HEA

HARSTEAD ENGINEERING ASSOCIATES • INC.

169 KINDERKAMACK ROAD, PARK RIDGE, N. J. 07656 • Phone: (201) 391-2115

D.C. COOK NUCLEAR POWER PLANT

AMERICAN ELECTRIC POWER

ESTIMATE OF ULTIMATE PRESSURE CAPACITY OF CONTAINMENT STRUCTURE

Prepared by:

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September 26, 1980

1. Introduction

A review of the Containment Structure of the Donald C. Cook Plant was undertaken for the purpose of obtaining a rough estimate of the ultimate strength of the containment to resist internal pressure loads. Due to the fact that D.C. Cook Units 1 and 2 make use of ice condensers, the design pressure for the containment structure is much lower than the dry containments such as TMI #2.

2. Description

2.1 Containment Dome and Cylinder

The cylinder has an inside radius of 57.5 ft. and a height from the base mat to the springline of dome of approximately 113 ft. The cylinder walls have a thichness of 3.0 ft. of reinforced concrete and an inner steel liner with a thickness of 3/8". The reinforcing is generally two layers of #18 @ 18" o/c in the hoop direction.

The dome is essentially hemispheric with a thickness that varies from 3 ft. at the springline and 2 ft. at its peak. The reinforcing pattern generally is two layers of #18 @ 18" o/c in both the meridional and hoop direction.

2.2 Penetrations

The containment cylinder has many penetrations for piping, electrical conduct, etc. The two largest are the equipment hatch and the personnel hatch. In general, the liner plate surrounding the opening has a thickness of 3/4", which satisfies the area replacement rule of openings in pressure vessels. The reinforcing bars are either bent aroung the opening or are interrupted. Thickening of the concrete around the opening is only provided at the equipment hatch and personnel hatch. In the case of these two hatches, practically all the bars are interrupted and anchored by

means of a cadwell connection weld to a steel plate.

The equipment hatch cover is mounted on the outside of the penetration barrel and is bolted to the barrel. The hatch cover also accomodates a second personnel air lock. The hatch cover is 4" thick ASTMA516 Gr. 70; however, due to the size, the plate is spliced and bolted together. In addition, the personnel air lock cover is 1" thick. The openings for the equipment hatch and the personnel air locks are about 20 ft. and 10 ft. respectively.

2.3 Foundation Base Mat

The mat is not an ideal circular disk with a thickness of 10 ft, due to the pits and depressions, such as those required by the reactor, instrumentation, refueling canal, etc. The top is lined with 1/4" steel plate.

2.4 Crane Wall

The crane extends from the base mat up 115 ft. to a little above the spring line of the dome. The operating deck acts as a diaphram and is located about 54 ft. above the mat. While the crane wall forms a cylinder above the operating deck, below the operating deck the wall is not continuous in the hoop direction.

3. Analysis

3.1 General

A review was undertaken of pertinent material from the FSAR and amendments. Additional familiarity with the structures was obtained by a review of the engineering drawings and certain vendor drawings. Dead loads and pressure loads were the only loads considered. Inasmuch as an estimate of ultimate capacity is desired, the elements of the structure were examined and likely failure mechanisms were postulated. In general, the failure mechanism was considered one where general yielding occurred due to primary stresses. Secondary stresses would not be a factor in significantly reducing ultimate capacity in a ductile structure. Under ultimate conditions self relieving stresses caused by thermal effects and geometrical constraints were ignored due to the fact that these effects have little effect on the ultimate capacity under internal pressure and would be less than the margin of error implicit in approximate methods used in this analysis.

3.2 Containment Dome

Based upon a failure mechanism due to membrane yielding of both the rebar and the liner, the ultimate pressure was calculated as 85 psig.

3.3 Containment Cylinder

Neglecting for the moment the effect of the penetraions, the failure mechanism in the hoop direction is the result of yielding of both the hoop rebar and the liner in the hoop direction. The ultimate pressure was calculated as 56 psig. In meridional direction, the failure mechanism is more complicated for several reasons:

(1) The liner is not anchored into the mat and therefore cannot carry meridional forces until the anchorage of the liner can provide adequate shear anchorage.

(2) The dead load effect of the containment structure

in resisting pressure loads increases for lower elevations.

(3) The anchorage of verticals into the mat may not fully develop the yield stress of the rebar.

The mechanism considered for the anchorage is that diagonal cracks will form from the ends of the hooked meridional bars. The resistance provided for the anchorage consists of the concrete plug, the weight of fill concrete, the pressure acting on the mat, and vertical #11 bars which were placed probably because of the two layered concrete pour of the mat. The vertical #11 bars were not considered very effective in increasing the anchorage capacity.

Discontinuity moments and shears were neglected in this analysis. The effects while resulting in very high stresses under elastic conditions are self relieving. Based upon the obervation of the reinforcing in the haunch of the cylinder and the liner "knuckle" detail, these effects should not have significant effects on the ultimate pressure load.

If the rebar were fully anchored into the mat the ultimate pressure would be 72 psig. Because of the anchorage detail used, the ultimate pressure is reduced to about 46 psig.

3.4 Equipment Hatch

3.4.1 Hatch Cover

The hatch cover is complicated by the personnel air lock and the fact that a splice was necessary. Due to the complexity of the structure several mathematical models were examined. If the splicing detail acted as a beam the ultimate capacity would be limited to approximately 17.3 psig. However, if it is assummed that the splice can transfer plate bending moments in full, the ultimate pressure would approach that of a 4" thick circular plate, namely 52 psig. A check of the splice; however, indicates that the ultimate would be limited to about 24 psig.

The hatch cover is located outside of the containment; therefore, the pressure will place the bolts in tension. The ultimate capacity of these bolts is equivalent to 53 psig.

3.4.2 Containment Reinforcement

The concrete is thickned surrounding the equipment hatch and additional reinforcing is placed. The liner is thickned in accordance with the rule of area replacement.

A failure mechnaism was assumed in which the hoop and meridional forces are carried by reinforced concrete beams which are formed on each of four sides. The liner carries considerable membrane force in both the hoop and meridional direction. The equipment hatch is located sufficiently above the elevation of the mat so that the meridional forces carried by the liner are transferred to the concrete wall above the elevation of the knuckle. The ultimate pressure load for this case was calculated at 58 psig.

3.5 Personnel Air Lock

3.5.1 General

There are two personnel air locks for each containment structure. One of the personnel air locks is incorporated into the equipment hatch cover, while the other is independently anchored to the containment cylindrical wall.

3.5.2 Air Lock Cover

The hatch cover is a steel plate of a thickness of 1" with an access door rated at a design pressure of 18 psig. Stiffening plates around the door form part of structural resistance to external pressure. An ultimate pressure was calculated as 40 psig; however, it should be established as 36 psig, twice the design capacity of the door.

As was the case for the equipment hatch, the bolting has greater capacity that the plate material itself.

3.5.3 Containment Reinforcement

A failure mechanism was assumed similar to the equipment hatch opening. With the assumption that the liner is sufficiently anchored in meridional direction, the ultimate pressure load was

calculated as 64 psig.

3.5.4 Foundation Base Mat

Considering that the mechanism described for the meridional anchorage of the containment cylinder develops, the mat will not be loaded so as to cause large bending moments or shear forces in the mat, in the area contained within the crane wall. This judgement is based upon the distribution of dead and operating loads of the internal structure.

3.5.5 Crane Wall

The crane wall is a reinforced concrete cylinder supported on the mat and rises to an elevation just above the springlines, for a height of about 115 ft. However an 80° segment is open which extends for the entire height except for the top 35 ft. which is a closed cylinder. Due to the opening, the crane wall cannot carry internal pressures by shell action. Horizontal tangential forces will develop at the sides of the opening, which will transfer reactions to the mat and to the upper closure cylinder. Using this mechanism for the purpose of analysis, the ultimate capacity was calculated as 16 psig.

3.5.6 Operating Deck

The operating deck is an irregular slab which extends from the walls surrounding the four steam generators, the pressurizer and the reactor cavity and instrumentation canal. Selecting a strip which appears to be critical by inspection, based upon one way action, the slab is very likely limited to a value not very different from the design value. It should be assumed that an ultimate pressure load of about 16 psi. is about all the capability that the operating deck possesses.

3.5.7 Pressurizer and Steam Generator Enclosures

By inspection it appears that these structures will possess sufficient capability to resist an ultimate pressure which would

be 22.5 psig. the pressurizer and the steam generator enclosures, respectively.

3.5.8 Missile Shield

This missile shield structure consists of concrete blocks which are held together by bolted steel rods. A pressure capability of 55.5 psig. is stated in the FSAR material. Without performing any analysis it would appear reasonable to take this value as ultimate pressure capability.

3.9 Small Penetrations

Since pipe penetrations are designed for penetrations, pipe reactions and thrusts, all these would have a high ultimate strength. Electrical penetrations might need further study; however, even these should have a high ultimate strength in resisting rupture.

