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SUBJECT: Discusses analysis used to meet current SRP seismic criteria for refueling water storage tank (RWST) per SEP Topic III-6. Preliminary results w/input & acceptance parameters encl. Final analysis will be available by 830715.

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ABSTRACT: Discusses analysis used to [illegible] current [illegible] seismic criteria for refueling water storage [illegible] (RWST) per SEP Topic III-6. Preliminary results w/input & acceptance parameters encl. Final analysis will be available by 850715.

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JOHN E. MAIER
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June 16, 1983

Director of Nuclear Reactor Regulation
Attention: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: SEP Topic III-6, Seismic Qualification of Tanks
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Crutchfield:

By letter dated January 14, 1982, RG&E stated that because the RWST did not meet current Standard Review Plan (SRP) seismic criteria, we planned to implement modifications. Since that time, RG&E has undertaken another analysis, using input criteria and acceptance criteria formulated for Ginna and other SEP plants during the course of the Systematic Evaluation Program. The preliminary results, together with the input and acceptance parameters, are included as Attachment A. As denoted in that analysis, RG&E considers that the RWST will not buckle, and should be acceptably anchored as well. The final certified analysis will not be available until approximately July 15, 1983. However, RG&E will commit to make any modifications deemed necessary by the results of the final analysis.

In RG&E's April 11, 1983 letter, we stated that the sodium hydroxide tank did not meet current SRP seismic criteria. However, the modifications required to meet current criteria were simple enough that the performance of a more refined analysis was not considered warranted. RG&E thus committed to perform the modification by the end of the 1984 refueling outage. For information RG&E has included, as Attachment B to this letter, the design criteria used in the analysis.

Finally, in the December 1982 Final Integrated Plant Safety Assessment Report for Ginna, it was noted that the only tank of concern with respect to flooding of safety-related equipment was the 75,000 gallon reactor makeup water tank. A more detailed review of all tanks in the auxiliary building has disclosed that additional tanks should have been seismically analyzed, since

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their collective failure, although not anticipated, could cause flood-related damage to safe shutdown equipment. The entire list of tanks, their capacity, and seismic qualification is provided in Attachment C. Also included is the net floor area of the auxiliary building basement, and the limiting height of safe shutdown equipment. Based on this evaluation, RG&E has concluded that the three CVCS Holdup Tanks should be seismically qualified, or prevented from impacting the safe shutdown equipment in the basement of the auxiliary building. The schedule for providing our resolution of the seismic qualification of these tanks is July 15, 1983. Based on the results of the analysis, which will use input and acceptance criteria previously found acceptable for SEP review, RG&E will modify the tanks, or prevent the content of the tanks from affecting vital safe shutdown equipment.

Very truly yours,

John E. Maier

ATTACHMENT A

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SUBJECT GINNA RWST

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OBJECTIVE:

TO INVESTIGATE THE ABILITY OF THE RWST TO WITHSTAND SSE INDUCED LATERAL LOADS. IT IS ASSUMED THAT THE TANK'S LATERAL LOAD CAPACITY IS GOVERNED BY THE MOMENT REQUIRED TO BUCKLE THE SHELL AND THE MOMENT CAPACITY OF THE BASE ANCHORAGE. THUS THESE TWO MOMENT CAPACITIES ARE CALCULATED AND COMPARED TO THE SSE INDUCED OVERTURNING MOMENT.

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CONCLUSIONS

THE SSE INDUCED OVERTURNING MOMENT IS:

$M = 4.34E5$ K-IN (PG 10)

THE MOMENT THAT INDUCES BUCKLING OF THE SHELL IS:

$M_{BUCKLE} = 5.29E5$ K-IN (PG 12)

THE MOMENT CAPACITY OF THE BASE IS:

$M_{BASE} = 4.10E5$ K-IN

∴ UNDER AN SSE THE TANK DOES NOT BUCKLE BUT THE ANCHORAGE IS SLIGHTLY OVERSTRESSED. HOWEVER, FURTHER ANALYSIS COULD REDUCE THE SSE MOMENT (& THUS RELIEF THE OVERSTRESS) THROUGH THE FOLLOWING REFINEMENTS:

1. CURRENT ANALYSIS ASSUMES THE TANK IS FULL TO ITS MAXIMUM (338,000 gal) CAPACITY. NORMAL TANK FILL IS 300,000 gal. (SEE P6). USE OF 300,000 gal - IF JUSTIFIABLE - SHOULD DECREASE M ~ 15% → 20%.

2. SLOSHING HAS BEEN IGNORED - A CONSERVATIVE ASSUMPTION FOR THIS CASE. INCORPORATING SLOSHING IN THE MODEL SHOULD DECREASE M ~ 5%.

3. BASE FLEXIBILITY HAS BEEN IGNORED IN CALCULATING THE FUNDAMENTAL FREQUENCY. INCORPORATING BASE FLEXIBILITY SHOULD DECREASE M ~ 5% → 10%.

