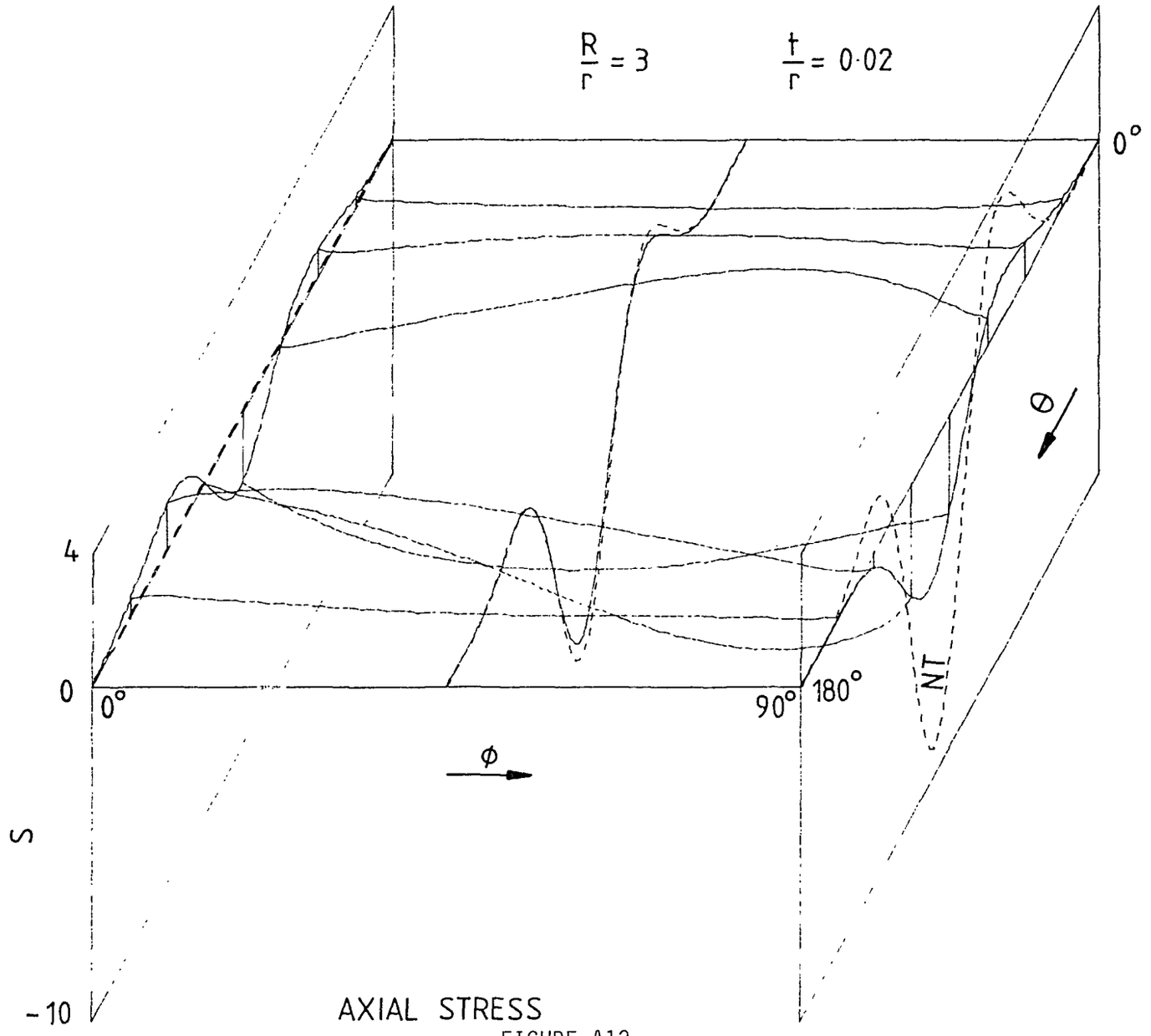
DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-115.49	-121.87	-136.91	-158.50	-184.62	-213.05	-241.59	-268.07	-290.60	-307.70	-318.46	-322.71	-321.37	-378.28



HOOP STRESS

FIGURE A11



AXIAL STRESS

FIGURE A12

TABLE A11

R/r = 3.0 t/r = 0.02

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2074	-0.0122	-0.1503	-0.2545	-0.3279	-0.3751	-0.3982	-0.3965	-0.3669	-0.3052	-0.2099	-0.0876	0.0777	-0.6920
45.0	1.2204	0.8187	0.6312	0.4924	0.3634	0.2300	0.0969	-0.0175	-0.0832	-0.0604	0.1010	0.4617	1.2274	-0.0363
67.5	2.0221	2.8489	3.5099	4.0377	4.4455	4.7422	4.9303	5.0054	4.9595	4.7874	4.4956	4.1136	3.7237	7.5629
90.0	-1.1035	-0.8955	-0.6732	-0.3512	0.1078	0.6884	1.3402	1.9879	2.5378	2.8812	2.8948	2.4318	1.3533	2.4541
112.5	-2.4374	-3.3994	-4.2005	-4.8623	-5.4380	-5.9448	-6.3716	-6.6817	-6.8197	-6.7207	-6.3216	-5.5783	-4.2482	-9.8090
135.0	0.5032	0.9484	0.9673	0.7794	0.4100	-0.0907	-0.6670	-1.2639	-1.8286	-2.3097	-2.6554	-2.8020	-2.6872	-1.3379
157.5	0.6950	0.8476	0.7969	0.6834	0.5346	0.3770	0.2287	0.0977	-0.0179	-0.1284	-0.2492	-0.3857	-0.5971	0.2965
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3443	0.1716	0.1056	0.0708	0.0474	0.0264	0.0057	-0.0129	-0.0240	-0.0188	0.0152	0.0963	0.2553	0.0152
45.0	0.8338	0.8213	0.9747	1.1044	1.1972	1.2493	1.2609	1.2343	1.1730	1.0845	0,9834	0.8988	1.0447	1.9981
67.5	-0.0811	0.2588	0.5999	0.9079	1.2196	1.5387	1.8456	2.1034	2.2617	2.2610	2.0342	1.5055	0.7896	3.1057
90.0	-2.0504	-3.0360	-3.7380	-4.2293	-4.5336	-4.6803	-4.6938	-4.5920	-4.3882	-4.0967	-3.7410	-3.3671	-3.0006	-6.9813
112.5	-0.0408	-0.5662	-0.9636	-1.4474	-2.0314	-2.6976	-3.4004	-4.0731	-4.6329	-4.9856	-5.0289	-4.6724	-3.4591	-5.4215
135.0	1.4106	1.7715	1.8476	1.7771	1.6004	1.3611	1.0892	0.8006	0.5002	0.1854	-0.1470	-0.5079	-0.5027	1.5641
157.5	0.5814	0.6238	0.5020	0.3798	0.2662	0.1768	0.1181	0.0883	0.0784	0.0732	0.0538	-0.0013	0.0359	0.2618
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.3998	-0.3966	-0.3860	-0.3718	-0.3510	-0.3249	-0.2957	-0.2663	-0.2397	-0.2180	-0.2019	-0.1885	-0.1811	-0.5112
22.5	-0.3940	-0.4187	-0.4166	-0.3996	-0.3720	-0.3379	-0.3011	-0.2653	-0.2341	-0.2114	-0.2014	-0.2070	-0.2443	-0.5537
45.0	-0.6626	-0.6450	-0.6127	-0.5626	-0.5035	-0.4382	-0.3676	-0.2927	-0.2157	-0.1417	-0.0795	-0.0456	-0.0480	-0.7704
67.5	-0.9998	-0.8767	-0.8081	-0.7656	-0.7281	-0.6784	-0.6026	-0.4902	-0.3341	-0.1300	0.1235	0.4249	0.7911	-0.8647
90.0	-0.0837	-0.1714	-0.2705	-0.3612	-0.4325	-0.4795	-0.5012	-0.4968	-0.4637	-0.3940	-0.2736	-0.0787	0.1686	0.0796
112.5	-0.0448	-0.0901	-0.0939	-0.0425	0.0275	0.0867	0.1120	0.0867	0.0008	-0.1492	-0.3610	-0.6301	-0.8885	0.3675
135.0	-0.7869	-0.6859	-0.5465	-0.4125	-0.2917	-0.1888	-0.1048	-0.0383	0.0122	0.0457	0.0577	0.0380	-0.0011	-0.5865
157.5	-0.6022	-0.6175	-0.6255	-0.6374	-0.6398	-0.6228	-0.5794	-0.5057	-0.4010	-0.2673	-0.1095	0.0668	0.2232	-0.9399
180.0	-0.5312	-0.6026	-0.6701	-0.7294	-0.7654	-0.7667	-0.7275	-0.6471	-0.5287	-0.3780	-0.2015	-0.0027	0.1791	-1.0314

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	57.39	63.80	73.55	85.62	99.17	113.23	126.74	138.66	148.02	154.08	156.40	155.02	150.81	197.27

TABLE A12

R/r = 3.0 t/r = 0.02

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.2296	-0.0535	0.1021	0.2124	0.2876	0.3356	0.3599	0.3599	0.3315	0.2690	0.1674	0.0286	-0.0825	0.6230
45.0	-1.3045	-0.9564	-0.7771	-0.6516	-0.5319	-0.4013	-0.2636	-0.1382	-0.0568	-0.0626	-0.2108	-0.5744	-1.2397	-0.2434
67.5	-2.2260	-3.0981	-3.8643	-4.4717	-4.9401	-5.2820	-5.4998	-5.5861	-5.5282	-5.3148	-4.9461	-4.4479	-3.9727	-8.4746
90.0	1.2011	0.9866	0.7396	0.3737	-0.1551	-0.8295	-1.5904	-2.3491	-2.9950	-3.3996	-3.4166	-2.8778	-1.5721	-2.8933
112.5	2.7599	4.0545	4.9323	5.6279	6.1981	6.6718	7.0448	7.2839	7.3340	7.1291	6.6054	5.7195	4.4119	10.8135
135.0	-0.3450	-0.5054	-0.5792	-0.4238	-0.0676	0.4419	1.0456	1.6800	2.2802	2.7812	3.1151	3.2237	2.8346	1.9971
157.5	-0.6078	-0.6892	-0.6896	-0.6059	-0.4649	-0.2947	-0.1178	0.0517	0.2087	0.3564	0.5022	0.6626	0.7076	-0.0281
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

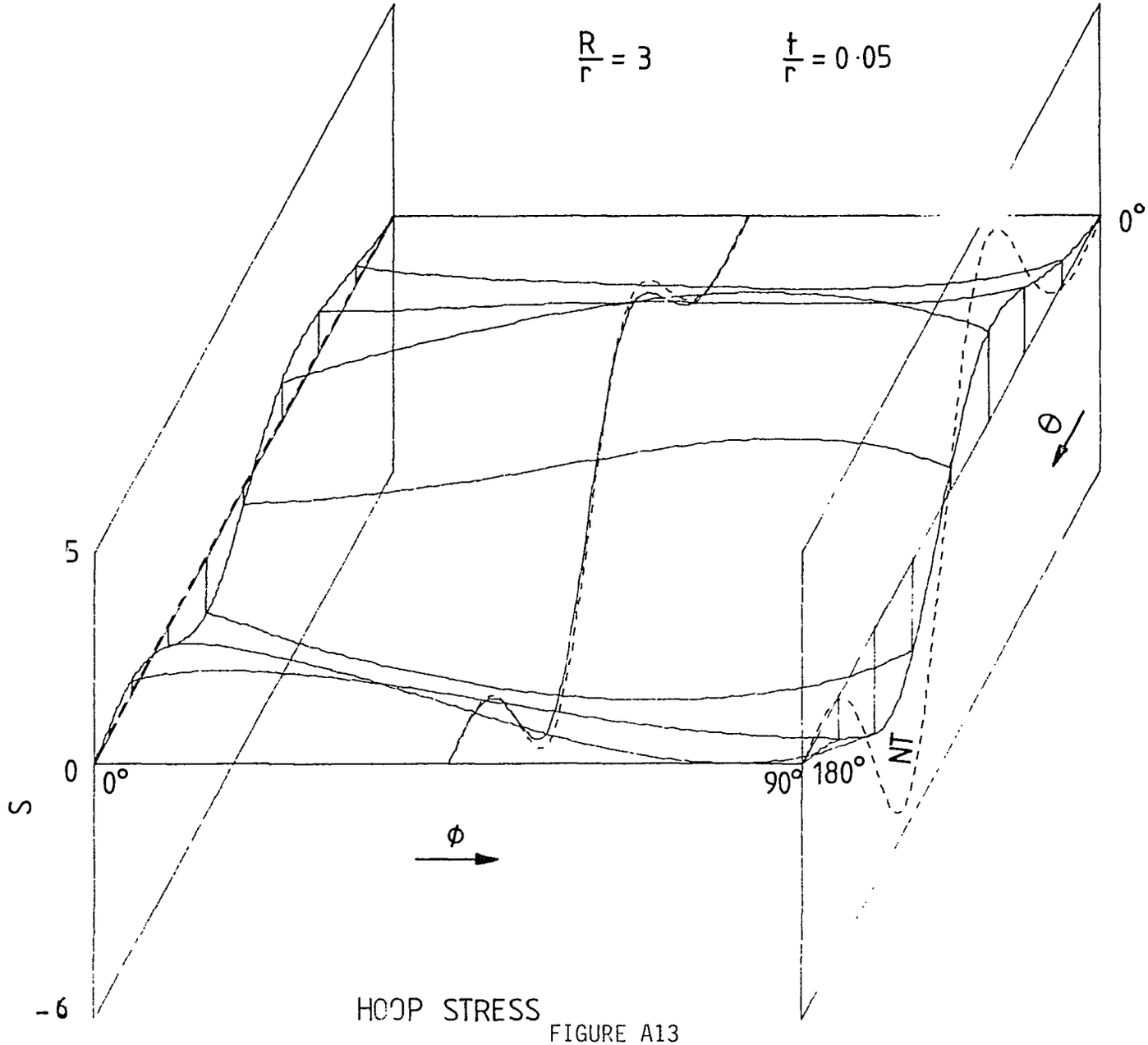
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2492	0.2260	0.2153	0.2195	0.2238	0.2217	0.2117	0.1952	0.1762	0.1612	0.1610	0.1916	0.2776	0.3491
45.0	0.0608	0.4136	0.5855	0.7337	0.8581	0.9580	1.0297	1.0659	1.0573	0.9939	0.8682	0.6802	0.2848	1.7025
67.5	-1.1357	-1.1062	-1.1880	-1.2225	-1.1976	-1.1179	-0.9989	-0.8636	-0.7417	-0.6693	-0.6913	-0.8644	-1.4847	-1.3163
90.0	-0.8309	-1.4922	-2.0729	-2.5824	-3.0549	-3.4970	-3.8951	-4.2192	-4.4273	-4.4710	-4.3006	-3.8675	-3.1441	-6.0262
112.5	1.4626	1.9590	2.1289	2.1660	2.0897	1.9249	1.6953	1.4211	1.1202	0.8117	0.5199	0.2981	-0.1776	2.5050
135.0	0.8738	0.8029	0.8529	0.9575	1.1393	1.3871	1.6753	1.9669	2.2186	2.3834	2.4133	2.2766	1.5485	2.8067
157.5	-0.0103	-0.2613	-0.3008	-0.2779	-0.1933	-0.0659	0.0858	0.2454	0.4000	0.5406	0.6606	0.7540	0.6690	0.3097
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.5083	-0.4076	-0.3393	-0.2925	-0.2588	-0.2324	-0.2096	-0.1876	-0.1632	-0.1322	-0.0892	-0.0282	0.0597	-0.1895
22.5	-0.4148	-0.3540	-0.3071	-0.2747	-0.2498	-0.2295	-0.2122	-0.1968	-0.1815	-0.1631	-0.1357	-0.0899	-0.0207	-0.1801
45.0	-0.1926	-0.2597	-0.2711	-0.2588	-0.2349	-0.2093	-0.1897	-0.1817	-0.1895	-0.2156	-0.2607	-0.3221	-0.4261	-0.2421
67.5	-0.6467	-0.6717	-0.6396	-0.5662	-0.4754	-0.3808	-0.2903	-0.2096	-0.1451	-0.1057	-0.1058	-0.1685	-0.3016	-0.8576
90.0	-1.1970	-1.1375	-1.0940	-1.0648	-1.0265	-0.9593	-0.8473	-0.6785	-0.4468	-0.1518	0.2000	0.5972	1.0125	-1.4623
112.5	-0.1681	-0.3517	-0.5491	-0.7133	-0.8276	-0.8844	-0.8825	-0.8242	-0.7115	-0.5435	-0.3153	-0.0149	0.3093	-0.5080
135.0	-0.2333	-0.2910	-0.3367	-0.3389	-0.3127	-0.2728	-0.2341	-0.2099	-0.2104	-0.2413	-0.3029	-0.3912	-0.4532	-0.0927
157.5	-0.5718	-0.4531	-0.3284	-0.2217	-0.1366	-0.0743	-0.0334	-0.0115	-0.0062	-0.0163	-0.0424	-0.0882	-0.1246	-0.3319
180.0	-0.5621	-0.4065	-0.2578	-0.1470	-0.0722	-0.0293	-0.0109	-0.0085	-0.0144	-0.0236	-0.0347	-0.0503	-0.0510	-0.3800