3.10 Dynamic Effects

In the event the internal pressure is rapidly developed, the dynamic effects would change the value of the ultimate pressure capability. As an illustration, the containment structure was idealized as a cylindrical shell. A fundamental period of T=1.6 sec and 1.3 sec was calculated in the hoop and vertical directions, respectively. If the pressure excursion when plotted against time could be taken as an isosceles triangle, the ultimate pressure would be close to the static value for time durations greater than 1.0 sec. However, assuming a ductility of 3.0, if time durations were less than 0.25 sec, the ultimate peak pressure would be at least three times that of the static value in the hoop direction. In the meridional direction that ductility is limited due to fact that a major portion of the resistance is dead load and the fact that the postulated failure mechanism for the rebar anchorage would not be considered ductile.

4. Summary and Conclusion

This review was undertaken because pressure excursions might

occur deu to hydrogen burning which exceeds LOCA. However, the review was confined to structural aspects only; furthermore, the review was carried out using simplifying assumptions and judgment of the writer. Indeed a rigorous analysis would probably be impractical considering the enormous computer costs involved in a time dependant non-elastic analysis. Such an analysis normally required for the design of containment structures is certainly not inconsiderable.

In general, the only load considered in combination with the internal pressure is dead loads.

Nevertheless, the information provided herein can provide guidance of future directions and decisions.

In general, it appears that the limiting factor for the ultimate pressure capacity of the containment structure is at the major penetrations, particularly the equipment hatch. If the nature of the pressure load is one of very short duration the net effect on the containment might be minimized due to long period dynamic response of the containment structure to internal pressures.

The interior structures appear to be adequate to carry the differential pressures due to LOCA; however there is not a large excess margin if this would be needed.

COMPARTMENT PRESSURES — Ref: Table 5.1.6-1, P. 5.1-11, Fig 5.2-4 & -5

MAX DIFF PRESSURES

OPER. DECK & LOWER CRANE WALL ELEMENT 6 — 13.3 psig

UPPER CRANE WALL ELEMENT 7-8-9 — 28 psig

MATERIALS

DESIGN PRESSURE 12 PSIG:
- EQUIPMENT HATCH — ASTM A 300
- PERSONNEL HATCH — ASTM A-516 Gr 70 & ASTM A-300

" HYDROSTATIC TEST TO 12 PSIG

	K/IN	K·IN/IN
Q. - 5.12	N11	M11
DL	-7	-400
INT. PRES.	+4.3	-370
OBE	±3	+30
DBE	±4.7	47

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PROJ. NO. C- 1 - 1 - 2
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PREP. BY GH DATE 5/27/80
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Q. - 5.14
LINER PL ASTM A 442 Gr. 60
Yield 32 KSI

LINER NOT ANCHORED INTO MAT FIG 5.16-2

Q 5.17
KNUCKLE ANALYSIS
@ LINER WALL TO MAT
TRANSITION

Q 5.23 LARGE OPNG
FACTORED LOAD
1.5 P + DL (1 ± .05) + (T' + TL')
1.25 P + DL (1 ± .05) + (T + TL'') + 1.25 E
1.0 P + DL (1 ± .05) + (T'' + TL'') + E

Q.5.26 INTERIOR STRUCTURES
SG ENCLOSURE 20 PSI
PRES 15
UPPER COMP. CRANEWALL 8
OPERATING DECK 12 PSI

SHRINKAGE - CONC IN TENSION CRANEWALL 53°F
S.G.+ PRES. ENCL 34°
TEMPERATURE

GRADIENT 3' CONC SECTION 174
2' CONC SECTION 163

Q 5.18 THICKENED LINER AROUND PENETRATION AREA REPLACEMENT

Q 5.20 PENETRATION DESIGN

PIPE — CARRY HIGH PRESSURE LOADS

PIPE BREAK LOADS

Q 5.23 UNDER 1.5P

PERSONNEL HATCH $\sigma_\phi = 34$ ksi $\sigma_\theta = 37.2$

EQUIP. HATCH $\sigma_\phi = 26$ $\sigma_\theta = 38$

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PROJ. NO. C- 2 - 1 - 1
SUBJ. SUBDIV. SHEET

PROJECT DC COOK CONTAINMENT
CLIENT NRC
SUBJECT MERIDIONAL CYLINDER STRENGTH

PREP. BY GH DATE
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DEAD LOAD

DOME-

$$r_{avg.} = \frac{\frac{732.375+690}{2} + \frac{690+720.375}{2}}{2}$$

$$= \frac{690}{2} + \frac{732.375+720.375}{(2)(2)}$$

$$= 708.1875'' = 59.02'$$

CONC. VOL = $2\pi r^2(3) = 65650 \text{ FT}^3$

WT/FT @ SPRINGLINE = $3r(150) = 26.6 \text{ K/FT}$

CYLINDER

$r_{avg.} = 690.375 + 21 = 711.375'' = 59.28 \text{ FT}$

WT/FT CIRCUM/FT HT = $3.5(150) = 0.525 \text{ K/FT/FT}$

TOTAL HT. OF CYLINDER = $709.5 - 596.42 = 113.08$

N_ϕ = DEAD LOAD @ MAT = $26.6 + 113.08(.525) = 85.97 \text{ K/FT}$

PRESSURE TO OPPOSE N_ϕ @ MAT

$$P_{DL\phi} = \frac{85970(2)}{690(12)} = 20.7 \text{ PSIG}$$

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PROJ. NO. C- 2 - 1 - 2
SUBJ. SUBDIV. SHEET

PROJECT DC COOK
CLIENT NRC
SUBJECT MERIDIONAL CYLINDER STRENGTH

PREP. BY GH DATE
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MERIDIONAL LOAD CARRIED @ YIELD BY RE-BAR
2 LAYERS #18 @ 18" o/c

$\sigma t = 5.333 (40) = 213.3^{K}/FT$

$$P_{RE\text{-}BAR_{\phi}} = \frac{213{,}300 (2)}{690 (12)} = 51.45 \text{ PSIG}$$

TOP OF MAT

LINER NOT WELL ANCHORED INTO MAT
IGNORE ITS STRENGTH CONTRIBUTION IN MERIDIONAL DIRECTION @ TOP OF MAT

TOTAL MERIDIONAL PRESSURE CAPABILITY OF TOP OF MAT

$$P_{\phi_{MAT}} = P_{DL_{\phi}} + P_{REBAR_{\phi}} = 72.15 \text{ PSIG}$$

DOME SPRINGLINE

LINER IS ANCHORED TO CYLINDER WALL

ANCHORAGE IS ASSUMMED TO BE SUCH THAT THE LINER TAKES UP LOAD EQUAL TO REDUCTION IN DEAD LOAD IN THE CYLINDER WALL ABOVE THE MAT — CONSERVATIVE ASSUMPTION IN VIEW OF ANCHORAGE

$$P_{DL_{DOME}} = \frac{26{,}600}{85.97} (20.7) = 6.4 \text{ PSIG}$$

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PROJECT DC COOK CLIENT NRC SUBJECT MERIDIONAL CYLINDER STRENGTH	PREP. BY GH DATE CHCKD. BY DATE

REQ'D BY LINER

$$P_{LINER} = P_{DL\phi @ MAT} - P_{DL\phi DOME} = 20.7 - 6.4 = 14.3 \text{ PSIG}$$

LINER FORCE $N_{\phi LINER} = \frac{14.3(690)}{2} = 4933.5$ #/IN

STRESS IN LINER $\sigma = \frac{4933.5}{.375} = 15180$ PSI

IF ANCHORAGE OF LINER TO CYLINDER IS ASSUMMED TO BE A LINEAR TRANSFER FROM DOME SPRINGLINE TO TOP OF MAT

THEN SHEAR FLOW = $\frac{4933.5}{113.08(12)} = 3.6$ #/IN/IN

THIS SHEAR IS EASILY TRANSFERRED

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PROJ. NO. C- 3 - 1 - 1
SUBJ. SUBDIV. SHEET

PROJECT: DC COOK
CLIENT: NRC
SUBJECT: HOOP CYLINDER STRENGTH

PREP. BY: GH DATE
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CYLINDER EL 596'-3½" TO EL 655'-10½"
REINF. 2 LAYERS #18@9" %

$$N_\theta = 10.67(40) = 426.67$$

$$P_{REBAR_\theta} = \frac{426,670}{690(12)} = 51.53 \text{ PSIG}$$

LINER $t = 3/8"$ $f_y = 32$ KSI

$$N_\theta = 32(.375)(12) = 144 \text{ K/FT}$$

$$P_{LINER_\theta} = \frac{144}{690(12)} = 17.4 \text{ PSIG}$$

$$P_\theta = P_{RE_\theta} + P_{LINER_\theta} = 68.93 \text{ PSIG}$$

CYLINDER EL. 655'-10½" TO DOME SPRINGLINE

$$P_{RE_\theta} = \frac{9}{12}(51.53) = 38.6$$

$$P_\theta = P_{RE_\theta} + P_{LINER_\theta} = 56.0 \text{ PSIG}$$

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PROJ. NO.	C- 4 - 1 - 1
	SUBJ. SUBDIV. SHEET
PROJECT	DC COOK
CLIENT	NRC
SUBJECT	SEISMIC SHEAR BARS
PREP. BY	GH DATE
CHCKD. BY	DATE

IN ABSCENCE OF SEISMIC EVENT, SHEAR BARS CONTRIBUTE TO CAPACITY TO RESIST INTERNAL PRESSURE.