ASSUMPTIONS

1. THE TANK IS FIXED AT ITS BASE

2. THE TANK IS FULL OF WATER - NOTE THAT THE NORMAL WATER HEIGHT IS ONLY 876".
(DENSITY OF H_2O = 3.61 E-5 K/IN³)

3. SLOSHING IS NEGLIGIBLE

4. THE FUNDAMENTAL MODE SHAPE OF THE TANK IS THAT OF A UNIFORM CANTILEVER BEAM: UNDER ...

$$\phi(x) = \cosh\left(\frac{1.88x}{L}\right) - \cos\left(\frac{1.88x}{L}\right) - .734\left[\sinh\left(\frac{1.88x}{L}\right) - \sin\left(\frac{1.88x}{L}\right)\right] \quad (F\text{-}1)$$

(REF: BLEVINS, "FORMULAS FOR NAT'L FRQ : MODE SHAPE", p.108)

5. THE TANK'S MASS IS UNIFORMLY DISTRIBUTED OVER A LENGTH OF 81'(972") (SEE ATTACHED DRAWING FOR DIMENSIONS):

$$\text{WATER WEIGHT} = \rho_w \cdot \pi R^2 \cdot H$$

$$= (3.61E\text{-}5)(\pi\, 159^2)(972)$$

$$= 2.79\,E3 \text{ KIPS}$$

$$\text{STEEL WEIGHT} = \rho_s \cdot 2\pi R \cdot (t_1 H_1 + t_2 H_2 + t_3 H_3) + \rho_s \cdot (2\pi R_s h)\, t_s$$

$$= (2.84E\text{-}4 \text{ K/IN}^3)(6.28 * 159")(5/16 * 97 + 9/32" * 97 + 1/4 * (972 - 194))$$

$$+ (2.84E\text{-}4 \text{ K/IN}^3)(6.28 * 312" * 44")(.1/9")$$

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$= 71.5^k + 6.12^k$

TOTAL WEIGHT = $2.87E3^k$

WEIGHT/IN = $2.87E3/972 = 2.95\ ^k/IN$

CALCULATION OF FUNDAMENTAL FREQUENCY (f)

FOR A CANTILEVER BEAM

$$f = .560 \left(\frac{EI}{mL^4}\right)^{1/2} \text{ Hz}$$

USING $I = \pi (159)^3 (5/16) = 3.94\ E6$

$$f = .560 \left(\frac{(29E3)(3.94E6)(386)}{(2.95)(972)^4}\right)^{1/2} = 2.29 \text{ HZ}$$

USING $I = \pi (159)^3 (1/4)$

$$f = 2.29 \left(\frac{1}{4} \cdot \frac{16}{5}\right)^{1/2} = 2.05 \text{ HZ}$$

ASSUME THE AVERAGE BETWEEN THE ABOVE TWO VALUES

$$f = 2.2 \text{ HZ}$$

FOR THE FUNDAMENTAL MODE OF A CANTILEVER BEAM THE PARTICIPATION FACTOR (Γ_1) THE MODAL WEIGHT (W_1), THE MODAL OVERTURNING MOMENT (M_1) & THE MODAL BASE SHEAR (V_1) CAN BE CALCULATED AS FOLLOWS

$$\Gamma = \frac{\int_0^L (1.0)\phi(x)\,dx}{\int_0^L \phi^2(x)\,dx} = \frac{2(.734)/(1.875/L)}{L} = .783$$

(SEE BLEVINS APPENDIX C ITEMS 1 & 5)

$$W_1 = \frac{w\left[\int_0^L \phi(x)\,dx\right]^2}{\int_0^L \phi^2(x)\,dx} = (.783)^2\, wL$$

$$= .613\, wL \quad \text{, i.e. } 61.3\%$$

OF THE TOTAL MASS PARTICIPATED IN THE 1ST MODE

$$M_1 = m\Gamma\hat{S}_a \int_0^L x\,\phi(x)\,dx$$

$$= m(.783)\hat{S}_a\,(2L^2/1.875^2)$$

$$= .445\, m\hat{S}_a L^2$$

WHERE $\hat{S}_a$ IS THE SPECTRAL ACCELERATION IN IN/S²

$\therefore M_1 = .445\, w S_a L^2$ WHERE S_a IS THE SPECTRAL ACCELERATION IN IN/S²