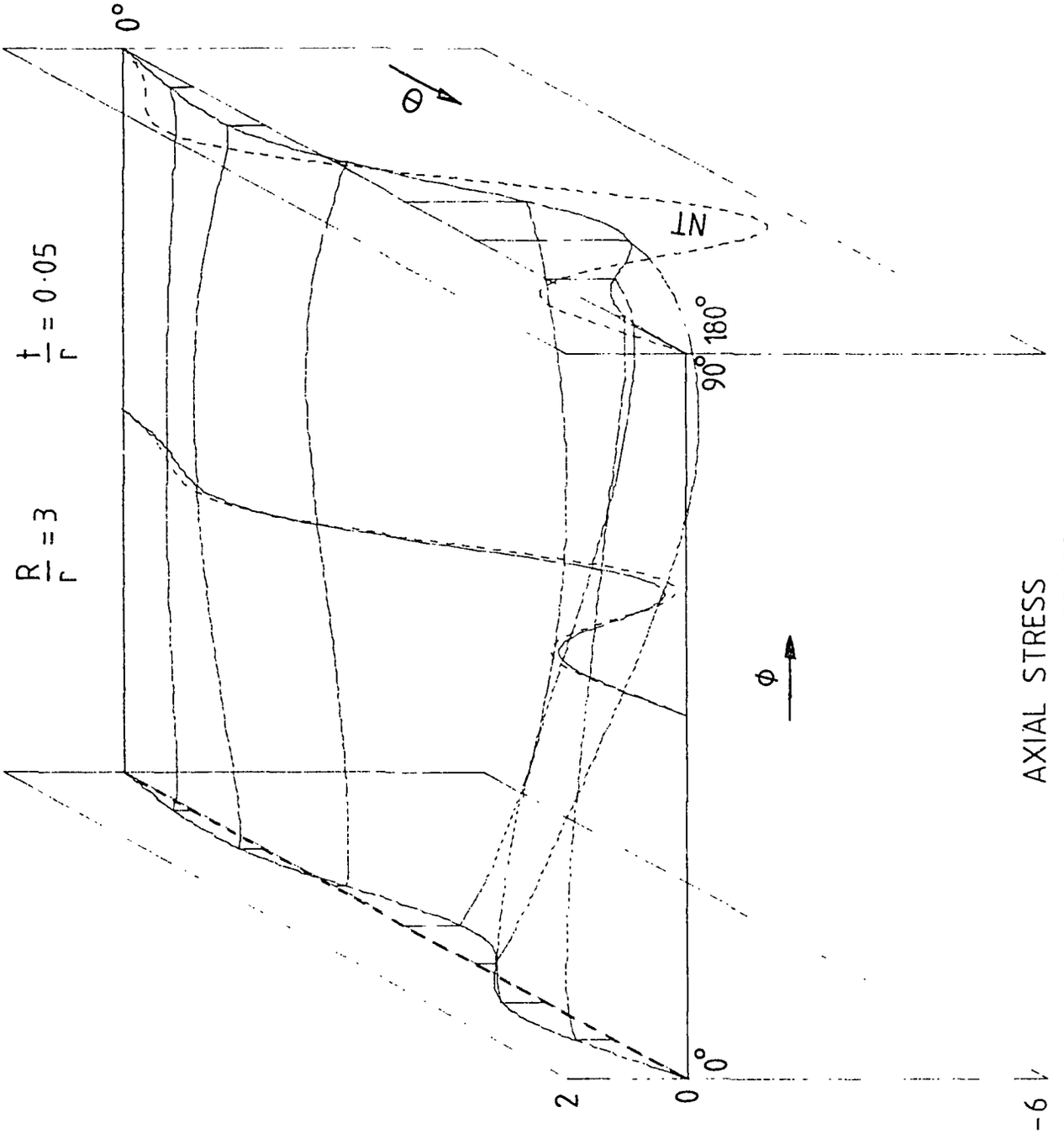
DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-57.39	-63.80	-73.55	-85.62	-99.17	-113.23	-126.74	-138.66	-148.02	-154.08	-156.40	-155.02	-150.81	-197.27



HOOP STRESS

FIGURE A13



AXIAL STRESS

FIGURE A14

TABLE A13

R/r = 3.0 t/r = 0.05

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.4538	0.2575	0.1634	0.0952	0.0382	-0.0130	-0.0570	-0.0874	-0.0937	-0.0610	0.0308	0.2075	0.5747	-0.0802
45.0	0.9860	0.9973	1.0619	1.1270	1.1755	1.2017	1.2064	1.1952	1.1779	1.1704	1.1960	1.2925	1.5533	1.9281
67.5	0.9212	1.3622	1.7300	2.0651	2.3666	2.6289	2.8401	2.9848	3.0460	3.0072	2.8536	2.5768	2.1218	4.4222
90.0	-0.3509	-0.2373	-0.1149	0.0513	0.2587	0.4964	0.7427	0.9691	1.1434	1.2298	1.1868	0.9676	0.5444	1.0233
112.5	-1.2850	-1.7318	-2.1599	-2.5153	-2.8132	-3.0520	-3.2249	-3.3220	-3.3314	-3.2418	-3.0468	-2.7257	-2.1607	-5.0286
135.0	-0.4246	-0.4731	-0.7496	-1.0953	-1.4968	-1.9275	-2.3508	-2.7270	-3.0161	-3.1802	-3.1839	-2.9627	-2.4959	-3.4837
157.5	0.3567	0.5769	0.5816	0.4889	0.3280	0.1213	-0.1075	-0.3372	-0.5510	-0.7364	-0.8816	-0.9582	-1.0272	-0.0922
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3577	0.3001	0.3538	0.4010	0.4371	0.4590	0.4659	0.4577	0.4351	0.3999	0.3572	0.3131	0.4108	0.7824
45.0	0.4235	0.4824	0.6528	0.8032	0.9358	1.0459	1.1269	1.1698	1.1642	1.0989	0.9636	0.7427	0.6137	1.8182
67.5	-0.1990	-0.2187	-0.1591	-0.0759	0.0337	0.1608	0.2891	0.3984	0.4650	0.4623	0.3597	0.1138	-0.2110	0.4362
90.0	-0.9191	-1.4599	-1.8586	-2.1674	-2.3996	-2.5624	-2.6617	-2.7008	-2.6812	-2.6038	-2.4727	-2.3026	-2.0307	-4.1297
112.5	-0.3314	-0.8724	-1.3379	-1.7922	-2.2485	-2.6903	-3.0933	-3.4269	-3.6559	-3.7422	-3.6509	-3.3492	-2.5640	-4.5894
135.0	0.7624	0.7992	0.6867	0.4994	0.2358	-0.0752	-0.4046	-0.7263	-1.0167	-1.2550	-1.4270	-1.4975	-1.1613	-0.4152
157.5	0.6952	0.8429	0.8179	0.7587	0.6673	0.5585	0.4443	0.3303	0.2165	0.0987	-0.0319	-0.1552	-0.1485	0.7363
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.3856	-0.4089	-0.4088	-0.3927	-0.3660	-0.3329	-0.2977	-0.2645	-0.2376	-0.2225	-0.2251	-0.2522	-0.3203	-0.5451
22.5	-0.4842	-0.4843	-0.4725	-0.4464	-0.4108	-0.3687	-0.3230	-0.2765	-0.2328	-0.1964	-0.1732	-0.1722	-0.1950	-0.6116
45.0	-0.7092	-0.6588	-0.6209	-0.5787	-0.5306	-0.4739	-0.4069	-0.3289	-0.2403	-0.1425	-0.0380	0.0671	0.1931	-0.7361
67.5	-0.7194	-0.6754	-0.6476	-0.6249	-0.5966	-0.5548	-0.4936	-0.4091	-0.2978	-0.1567	0.0188	0.2356	0.4902	-0.6284
90.0	-0.2977	-0.3307	-0.3657	-0.3905	-0.4040	-0.4060	-0.3960	-0.3731	-0.3351	-0.2776	-0.1935	-0.0762	0.0555	-0.1126
112.5	-0.1334	-0.1533	-0.1677	-0.1612	-0.1465	-0.1369	-0.1414	-0.1651	-0.2095	-0.2736	-0.3548	-0.4550	-0.5275	0.1426
135.0	-0.5333	-0.4968	-0.4279	-0.3541	-0.2804	-0.2151	-0.1640	-0.1303	-0.1153	-0.1202	-0.1470	-0.1937	-0.2289	-0.3942
157.5	-0.7019	-0.7087	-0.6845	-0.6556	-0.6173	-0.5633	-0.4905	-0.3978	-0.2869	-0.1617	-0.0274	0.1149	0.2213	-0.9429
180.0	-0.6492	-0.6980	-0.7319	-0.7542	-0.7573	-0.7296	-0.6649	-0.5618	-0.4234	-0.2558	-0.0653	0.1419	0.3027	-1.0816

IAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	20.666	24.776	29.708	35.091	40.599	45.880	50.556	54.253	56.638	57.459	56.594	54.090	50.335	78.281

TABLE A14

R/r = 3.0 t/r = 0.05

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.4892	-0.3031	-0.2084	-0.1422	-0.0870	-0.0356	0.0111	0.0468	0.0604	0.0361	-0.0485	-0.2223	-0.5532	-0.0109
45.0	-1.1074	-1.1183	-1.2144	-1.3028	-1.3692	-1.4063	-1.4143	-1.3979	-1.3666	-1.3355	-1.3290	-1.3803	-1.6217	-2.2847
67.5	-1.0754	-1.5255	-1.9664	-2.3582	-2.7108	-3.0173	-3.2630	-3.4283	-3.4911	-3.4287	-3.2205	-2.8402	-2.3473	-5.0923
90.0	0.3836	0.2911	0.1295	-0.0785	-0.3410	-0.6435	-0.9576	-1.2472	-1.4711	-1.5842	-1.5362	-1.2565	-0.7051	-1.3145
112.5	1.5125	2.1505	2.6011	2.9639	3.2482	3.4554	3.5830	3.6247	3.5710	3.4122	3.1422	2.7766	2.2598	5.6401
135.0	0.5883	0.9042	1.1819	1.5225	1.9253	2.3597	2.7868	3.1621	3.4395	3.5740	3.5265	3.2761	2.6471	4.1906
157.5	-0.3005	-0.3852	-0.4060	-0.3356	-0.1791	0.0365	0.2829	0.5335	0.7654	0.9600	1.1054	1.1941	1.0956	0.3942
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