BARS ARE PLACED 45° DIAGONALLY
#11 @ 3'-0" @ 45°

HOOP & MERIDONAL RESISTANCE

$$N_\theta = N_\phi = \sqrt{2}\,(1.56)(40) = 29.4\ ^{k}/_{FT}$$

$$P_{DIAG\,\phi} = P_{DIAG\,\theta} = \frac{29400}{690(12)} = 3.6\ PSIG$$

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PROJ. NO. C- 5 - 1 - 1
SUBJ. SUBDIV. SHEET

PROJECT DC COOK
CLIENT NRC
SUBJECT DOME

PREP. BY GH DATE
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$$N_\theta = N_\phi = \frac{Pr}{2}$$

$N_\theta = N_\phi$ LINER $= 32(.375)(12) = 144$ K/FT C-3-1-1

$$P = \frac{2(144)}{690(12)} = 34.8 \text{ PSIG}$$

THE RADIUS FOR REINF VARIES

USE $r_{avg} = \frac{690 + 732.375}{2} = 711''$

HOOP - REBAR 2 LAYERS #18 @ 18" o/c

MERIDIONAL REBAR APPEARS TO AVERAGE 2 LAYERS #18 @ 18" o/c - THESE BARS ARE ANCHORED ALTERNATELY FROM THE SPRINGLINE TO THE APEX - CONTINUOUS BAR ARE ANCHORED TO A TENSION RING

$N_\phi = N_\phi = (40)(5.333) = 213$ K/FT

$$P = \frac{2(213)}{711(12)} = 50.0 \text{ PSIG}$$

$P_{ULT_{DOME}} = 84.8$ PSIG

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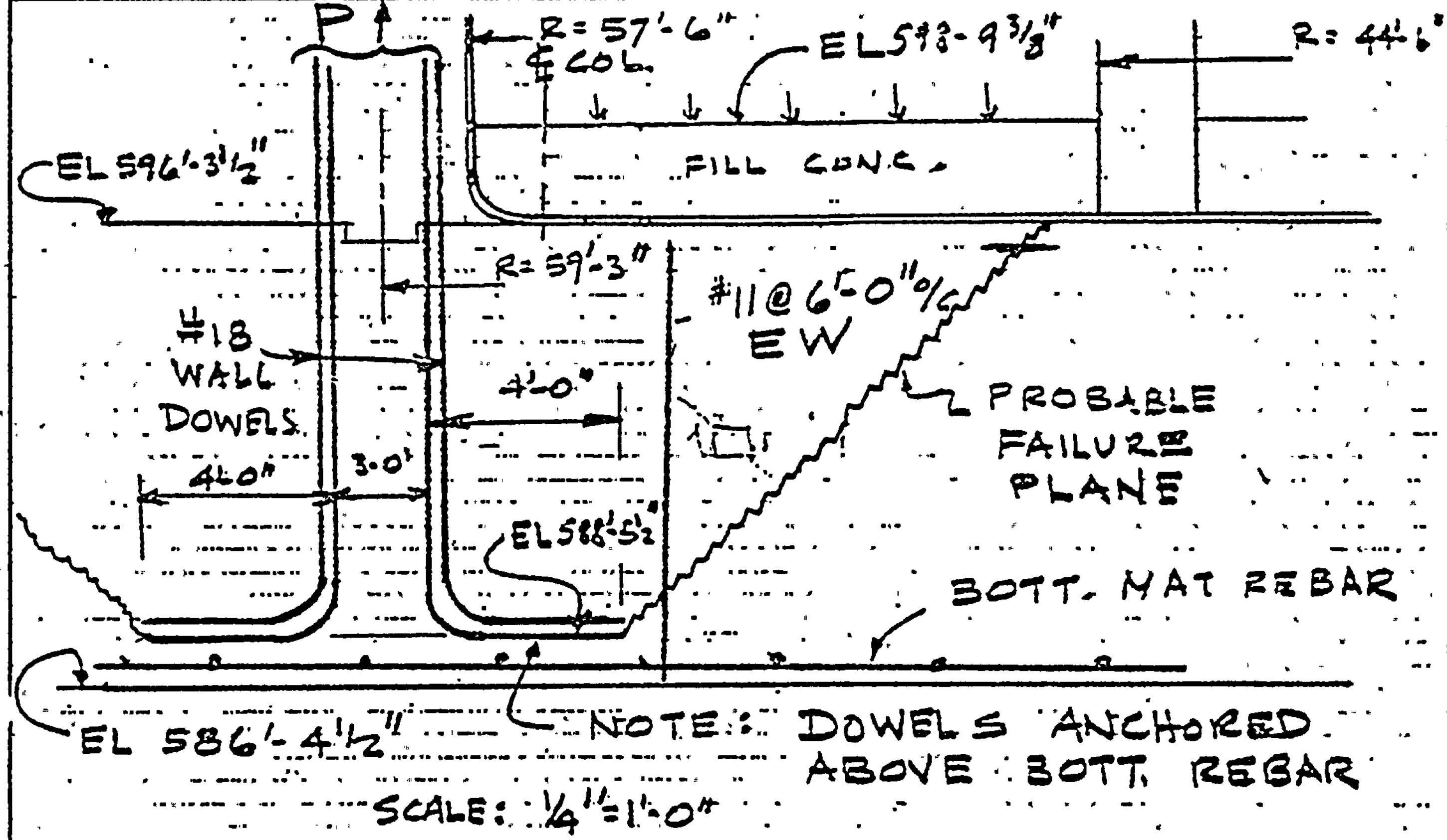
PROJ. NO. C- 5 - 1 - 1
SUBJ. SUBDIV. SHEET

PROJECT: DC COOK
CLIENT: NRC
SUBJECT: ANCHORAGE OF VERT. REBARS

PREP. BY: GH DATE
CHCKD. BY DATE



ASSUME UPLIFT FORCE P - THIS FORCE IS RESOLVED INTO SHEAR IN THE MAT - SHEAR CAUSES A PRINCIPAL TENSILE STRESS ACROSS A PLANE - 45° FROM HORIZ. ASSUME CONC. TAKES NO TENSION

RESISTANCE TO UPLIFT FORCE PROVIDED BY:

1. DEAD LOAD OF CONCRETE PLUG
2. RESTRAINT PROVIDED #11 @ 6'-0" o/c
3. FILL CONCRETE
4. PRESSURE ACTING ON BASE

ASSUME NO SOIL BRG OUTBOARD FROM CRANE WALL ON PLUG -

NEGLECT WT OF ICE CONDENSER

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PROJ. NO.	C- 5 - 1 - 2
SUBJ. SUBDIV. SHEET	
PREP. BY	DATE
CHCKD. BY	DATE

PROJECT DC COOK
CLIENT NRC
SUBJECT ANCHORAGE OF VERT. BARS

DL MAT PLUG

$$AREA = \left[(7.833)(11) + 2\left(\tfrac{1}{2}\right)(7.833)(11)\right] = 172.325$$

$$WT/_{FT} = 25.8\ ^{K}/_{FT}$$

$$WIDTH\ OF\ PLUG = 2(7.833) + 11 = 26.666^{FT}$$

BASIC DEVELOPMENT LENGTH OF #11

$$\ell_d = \frac{0.04(1.56)(40000)}{55} = 45''$$

EFFECTIVENESS OF #11 AS ANCHOR IS LIMITED DUE TO LARGE SPACING AND THE LONG DEVELOPMENT LENGTH REQUIRED ⟶ ASSUME NO ANCHORAGE CAPABILITY

FILL CONC.

2'-5½

$$WT/_{FT} = \left[(598 - 9\tfrac{3}{8}) - (596 - 3\tfrac{1}{2})\right](12)(150)$$

$$= 4.5\ ^{K}/_{FT}$$

UPLIFT LOAD

$$P = \frac{pr}{2} - N_{\phi DL} = \frac{p(690)}{2} - \frac{85{,}970}{12}$$

$$= 345p - 7164$$

RESISTANCE

$$R = \frac{25{,}800 + 4500}{12} + 144p$$

SOLVE FOR P

$201p = 9689 \qquad p = 48.2$ PSIG

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PROJECT: DC COOK	PROJ. NO. C- 5 - 1 - 3 (SUBJ. SUBDIV. SHEET)
CLIENT: NRC	PREP. BY GH DATE
SUBJECT: ANCHORAGE OF VERT. BARS	CHCKD. BY DATE

CORRECTION FOR CURVATURE

DL MAT PLUG

$172.325(2\pi)(59.25)(150) = 3063077\pi$ #

DL FILL $2.48\pi[(57.5)^2 - (45.5)^2](150)$

$= 459792\pi$ #

PRES $= \pi p[(57.5)^2 - 45.5^2](144) = 177,984\pi p$

UPLIFT $= (12)2\pi(57.5)(345)p - 7164\ 2\pi(59.25)(12)$

$= 476100\pi p - 10187208\pi$

RESISTANCE = 3522869 + 177,984p

SOLVE FOR p

$298116p = 13710077$

$p = 46$ PSIG

CHECK FOR SHEAR

$P_{UPLIFT} = 345(46) - 7164 = 8706$ #/IN

$\tau_{REQ'D} = \frac{8706}{(2)(7.833)(12)} = 46$ PSI

OK

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PROJ. NO. C- 5 - 1 - 4
SUBJ. SUBDIV. SHEET