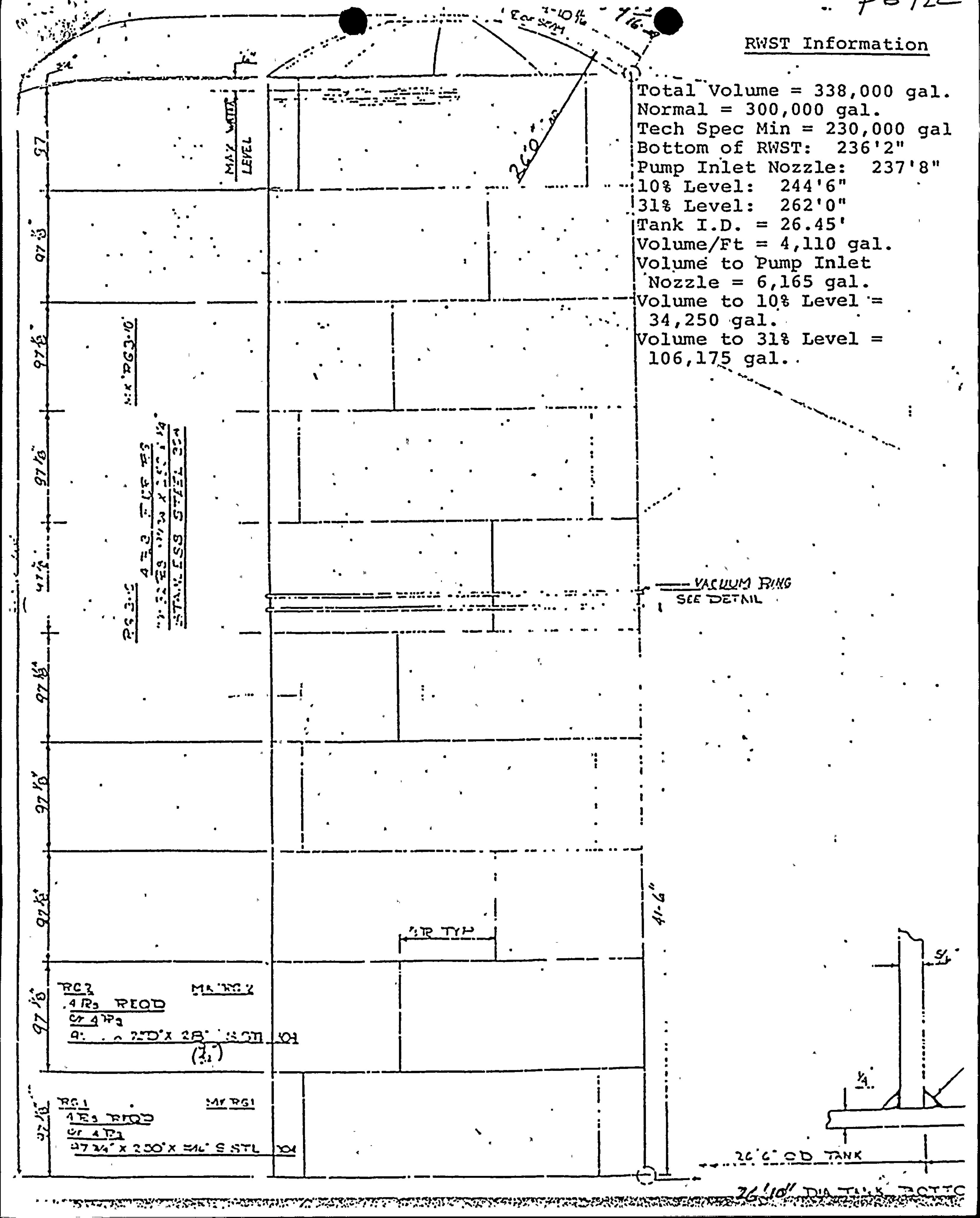
$$V = m\Gamma\hat{S}_a \int_0^L \phi(x)\,dx$$

$$= w\Gamma S_a \int_0^L \phi(x)\,dx$$

$$= W_1 S_a = .613\, wLS_a$$

RWST Information

Total Volume = 338,000 gal.
Normal = 300,000 gal.
Tech Spec Min = 230,000 gal
Bottom of RWST: 236'2"
Pump Inlet Nozzle: 237'8"
10% Level: 244'6"
31% Level: 262'0"
Tank I.D. = 26.45'
Volume/Ft = 4,110 gal.
Volume to Pump Inlet Nozzle = 6,165 gal.
Volume to 10% Level = 34,250 gal.
Volume to 31% Level = 106,175 gal.



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SUBJECT: GINNA RWST - SPECTRA -

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SPECTRA

FROM THE ATTACHED FIGURE:

FOR 5% DAMPING

$$S_a(f=2\,Hz) = .285\,g$$

$$S_a(f=2.5\,Hz) = .331\,g$$

ASSUMING A LINEAR RELATIONSHIP IN LOG-LOG SCALE BETWEEN S_a & f:

$$\log_{10}(S_a) = a\log_{10} f + b$$

$$\log_{10}(.285) = a\log_{10}(2) + b$$

$$\log_{10}(.331) = a\log_{10}(2.5) + b$$

$$-.545 = .301a + b$$

$$-.480 = .398a + b$$

$$\therefore -.545 = .301a - .480 - .398a$$

$$a = .670$$

$$b = -.480 - .398(.670) = -.747$$

$$\therefore \log_{10}(S_a) = .670\log_{10}(f) - .747$$

$$S_a = .179 f^{.670}$$

(S_a IN g's, f IN Hz)