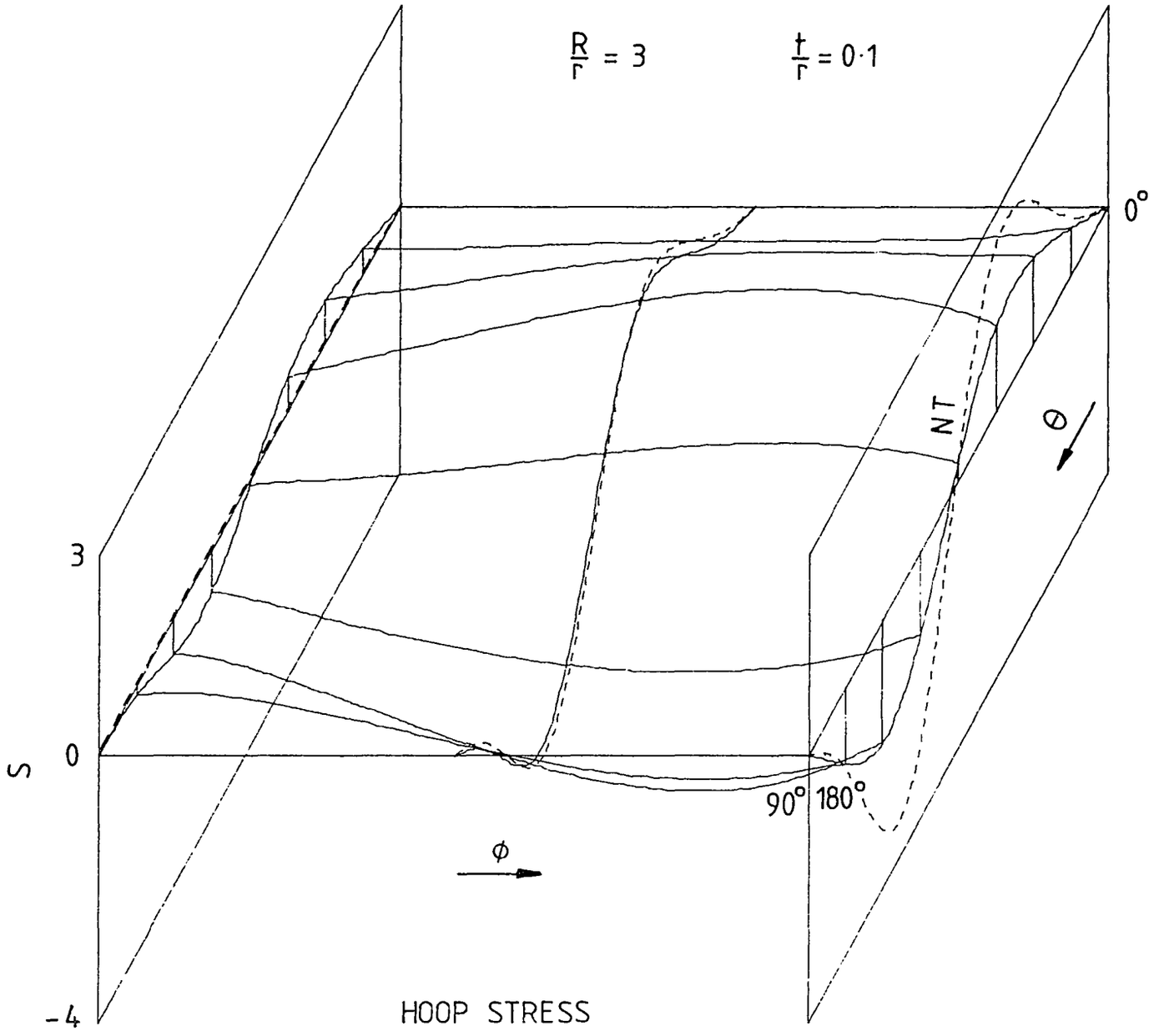
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0359	0.1890	0.2494	0.3097	0.3613	0.4019	0.4292	0.4399	0.4303	0.3965	0.3353	0.2536	0.0349	0.7086
45.0	-0.2108	-0.0189	0.0395	0.1043	0.1692	0.2306	0.2820	0.3149	0.3184	0.2800	0.1857	0.0277	-0.4096	0.4770
67.5	-0.5883	-0.7044	-0.8555	-0.9719	-1.0579	-1.1173	-1.1543	-1.1740	-1.1821	-1.1858	-1.1955	-1.2218	-1.3924	-1.7656
90.0	-0.3464	-0.6419	-0.9504	-1.2385	-1.5075	-1.7554	-1.9731	-2.1475	-2.2629	-2.3022	-2.2468	-2.0678	-1.7947	-2.9510
112.5	0.5541	0.6433	0.6052	0.5149	0.3972	0.2581	0.1067	-0.0468	-0.1911	-0.3138	-0.3951	-0.4060	-0.5814	0.3277
135.0	0.8040	0.9312	1.0778	1.1923	1.3115	1.4313	1.5393	1.6200	1.6561	1.6316	1.5386	1.3472	0.7479	2.4311
157.5	0.3016	0.1855	0.2233	0.2851	0.3853	0.5150	0.6578	0.7956	0.9107	0.9879	1.0166	0.9569	0.6844	1.0080
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.3735	-0.3188	-0.2716	-0.2444	-0.2268	-0.2150	-0.2071	-0.2020	-0.1977	-0.1906	-0.1744	-0.1351	-0.0884	-0.1435
22.5	-0.3299	-0.3066	-0.2745	-0.2501	-0.2305	-0.2154	-0.2052	-0.1998	-0.1990	-0.2011	-0.2027	-0.1961	-0.2024	-0.1772
45.0	-0.3674	-0.3814	-0.3668	-0.3361	-0.3001	-0.2647	-0.2338	-0.2101	-0.1956	-0.1929	-0.2058	-0.2411	-0.3087	-0.3760
67.5	-0.6921	-0.6879	-0.6611	-0.6109	-0.5470	-0.4735	-0.3926	-0.3059	-0.2158	-0.1264	-0.0450	0.0166	0.0715	-0.8302
90.0	-0.8883	-0.9070	-0.9084	-0.8908	-0.8489	-0.7763	-0.6693	-0.5258	-0.3459	-0.1316	0.1139	0.3887	0.6619	-1.1230
112.5	-0.4837	-0.5833	-0.6836	-0.7520	-0.7835	-0.7730	-0.7187	-0.6213	-0.4825	-0.3040	-0.0860	0.1676	0.4078	-0.7053
135.0	-0.2162	-0.2624	-0.3275	-0.3688	-0.3880	-0.3897	-0.3791	-0.3615	-0.3411	-0.3202	-0.2996	-0.2852	-0.2427	-0.1959
157.5	-0.4439	-0.3571	-0.2663	-0.1905	-0.1297	-0.0870	-0.0639	-0.0608	-0.0771	-0.1122	-0.1662	-0.2348	-0.2698	-0.2404
180.0	-0.5769	-0.4366	-0.2802	-0.1573	-0.0672	-0.0086	0.0217	0.0280	0.0149	-0.0148	-0.0603	-0.1135	-0.1468	-0.3540

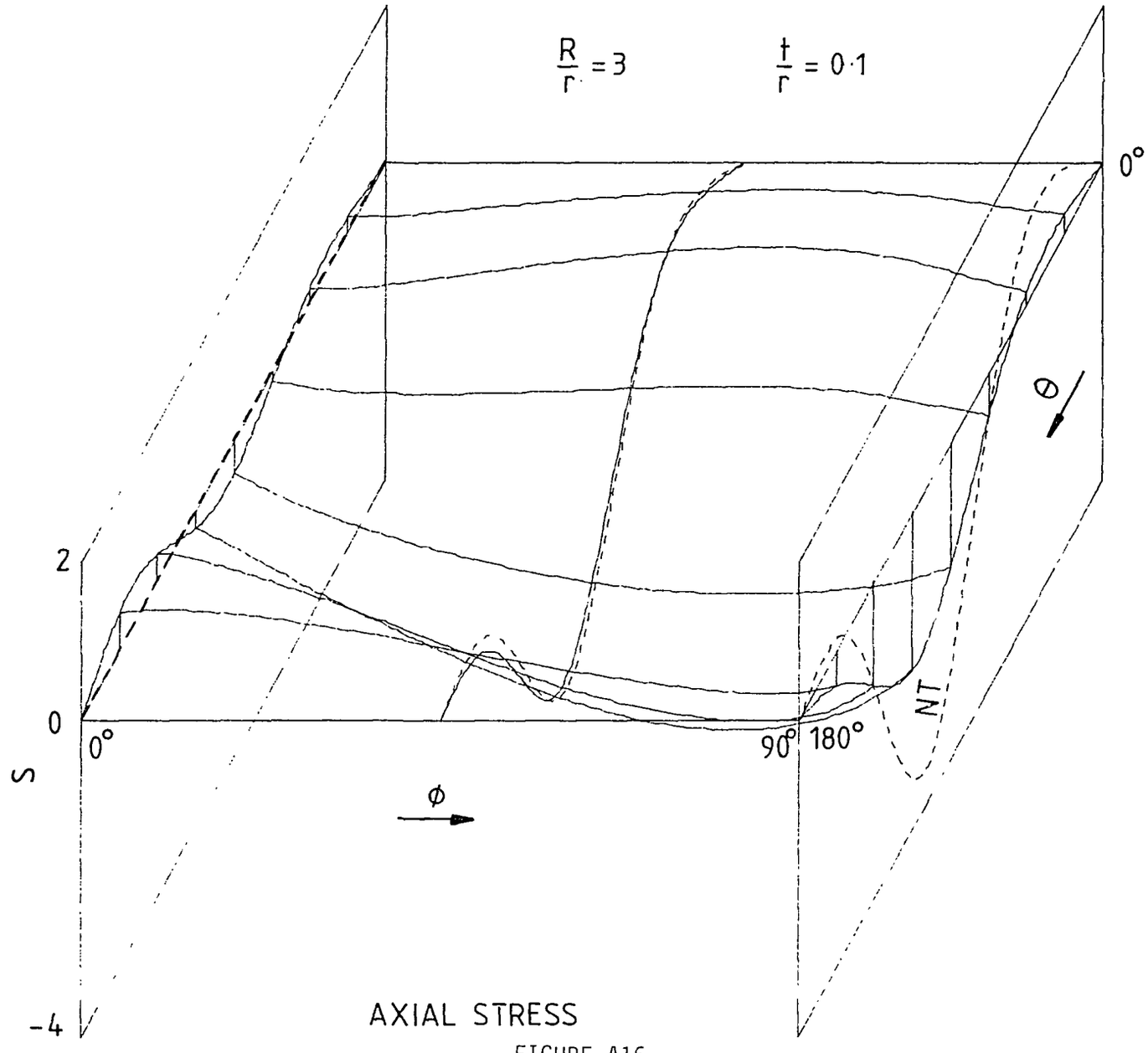
DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-20.666	-24.776	-29.708	-35.091	-40.599	-45.880	-50.556	-54.253	-56.638	-57.459	-56.594	-54.090	-50.335	-78.281



HOOP STRESS

FIGURE A15



AXIAL STRESS

FIGURE A16

TABLE A15

R/r = 3.0 t/r = 0.1

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3841	0.3848	0.4082	0.4420	0.4713	0.4927	0.5056	0.5114	0.5133	0.5174	0.5347	0.5942	0.7112	0.8542
45.0	0.6327	0.7589	0.8829	1.0141	1.1328	1.2320	1.3069	1.3543	1.3732	1.3659	1.3400	1.3248	1.2896	2.1075
67.5	0.5056	0.7383	0.9397	1.1469	1.3450	1.5237	1.6719	1.7778	1.8301	1.8184	1.7345	1.5804	1.2824	2.5708
90.0	-0.0778	-0.0106	0.0399	0.1142	0.2043	0.3014	0.3960	0.4772	0.5332	0.5510	0.5170	0.4245	0.2535	0.4712
112.5	-0.6297	-0.8218	-1.0553	-1.2678	-1.4547	-1.6125	-1.7342	-1.8124	-1.8405	-1.8138	-1.7265	-1.5545	-1.2593	-2.7379
135.0	-0.5481	-0.6914	-0.9688	-1.2800	-1.5996	-1.9089	-2.1853	-2.4047	-2.5448	-2.5856	-2.5037	-2.2588	-1.8583	-3.1872
157.5	-0.1358	-0.1079	-0.2145	-0.3793	-0.5741	-0.7814	-0.9824	-1.1585	-1.2931	-1.3717	-1.3773	-1.2894	-1.1520	-1.2881
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.1976	0.2160	0.2897	0.3610	0.4237	0.4760	0.5144	0.5345	0.5310	0.4980	0.4276	0.3190	0.2421	0.8181
45.0	0.1840	0.2031	0.2961	0.3965	0.4921	0.5783	0.6471	0.6888	0.6923	0.6447	0.5293	0.3403	0.1432	0.9854
67.5	-0.1162	-0.2291	-0.2684	-0.2714	-0.2564	-0.2298	-0.2006	-0.1787	-0.1751	-0.2024	-0.2776	-0.4041	-0.5589	-0.3937
90.0	-0.4097	-0.7699	-1.0603	-1.2944	-1.4918	-1.6543	-1.7808	-1.8696	-1.9178	-1.9232	-1.8859	-1.7894	-1.5837	-2.7771
112.5	-0.2107	-0.6159	-1.0060	-1.3712	-1.7219	-2.0481	-2.3336	-2.5604	-2.7094	-2.7627	-2.7035	-2.4907	-1.9796	-3.3896
135.0	0.3412	0.1956	-0.0352	-0.2922	-0.5740	-0.8648	-1.1438	-1.3908	-1.5874	-1.7184	-1.7694	-1.6913	-1.3137	-1.4047
157.5	0.4730	0.5172	0.4549	0.3601	0.2386	0.1001	-0.0433	-0.1817	-0.3081	-0.4189	-0.5093	-0.5456	-0.4389	0.1614
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4973	-0.4933	-0.4861	-0.4609	-0.4249	-0.3814	-0.3332	-0.2833	-0.2357	-0.1961	-0.1728	-0.1824	-0.2057	-0.6185
22.5	-0.5473	-0.5322	-0.5185	-0.4907	-0.4529	-0.4068	-0.3542	-0.2973	-0.2392	-0.1844	-0.1390	-0.1143	-0.0909	-0.6404
45.0	-0.6291	-0.5988	-0.5750	-0.5458	-0.5078	-0.4597	-0.4010	-0.3319	-0.2533	-0.1663	-0.0716	0.0315	0.1520	-0.6494
67.5	-0.5904	-0.5705	-0.5527	-0.5341	-0.5076	-0.4705	-0.4209	-0.3575	-0.2789	-0.1825	-0.0640	0.0843	0.2483	-0.5179
90.0	-0.3926	-0.3975	-0.3994	-0.3975	-0.3890	-0.3749	-0.3551	-0.3286	-0.2931	-0.2449	-0.1796	-0.0935	0.0026	-0.2264
112.5	-0.2753	-0.2786	-0.2761	-0.2680	-0.2573	-0.2495	-0.2479	-0.2531	-0.2640	-0.2783	-0.2950	-0.3131	-0.3079	-0.0669
135.0	-0.4423	-0.4348	-0.4060	-0.3716	-0.3349	-0.2999	-0.2695	-0.2454	-0.2282	-0.2186	-0.2177	-0.2212	-0.2128	-0.3595
157.5	-0.6802	-0.6941	-0.6748	-0.6413	-0.5952	-0.5341	-0.4573	-0.3663	-0.2643	-0.1555	-0.0431	0.0706	0.1510	-0.8685
180.0	-0.7605	-0.7941	-0.7955	-0.7760	-0.7360	-0.6700	-0.5752	-0.4530	-0.3083	-0.1470	0.0259	0.2011	0.3208	-1.0955

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	8.128	10.302	12.771	15.384	17.961	20.332	22.323	23.768	24.524	24.482	23.591	21.880	19.484	34.39

TABLE A16

R/r = 3.0 t/r = 0.1

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.4491	-0.4242	-0.4625	-0.5035	-0.5381	-0.5624	-0.5754	-0.5779	-0.5725	-0.5651	-0.5658	-0.5933	-0.7444	-0.9811
45.0	-0.7598	-0.8520	-1.0145	-1.1709	-1.3109	-1.4268	-1.5121	-1.5618	-1.5727	-1.5452	-1.4836	-1.3996	-1.4081	-2.4476
67.5	-0.6328	-0.8407	-1.0971	-1.3491	-1.5895	-1.8072	-1.9873	-2.1139	-2.1711	-2.1446	-2.0191	-1.7771	-1.4763	-3.0490
90.0	0.0663	0.0447	-0.0402	-0.1519	-0.2835	-0.4258	-0.5650	-0.6849	-0.7691	-0.8004	-0.7566	-0.6088	-0.3755	-0.6645
112.5	0.7552	1.0768	1.3197	1.5259	1.7009	1.8387	1.9331	1.9783	1.9684	1.8996	1.7745	1.6007	1.3286	3.1348
135.0	0.6740	1.0055	1.3077	1.6228	1.9502	2.2671	2.5457	2.7581	2.8782	2.8842	2.7631	2.5033	2.0109	3.7918
157.5	0.1771	0.2790	0.3984	0.5583	0.7573	0.9753	1.1880	1.3720	1.5066	1.5764	1.5729	1.4849	1.2344	1.6142
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