PROJECT: DC COOK
CLIENT: NRC
SUBJECT: ANCHORAGE OF VERT BARS

PREP. BY: SH DATE
CHCKD. BY DATE

EFFECT OF SEISMIC LOADS ON ULTIMATE PRESSURE CAPABILITY

$N_{\phi_{OBE}} = \pm 36\ ^{K}/FT = 3000\ \#/IN$

$N_{\phi_{DBE}} = \pm 56.4\ ^{K}/FT = 4700\ \#/IN$

REFER TO C-5-1-2

OBE

UPLIFT LOAD = $P = \frac{pr}{2} - N_{\phi_{DL}} + N_{\phi_{OBE}}$

$P = 345p - 7164 + 3000$

RESISTANCE

$R = \frac{25,800 + 4500}{12} + 144p$

SOLVE FOR P R = P 201p = 6689

P = 33.3 PSIG

SSE

SIMILARLY P = 24.8 PSIG

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PROJ. NO. C- 6 - 1 - 1
SUBJ. SUBDIV. SHEET

PROJECT DC COOK
CLIENT NRC
SUBJECT PERSONNEL AIR LOCK - COVER

PREP. BY GH DATE
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PERSONNEL HATCH FSAR 5.2-56

117" I.D. $t = 1''$

$M_{ULT} = Zf = \frac{3+\nu}{16} p r^2$ Theory of Plates & Shells - Timoshenko p. 63

PLASTIC MODULUS $Z = \frac{d^2}{4} = .25$

ASSUME $f_y = 38$ KSI (ASTM A-516 Gr 70 / A-300)

$$p = \left(\frac{16}{3.3}\right)\frac{Zf}{r^2} = \left(\frac{16}{3.3}\right)\frac{(.25)(38{,}000)(4)}{(117)^2} = 13.4 \text{ PSIG}$$

OTHER STRUCTURAL MECHANISMS CAN BE USED

40 - 5/8" BOLTS $A = 0.3068$ IN^2
ASSUME $f_y = 60$ KSI

$$P = \frac{(.3068)(40)(60{,}000)}{\frac{\pi (117)^2}{4}} = 68.3 \text{ PSIG}$$

BOLT SPACING ~ $\frac{2\pi(117)}{40} = 18.4''$

TENSILE FORCE/BOLT 21 K/BOLT

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PROJECT DC COOK CONTAINMENT	PROJ. NO. C- 6 - 1 - 2 (SUBJ. SUBDIV. SHEET)
CLIENT NRC	PREP. BY GH DATE
SUBJECT PERSONNEL AIRLOCK - COVER	CHCKD. BY DATE

$$M_\theta = M_\phi = \frac{t^2}{6} S_r = \frac{W}{16\pi m}(3m+1) = \frac{(10.9) P \pi r^2}{16 \pi (3.3)}$$

$m = 3.3$

$Z = 0.25$

REF: ROARK Table X Formula 1.

$f_y = 38000$ PSI

$$P = \frac{16(3.3)(.25)(38,500)}{10.9(58.5)^2} = 13.4 \text{ PSIG}$$

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PROJ. NO. C- 6 - 1 - 3
SUBJ. SUBDIV. SHEET

PROJECT DC COOK
CLIENT NRC
SUBJECT PERSONNEL AIR LOCK - COVER

PREP. BY GH DATE
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IF LOCK COVER IS CONSIDERED CLAMPED

MEMBRANE STRESS — THEORY OF PLATES & SHELLS, TIMOSHENKO p. 337

Try p = 50 psi

$$\sigma_{r=0} = .423 \sqrt[3]{\frac{E p^2 r^2}{h^2}}$$

#/in²

$$= .423 \sqrt[3]{\frac{E(50)^2(117)^2}{4}}$$

$$= 26{,}180 \text{ \#/in}$$

CIRCULAR PL — ROARK - 4th Edition p 245

$$\frac{wa^4}{Et^4} = \frac{16}{3(1-\nu^2)}\left[\left(\frac{y}{t}\right) + 0.488\left(\frac{y}{t}\right)^3\right]$$

$$\frac{50}{(29)(10^6)}\left(\frac{117}{2}\right)^4 \frac{3}{16} = 3.786 = \frac{y}{t} + .488\left(\frac{y}{t}\right)^3$$

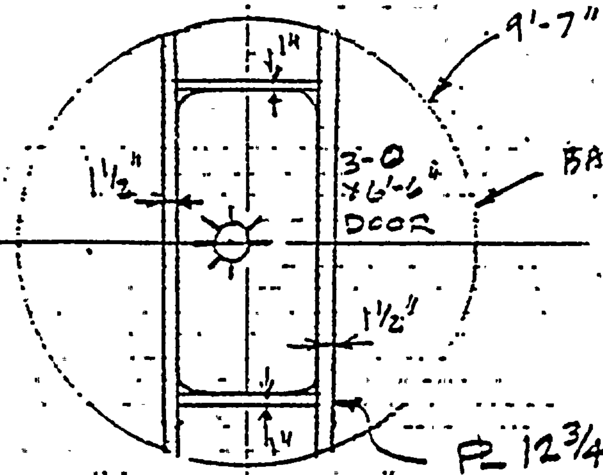
y/t	$y/t + .488(y/t)^3$
1	1.488
1.2	2.043
1.4	2.739
1.6	3.598848
1.65	3.842157
1.638	3.78448 OK

HARSTEAD ENGINEERING ASSOCIATES • INC.
169 KINDERKAMACK ROAD, PARK RIDGE, N. J. 07656

PROJ. NO. C- 6 - 1 - 4 (SUBJ. SUBDIV. SHEET)

PROJECT: DC COOK CONTAINMENT
CLIENT: NRC
SUBJECT: PERSONNEL AIR LOCK - COVER

PREP. BY ____ DATE ____
CHCKD. BY ____ DATE ____



REF:
(1) W.J. WOOLLEY CO. DWG # 30533, 10/28/70
DOOR - DES. PRES. - 13 PSI

1/4" = 1'-0" scaled?

$Z_{PL} = \frac{bd^2}{4} = \frac{1.5(12.75)^2}{4} = 60.96 \text{ IN}^3$

CHECK PL 12 3/4 x 1 1/2 (VERTICAL STIFFNESS)

$w = 40p$ #/IN $\ell = 9' = 108"$

$M < Zf = 60.96(38) = 2316$ K in

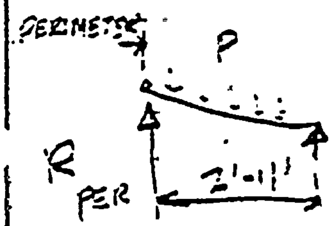
$M = \frac{w\ell^2}{8}$; $P_{ULT} = \frac{(2316)(8)}{(40)(108)^2} = 40$ psig

$R = 40(40)(\frac{108}{2}) = 86.4^K$

REQ'D WELD CAPACITY = 3.6 K/IN

CHECK 1" PL (HORIZONTAL STIFFNESS)

DOOR REACTION $R = 19.5(p)$



$M = \frac{w\ell^2}{8} = P\frac{(35)^2}{8}$

$P_{ULT} = \frac{8(38{,}000)(.25)}{(35)^2} = 62$ psi

$Z = \frac{1}{4}$

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PROJ. NO. C- 6 - 1 - 5
SUBJ. SUBDIV. SHEET

PROJECT DC COOK
CLIENT NRC
SUBJECT PERSONNEL AIR LOCK COVER

PREP. BY GH DATE
CHCKD. BY DATE

MEMBRANE ACTION

$$S_{at\ edge} = 4.4E\left(\frac{y t}{a^2}\right) + .476E\left(\frac{y}{a}\right)^2$$

$$= 4.4E\left(\frac{1.638}{(\frac{11.7}{2})^2}\right) + .476E\left(\frac{1.638}{(\frac{11.7}{2})}\right)^2$$

$$= 61073 + 10822 = 71896 \text{ psi}$$

$$S_{at\ center} = 2.86E\left(\frac{y t}{a^2}\right) + .976E\left(\frac{y}{a}\right)^2$$

$$= 39698 + 22190 = 61888 \text{ psi}$$

SHEAR FORCE / BOLT = 71.9(18.4) = 1323 K/BOLT

OBVIOUSLY MEMBRANE ACTION IS LIMITED BY AMOUNT OF SHEAR CAPACITY IN BOLTS

BASED UPON CAPABILITY OF DOOR STIFFENER INCREASE CAPABILITY TO 40 PSIG

HOWEVER DOOR IS UNKNOWN – DESIGN CAPABILITY STATED AS 18

ASSUME $P_{ULT} = 2(18) = 36$

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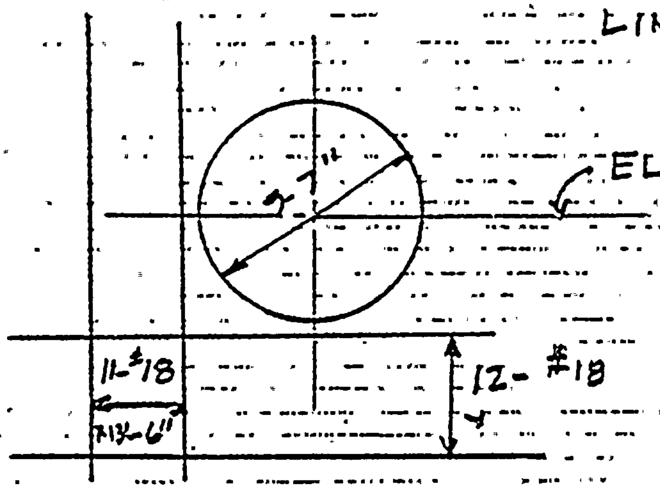
PROJ. NO.		
C- 7 - 1 -		
SUBJ.	SUBDIV.	SHEET