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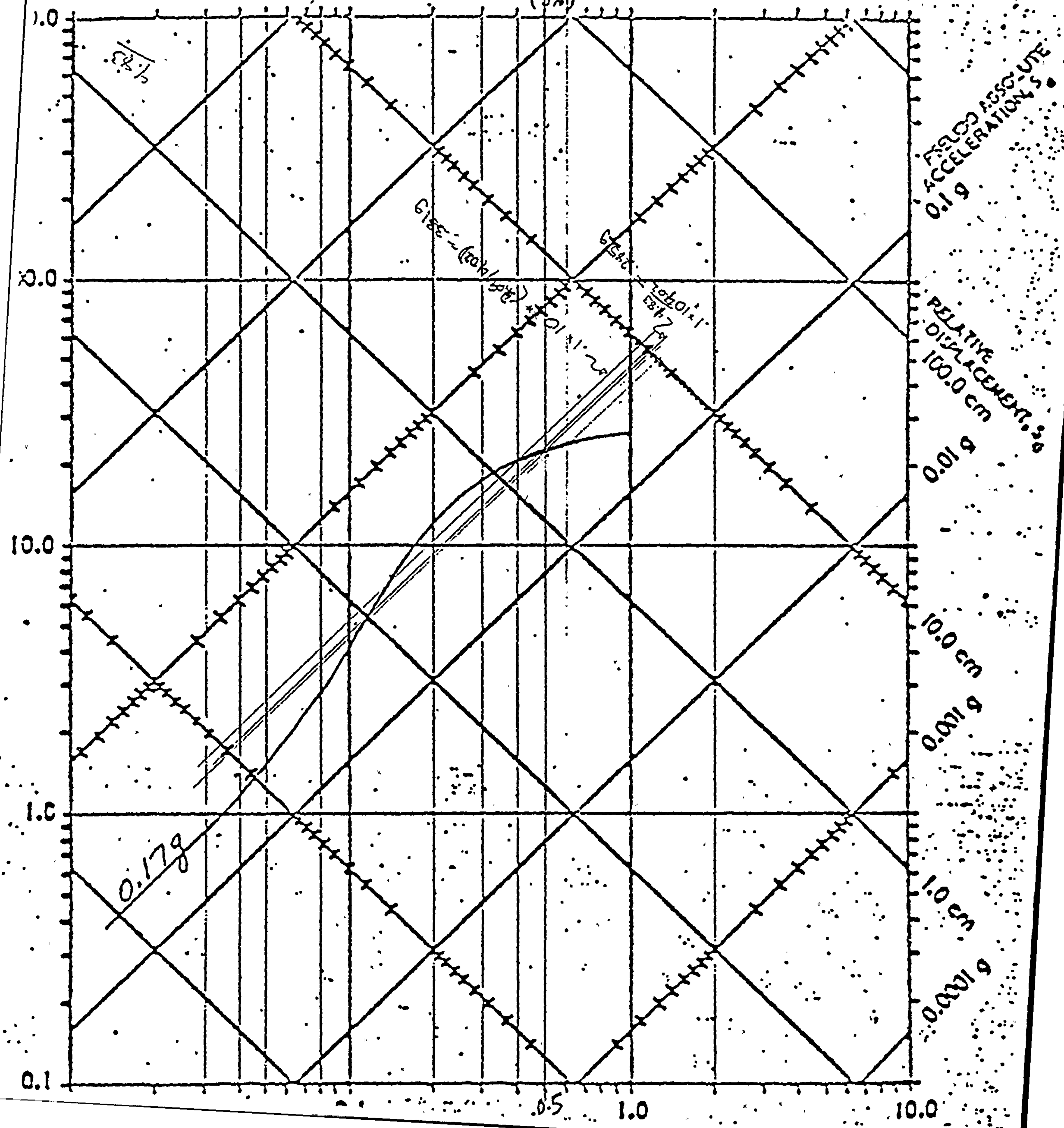
(FROM USNRC LETTER LS05-81-06-068 DATED 6/17/81; ATTACHMENT 1)

Attachment 1

Site Specific Spectrum



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ASSUMING (REF: IBID, ATTACHMENT 2)

$$S_a^{(x\%)} = S_a^{(5\%)} \times 10^{-2(x-.05)}$$

∴ @ 3% DAMPING $S_a^{(3\%)} = 1.10\, S_a^{(5\%)} = .197 f^{.670}$

@ 4% DAMPING $S_a^{(4\%)} = 1.05\, S_a^{(5\%)} = .188 f^{.670}$

@ 7% DAMPING $S_a^{(7\%)} = .912\, S_a^{(5\%)} = .163 f^{.670}$

S_a AS A FUNCTION OF f & DAMPING

f \ DAMP.	3%	4%	7%
2.00	.313	.299	.259
2.05	.319	.304	.264
2.10	.324	.309	.268
2.15	.329	.314	.272
2.20	.334	.319	.276
2.25	.339	.324	.281
2.30	.344	.328	.285
2.35	.349	.333	.289

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ASSUMPTIONS

1. THE 38.6% OF THE TANK MASS THAT DOES NOT PARTICIPATE IN THE 1ST MODE IS ACCELERATED @ THE ZPA VALUE OF 0.17g & WILL BE ABSOLUTELY SUMMED WITH THE 1ST MODE RESPONSE.

2. BOLT YIELD WILL OCCUR PRIOR TO SHELL BUCKLING THEREFORE 7% DAMPING WILL BE ASSUMED. ($M_{BASE} < M_{BUCKLE}$ SEE PGS 12 & 22 [illegible] IF [illegible] DAMPING WILL [illegible] ASSUMED)

CALCULATION OF OVERTURNING MOMENT (M) & BASE SHEAR (V)

	M (K·IN)		V (K)	
	7% DAMPING	4% DAMPING	7% DAMPING	4% DAMPING
1ST MODE	$.445\, w\, S_a L^2$ $= (.445)(2.95\,K/IN)(.276)(972)^2$ $= 3.42E5$ K·IN	$3.42E5 \frac{.319}{.276}$ $= 3.92E5$	$.613\, w L\, S_a$ $= .613(2870^K)(.276)$ $= 486^K$	$486^K \frac{.319}{.276}$ $= 562^K$
REMAINING MASS	$.386(2870^K)\left(\frac{1172}{2}\right)(.17)$ $= 9.15E4$ K·IN	$= 9.15E4$ K·IN	$.386(2870^K)(.17)$ $= 188^K$	$= 188^K$
TOTAL	$= 4.34E5$ K·IN	$= 4.84E4$ K·IN	$= 674^K$	$= 750^K$

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SUBJECT GINNA RWST
- SHELL BUCKLING -

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ASSUMPTIONS

1. THE SHELL BUCKLING FORMULAE USED ARE BASED ON LOWER BOUND ENVELOPES OF TEST RESULTS. AN ADDITIONAL SAFETY FACTOR OF 1.5 WILL BE APPLIED.

