ATTACHMENT J.4.60

SILO DOME LIVE LOAD LIMITS

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04424331
BY:	J. Brant
DATE:	March 1998
PAGE:	1 OF 18
REVISED:	

SUBJECT: SILO DOME LIVE LOAD LIMITS -

Silo Dome
Live Load Limits

A review of the physical test (see Silo Dome Properties Draft Report Dated March 1, 1998) results and Non Destructive Test results compiled since 1986 indicates that about the only thing we know for sure about the existing condition of the concrete Silo Domes is that the general condition of the concrete is poor. Petrographic examinations reveal extensive microcracking due to freeze-thaw damage and alkali-aggregate reaction. Very few core samples have [redacted] successfully been taken. Most samples attempted were fragmented and not suitable for compression testing. It is suspected that most of the central dome area for all four domes have delaminated at the reinforcement strata and that these areas to be assumed to be taken as two independent two inch thick layers of plain concrete. Due the amount of reported damage due to freeze-thaw and other contributing factors it felt that any strength evaluation be based on an assumed concrete strength of 2000 psi (approximately half the original design value).

With these two assumptions a single evaluation enveloping all four Silo Domes was made to determine their capacity to resist a 700 pounds (including up to three persons) live load was made. Three modes of failure were investigated; 1) direct shear or punch through failure, 2) overall buckling failure, and 3) local concrete failure.

The critical mode or failure was a local concrete failure due to tensile flexural loads introduced to the dome by a local concentrated load of 700 pounds. It has been determined that the Silo Domes have the capacity to resist a 700 pound live load spread out over a circular area no less three feet in diameter. This was determined by comparing the level of strees created by the application of an unfactored 700 pound load on a three foot diameter circular area with the predicted ultimate load capacity of the concrete dome. No code prescribed or other factor of safeties were used in this evaluation. This load limit must be reduced to reflect the level of risk associated with a potential dome failure.

This evaluation will be documented by forth coming calculations.

INFORMATION
ONLY

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04424331
BY:	P Grant
DATE:	March 1998
PAGE:	2 OF 18
REVISED:	

SUBJECT: SILO DOME LIVE LOAD LIMITS

Table of Contents

Overview	sht 3
Punch Through Evaluation	sht 4
Dome Buckling	sht 6
Overview Local Effects	sht 8
Self Wt Plus Foam	sht 9
Self Wt Plus Foam Plus Snow	sht 10
Self Wt Plus Foam w/700#	
on 1 ft sq area	sht 11
on 3 ft ø circular area	sht 14
on 4 ft ø circular area	sht 15
Determination of Most Critical Area	sht 16
Re-Evaluation at Critical Area	sht 17

APPENDIX A - RISA 3D - Single Strip Arch Model
- Load Deformation Graphic
- Moment & AXIAL Loads on elements

APPENDIX B - RISA 3D - 2way ACTION MODEL

APPENDIC C - RISA 3D - 2way Action Computer Evaluation - (output)

FS-F-78 B (REV 2/2)

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04 424331
BY:	P Grant/M.Ty
DATE:	March 7 1998
PAGE:	3 OF 18
REVISED:	

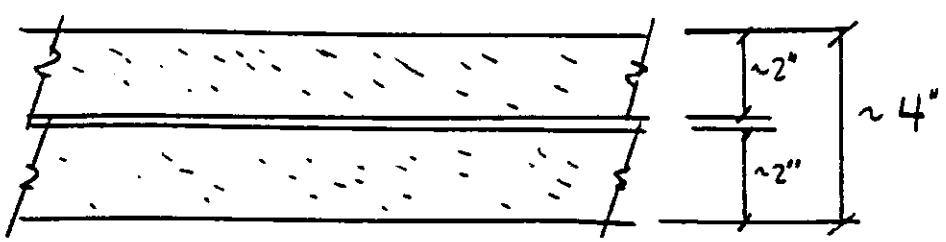
SUBJECT: SILO DOME LIVE LOAD LIMITS

Evaluate SILO Domes for capacity to resist a live load of 700 (3-Persons) any where on its surface.

For the purposes of this evaluation
Assume: $f_c' = 2000$ psi

Investigate local failure over center portion of dome:

Based on a review of NDT (1986 & 1993) and reported problems taking core samples: it is clear that there is a high probability that the concrete in the center dome area has delaminated at the level of the welded wire reinforcement resulting in 2- 2" unreinforced concrete layers



Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

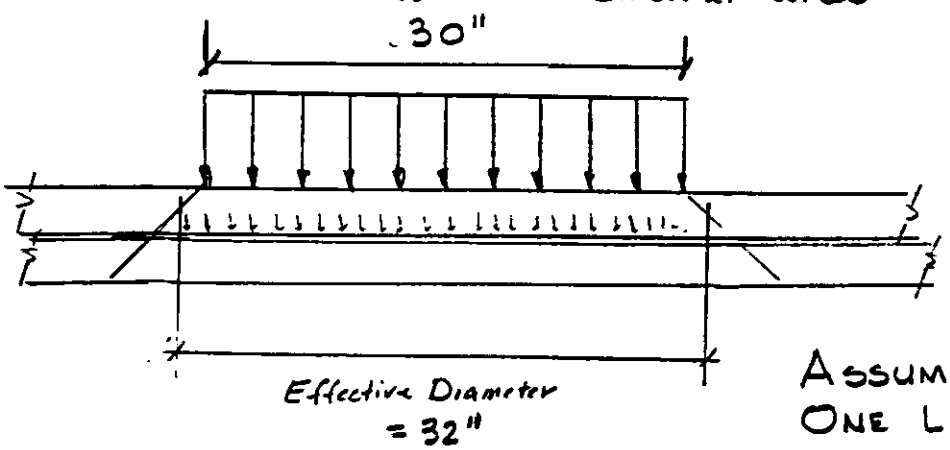
ENGINEERING CALCULATION

PROJECT NUMBER:	04 424331
BY:	P Brant/M.Ty
DATE:	March 7 1998
PAGE:	4 OF 18
REVISED:	