PROJECT: DC COOK CONTAINMENT
CLIENT: NRC
SUBJECT: PERSONNEL HATCH, CONCRETE

PREP. BY: GH DATE:
CHCKD. BY: DATE:

LINER THICKENED



VERTICAL 11-#18 TAKE REACTION

$R = N_\phi (60) = 11(4.0)(40) = 1760^K$

$N_\phi = 29.33\ K/N = 352.0\ ^K/FT$

$P_{REBAR} = \frac{2(29330)}{690} = 85.0$ PSIG

$P_{LINER} = 34.8$ PSIG

$P_{DL} = 6.4 + (20.7 - 6.4)\left(\frac{709.5 - 616.33}{709.5 - 576.25}\right)$

$= 18.2$ PSIG

$P_{TOT} = 85 + 34.8 + 18.2 = 138$ PSIG

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PROJECT DC COOK CONTAINMENT	PROJ. NO. C- 7 - 1 - 2 (SUBJ. SUBDIV. SHEET)
CLIENT NRC	PREP. BY GH DATE
SUBJECT PERSONNEL HATCH, CONCRETE	CHCKD. BY DATE

HORIZONTAL 12-#18 - TAKE REACTION

$R = N_\phi(60) = 12(4.0)(40) = 1920$

$N_\phi = 32.0\ K/IN = 384.0\ K/FT$

$P_{REBAR} = \frac{32000}{690} = 46.4$ PSIG

$P_{LINER} = 17.4$ PSIG

$P_{HOOP} = 63.8$

NORMALLY HOOP REBAR CAN CARRY 51.53

ASSUME BAND OF WIDTH = 30 FT

$P_{REBAR\ AVG} = \frac{46.4(10) + 51.53(20)}{30} = 49.8$ PSIG

$P_{HORIZ} = 17.4 + 49.8 = 67.2$

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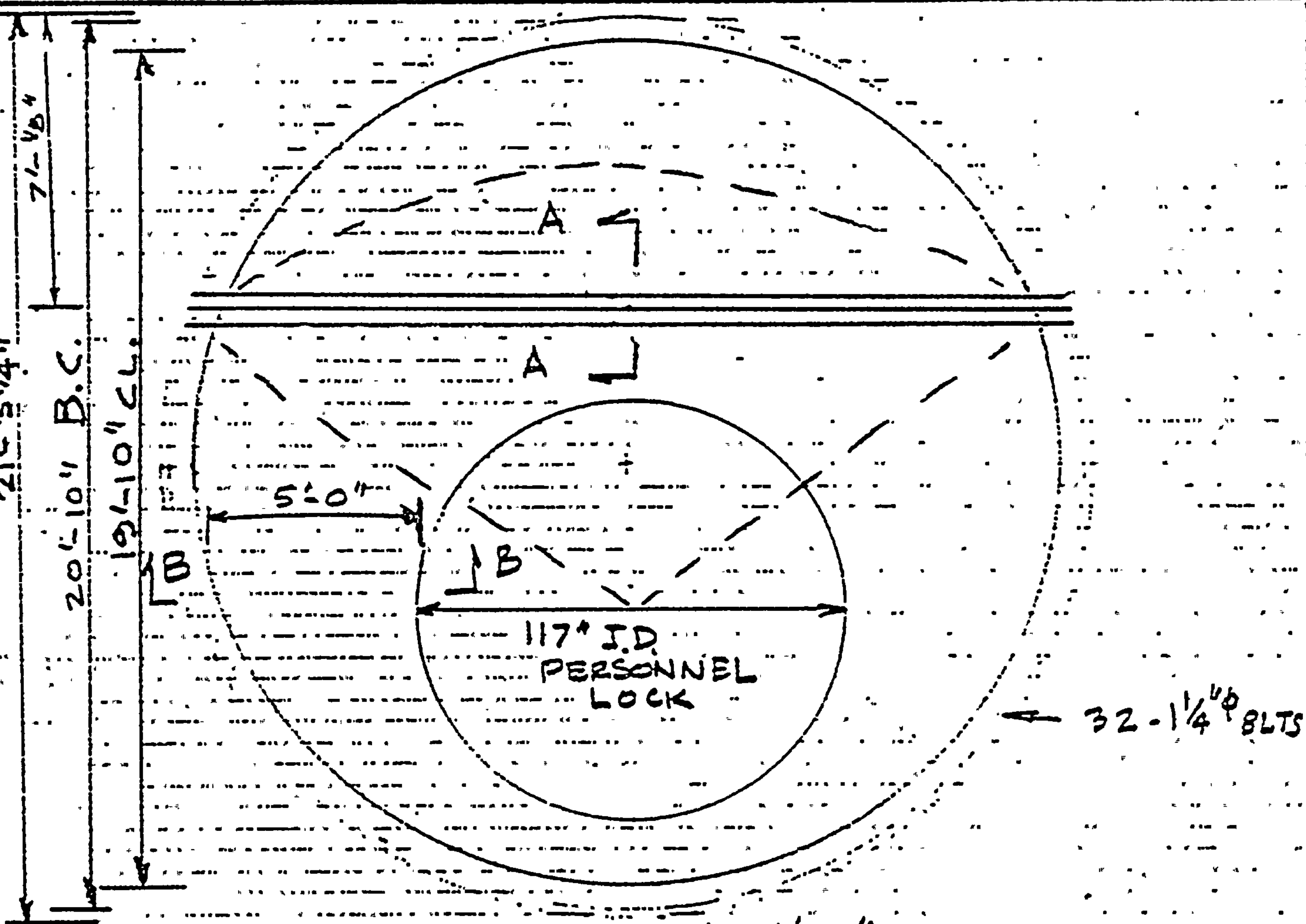
PROJ. NO. C- 8 - 1 - 1
SUBJ. SUBDIV. SHEET

PROJECT: DC COOK
CLIENT: NRC
SUBJECT: EQUIPMENT HATCH, COVER

PREP. BY: GH DATE:
CHCKD. BY: DATE:

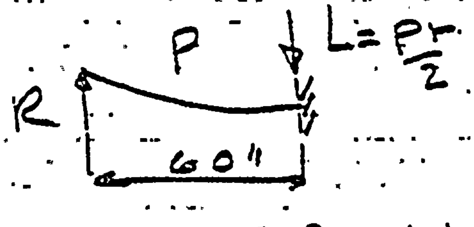


SCALE 1/4" = 1'-0"

DASHED LINES REPRESENT TRIBUTARY AREAS.

PERIMETER LOAD FROM PERSONNEL HATCH

$$L = \frac{p\pi r^2}{2\pi r} = \frac{pr}{2} = 29.25p$$



$$R = L + 60p = 89.25p$$

SECTION B-B $M = 60(89.25)p - \frac{p(60)^2}{2} = 3555p$

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PROJ. NO.	C- 3 - 1 - 2 (SUBJ. / SUBDIV. / SHEET)
PROJECT	DC COOK
CLIENT	NRC
SUBJECT	EQUIPMENT HATCH - COVER
PREP. BY	GH
DATE	
CHCKD. BY	
DATE	