2. THE CRITICAL ELEVATION FOR BUCKLING IS AT THE TANK BASE - MAXIMUM BENDING MOMENT OCCURS AT THIS POINT.

3. BENDING MOMENT IS THE SIGNIFICANT CAUSE OF BUCKLING; THE EFFECT OF SHEAR FORCES ON BUCKLING ARE NEGLECTED

CALCULATION OF M_{BUCKLE}, THE MOMENT @ WHICH BUCKLING IS INDUCED AT THE BOTTOM OF THE TANK

SHELL PARAMETERS:

- $R/t = 159"/(5/16") = 509$
- $Et/R = 29000 \text{ KSI}/509 = 57.0 \text{ KSI}$
- P = HYDROSTATIC PRESSURE @ TANK BOTTOM
  $= (3.61E\text{-}5 \text{ K/IN}^3) \cdot (972") = 3.51E\text{-}2 \text{ KSI}$
- $\frac{P}{E}\left(\frac{R}{t}\right)^2 = \frac{3.51E\text{-}2}{29.E3}(509)^2 = .314$

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- SHELL BUCKLING -

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THE BUCKLING EQUATIONS USED ARE FROM:

BAKER, KOVALEVSKY, & RISH, STRUCTURAL ANALYSIS OF SHELLS, CHAPTER 10

$$M_{BUCKLE} = \pi R^2 \sigma_{BUCKLE} t$$

WHERE

$$\sigma_{BUCKLE} = (\gamma C + \Delta C) \frac{Et}{R}$$

AND

$$C = \frac{1}{\sqrt{3(1-\nu^2)}} = \frac{1}{\sqrt{3(1-.3^2)}} = .605$$

$\gamma = .42$ (FIGURE 10-13 (ATTACHED))

$\Delta C = .31$ (FIGURE 10-14 (ATTACHED))

THEREFORE

$$\sigma_{BUCKLE} = (.42(.605) + .31)\,57 \text{ KSI}$$
$$= 32 \text{ KSI}$$

$$\therefore M_{BUCKLE} = \pi (159)^2 (5/16)\,32 = 7.94E5 \text{ K·IN}$$

APPLY AN ADDITIONAL SAFETY FACTOR OF 1.5:

$$M_{BUCKLE} = \frac{7.94E5}{1.5} = 5.29E5 \text{ K·IN}$$

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(BAKER, KOVALEVSKY ; RISH) PB/22

The formula for the buckling stress of moderately long cylinders subjected to bending may be written in the more useful form

$$\frac{\sigma_{cr}}{\eta} = \gamma C_b \frac{Et}{R}$$

where

$$C_b = \frac{1}{[3(1-\mu^2)]^{1/2}}$$

σ_{cr} is the maximum stress due to the bending moment (e.g., the outer fiber stress). For elastic buckling, the plasticity correction term $\eta = 1.0$ is used. For inelastic buckling, the critical stress σ_{cr} may be found by using the plasticity corrections suggested in axial compression.

If the stresses are elastic, the allowable moment is

$$M_{cr} = \pi R^2 \sigma_{cr} t$$

Pressurized: The buckling stress of moderately long cylinders subjected to internal pressure and bending may be determined by using Fig. 10-14 in conjunction with Fig. 10-13. Figure 10-14 presents curves

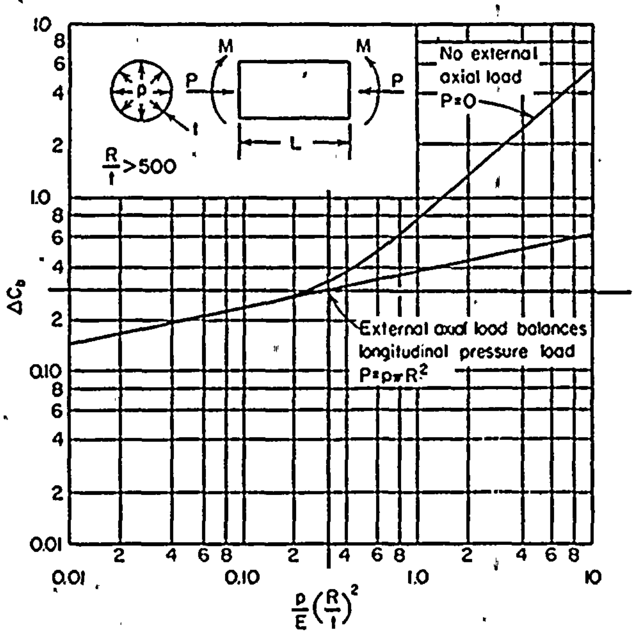

Figure 10-14 *Increase in bending buckling-stress coefficient for cylinders due to internal pressure.*