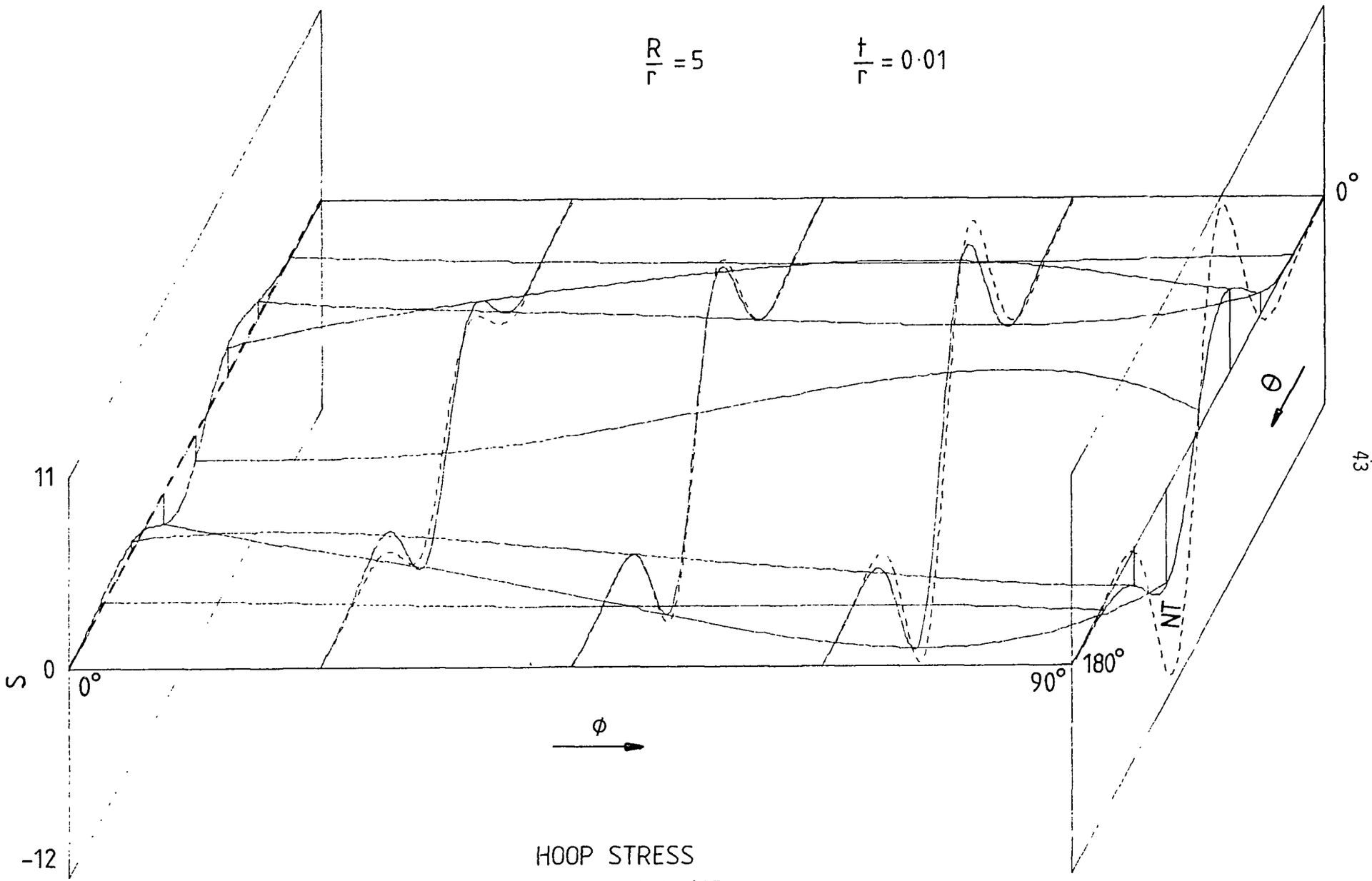
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.0828	0.0052	0.0313	0.0562	0.0818	0.1050	0.1229	0.1319	0.1271	0.1027	0.0529	-0.0377	-0.2701	0.1827
45.0	-0.2162	-0.1625	-0.1762	-0.1880	-0.1919	-0.1923	-0.1928	-0.1981	-0.2143	-0.2491	-0.3102	-0.4235	-0.6989	-0.3178
67.5	-0.3060	-0.4037	-0.5276	-0.6459	-0.7474	-0.8344	-0.9070	-0.9655	-1.0109	-1.0447	-1.0674	-1.0969	-1.1674	-1.3931
90.0	-0.1508	-0.3093	-0.4854	-0.6677	-0.8388	-0.9956	-1.1337	-1.2474	-1.3302	-1.3745	-1.3683	-1.3112	-1.2253	-1.6429
112.5	0.2418	0.2248	0.1711	0.0857	-0.0063	-0.0991	-0.1906	-0.2779	-0.3568	-0.4197	-0.4541	-0.4687	-0.5940	-0.1249
135.0	0.4924	0.5727	0.6687	0.7340	0.7896	0.8379	0.8724	0.8854	0.8707	0.8263	0.7507	0.6037	0.2144	1.4240
157.5	0.3482	0.3718	0.4628	0.5490	0.6359	0.7224	0.7997	0.8578	0.8877	0.8834	0.8367	0.7083	0.4149	1.2064
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.2995	-0.2760	-0.2442	-0.2221	-0.2070	-0.1977	-0.1944	-0.1974	-0.2065	-0.2206	-0.2361	-0.2477	-0.2813	-0.1568
22.5	-0.3278	-0.3101	-0.2821	-0.2577	-0.2379	-0.2224	-0.2119	-0.2070	-0.2078	-0.2139	-0.2236	-0.2360	-0.2670	-0.2222
45.0	-0.4421	-0.4338	-0.4123	-0.3818	-0.3484	-0.3141	-0.2798	-0.2465	-0.2151	-0.1865	-0.1623	-0.1480	-0.1395	-0.4292
67.5	-0.6349	-0.6391	-0.6264	-0.5938	-0.5471	-0.4880	-0.4169	-0.3344	-0.2417	-0.1403	-0.0332	0.0746	0.1870	-0.7333
90.0	-0.7304	-0.7671	-0.7834	-0.7715	-0.7321	-0.6653	-0.5706	-0.4485	-0.2999	-0.1264	0.0697	0.2846	0.4895	-0.9134
112.5	-0.5675	-0.6312	-0.6871	-0.7122	-0.7040	-0.6627	-0.5890	-0.4845	-0.3511	-0.1909	-0.0072	0.1904	0.3702	-0.7286
135.0	-0.3526	-0.3745	-0.4074	-0.4272	-0.4293	-0.4153	-0.3873	-0.3480	-0.2996	-0.2445	-0.1866	-0.1315	-0.0617	-0.3556
157.5	-0.3643	-0.2980	-0.2342	-0.1861	-0.1512	-0.1294	-0.1211	-0.1267	-0.1460	-0.1791	-0.2254	-0.2753	-0.2893	-0.2103
180.0	-0.4360	-0.3263	-0.2067	-0.1154	-0.0530	-0.0177	-0.0082	-0.0226	-0.0587	-0.1148	-0.1869	-0.2587	-0.2971	-0.2328

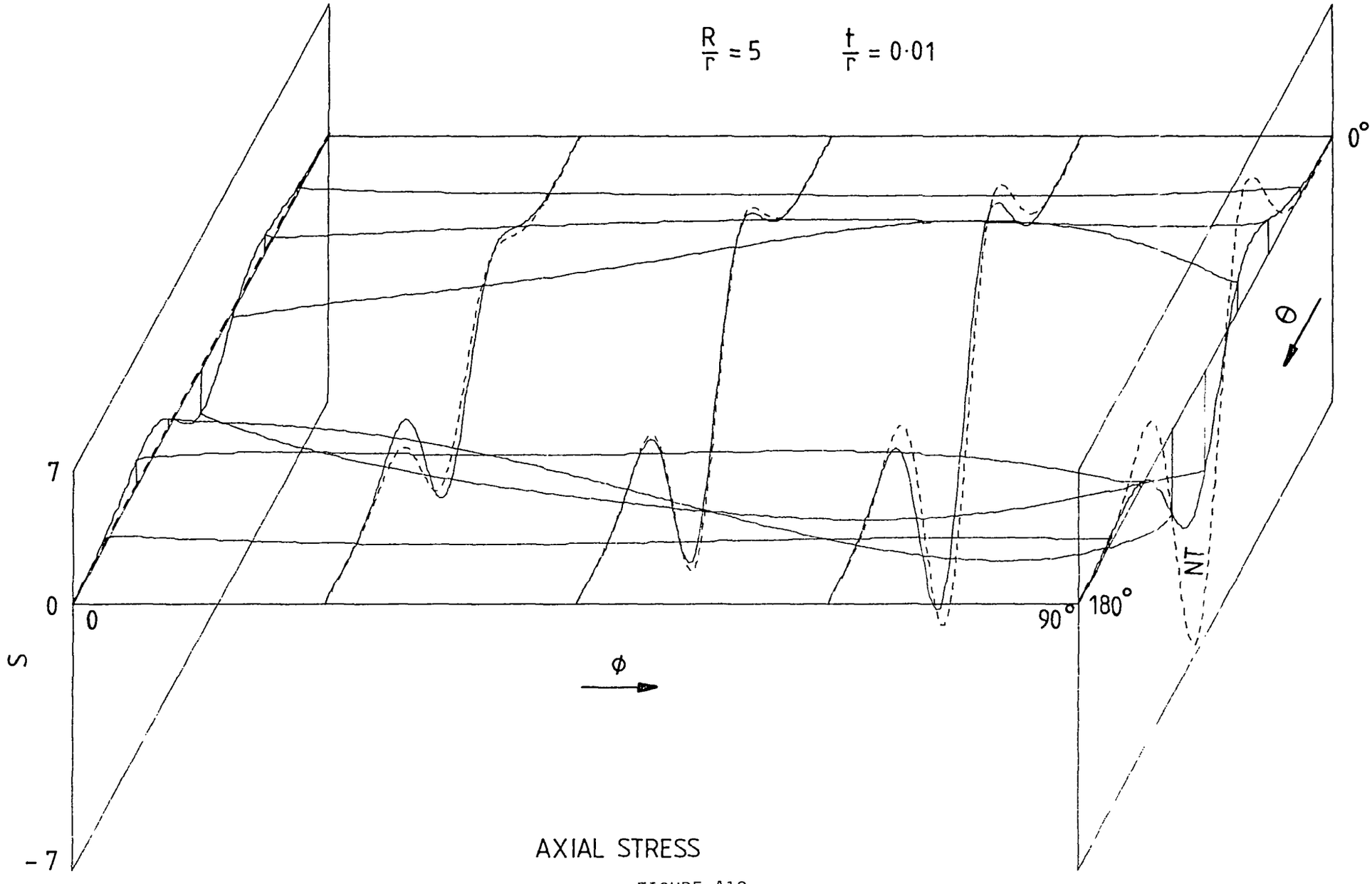
DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-8.128	-10.302	-12.771	-15.384	-17.961	-20.332	-22.323	-23.768	-24.524	-24.482	-23.591	-21.880	-19.484	-34.391



HOOP STRESS

FIGURE A17



AXIAL STRESS

FIGURE A18

TABLE A17

R/r = 5.0 t/r = 0.01

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.1695	0.0151	-0.1007	-0.1868	-0.2493	-0.2953	-0.3271	-0.3403	-0.3259	-0.2739	-0.1807	-0.0655	0.0236	-0.5082
45.0	1.0544	0.6456	0.4612	0.3241	0.1710	-0.0161	-0.2265	-0.4292	-0.5758	-0.5971	-0.3981	0.1448	1.2626	-0.3540
67.5	1.7183	2.7399	3.5788	4.2852	4.9112	5.4844	5.9921	6.3821	6.5761	6.4946	6.0964	5.4392	4.8053	8.9538
90.0	-1.4134	-1.4062	-1.3388	-1.0305	-0.4607	0.3080	1.1826	2.0662	2.8582	3.4302	3.5825	2.9908	1.1563	1.7888
112.5	-1.7197	-2.6947	-3.4790	-4.2511	-5.1172	-6.0913	-7.1119	-8.0602	-8.7771	-9.0746	-8.7495	-7.6106	-5.4122	-10.6752
135.0	0.6498	1.0868	1.1362	0.9332	0.5726	0.1444	-0.2877	-0.6947	-1.0771	-1.4497	-1.8132	-2.1170	-2.2441	-0.4015
157.5	0.4728	0.5112	0.4266	0.3089	0.2035	0.1355	0.1101	0.1176	0.1385	0.1473	0.1113	-0.0088	-0.2807	0.2573
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2670	0.1219	0.0644	0.0380	0.0201	0.0010	-0.0213	-0.0437	-0.0585	-0.0535	-0.0101	0.0944	0.2743	-0.0187
45.0	0.6794	0.7077	0.8661	1.0085	1.1188	1.1963	1.2408	1.2484	1.2134	1.1374	1.0436	1.0020	1.2672	1.8848
67.5	-0.1881	0.2564	0.6210	0.9906	1.4248	1.9248	2.4519	2.9397	3.2996	3.4211	3.1704	2.3935	1.0974	3.7060
90.0	-1.6745	-2.7605	-3.5512	-4.1333	-4.5903	-4.9793	-5.3123	-5.5556	-5.6424	-5.4993	-5.0858	-4.4516	-3.8004	-7.8975
112.5	0.3697	0.1684	-0.0772	-0.5178	-1.1500	-1.9189	-2.7479	-3.5575	-4.2682	-4.7867	-4.9802	-4.6465	-3.2739	-4.0912
135.0	0.9967	1.2577	1.2868	1.2378	1.1913	1.1889	1.2343	1.3008	1.3394	1.2873	1.0781	0.6575	0.1751	1.9575
157.5	0.3188	0.2577	0.1523	0.0770	0.0458	0.0570	0.0985	0.1557	0.2157	0.2680	0.3008	0.2924	0.2435	0.2361
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4538	-0.4446	-0.4354	-0.4199	-0.3958	-0.3640	-0.3266	-0.2863	-0.2463	-0.2101	-0.1795	-0.1518	-0.1206	-0.5157
22.5	-0.4377	-0.4561	-0.4546	-0.4381	-0.4102	-0.3740	-0.3322	-0.2877	-0.2444	-0.2076	-0.1833	-0.1758	-0.1890	-0.5373
45.0	-0.5901	-0.6022	-0.5829	-0.5496	-0.5093	-0.4616	-0.4035	-0.3330	-0.2513	-0.1652	-0.0904	-0.0559	-0.1058	-0.6727
67.5	-0.8291	-0.7243	-0.6854	-0.6774	-0.6733	-0.6530	-0.6029	-0.5135	-0.3762	-0.1826	0.0751	0.3980	0.7854	-0.7298
90.0	-0.1446	-0.2107	-0.2731	-0.3072	-0.3109	-0.2959	-0.2786	-0.2730	-0.2839	-0.3008	-0.2912	-0.1935	0.0618	-0.0536
112.5	-0.3043	-0.3233	-0.2547	-0.1422	-0.0291	0.0570	0.1019	0.0999	0.0468	-0.0652	-0.2494	-0.5211	-0.8583	-0.0344
135.0	-0.6937	-0.6062	-0.5169	-0.4475	-0.3976	-0.3590	-0.3200	-0.2692	-0.1991	-0.1087	-0.0075	0.0804	0.1161	-0.6071
157.5	-0.5388	-0.5573	-0.5851	-0.6086	-0.6144	-0.5946	-0.5471	-0.4736	-0.3773	-0.2611	-0.1262	0.0272	0.1854	-0.7397
180.0	-0.5095	-0.5663	-0.6251	-0.6667	-0.6773	-0.6521	-0.5934	-0.5078	-0.4027	-0.2841	-0.1553	-0.0161	0.1294	-0.7749