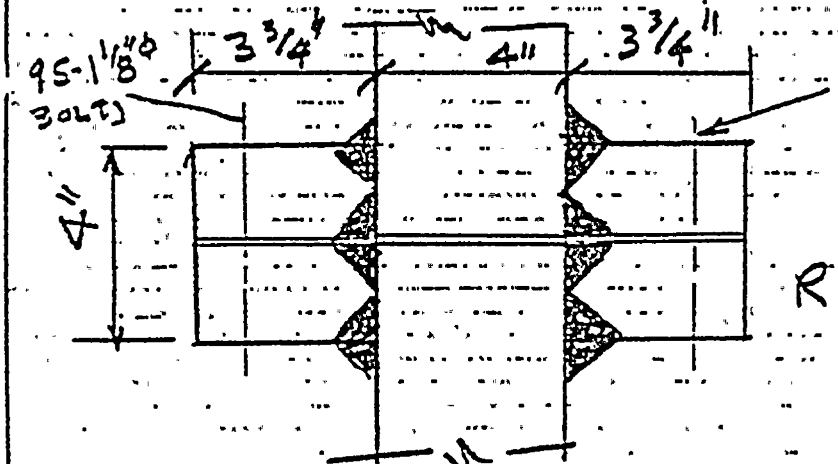
$$Z = \frac{t^2}{4} = \frac{(4)^2}{4} = \frac{16.0}{4} = 4$$

$$f = \frac{M}{S} = \frac{3555\,p}{4} = 888\,p$$

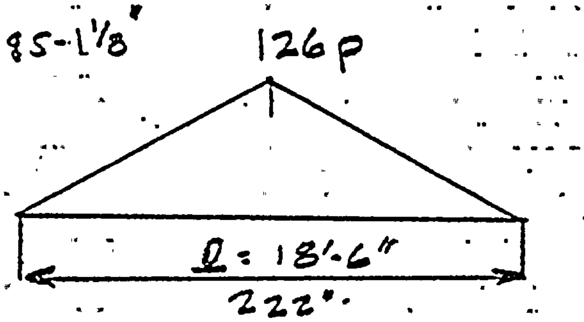
$$f_y = 38000 \text{ PSI}$$

$$P = 42.7 \text{ PSIG}$$

STIFFENING @ JOINT ACTS AS BEAM



SECT. A-A
SCALE 3" = 1'-0"



$$R = \frac{126\,p(111)}{2} = 6993\,p$$

$$M = R(111) - R\left(\frac{111}{3}\right)$$

$$M = 517482\,P$$

$$Z = \frac{4(11.5)^2}{4} = 132.3 \text{ in}^3$$

$$f_y = 38000 \text{ psi}$$

$$P_{ST} = \frac{Z f_y}{517482} = 9.5 \text{ PSIG}$$

ASSUME SURROUNDING ℞ CAN ASSIST.

b = 60" z = 60(4) = 120

f_y = 38000 $M = \frac{bp(222)^2}{8}$ = 61605 p(eg)

= 369630 p

$P_{℞}$ = 9.7 PSIG

TOTAL p = $P_{℞}$ + P_{ST} = 17.3 PSIG

BOLT CAPACITY IN TENSION 32 - 1¼ BOLTS

A = 1.2272

TOTAL TENSILE FORCE, T = $\frac{\pi(240)^2}{4}$ p = 45239 p

EQUIPMENT HATCH ID = 238"
CHECK BOLTS

32 - $1\frac{1}{4}$" BOLTS A = 1.2272 in^2

SA 193 Gr B7 ASSUME $f_y = 60$ KSI

$$P = \frac{(1.2272)(32)(60{,}000)}{\frac{\pi (238)^2}{4}} = 53.0 \text{ PSIG}$$

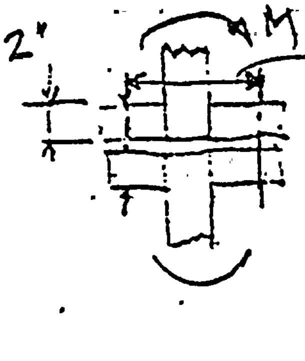
ASSUME 4" THICK CIRCULAR PL 19'-10" φ

$f_y = 38$ KSI $M_{ULT} = \frac{3+\nu}{16} p r^2$ $Z = \frac{d^2}{4} = 4$

$$P = \frac{16}{3.3}\frac{Z f}{r^2} = \left(\frac{16}{3.3}\right)\frac{(4)(38{,}000)}{\left(\frac{238}{2}\right)^2} = 52 \text{ psig}$$

CAN SPLICE TRANSFER PLATE MOMENTS?
IF SO, ULTIMATE CAPACITY CAN APPROACH PL

IF $p = 40$ psig $M = \frac{3+\nu}{16} p r^2 = 116{,}828$ "#
MAX MOMENT USED - CONSERVATIVE



$T = \frac{M}{(4\frac{1}{2})} = 25962$ #/IN

BOLT SPACING $\frac{222}{35} = 2.6$ IN SPACING IS CLOSE

TENSION ON BOLT = 26 (2.6) = 70 k/BOLT

APPEARS EXCESSIVE

$$P_{ULT} = 40\frac{(.994)(60)}{70} = 35 \text{ PSIG}$$

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PROJ. NO.	C- 8 - 1 - 5
SUBJ. SUBDIV. SHEET	
PREP. BY	DATE
CHCKD. BY	DATE

PROJECT DC COOK
CLIENT NRC
SUBJECT EQUIPMENT HATCH – COVER

MOMENT IN 2" PL (SPLICE PL) = 25.9(2.5) = 64.75

Z = 1

f = 64.75

$P_{ULT} = 40\left(\frac{38}{64.75}\right) = 23.5$ psig

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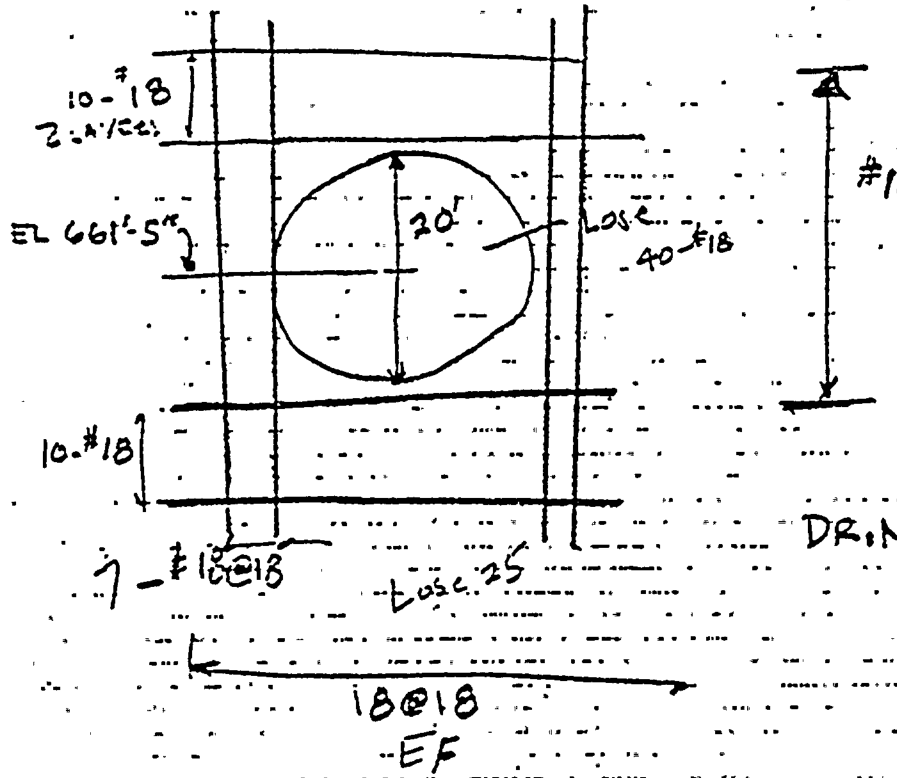
PROJ. NO.	C- 9 - 1 - 1
	SUBJ. SUBDIV. SHEET
PROJECT	DC COOK CONTAINMENT
CLIENT	NRC
SUBJECT	EQUIP HATCH-CONCRETE
PREP. BY	GW DATE
CHCKD. BY	DATE



DR. NO. 1-2-3202-2

VERTICAL 7-#18 TAKE REACTION.

$R = N_\phi(120) = 7(4.0)(40) = 1120^K$

$N_\phi = 9.333^K/IN = 1120\ ^K/FT$

$P_{REBAR} = \frac{2(3640)}{690} = 27.05$ PSIG

ELEV SPRING LINE 709'-6"
ELEV TOP OF MAT 596'-3½"

$P_{DL} = 6.4 + (20.7-6.4)\left(\frac{709.5-661.42}{709.5-596.25}\right) = 12.5$ PSIG (48.08)

LINER IS THICKENED TO 3/4 ∴ USE LINER WELL ABOVE MAT

$P_{LINER\ VERT} = \frac{2N_\phi}{r} = \frac{2(.375)(32,000)}{690} = 34.8$ PSIG

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PROJ. NO. C- 9 - 1 - 2
SUBJ. SUBDIV. SHEET