(BAKER, KOVALEVSKY & RISH) P14/22

subjected to torsion and internal pressure only. The second curve, labeled "External axial load balances longitudinal pressure load," should be used to calculate the critical stress of a cylinder subjected to torsion and internal pressure plus an external axial compression load equal to the internal pressure load $\pi R^2 p$, acting on the heads of the cylinder. It should be noted that the pressurized design curves of Fig. 10-12 are valid only for moderately long cylinders. For inelastic buckling the critical shear stress may be obtained by following the procedure outlined in Sec. 10-3. The total stress field should be taken into consideration when the plasticity correction is determined.

Bending, Unstiffened Cylinders

Unpressurized: The design-allowable buckling stress for a thin-walled circular cylinder subjected to bending may be obtained from the equations presented for axial compression if γ is obtained from Fig. 10-13. The classical theoretical buckling stress is

$$\sigma_c = \frac{Et}{R[3(1-\mu^2)]^{1/2}}$$

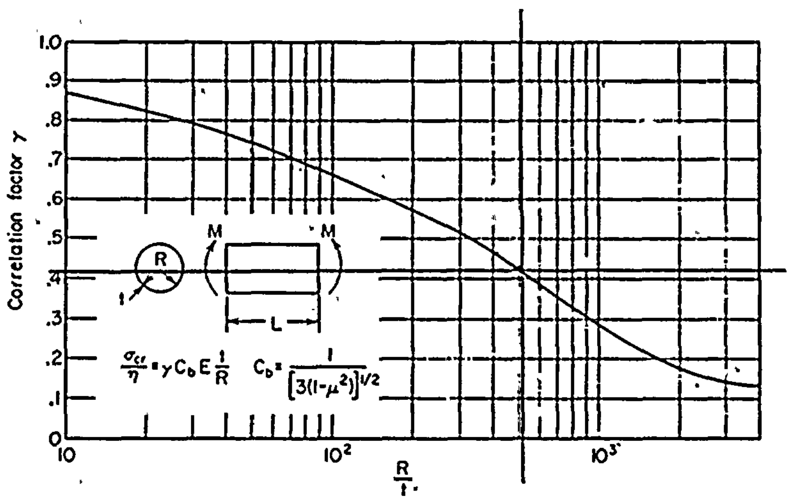

figure 10-13 *Correlation factors for unstiffened unpressurized circular cylinders subjected to bending.*

The majority of the test data available for cylinders subjected to bending are presented in Refs. 10-2 and 10-3. Very few data are available in the short-cylinder range.

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ASSUMPTIONS

1. THE TANK BOTTOM IS INFINITELY FLEXIBLE; THE OVERTURNING MOMENT IS RESISTED COMPLETELY BY BEARING OF THE SHELL ON THE CONCRETE ON THE COMPRESSION SIDE & THE ANCHOR BOLTS ON THE TENSION SIDE.

2. ON THE COMPRESSION SIDE THE LOAD FROM THE SHELL IS DISTRIBUTED OVER A STRIP OF THICKNESS t_c EQUAL TO 6 x THE SHELL THICKNESS; $t_c = 6 \cdot 5/16'' = 1.88''$

3. THE CONCRETE STRESS DEVELOPED IS EQUAL TO THE ACI ALLOWABLE BEARING STRESS FOR CONCRETE:

$$F_c = 2 \cdot \phi \cdot (.85 f_c')$$
$$= 2(.7)(.85 f_c')$$
$$= 1.19 f_c'$$

(REF ACI 9.2.1 ; 10.14.2)

4. $f_c' = 3$ KSI (REF: CONVERSATION W/ G. WROBEL)

$$\therefore F_c = (1.19)(3\text{ KSI}) = 3.57 \text{ KSI}$$

5. ON THE TENSION SIDE THE LOAD IS RESISTED BY A SMEARED BOLT AREA OF t_B, BASED ON THE NOMINAL AREA OF 30 2 1/4" ϕ ANCHOR BOLTS EQUALLY SPACED ABOUT THE TANK PERIMETER.

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- BASE CAPACITY -

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$$t_B = \frac{\pi (2.25\,IN)^2/4}{2\pi (159\,IN)/30} = 0.119\,IN$$

6. THE TENSILE FORCES ON THE SHELL BOTTOM VARY LINEARLY FROM ZERO AT THE NEUTRAL AXIS TO A MAXIMUM AT A DISTANCE R (THE TANK RADIUS) FROM THE NEUTRAL AXIS

7. THE MAXIMUM ALLOWABLE TENSILE STRESS IN THE BOLT IS:

$$F_B = 0.7\,F_U$$

[illegible]

WHERE

$F_U = 58$ KSI (BASED ON A36 MILD STEEL REF AISC TABLE 1B, P4-3)

$$\therefore F_B = 0.7(58) = 40.6\ KSI$$

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SUBJECT: GINNA RWST – BASE CAPACITY –