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	80.32	93.34	116.94	148.69	185.7.	224.76	262.40	295.43	321.08	337.29	342.97	338.42	326.01	390.56

TABLE A18

R/r = 5.0 t/r = 0.01

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.1881	-0.0499	0.0725	0.1586	0.2189	0.2632	0.2941	0.3075	0.2939	0.2415	0.1442	0.0166	-0.0455	0.4543
45.0	-1.0937	-0.7168	-0.5445	-0.4218	-0.2803	-0.1003	0.1078	0.3133	0.4676	0.5000	0.3103	-0.2373	-1.2795	0.1686
67.5	-1.8053	-2.8664	-3.7758	-4.5381	-5.2151	-5.8382	-6.3932	-6.8215	-7.0349	-6.9414	-6.4879	-5.7247	-4.9864	-9.5582
90.0	1.4987	1.5076	1.4451	1.1174	0.5006	-0.3373	-1.2945	-2.2644	-3.1362	-3 7679	-3.9389	-3.2910	-1.2571	-1.9601
112.5	1.8460	3.0021	3.8320	4.6262	5.5078	6.5010	7.5452	8.5158	9.2413	9.5177	9.1266	7.8667	5.5798	11.3356
135.0	-0.6036	-0.9592	-1.0369	-0.8420	-0.4658	-0.0022	0.4777	0.9360	1.3650	1.7713	2.1460	2.4244	2.3312	0.7172
157.5	-0.4444	-0.4786	-0.4133	-0.2985	-0.1813	-0.0919	-0.0417	-0.0255	-0.0266	-0.0199	0.0271	0.1530	0.3413	-0.1380
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

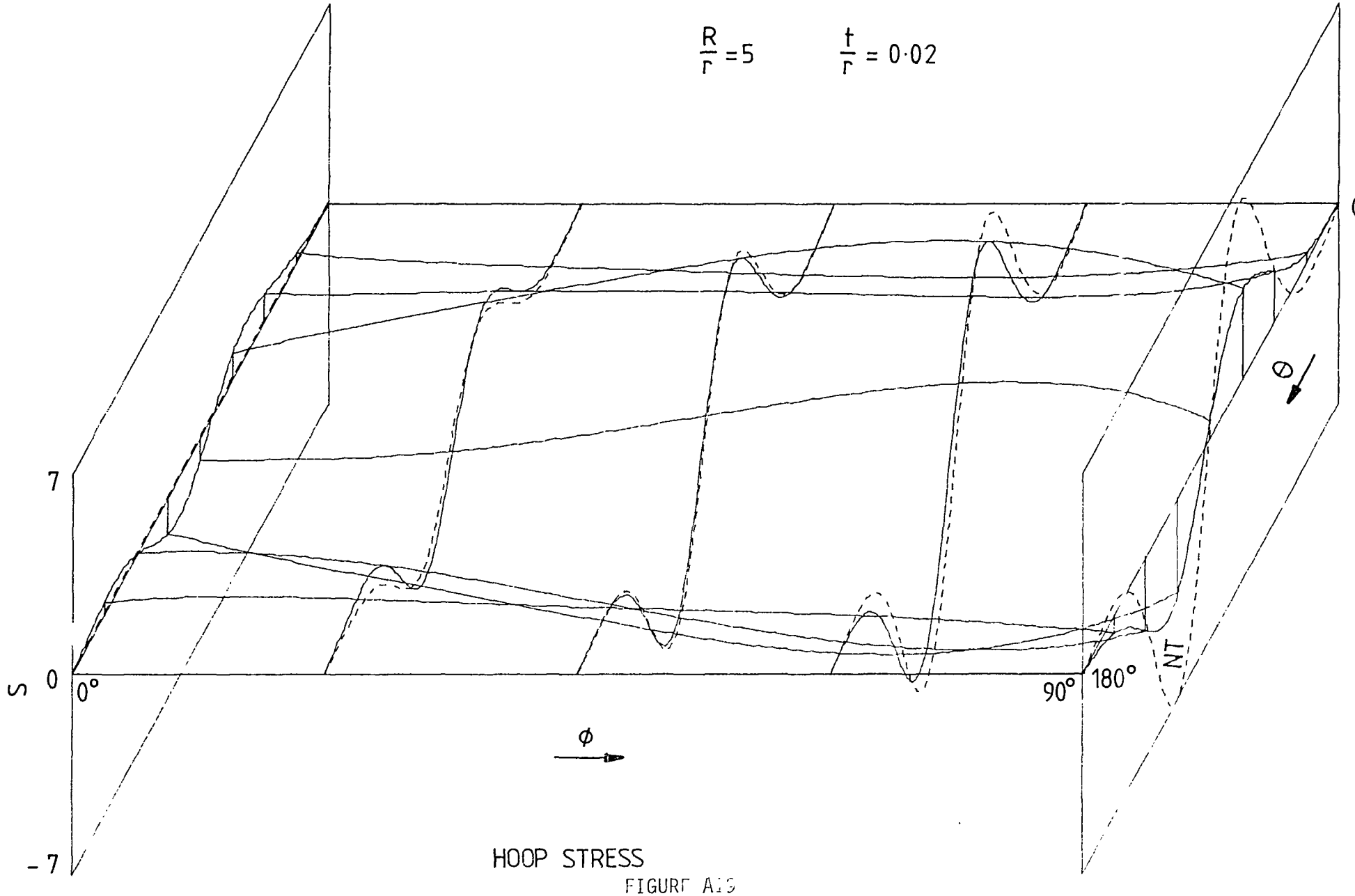
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.1871	0.1411	0.1366	0.1482	0.1577	0.1591	0.1514	0.1359	0.1160	0.0996	0.1026	0.1545	0.3020	0.2448
45.0	0.0485	0.3725	0.5873	0.7756	0.9490	1.1128	1.2601	1.3721	1.4210	1.3763	1.2149	0.9395	0.5217	1.9177
67.5	-1.1147	-1.1771	-1.3107	-1.3674	-1.3319	-1.2195	-1.0558	-0.8673	-0.6840	-0.5513	-0.5504	-0.8247	-1.7914	-1.5375
90.0	-0.5769	-1.3885	-2.0493	-2.6942	-3.3931	-4.1509	-4.9228	-5.6284	-6.1614	-6.3965	-6.1953	-5.4200	-3.9601	-7.3296
112.5	1.3499	1.8875	2.1369	2.2300	2.2377	2.2127	2.1765	2.1171	1.9968	1.7712	1.4171	0.9734	0.3585	3.3151
135.0	0.5127	0.3910	0.3889	0.5130	0.7626	1.1043	1.4904	1.8719	2.2031	2.4381	2.5191	2.3628	1.6931	2.3153
157.5	-0.0289	-0.1872	-0.2145	-0.1726	-0.0896	0.0071	0.0976	0.1728	0.2346	0.2931	0.3621	0.4512	0.5163	0.1540
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.5009	-0.4210	-0.3653	-0.3243	-0.2908	-0.2614	-0.2342	-0.2082	-0.1813	-0.1494	-0.1064	-0.0448	0.0400	-0.3002
22.5	-0.4602	-0.3969	-0.3538	-0.3202	-0.2901	-0.2619	-0.2359	-0.2127	-0.1913	-0.1684	-0.1364	-0.0817	0.0137	-0.3021
45.0	-0.3048	-0.3484	-0.3477	-0.3223	-0.2849	-0.2458	-0.2124	-0.1906	-0.1853	-0.2007	-0.2386	-0.2936	-0.3589	-0.3419
67.5	-0.6201	-0.6626	-0.6343	-0.5772	-0.5130	-0.4466	-0.3753	-0.2959	-0.2108	-0.1331	-0.0921	-0.1382	-0.3388	-0.7676
90.0	-0.9301	-0.8773	-0.8829	-0.9145	-0.9375	-0.9256	-0.8609	-0.7313	-0.5283	-0.2449	0.1219	0.5647	1.0522	-1.0978
112.5	-0.1983	-0.3518	-0.4875	-0.5687	-0.5923	-0.5711	-0.5249	-0.4717	-0.4221	-0.3725	-0.3001	-0.1580	0.1024	-0.3967
135.0	-0.3953	-0.4225	-0.4019	-0.3455	-0.2749	-0.2072	-0.1539	-0.1215	-0.1142	-0.1369	-0.1970	-0.3010	-0.4232	-0.2756
157.5	-0.5521	-0.4608	-0.3787	-0.3164	-0.2725	-0.2409	-0.2146	-0.1875	-0.1560	-0.1205	-0.0857	-0.0624	-0.0600	-0.4238
180.0	-0.5369	-0.4302	-0.3496	-0.2998	-0.2724	-0.2554	-0.2384	-0.2149	-0.1826	-0.1427	-0.0980	-0.0538	-0.0149	-0.4487

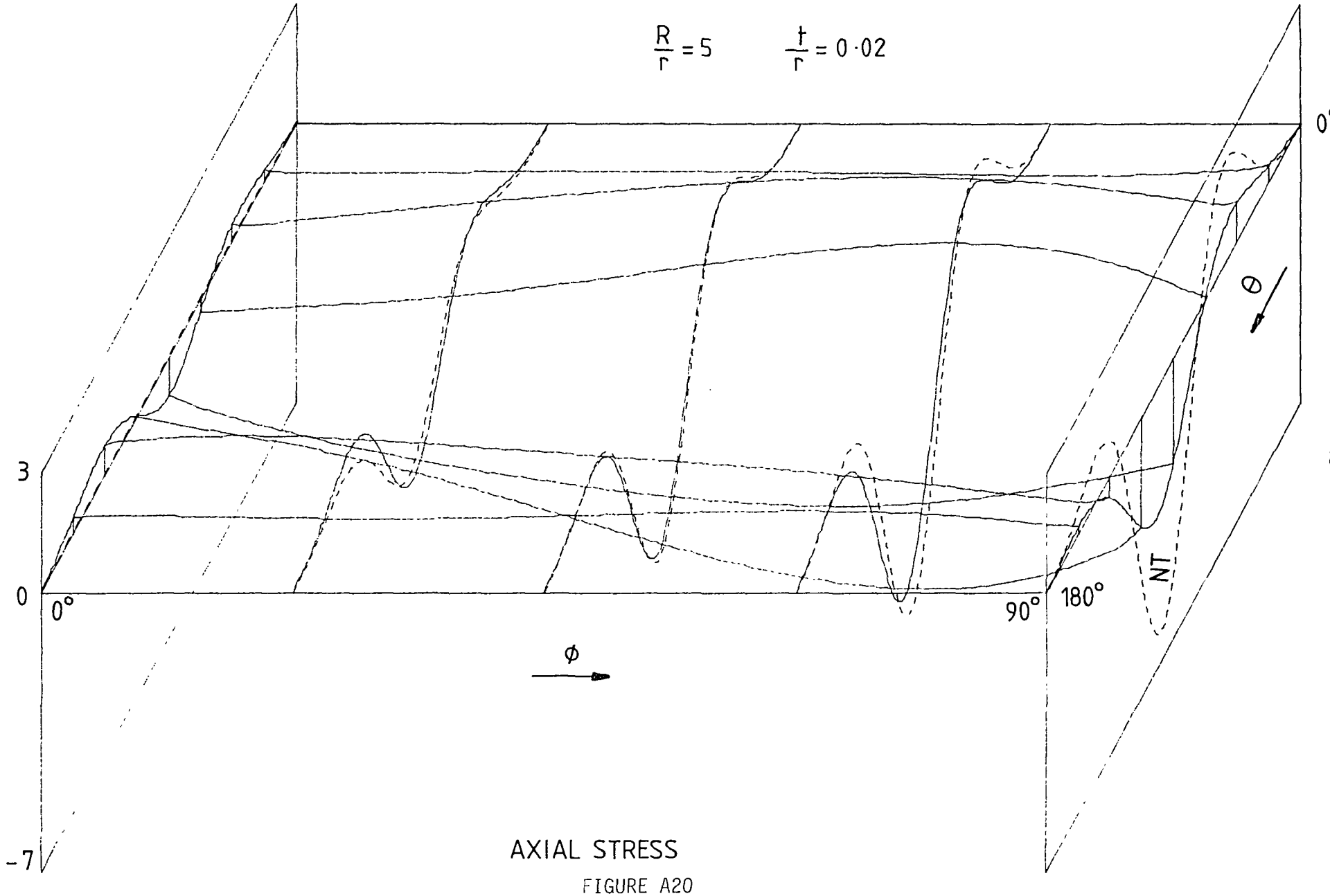
DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-80.32	-93.34	-116.94	-148.69	-185.72	-224.76	-262.40	-295.43	-321.08	-337.29	-342.97	-338.42	-326.01	-390.56