PROJECT DC COO
CLIENT
SUBJECT EQUIP HATCH CONCRETE

PREP. BY GH DATE
CHCKD. BY DATE

$P_{VERT} = 10.5 + 12.5 + 34.8 = 57.8$ PSIG

FULL LINER OK. SHEAR FLOW THRU LINER ANCHORAGE $= \frac{144}{(661.42 - 594.25)} = 2.2^{K}/FT$ OK

HORIZONTAL

10-#18 TAKE REACTION

$R = N_\phi(120) = 10(4.0)(40) = 1600$

$N_\phi = 13.33\ ^{K}/_{IN} = 160\ ^{K}/FT$

$P_{REBAR} = \frac{(13333)}{690} = 19.32$ PSIG

$P_{LINER} = 17.4$ PSIG

NORMALLY HOOP REBAR CAN CARRY 51.53 PSIG

ASSUME BAND OF WIDTH 60 FT

$P_{REBAR\ AVG} = \frac{19.32(20) + 51.53(40)}{60} = 40.8$

$P_{HORIZ} = 17.4 + 40.8 = 58.2$ PSIG

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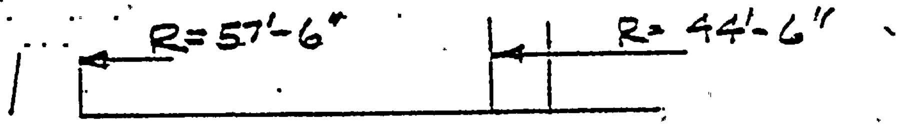
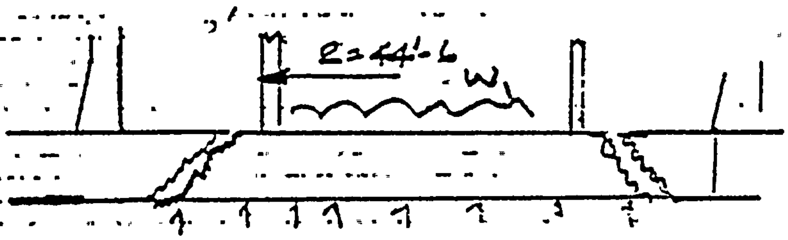
PROJECT: D C COOK	PROJ. NO. C- 10 - 1 - 1 (SUBJ. / SUBDIV. / SHEET)
CLIENT: NRC	PREP. BY GH DATE
SUBJECT: MAT	CHCKD. BY DATE



BASED UPON THEORY USED C-5-1-1
UPLIFT FORCE IS RESOLVED WITHOUT
REQUIRING BENDING OF MAT



DL ON MAT

MAT	1500 PSF
FILL	375
OPERATING DECK	450
WALLS SHIELD CONC. REACTOR	500
TOTAL	2825 PSF say 3000 PSF

PRESSURE ~ 46 PSIG

$P = 46(144) = 6624$ PSF

$W_1 = 6624 + 3000 = 9624$ PSF

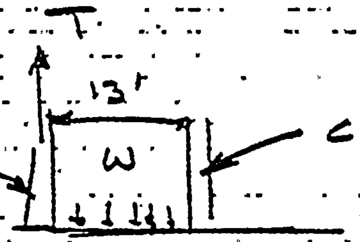
BY MECHANISM MAT WILL NOT CARRY MUCH BENDING ASSUMMING DL & PRESSURE ARE UNIFORMLY DISTRIBUTED

IF WE ASSUME HIGH CONC. TENSION

CALCULATE CAPACITY OF MAT IN BENDING

ASSUME LIFT OFF OUTBOARD OF CRANE WALL

P = 46 PSIG

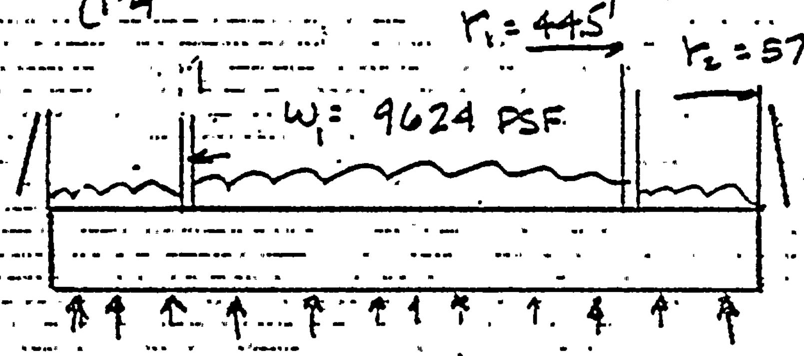


$T = P + DL\ MAT = \frac{Pr}{2} - N_{\phi_{DL}} - \frac{25,800}{12}$ C-5-1-2

$= 6556\ \#/IN$ NOTE: DUE TO MAT OVERHANG THE MAT D.L. ACTS ROUGHLY AT CONT. WALL

$\omega_2 = \frac{375}{(12)^2} + 46 = 48.6\ PSI = 6999\ PSF$

ASSUME W_2 USED TO RESIST UPLIFT



$\pi r_2^2 W_s = w_1 \pi r_1^2 +$

$w_s = \frac{w_1 r_1^2 +}{r_2^2} = 5764$ PSF

$W = w_1 r_1^2 \pi = 59,873,240\ \#$

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PROJECT DC COOK CONTAINMENT	PROJ. NO. C- 10 - 1 - 3 (SUBJ. SUBDIV. SHEET)
CLIENT NRC	PREP. BY GH DATE
SUBJECT MAT	CHCKD. BY DATE

$$M = f\frac{t^2}{6}$$

USE CASE 11 Table X Roark

ASSUME $m \to \infty$ i.e $\nu \to 0$

$$M_\theta = M_\varphi = \frac{t^2}{6}\frac{3W}{2\pi t^2}\left(\ln\frac{r_2}{r_1} - \frac{1}{4}\left(1-\frac{r_1^2}{r_2^2}\right)\right]$$

$$= \frac{W}{4\pi}\left(.2563 - .10026\right) = 743427^{\#'}$$

$743^{'K}/'$

FOR SECTION 10' DP

2-#18 /FT

$A_s = 8^{\square''}/FT$

$jd \approx 8$

$$T = C = \frac{743}{8} = 92.825\ ^K/FT$$

$$ad = \frac{92875}{(3000)(12)} = 2.5'' \quad \underline{OK}$$

$$f_s = \frac{92875}{8} = 11.6\ KSI\ OK$$

MAT CAN CARRY PRESSURE LOADS IN EXCESS OF 46 PSIG

DESIGN Q5.26-2

STRUCTURE	INTERNAL PRESSURE
S.G. ENCL.	20 / 30 Fig 5.26.2-2
PRESSURIZER ENCL.	15 / 22.5 Fig 5.26.2-3
UPPER COMPARTMENT CRANE - WALL FIG 5.26.2-2	8 COMPR.
OPERATING DECK	12 (DIFFERENTIAL)
MISSILE SHIELD COVER REMOVEABLE WALL (FIG. 5.26 1-10)	55.5

UPPER CRANE WALL PROBABLY CAPABLE OF CONSIDERABLY GREATER THAN 8 PSIG

OPERATING DECK — DR. NO. 1-2-3186 8-3 SECT J-2 3/8" = 1'-0"

ONE WAY SLAB ACTION

ASSUME 2 LAYER #11 @ 12" c.

$\ell = 22'$ $A_s = 3.12$ □"/FT.

$$M = \frac{w\ell^2}{8} = A_s a d = 3.12(22)$$

$$p\frac{(12)^2(22)^2}{8} = \frac{3,120(22)}{22(18)};\ p = 7.5 \text{ PSIG}$$

D.L. (3' SLAB) P_{DL} 3.0

10.5 PSIG

DESIGN PRESSURE = 12 PSIG

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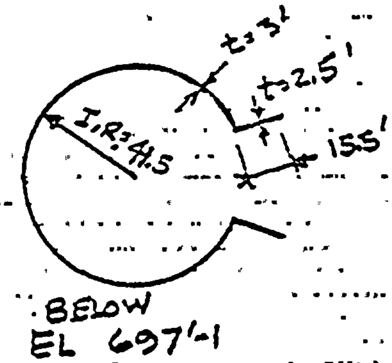
PROJ. NO.		
C- 12 -	-	1
SUBJ.	SUBDIV.	SHEET

PROJECT DC COOK
CLIENT
SUBJECT CRANE WALL

PREP. BY DATE
CHCKD. BY DATE



HOOP #11@9 E.F
VERT #9@12 EF

$$N_\phi = 1.56\left(\frac{4}{3}\right)(2)(40) = 166.4\ ^{K}/_{FT}$$

$$P = \frac{166400}{(12)^2(41.5)} = 27.8 \text{ PSIG}$$ ABOVE OPERATING DECK

TOP OF CRANE WALL EL 713'-11"