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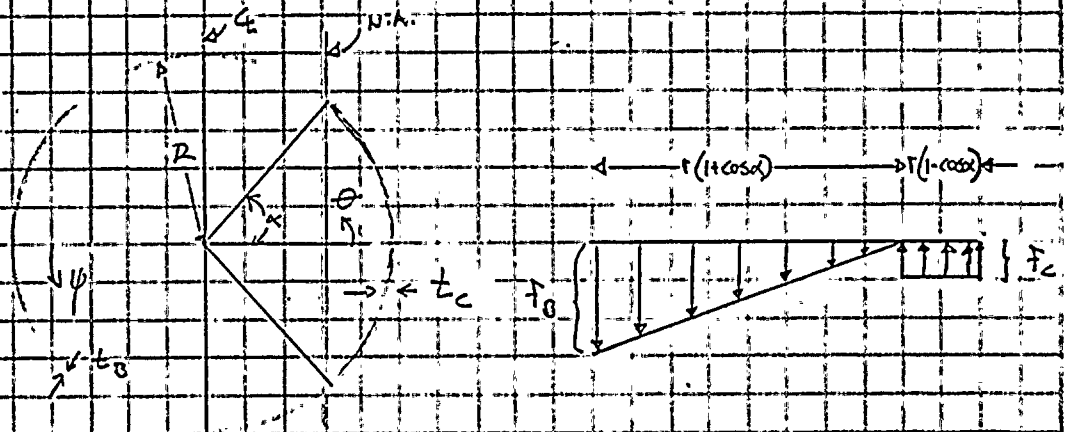
CALCULATION OF M_{BASE}, THE MOMENT CAPACITY OF THE TANK BASE



FORCE DUE TO BOLT STRESS

$$F_B = \frac{2Rt_Bf_B}{1+\cos\alpha}\int_0^{\pi-\alpha}(\cos\psi+\cos\alpha)\,d\psi$$

$$= \frac{2Rt_Bf_B}{1+\cos\alpha}\Big[\sin\psi+\psi\cos\alpha\Big]_0^{\pi-\alpha}$$

$$= 2Rt_Bf_B\,\frac{\sin\alpha+(\pi-\alpha)\cos\alpha}{1+\cos\alpha}$$

$$= 2Rt_Bf_Bg_1 \qquad (B\text{-}1)$$

$$\left(g_1 = \frac{\sin\alpha+(\pi-\alpha)\cos\alpha}{1+\cos\alpha}\right)$$

MOMENT DUE TO BOLT STRESS (ABOUT ℄):

$$M_B = \frac{2R^2 t_B f_B}{1+\cos\alpha}\int_0^{\pi-\alpha}(\cos\psi + \cos\alpha)\cos\psi\, d\psi$$

$$= \frac{2R^2 t_B f_B}{1+\cos\alpha}\left[\frac{\psi}{2} + \frac{\sin 2\psi}{4} + \sin\psi\cos\alpha\right]_0^{\pi-\alpha}$$

$$= \frac{2R^2 t_B f_B}{1+\cos\alpha}\left(\frac{\pi-\alpha}{2} - \frac{\sin 2\alpha}{4} + \sin\alpha\cos\alpha\right)$$

$$= \frac{2R^2 t_B f_B}{1+\cos\alpha}\left(\frac{\pi-\alpha}{2} - \frac{\sin\alpha\cos\alpha}{2}\right)$$

$$= R^2 t_B f_B g_2 \qquad \text{(B-2)}$$

$$\left(g_2 = \frac{\pi-\alpha-\sin\alpha\cos\alpha}{1+\cos\alpha}\right)$$

FORCE DUE TO CONCRETE STRESS:

$$F_c = 2\alpha R t_c f_c \qquad \text{(B-3)}$$

MOMENT DUE TO CONCRETE STRESS: (ABOUT ℄)

$$M_c = 2R^2 t_c f_c \int_0^{\alpha}\cos\theta\, d\theta$$

$$= 2R^2 t_c f_c \sin\alpha \qquad \text{(B-4)}$$

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FORCE EQUILIBRIUM:

$$F_B = F_C$$

$$2 R t_B f_B g_1 = 2 \alpha R t_c f_c$$

$$g_1 / \alpha = \frac{t_c f_c}{t_B f_B} \quad \text{(B-5)}$$

MOMENT EQUILIBRIUM:

$$M_{BASE} = M_B + M_C$$

$$= R^2 t_B f_B g_2 + 2 R^2 t_c f_c \sin\alpha$$

$$= R^2 t_B f_B \left(g_2 + \frac{2 g_1}{\alpha} \sin\alpha \right) \quad \text{(B-6)}$$

$$\frac{M_{BASE}}{\pi R^2 t_B f_B} = \left(g_2 + \frac{2 g_1}{\alpha} \sin\alpha \right) / \pi \quad \text{(B-6)}$$