HOOP STRESS

FIGURE A13



AXIAL STRESS

FIGURE A20

TABLE A19

R/r = 5.0 t/r = 0.02

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3481	0.1038	-0.0403	-0.1483	-0.2442	-0.3371	-0.4236	-0.4913	-0.5200	-0.4830	-0.3482	-0.0839	0.3629	-0.5986
45.0	0.9917	0.9554	1.0150	1.0707	1.0936	1.0783	1.0306	0.9624	0.8928	0.8545	0.9041	1.1380	1.7808	1.6416
67.5	0.9158	1.6045	2.1913	2.7419	3.2802	3.8007	4.2725	4.6451	4.8574	4.8480	4.5674	3.9975	3.1698	6.3268
90.0	-0.7398	-0.7161	-0.6359	-0.4276	-0.0900	0.3409	0.8153	1.2793	1.6759	1.9350	1.9576	1.5935	0.6183	0.9742
112.5	-1.2396	-1.9375	-2.5366	-3.0989	-3.6619	-4.2252	-4.7540	-5.1868	-5.4466	-5.4529	-5.1355	-4.4503	-3.2961	-7.0265
135.0	0.0811	0.1590	-0.0012	-0.3352	-0.8010	-1.3403	-1.8946	-2.4126	-2.8491	-3.1585	-3.2835	-3.1436	-2.6027	-2.6221
157.5	0.4502	0.6357	0.6470	0.5740	0.4658	0.3569	0.2618	0.1777	0.0897	-0.0216	-0.1737	-0.3745	-0.6348	0.4587
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3105	0.2280	0.2401	0.2612	0.2739	0.2734	0.2602	0.2365	0.2068	0.1802	0.1752	0.2281	0.4407	0.4314
45.0	0.4179	0.5652	0.7789	0.9774	1.1616	1.3288	1.4691	1.5652	1.5955	1.5390	1.3832	1.1371	0.9854	2.2122
67.5	-0.2932	-0.1939	-0.0757	0.0913	0.3199	0.5953	0.8869	1.1549	1.3520	1.4203	1.2861	0.8500	0.0724	1.2110
90.0	-0.9466	-1.6292	-2.1527	-2.5720	-2.9222	-3.2218	-3.4681	-3.6389	-3.7016	-3.6250	-3.3953	-3.0355	-2.6193	-5.1797
112.5	0.0156	-0.3879	-0.7744	-1.2441	-1.7990	-2.4092	-3.0257	-3.5887	-4.0324	-4.2830	-4.2537	-3.8376	-2.7560	-4.2810
135.0	0.7795	0.9613	0.9771	0.8910	0.7565	0.6089	0.4629	0.3155	0.1530	-0.0393	-0.2663	-0.5122	-0.5489	0.8254
157.5	0.4183	0.4565	0.4177	0.3823	0.3767	0.4073	0.4639	0.5272	0.5743	0.5814	0.5245	0.3793	0.1917	0.7280
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4215	-0.4360	-0.4352	-0.4203	-0.3937	-0.3588	-0.3192	-0.2788	-0.2420	-0.2146	-0.2020	-0.2062	-0.2293	-0.5170
22.5	-0.4707	-0.4859	-0.4793	-0.4576	-0.4252	-0.3848	-0.3384	-0.2886	-0.2392	-0.1964	-0.1688	-0.1673	-0.2071	-0.5625
45.0	-0.6555	-0.6290	-0.6016	-0.5714	-0.5359	-0.4903	-0.4305	-0.3541	-0.2612	-0.1553	-0.0448	0.0530	0.1199	-0.6782
67.5	-0.6759	-0.6224	-0.6054	-0.6011	-0.5916	-0.5656	-0.5166	-0.4401	-0.3317	-0.1852	0.0082	0.2600	0.5849	-0.6067
90.0	-0.2672	-0.3014	-0.3259	-0.3331	-0.3251	-0.3094	-0.2941	-0.2843	-0.2795	-0.2708	-0.2391	-0.1514	0.0182	-0.1683
112.5	-0.2780	-0.2912	-0.2530	-0.1845	-0.1138	-0.0604	-0.0362	-0.0467	-0.0941	-0.1790	-0.3013	-0.4594	-0.6311	-0.0908
135.0	-0.6184	-0.5650	-0.4920	-0.4198	-0.3560	-0.3012	-0.2517	-0.2033	-0.1546	-0.1088	-0.0760	-0.0732	-0.1075	-0.5254
157.5	-0.5973	-0.6026	-0.6114	-0.6188	-0.6123	-0.5835	-0.5283	-0.4461	-0.3390	-0.2104	-0.0656	0.0883	0.2292	-0.7556
180.0	-0.5314	-0.5789	-0.6313	-0.6714	-0.6833	-0.6600	-0.6017	-0.5128	-0.3990	-0.2651	-0.1143	0.0515	0.2163	-0.7870

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	37.73	47.67	61.69	78.85	97.97	117.57	135.97	151.49	162.56	167.92	166.83	159.39	147.12	200.30

TABLE A20

R/r = 5.0 t/r = 0.02

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.3609	-0.1321	0.0133	0.1182	0.2111	0.3024	0.3893	0.4593	0.4917	0.4587	0.3250	0.0532	-0.3531	0.5400
45.0	-1.0473	-1.0263	-1.1087	-1.1851	-1.2246	-1.2214	-1.1808	-1.1135	-1.0373	-0.9840	-1.0116	-1.2228	-1.8164	-1.8764
67.5	-0.9841	-1.6962	-2.3357	-2.9337	-3.5194	-4.0880	-4.6051	-5.0139	-5.2451	-5.2275	-4.9013	-4.2379	-3.3355	-6.8150
90.0	0.7987	0.7902	0.7066	0.4765	0.0987	-0.3863	-0.9218	-1.4472	-1.8972	-2.1926	-2.2212	-1.8128	-0.6978	-1.1019
112.5	1.3536	2.1759	2.8130	3.3949	3.9687	4.5395	5.0729	5.5041	5.7496	5.7225	5.3474	4.5792	3.4209	7.5183
135.0	-0.0364	-0.0096	0.1433	0.4817	0.9680	1.5416	2.1377	2.6961	3.1627	3.4829	3.5903	3.3943	2.6935	2.9899
157.5	-0.4310	-0.5911	-0.6216	-0.5522	-0.4330	-0.3028	-0.1820	-0.0725	0.0366	0.1624	0.3202	0.5143	0.6708	-0.3327
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

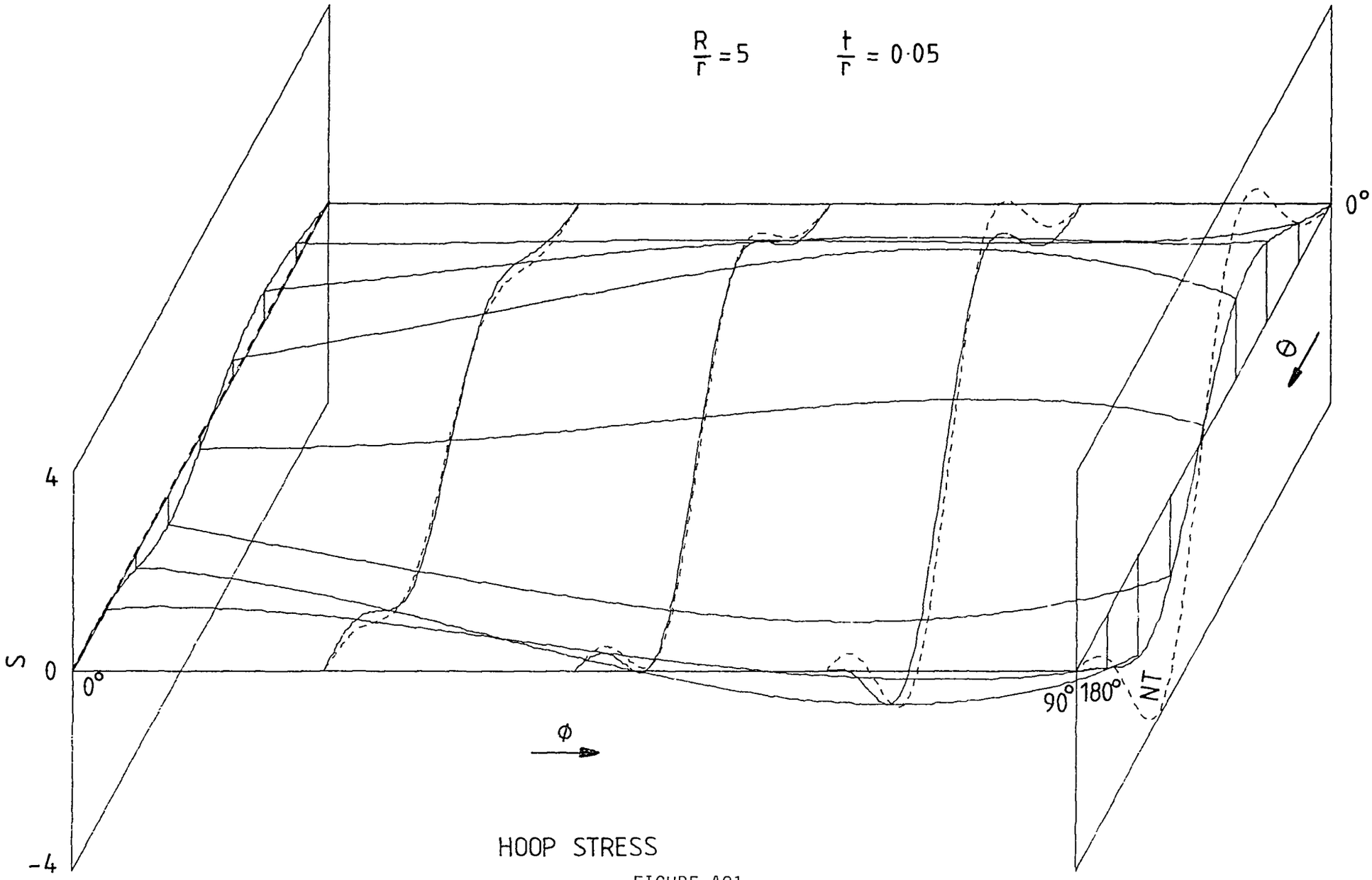
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.1006	0.1929	0.2666	0.3355	0.3940	0.4408	0.4738	0.4888	0.4806	0.4453	0.3848	0.3164	0.2534	0.7297
45.0	-0.1840	0.0472	0.1821	0.3162	0.4583	0.6057	0.7464	0.8603	0.9218	0.9001	0.7616	0.4730	-0.1208	1.0857
67.5	-0.7301	-0.9434	-1.1512	-1.3036	-1.4050	-1.4649	-1.4907	-1.4866	-1.4570	-1.4132	-1.3833	-1.4276	-1.7654	-2.2729
90.0	-0.3153	-0.7988	-1.2390	-1.6802	-2.1439	-2.6217	-3.0830	-3.4827	-3.7671	-3.8774	-3.7520	-3.3293	-2.5517	-4.4593
112.5	0.7423	0.9294	0.9671	0.9266	0.8310	0.7021	0.5538	0.3911	0.2139	0.0260	-0.1527	-0.2724	-0.3880	0.9732
135.0	0.6209	0.7202	0.8321	0.9951	1.2193	1.4891	1.7718	2.0261	2.2082	2.2742	2.1812	1.8874	1.1683	2.6197
157.5	0.0905	-0.0560	-0.0869	-0.0404	0.0658	0.2066	0.3583	0.5031	0.6293	0.7290	0.7925	0.8033	0.6669	0.5087
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4660	-0.3894	-0.3406	-0.3074	-0.2808	-0.2573	-0.2363	-0.2172	-0.1984	-0.1753	-0.1394	-0.0761	0.0288	-0.2851
22.5	-0.4045	-0.3656	-0.3324	-0.3028	-0.2747	-0.2488	-0.2267	-0.2099	-0.1983	-0.1899	-0.1792	-0.1541	-0.1042	-0.2905
45.0	-0.3761	-0.4054	-0.3915	-0.3568	-0.3148	-0.2730	-0.2362	-0.2075	-0.1904	-0.1898	-0.2125	-0.2667	-0.3693	-0.4039
67.5	-0.6666	-0.6748	-0.6496	-0.6076	-0.5570	-0.4974	-0.4257	-0.3397	-0.2412	-0.1381	-0.0474	0.0003	-0.0276	-0.7642
90.0	-0.7864	-0.7888	-0.8070	-0.8242	-0.8221	-0.7873	-0.7109	-0.5880	-0.4157	-0.1929	0.0794	0.3968	0.7442	-0.9396
112.5	-0.3636	-0.4616	-0.5503	-0.6064	-0.6238	-0.6067	-0.5630	-0.4995	-0.4186	-0.3152	-0.1761	0.0219	0.2845	-0.5218
135.0	-0.3229	-0.3605	-0.3702	-0.3482	-0.3081	-0.2640	-0.2275	-0.2063	-0.2042	-0.2224	-0.2591	-0.3085	-0.3445	-0.2802
157.5	-0.5243	-0.4470	-0.3709	-0.3062	-0.2550	-0.2152	-0.1835	-0.1571	-0.1356	-0.1214	-0.1205	-0.1411	-0.1752	-0.3924
180.0	-0.5639	-0.4546	-0.3647	-0.3042	-0.2663	-0.2403	-0.2161	-0.1876	-0.1533	-0.1153	-0.0794	-0.0549	-0.0447	-0.4489