HT. OF CRANE WALL = 679.08 - 598.78 = 80.3'
MAT TO OPER. DECK $R = \frac{80.3}{2}(166.4) = 6681^K$

$$\bar{X} = \frac{24(3)(12 + 12.5(2.5)[(1.25) + 14.75]}{72 + 12.5(2.5)(2)}$$

$\bar{X} = 10.1'$ 13824

$$I = \frac{3(24)^3}{12} + 72(1.9)^2 \cdot)^2 + 12.5(2.5)[(10.75)^2 + (4.6)^2]$$

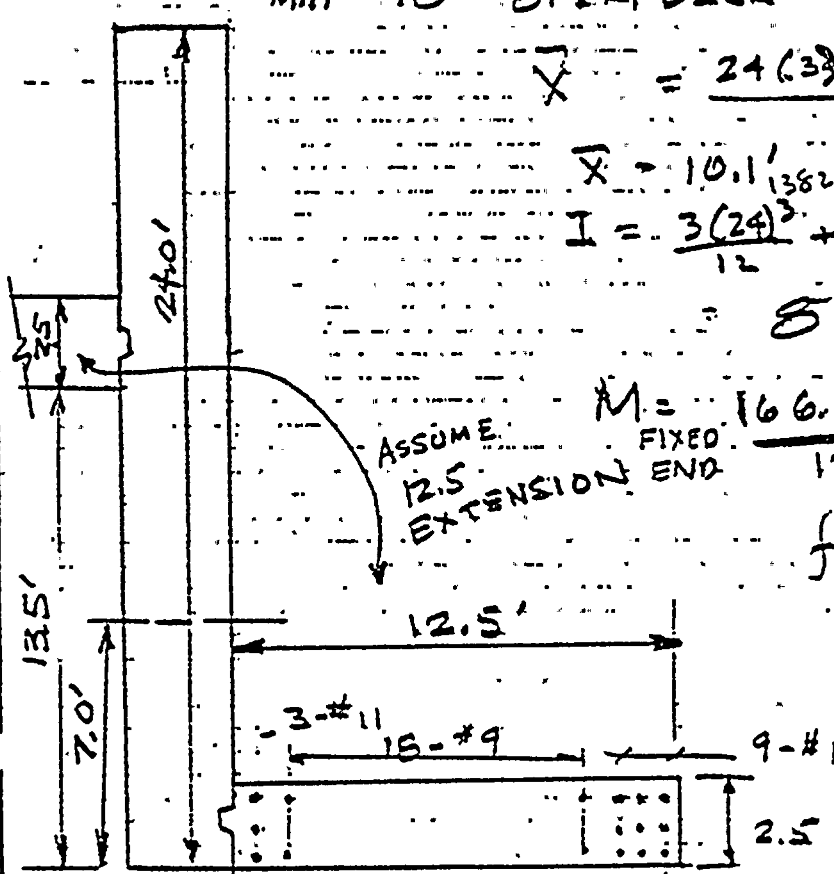
= 8003 ft^4

$$M_{FIXED\ END} = \frac{166.4(80.3)^2}{12} = 89{,}413.5\ ^{'K}$$

$$f = \frac{M}{I}y = 155.3 \text{ KSF}$$

= 1.1 KSI

CRANE WALL OPNG DEFEATS SHELL ACTION



IDEALIZED RETURN DETAIL

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PROJ. NO.		
C- 12 -	1 -	2
SUBJ.	SUBDIV.	SHEET

PROJECT
CLIENT.
SUBJECT CRANE WALL

PREP. BY DATE
CHCKD. BY DATE

REACTION FROM OPNG. $R = 6681^k$

ESTIMATE 60 ADD'L #11 HOOP BARS ABOVE OPENG

$$R_{CAPACITY} = 60(1.56)(40) = 3744$$

PRESSURE CAPACITY

$$P = 27.8\left(\frac{3744}{6681}\right) = 15.6 \text{ PSIG}$$

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PROJ. NO.		
C- 13	1	1
SUBJ.	SUBDIV.	SHEET

PROJECT
CLIENT
SUBJECT DYNAMICS

PREP. BY DATE
CHCKD. BY DATE

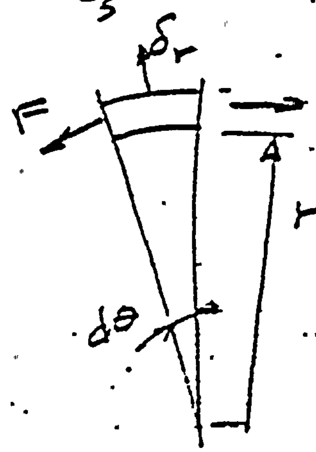
FUNDAMENTAL FREQ OF CYLINDER (HOOP DIRECTION)

EQUATION OF MOTION

t' = EQUIV THICKNESS OF REBAR AREA

$$m(\ddot{\delta}_r) + F\,d\theta = 0 \quad ; \quad F = \sigma t' \ell$$

$$\frac{\sigma}{E_s} = \epsilon = \frac{\delta_r}{r}$$



$$(\ddot{\delta}_r) + \frac{F\,d\theta}{m} = 0$$

$$\ddot{\delta}_r + \frac{\frac{E_s \delta_r}{r} t' \ell\, d\theta}{r\, d\theta\, t\, \ell\, \mu} = 0$$

$$\ddot{\delta}_r = \frac{E_s t'}{r^2 t \mu} \delta_r = 0$$

$$\omega^2 = \frac{E_s t'}{r^2 t \mu}$$

μ = wt/cu. in

HOOP REBAR #18 @ 9" o.c.
2 LAYERS

$$t' = \frac{10.67}{12} =$$

t = 42"

$$\mu = \frac{1}{12}\ \#/in^3$$

$$\omega^2 = \frac{29{,}000{,}000\left(\frac{10.67}{12}\right)}{(690)^2(42)\left(\frac{1}{12}\right)} = 15.5$$

ω = 3.94 rad/sec = .63 Hz   T = 1.6 SEC

$N_{\theta\ YIELD}$ = 426.67 K/FT = 35.6 K/IN

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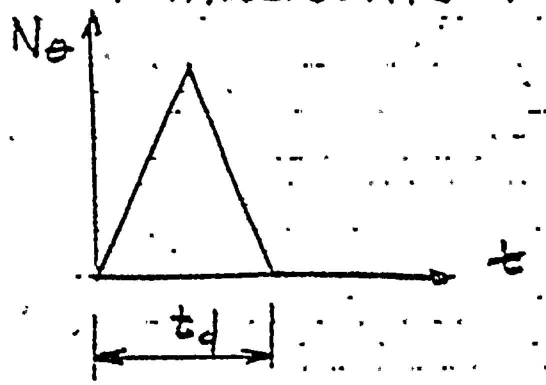
PROJECT
CLIENT
SUBJECT DYNAMICS

PROJ. NO. C- 13 - 1 - 2
SUBJ. SUBDIV. SHEET
PREP. BY DATE
CHCKD. BY DATE

SUPPOSE PRESSURE EXCURSION IS TRIANGULAR PULSE



ASSUME DUCTILITY FACTOR $\mu = 3.0$

REF: INTRO. TO STRUCTURAL DYNAMICS, J.M. BIGGS

FIG 2.26

t_d/T	$N_{\theta\,YIELD} / N_{\theta\,APPIED}$
1.0	.8
2.0	.8
8.0	.9
.8	.8
.6	.7
.4	.5
.2	.3
.1	.2

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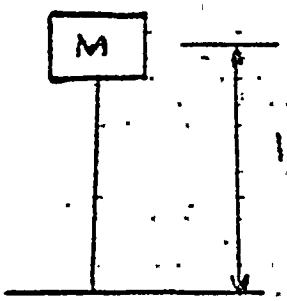
PROJECT
CLIENT
SUBJECT DYNAMICS

PREP. BY DATE
CHCKD. BY DATE

FUNDAMENTAL FREQ OF CYLINDER (VERTICAL)



$$WT/FT = 26.6 + \frac{113.08(.525)}{2} = 56.28 \ ^{K}/_{FT}$$

$$K = \frac{AE}{l} = \frac{5.33(29{,}000)}{113(12)}$$

$$m\ddot{x} + Kx = 0$$

$$\omega^2 = \frac{K}{m} = \frac{\frac{5.33(29000)}{(113)(12)}}{56.28} = 24.3$$

$$\omega = 4.9 \ ^{rad}/_{sec} = .79 \ Hz \qquad T = 1.3 \ sec.$$

MERIDIONAL PERIOD SOMEWHAT LESS THAN HOOP PERIOD - DYNAMIC EFFECT ARE SIMILAR

EFFECT OF SEISMIC

OBE $N_{\phi_{MAT}} = 3^{K}/IN$ FIG 5.12-11

$= 36^{K}/FT$

DBE $N_{\phi_{MAT}} = 5^{K}/IN$ FIG. 5.12-32

$= 60^{K}/FT$

EFFECT ON ANCHORAGE REF C-5-1-3

$$\text{UPLIFT} = 476100\pi p - \left(\frac{7164-5000}{7164}\right)(10187208)\pi$$

$$= 476100\pi p - 3{,}077{,}208\,\pi$$

$$\text{RESISTANCE} = 3{,}523{,}869\,\pi + 177984\,\pi p$$

SOLVE FOR P

$$298116\,p = 6{,}609{,}077$$

$$p = 22.1 \text{ PSIG}$$

DRAMATIC REDUCTION IN THE ULTIMATE PRESSURE LOAD WHEN DBE IS INCLUDED.

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PROJ: NO. C- 15 - 1 - 1 (SUBJ. SUBDIV. SHEET)

PROJECT
CLIENT
SUBJECT: ULTIMATE PRESSURE CAPACITY

PREP. BY SH DATE
CHCKD. BY DATE

PRESSURE COMBINED WITH DEAD LOAD

SUMMARY

STRUCTURAL COMPONENT	ULTIMATE PRESSURE PSIG
CONTAINMENT CYLINDER	
MERIDIONAL	46
HOOP	56
DOME	85
EQUIPMENT HATCH	
COVER	23.5
CONCRETE & LINER	58
PERSONNEL AIR LOCK	
COVER	36
CONCRETE & LINER	67
CRANE WALL	16

= 2.2 P[illegible]
EFFEC[illegible]

[illegible]