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```
10 PI=3.14159:LPRINT "          Alpha          B-5          B-6":LPRINT
20 FOR I=1 TO 90
30 A=I*PI/180:S=SIN(A):C=COS(A)
40 G1=(S+(PI-A)*C)/(1+C)
50 G2=(PI-A-S*C)/(1+C)
60 B5=G1/A
70 B6=(G2+2*G1*S/A)/PI
80 A=A*180/PI
90 LPRINT USING "      ##.##^^^^";A;B5;B6
100 NEXT I
```

Alpha (DEG)	B-5	B-6
1.00E+00	9.00E+01	1.49E+00
2.00E+00	4.50E+01	1.49E+00
3.00E+00	3.00E+01	1.48E+00
4.00E+00	2.25E+01	1.48E+00
5.00E+00	1.80E+01	1.47E+00
6.00E+00	1.50E+01	1.46E+00
7.00E+00	1.28E+01	1.46E+00
8.00E+00	1.12E+01	1.45E+00
9.00E+00	9.94E+00	1.44E+00
1.00E+01	8.94E+00	1.44E+00
1.10E+01	8.11E+00	1.43E+00
1.20E+01	7.42E+00	1.42E+00
1.30E+01	6.84E+00	1.41E+00
1.40E+01	6.34E+00	1.41E+00
1.50E+01	5.91E+00	1.40E+00
1.60E+01	5.53E+00	1.39E+00
1.70E+01	5.19E+00	1.38E+00
1.80E+01	4.89E+00	1.38E+00
1.90E+01	4.62E+00	1.37E+00
2.00E+01	4.38E+00	1.36E+00
2.10E+01	4.16E+00	1.35E+00
2.20E+01	3.96E+00	1.34E+00
2.30E+01	3.78E+00	1.33E+00
2.40E+01	3.61E+00	1.33E+00
2.50E+01	3.46E+00	1.32E+00
2.60E+01	3.31E+00	1.31E+00
2.70E+01	3.18E+00	1.30E+00
2.80E+01	3.06E+00	1.29E+00
2.90E+01	2.94E+00	1.28E+00
3.00E+01	2.83E+00	1.27E+00
3.10E+01	2.73E+00	1.27E+00
3.20E+01	2.64E+00	1.26E+00
3.30E+01	2.55E+00	1.25E+00
3.40E+01	2.46E+00	1.24E+00
3.50E+01	2.38E+00	1.23E+00
3.60E+01	2.31E+00	1.22E+00
3.70E+01	2.23E+00	1.21E+00
3.80E+01	2.17E+00	1.20E+00
3.90E+01	2.10E+00	1.20E+00
4.00E+01	2.04E+00	1.19E+00
4.10E+01	1.98E+00	1.18E+00
4.20E+01	1.92E+00	1.17E+00
4.30E+01	1.87E+00	1.16E+00
4.40E+01	1.82E+00	1.15E+00

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4.50E+01	1.77E+00	1.14E+00
4.60E+01	1.72E+00	1.13E+00
4.70E+01	1.68E+[illegible]	1.13E+00
4.80E+01	1.63E+00	1.12E+00
4.90E+01	1.59E+00	1.11E+00
5.00E+01	1.55E+00	1.10E+00
5.10E+01	1.51E+00	1.09E+00
5.20E+01	1.48E+00	1.08E+00
5.30E+01	1.44E+00	1.08E+00
5.40E+01	1.40E+00	1.07E+00
5.50E+01	1.37E+00	1.06E+00
5.60E+01	1.34E+00	1.05E+00
5.70E+01	1.31E+00	1.05E+00
5.80E+01	1.28E+00	1.04E+00
5.90E+01	1.25E+00	1.03E+00
6.00E+01	1.22E+00	1.02E+00
6.10E+01	1.19E+00	1.02E+00
6.20E+01	1.16E+00	1.01E+00
6.30E+01	1.14E+00	1.00E+00
6.40E+01	1.11E+00	9.97E-01
6.50E+01	1.09E+00	9.91E-01
6.60E+01	1.06E+00	9.84E-01
6.70E+01	1.04E+00	9.78E-01
6.80E+01	1.02E+00	9.73E-01
6.90E+01	9.95E-01	9.67E-01
7.00E+01	9.74E-01	9.62E-01
7.10E+01	9.53E-01	9.56E-01
7.20E+01	9.32E-01	9.51E-01
7.30E+01	9.12E-01	9.47E-01
7.40E+01	8.93E-01	9.42E-01
7.50E+01	8.74E-01	9.38E-01
7.60E+01	8.56E-01	9.34E-01
7.70E+01	8.38E-01	9.30E-01
7.80E+01	8.20E-01	9.26E-01
7.90E+01	8.03E-01	9.23E-01
8.00E+01	7.86E-01	9.20E-01
8.10E+01	7.69E-01	9.17E-01
8.20E+01	7.53E-01	9.14E-01
8.30E+01	7.38E-01	9.12E-01
8.40E+01	7.22E-01	9.10E-01
8.50E+01	7.07E-01	9.09E-01
8.60E+01	6.93E-01	9.07E-01
8.70E+01	6.78E-01	9.06E-01
8.80E+01	6.64E-01	9.06E-01
8.90E+01	6.50E-01	9.05E-01
9.00E+01	6.37E-01	9.05E-01

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FOR THE LISTED ASSUMPTIONS

$$\frac{t_c F_c}{t_B F_B} = \frac{(1.88)(3.57)}{(.119)(40.6)} = 1.39$$

∴ FROM P B7 ... "1"

$$\alpha = 54^\circ$$

$$\frac{M_{BASE}}{\pi R^2 t_B F_B} = .1007$$

$$M_{BASE} = .1007 \pi (159)^2 (.119)(40.6)$$

$$= 4.10E5 \text{ K-IN}$$