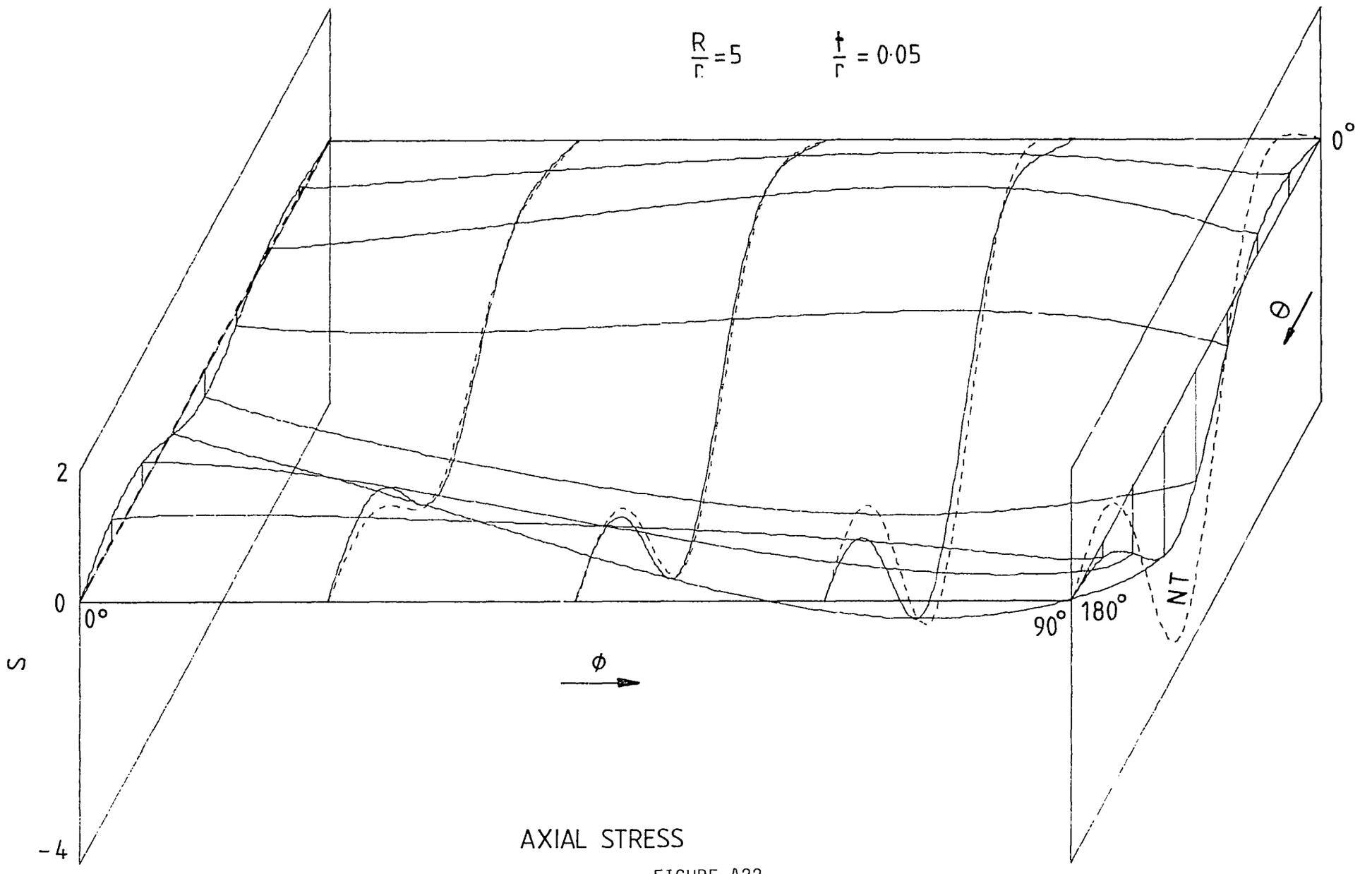
DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-37.73	-47.67	-61.69	-78.85	-97.97	-117.57	-135.97	-151.49	-162.56	-167.92	-166.83	-159.39	-147.12	-200.30



HOOP STRESS

FIGURE A21



AXIAL STRESS

FIGURE A22

TABLE A21

R/r = 5.0 t/r = 0.05

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3894	0.3654	0.3928	0.4237	0.4442	0.4509	0.4445	0.4283	0.4086	0.3978	0.4199	0.5196	0.8063	0.7673
45.0	0.6223	0.7847	0.9743	1.1626	1.3360	1.4848	1.5997	1.6712	1.6929	1.6655	1.6039	1.5481	1.5880	2.4702
67.5	0.4052	0.7136	1.0150	1.3322	1.6593	1.9773	2.2602	2.4789	2.6039	2.6076	2.4656	2.1564	1.6327	3.2538
90.0	-0.2331	-0.2124	-0.1616	-0.0632	0.0771	0.2429	0.4155	0.5762	0.7055	0.7795	0.7652	0.6092	0.2412	0.3839
112.5	-0.5937	-0.9089	-1.2183	-1.5183	-1.8064	-2.0712	-2.2942	-2.4523	-2.5222	-2.4842	-2.3264	-2.0524	-1.5988	-3.4100
135.0	-0.2868	-0.4572	-0.7497	-1.1163	-1.5317	-1.9594	-2.3603	-2.6959	-2.9289	-3.0226	-2.9403	-2.6447	-2.0332	-3.2288
157.5	0.0612	0.1129	0.0270	-0.1359	-0.3477	-0.5798	-0.8086	-1.0155	-1.1846	-1.2997	-1.3426	-1.2906	-1.1072	-0.9726
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.1764	0.2256	0.3219	0.4135	0.4984	0.5737	0.6338	0.6710	0.6764	0.6410	0.5580	0.4283	0.3562	0.9466
45.0	0.1276	0.2076	0.3430	0.4866	0.6358	0.7818	0.9109	1.0057	1.0461	1.0097	0.8729	0.6110	0.3062	1.2797
67.5	-0.1852	-0.2773	-0.3049	-0.2920	-0.2463	-0.1799	-0.1055	-0.0371	0.0098	0.0152	-0.0488	-0.2237	-0.5282	-0.3083
90.0	-0.3763	-0.7698	-1.0846	-1.3614	-1.6088	-1.8274	-2.0092	-2.1415	-2.2104	-2.2041	-2.1164	-1.9516	-1.7068	-3.0005
112.5	-0.0630	-0.4327	-0.7843	-1.1620	-1.5553	-1.9449	-2.3051	-2.6070	-2.8192	-2.9086	-2.8386	-2.5701	-1.9559	-3.1815
135.0	0.3788	0.3149	0.1811	-0.0147	-0.2433	-0.4827	-0.7175	-0.9363	-1.1277	-1.2766	-1.3614	-1.3560	-1.0627	-0.7968
157.5	0.3744	0.4397	0.4356	0.3989	0.3514	0.3027	0.2523	0.1944	0.1226	0.0328	-0.0753	-0.2015	-0.2333	0.4826
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.4844	-0.4984	-0.4918	-0.4686	-0.4338	-0.3902	-0.3400	-0.2861	-0.2331	-0.1884	-0.1634	-0.1735	-0.2343	-0.5742
22.5	-0.5333	-0.5330	-0.5214	-0.4976	-0.4632	-0.4188	-0.3654	-0.3048	-0.2407	-0.1789	-0.1280	-0.1008	-0.1059	-0.5977
45.0	-0.6074	-0.5832	-0.5658	-0.5451	-0.5155	-0.4735	-0.4176	-0.3478	-0.2649	-0.1702	-0.0646	0.0502	0.1800	-0.6124
67.5	-0.5536	-0.5343	-0.5235	-0.5119	-0.4924	-0.4617	-0.4186	-0.3621	-0.2903	-0.1987	-0.0794	0.0812	0.2907	-0.5027
90.0	-0.3807	-0.3857	-0.3807	-0.3664	-0.3472	-0.3270	-0.3084	-0.2915	-0.2735	-0.2481	-0.2050	-0.1283	-0.0178	-0.2865
112.5	-0.3435	-0.3407	-0.3162	-0.2779	-0.2407	-0.2132	-0.1997	-0.2010	-0.2158	-0.2413	-0.2740	-0.3108	-0.3428	-0.2249
135.0	-0.5023	-0.4830	-0.4462	-0.4013	-0.3554	-0.3123	-0.2730	-0.2377	-0.2073	-0.1839	-0.1717	-0.1779	-0.1921	-0.4519
157.5	-0.6174	-0.6225	-0.6171	-0.6047	-0.5774	-0.5312	-0.4646	-0.3789	-0.2774	-0.1651	-0.0490	0.0626	0.1572	-0.7227
180.0	-0.6325	-0.6602	-0.6804	-0.6911	-0.6781	-0.6345	-0.5590	-0.4539	-0.3237	-0.1746	-0.0136	0.1517	0.2958	-0.8214

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	12.124	17.069	23.199	30.145	37.451	44.561	50.865	55.748	58.642	59.084	56.808	51.861	44.773	73.726

TABLE A22

R/r = 5.0 t/r = 0.05

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.4215	-0.3918	-0.4262	-0.4644	-0.4904	-0.5006	-0.4954	-0.4778	-0.4532	-0.4338	-0.4436	-0.5314	-0.8152	-0.8508
45.0	-0.6854	-0.8444	-1.0575	-1.2685	-1.4627	-1.6297	-1.7585	-1.8375	-1.8573	-1.8159	-1.7258	-1.6271	-1.6595	-2.7092
67.5	-0.4549	-0.7673	-1.1011	-1.4539	-1.8196	-2.1768	-2.4956	-2.7421	-2.8813	-2.8795	-2.7055	-2.3295	-1.7593	-3.5787
90.0	0.2585	0.2564	0.1968	0.0781	-0.0920	-0.2934	-0.5031	-0.6987	-0.8564	-0.9478	-0.9329	-0.7500	-0.2965	-0.4637
112.5	0.6687	1.0581	1.3852	1.6955	1.9886	2.2546	2.4742	2.6228	2.6749	2.6093	2.4145	2.0940	1.6747	3.7104
135.0	0.3318	0.5946	0.8939	1.2763	1.7144	2.1686	2.5944	2.9475	3.1849	3.2656	3.1494	2.7960	2.1269	3.5730
157.5	-0.0546	-0.0534	0.0241	0.1915	0.4175	0.6694	0.9189	1.1428	1.3218	1.4373	1.4690	1.3944	1.1419	1.1241
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.0793	0.0234	0.0803	0.1378	0.1969	0.2554	0.3079	0.3464	0.3611	0.3398	0.2679	0.1293	-0.1732	0.4133
45.0	-0.2412	-0.1965	-0.1955	-0.1823	-0.1567	-0.1222	-0.0851	-0.0537	-0.0394	-0.0580	-0.1316	-0.2901	-0.6841	-0.2143
67.5	-0.3426	-0.5207	-0.6983	-0.8555	-0.9959	-1.1186	-1.2197	-1.2944	-1.3394	-1.3548	-1.3469	-1.3305	-1.3811	-1.8465
90.0	-0.1268	-0.3706	-0.6243	-0.8780	-1.1337	-1.3826	-1.6101	-1.7993	-1.9321	-1.9898	-1.9525	-1.7957	-1.4989	-2.2635
112.5	0.2913	0.2708	0.1875	0.0890	-0.0211	-0.1377	-0.2567	-0.3743	-0.4856	-0.5813	-0.6453	-0.6465	-0.6404	-0.2131
135.0	0.4454	0.5463	0.6222	0.7126	0.8175	0.9261	1.0216	1.0851	1.0993	1.0507	0.9315	0.7449	0.3273	1.5298
157.5	0.2546	0.2801	0.3403	0.4339	0.5554	0.6899	0.8190	0.9243	0.9892	0.9992	0.9416	0.8079	0.4783	1.1406
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.3717	-0.3322	-0.2996	-0.2733	-0.2501	-0.2307	-0.2166	-0.2091	-0.2087	-0.2139	-0.2193	-0.2115	-0.1871	-0.2657
22.5	-0.3869	-0.3613	-0.3316	-0.3028	-0.2752	-0.2505	-0.2301	-0.2155	-0.2075	-0.2062	-0.2096	-0.2124	-0.2191	-0.3135
45.0	-0.4745	-0.4696	-0.4452	-0.4121	-0.3753	-0.3364	-0.2959	-0.2548	-0.2147	-0.1783	-0.1508	-0.1416	-0.1634	-0.4707
67.5	-0.6269	-0.6331	-0.6210	-0.5953	-0.5572	-0.5052	-0.4377	-0.3540	-0.2555	-0.1455	-0.0309	0.0747	0.1648	-0.6915
90.0	-0.6562	-0.6899	-0.7100	-0.7119	-0.6902	-0.6419	-0.5652	-0.4596	-0.3249	-0.1616	0.0294	0.2466	0.4802	-0.7745
112.5	-0.4854	-0.5465	-0.5922	-0.6124	-0.6052	-0.5728	-0.5180	-0.4423	-0.3454	-0.2252	-0.0775	0.1053	0.3067	-0.5948
135.0	-0.3743	-0.3961	-0.4090	-0.4036	-0.3847	-0.3578	-0.3277	-0.2970	-0.2663	-0.2350	-0.2010	-0.1614	-0.1120	-0.3795
157.5	-0.4493	-0.3910	-0.3375	-0.2899	-0.2500	-0.2175	-0.1922	-0.1745	-0.1658	-0.1687	-0.1860	-0.2213	-0.2517	-0.3489
180.0	-0.5150	-0.4193	-0.3356	-0.2711	-0.2236	-0.1881	-0.1606	-0.1399	-0.1277	-0.1279	-0.1451	-0.1855	-0.2239	-0.3810

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-12.124	-17.069	-23.199	-30.145	-37.451	-44.561	-50.865	-55.748	-58.642	-59.084	-56.808	-51.861	-44.773	-73.726

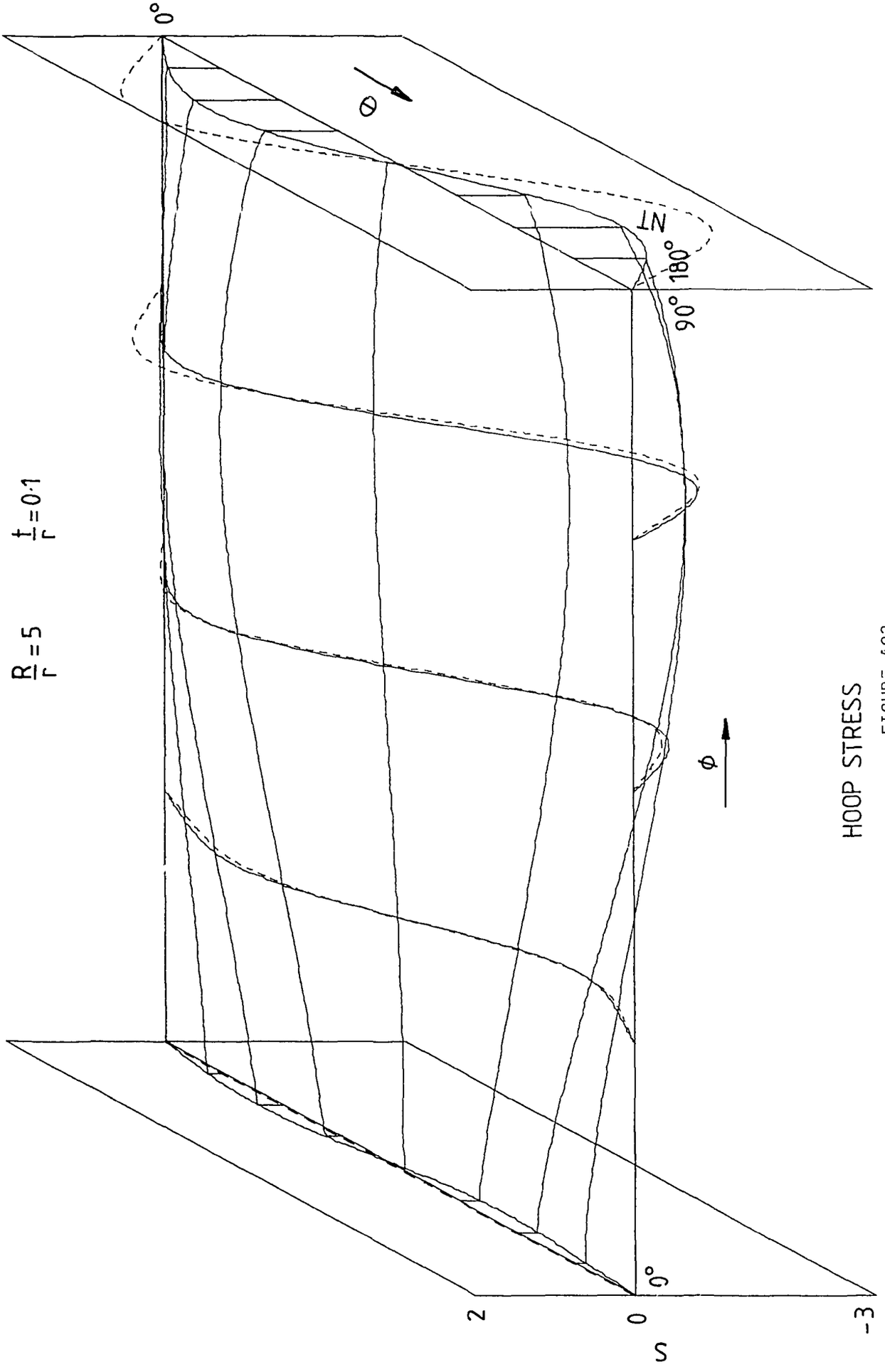
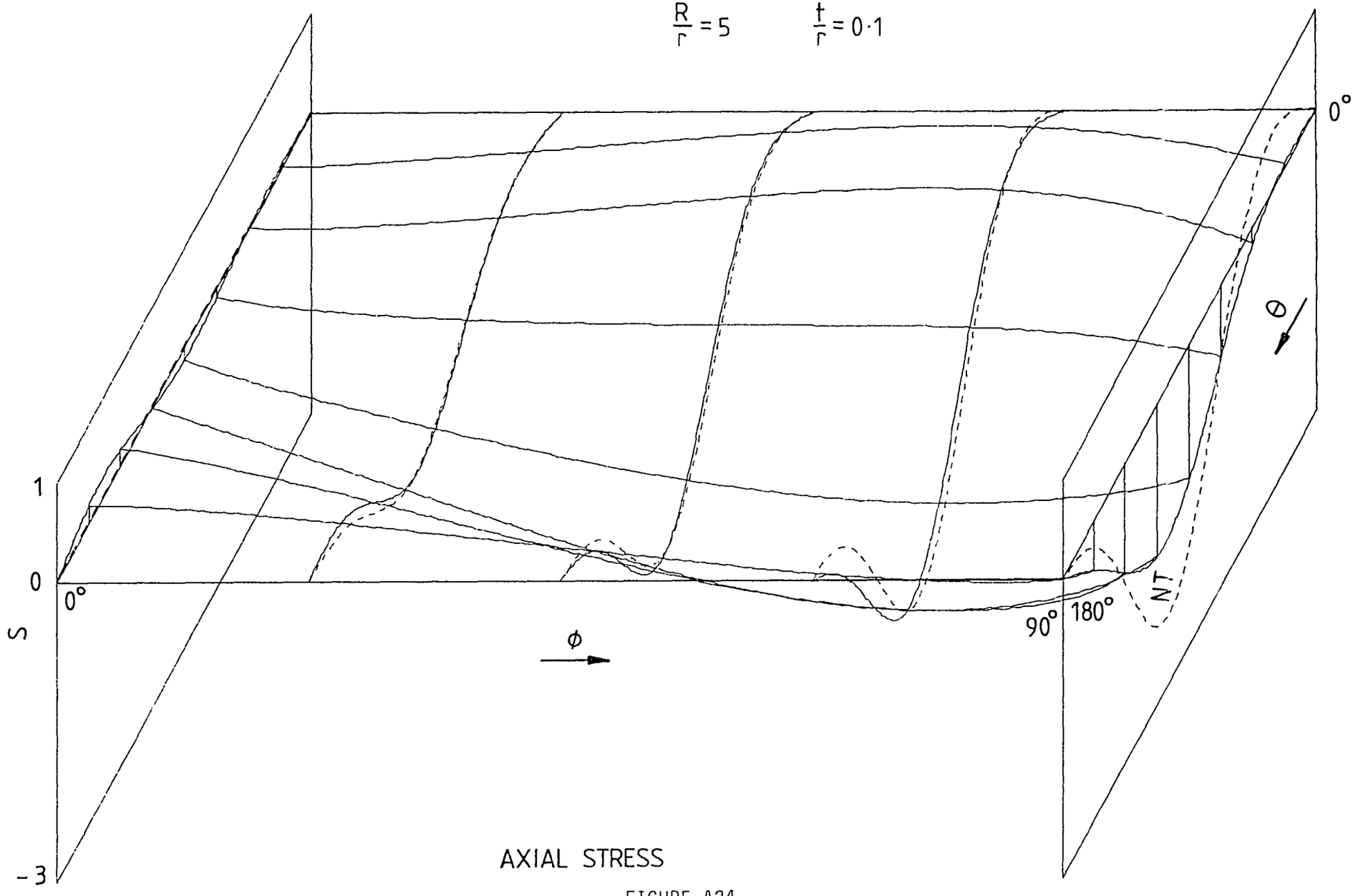


FIGURE A23



AXIAL STRESS

FIGURE A24

TABLE A23

R/r = 5.0 t/r = 0.1

OUTSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2159	0.2935	0.3859	0.4819	0.5738	0.6558	0.7216	0.7652	0.7818	0.7694	0.7325	0.6903	0.6720	1.0911
45.0	0.3130	0.4714	0.6464	0.8315	1.0144	1.1830	1.3243	1.4246	1.4718	1.4572	1.3791	1.2528	1.0805	1.9482
67.5	0.2081	0.3667	0.5392	0.7304	0.9281	1.1180	1.2846	1.4115	1.4829	1.4837	1.4014	1.2280	0.9229	1.8137
90.0	-0.0517	-0.0355	-0.0127	0.0281	0.0807	0.1390	0.1974	0.2501	0.2907	0.3113	0.3005	0.2403	0.1123	0.1969
112.5	-0.2600	-0.4065	-0.5829	-0.7637	-0.9433	-1.1104	-1.2525	-1.3558	-1.4075	-1.3960	-1.3144	-1.1624	-0.8904	-1.8190
135.0	-0.2545	-0.4149	-0.6561	-0.9315	-1.2236	-1.5096	-1.7661	-1.9699	-2.0966	-2.1224	-2.0254	-1.7841	-1.3289	-2.4299
157.5	-0.1176	-0.1872	-0.3337	-0.5151	-0.7155	-0.9169	-1.1025	-1.2562	-1.3610	-1.3991	-1.3532	-1.2039	-0.9155	-1.4583
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0520	0.0811	0.1380	0.1995	0.2640	0.3270	0.3825	0.4231	0.4403	0.4233	0.3585	0.2272	0.0513	0.5184
45.0	0.0227	0.0211	0.0676	0.1277	0.1974	0.2697	0.3363	0.3870	0.4096	0.3875	0.2988	0.1122	-0.1621	0.4059
67.5	-0.0783	-0.2031	-0.2698	-0.3155	-0.3456	-0.3640	-0.3740	-0.3793	-0.3865	-0.4063	-0.4552	-0.5586	-0.7196	-0.6359
90.0	-0.1246	-0.3913	-0.6098	-0.8153	-1.0088	-1.1856	-1.3382	-1.4581	-1.5378	-1.5719	-1.5563	-1.4910	-1.3371	-1.9525
112.5	-0.0087	-0.2890	-0.5586	-0.8382	-1.1192	-1.3890	-1.6340	-1.8394	-1.9890	-2.0639	-2.0413	-1.8985	-1.5179	-2.2417
135.0	0.1689	0.0172	-0.1647	-0.3718	-0.5891	-0.8042	-1.0086	-1.1934	-1.3468	-1.4512	-1.4831	-1.4199	-1.1088	-1.2688
157.5	0.1855	0.1531	0.0859	0.0003	-0.0926	-0.1867	-0.2807	-0.3739	-0.4629	-0.5397	-0.5926	-0.6117	-0.4939	-0.2776
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.5482	-0.5475	-0.5385	-0.5161	-0.4819	-0.4361	-0.3793	-0.3134	-0.2423	-0.1720	-0.1130	-0.0838	-0.0885	-0.6011
22.5	-0.5567	-0.5517	-0.5418	-0.5202	-0.4872	-0.4425	-0.3865	-0.3209	-0.2486	-0.1745	-0.1061	-0.0562	-0.0242	-0.5965
45.0	-0.5582	-0.5466	-0.5350	-0.5155	-0.4859	-0.4454	-0.3943	-0.3334	-0.2637	-0.1864	-0.1025	-0.0110	0.0939	-0.5648
67.5	-0.5146	-0.5024	-0.4892	-0.4703	-0.4445	-0.4120	-0.3732	-0.3282	-0.2758	-0.2133	-0.1348	-0.0280	0.1079	-0.4795
90.0	-0.4424	-0.4324	-0.4151	-0.3918	-0.3663	-0.3411	-0.3175	-0.2952	-0.2719	-0.2429	-0.2001	-0.1314	-0.0407	-0.3707
112.5	-0.4231	-0.4115	-0.3876	-0.3569	-0.3267	-0.3006	-0.2802	-0.2654	-0.2549	-0.2455	-0.2327	-0.2133	-0.1841	-0.3451
135.0	-0.4977	-0.4905	-0.4684	-0.4384	-0.4042	-0.3674	-0.3288	-0.2892	-0.2495	-0.2104	-0.1739	-0.1446	-0.1165	-0.4747
157.5	-0.5987	-0.6095	-0.6032	-0.5862	-0.5542	-0.5055	-0.4401	-0.3596	-0.2672	-0.1676	-0.0681	0.0243	0.1005	-0.6719
180.0	-0.6412	-0.6637	-0.6681	-0.6598	-0.6306	-0.5772	-0.4994	-0.3992	-0.2807	-0.1504	-0.0173	0.1112	0.2151	-0.7644

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	3.818	5.911	8.481	11.349	14.31[illegible]	17.15[illegible]	[illegible]	21.473	22.478	22.423	21.160	18.663	15.089	27.900

TABLE A24

R/r = 5.0 t/r = 0.1

INSIDE HOOP STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Without Tangents x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.2522	-0.3192	-0.4221	-0.5278	-0.6290	-0.7193	-0.7915	-0.8384	-0.8537	-0.8341	-0.7821	-0.7135	-0.7167	-1.1949
45.0	-0.3705	-0.5156	-0.7120	-0.9185	-1.1235	-1.3130	-1.4718	-1.5837	-1.6335	-1.6089	-1.5049	-1.3290	-1.1730	-2.1576
67.5	-0.2539	-0.3982	-0.5949	-0.8129	-1.0406	-1.2608	-1.4547	-1.6028	-1.6852	-1.6824	-1.5770	-1.3516	-1.0276	-2.0382
90.0	0.0478	0.0612	0.0278	-0.0271	-0.0985	-0.1779	-0.2575	-0.3301	-0.3870	-0.4172	-0.4062	-0.3280	-0.1536	-0.2492
112.5	0.2904	0.4937	0.6768	0.8670	1.0544	1.2274	1.3715	1.4714	1.5121	1.4817	1.3728	1.1914	0.9466	2.0151
135.0	0.2808	0.5084	0.7583	1.0537	1.3706	1.6818	1.9596	2.1759	2.3026	2.3123	2.1810	1.8953	1.4227	2.7069
157.5	0.1238	0.2372	0.3850	0.5791	0.7982	1.0200	1.2241	1.3907	1.4997	1.5308	1.4653	1.2912	0.9724	1.6206
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.0862	-0.0784	-0.0917	-0.0998	-0.1033	-0.1029	-0.1000	-0.0970	-0.0974	-0.1074	-0.1375	-0.2046	-0.3886	-0.1872
45.0	-0.1567	-0.1991	-0.2664	-0.3249	-0.3752	-0.4169	-0.4494	-0.4734	-0.4915	-0.5102	-0.5425	-0.6101	-0.8044	-0.7094
67.5	-0.1618	-0.2860	-0.4294	-0.5654	-0.6936	-0.8102	-0.9105	-0.9899	-1.0456	-1.0776	-1.0906	-1.0926	-1.1206	-1.3424
90.0	-0.0553	-0.1931	-0.3558	-0.5164	-0.6733	-0.8216	-0.9555	-1.0687	-1.1551	-1.2088	-1.2229	-1.1836	-1.0971	-1.3385
112.5	0.1171	0.0662	-0.0169	-0.0995	-0.1795	-0.2573	-0.3337	-0.4093	-0.4833	-0.5521	-0.6070	-0.6243	-0.6642	-0.4057
135.0	0.2193	0.2544	0.2736	0.2996	0.3328	0.3651	0.3870	0.3891	0.3634	0.3058	0.2177	0.1141	-0.1270	0.6001
157.5	0.1649	0.2062	0.2523	0.3080	0.3720	0.4358	0.4897	0.5242	0.5307	0.5027	0.4374	0.3385	0.1088	0.7052
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.3770	-0.3509	-0.3213	-0.2938	-0.2678	-0.2443	-0.2248	-0.2109	-0.2044	-0.2070	-0.2195	-0.2383	-0.2713	-0.3125
22.5	-0.4042	-0.3828	-0.3555	-0.3281	-0.3006	-0.2737	-0.2485	-0.2264	-0.2093	-0.1990	-0.1969	-0.2021	-0.2212	-0.3553
45.0	-0.4777	-0.4693	-0.4496	-0.4244	-0.3941	-0.3585	-0.3180	-0.2735	-0.2265	-0.1787	-0.1324	-0.0909	-0.0570	-0.4704
67.5	-0.5579	-0.5696	-0.5648	-0.5471	-0.5166	-0.4725	-0.4146	-0.3429	-0.2577	-0.1598	-0.0504	0.0671	0.1892	-0.6037
90.0	-0.5760	-0.6103	-0.6243	-0.6181	-0.5922	-0.5468	-0.4819	-0.3969	-0.2906	-0.1618	-0.0095	0.1668	0.3513	-0.6609
112.5	-0.5099	-0.5487	-0.5700	-0.5689	-0.5480	-0.5098	-0.4553	-0.3843	-0.2950	-0.1852	-0.0533	0.1022	0.2596	-0.5848
135.0	-0.4351	-0.4411	-0.4417	-0.4292	-0.4064	-0.3760	-0.3397	-0.2980	-0.2508	-0.1980	-0.1397	-0.0774	-0.0125	-0.4424
157.5	-0.4218	-0.3764	-0.3388	-0.3054	-0.2748	-0.2464	-0.2207	-0.1993	-0.1849	-0.1807	-0.1895	-0.2144	-0.2276	-0.3498
180.0	-0.4327	-0.3627	-0.3057	-0.2618	-0.2268	-0.1978	-0.1741	-0.1580	-0.1535	-0.1654	-0.1976	-0.2531	-0.2923	-0.3274

DIAMETER EXPANSION FACTORS

Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	-3.818	-5.911	-8.481	-11.349	-14.314	-17.150	-19.617	-21.473	-22.478	-22.423	-21.160	-18.663	-15.089	-27.900