SUBJECT: SILO DOME LIVE LOAD LIMITS

Local application of a 700 lb Live Load may result in a "PUNCH THROUGH" the dome

Assume the 700 lb load will be distributed over a 2'-6 diameter circular area –



ASSUME ONLY ONE LAYER IS EFFECTIVE IN RESISTING PUNCH THROUGH

Concrete Capacity to resist punch through

$V_c = 4\sqrt{f_c'}\ b_o d$ (Ultimate Un Factored Concrete Capacity)

$d = \pi\, d_{eff} = \pi\,(32)$
$\cong 100''$

$b = 2''$

REDUCE BY HALF FOR UNREINFORED SECTIONS

$V_c = 4\,[2000]^{1/2}\,(2)(100)\,(1/2)$
$\cong 17{,}800^{\#}$

TOTAL Applied Load shall not exceed $\phi V_c = .85\,(17{,}800^{\#})$
$\cong 15{,}000^{\#} > 700^{\#}$

Concrete (Unfactored Capacity)

OK

FS-F-78 B (REV 2/2)

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04 424331
BY:	P Brant/M.E.
DATE:	March 7 1998
PAGE:	5 OF 18
REVISED:	

SUBJECT: Silo Dome Live Load Limits –

If 700# Load were distributed over a 1'-0 diameter circular area

$d = \pi(14) \cong 44''$

$V_c = 4[2000]^{1/2}(2)(44)(\frac{1}{2})$
$= 7{,}900^{\#}$

Unfactored load Capacity –

$.85\,V_c = .85(7900) \cong 7{,}000^{\#} > 700^{\#}$ OK

$700^{\#}$ actual applied load

EFFECTIVE DIAMETER REQUIRED TO RESIST A 700# POINT LOAD

$700^{\#} = \phi V_c = .85[4\sqrt{2000}](2'')(\pi d_{eff})(\frac{1}{2})$

$\therefore d_{eff} = 700 / [.85[4\sqrt{2000}](2)(\pi)(1/2)]$

$= \underline{\underline{1.5\ in}}$ –

$\therefore$ SILO DOMES can support a 700# LIVE LOAD WITHOUT "PUNCH THROUGH"

FS-F-76 B (REV 2/2)

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04 424331
BY:	R Grant/M. Tay
DATE:	March 7 1998
PAGE:	6 OF 18
REVISED:	

SUBJECT: SILO DOME LIVE LOAD LIMITS

INVESTIGATE DOME BUCKLING (2" thick Concrete Dome) spalled center dome thickness

REFER TO ACI 344 SECTION 2.4.2.1

$$t_{min} = r_d \left[\frac{1.5 P_u}{\phi \beta_i \beta_c E_c} \right]^{1/2}$$

$$P_u = t^2 (\phi \beta_i \beta_c E_c) / 1.5 r_d$$

$r_d = 86.35'$

$\beta_i = (r_d / r_i)^2 \qquad r_i = 1.4 r_d$

$\therefore \beta_i = [r_d / 1.4 r_d]^2 = .51$

$\beta_c = 0.44 + .003 (\overset{0}{LL}) = 0.44$

$\phi = 0.7$

$E_c = 57{,}000\sqrt{2000} = 2{,}550{,}000$ psi

$$DL = 150^{\#}/FT^3 \times t/12 + 3PSF$$ FOAM COVER
$= 28$ PSF

$$P_u = 1.4(DL) + 1.7(LL)$$

$$\therefore LL = \left[\left(t/r_d\right)^2 \left(\frac{1}{1.5}\right) (\phi \beta_i \beta_c E) - 1.4(DL) \right] / 1.7$$

$$= \left[\left(\frac{\overset{3.725\times10^{-4}}{2}}{86.35\times12} \right)^2 \left(\frac{1}{1.5}\right) \left(.7(.44)(.51)\overset{2{,}67{,}000}{(2.55\times10^6)}(144) - 1.4(28)\right] / 1.7$$

$= 61$ PSF

$700 / 61 = 11$ SQ FT $\Rightarrow$ 3.6 foot ϕ circular area

or 3'-3 square area

FS-F-78 B (REV 2/5)

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04 424331
BY:	P Brant / M. Tay
DATE:	March 7 1998
PAGE:	7 OF 18
REVISED:	

SUBJECT: SILO DOME LIVE LOAD LIMITS

Alternately Per ACI SP-67

$$t_{min} = r\left[S(g+P)/KE_c \right]^{1/2}$$

S = Safety factor
g = DL
P = LL
K = 0.25

$E_c = 57000\sqrt{2000}$
$= 2.55\times10^6$
$r = 12(86.35')$

$$P_{LL} = \left(\frac{t}{r}\right)^2 \frac{1}{S}(KE_c) - g$$

$$= \left(\frac{\overset{3.725\times10^{-4}}{2}}{12\times86.35}\right)^2 \frac{1}{5}\overset{127,500}{(.25)(2.55\times10^6)}\overset{IN^2 \Rightarrow FT^2}{(144)} - 28$$

$$= \underline{40\ PSF}$$

$$Area = \frac{700}{40} = 17\ SQFT =$$ or <u>5.5 ø circular area</u>

or <u>4 foot square area</u>

FS-F-78 B (REV 2/2

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04424331
BY:	P Grant/M. Fay
DATE:	March 7 1998
PAGE:	8 OF 18
REVISED:	

SUBJECT: SILO DOME LIVE LOAD LIMITS

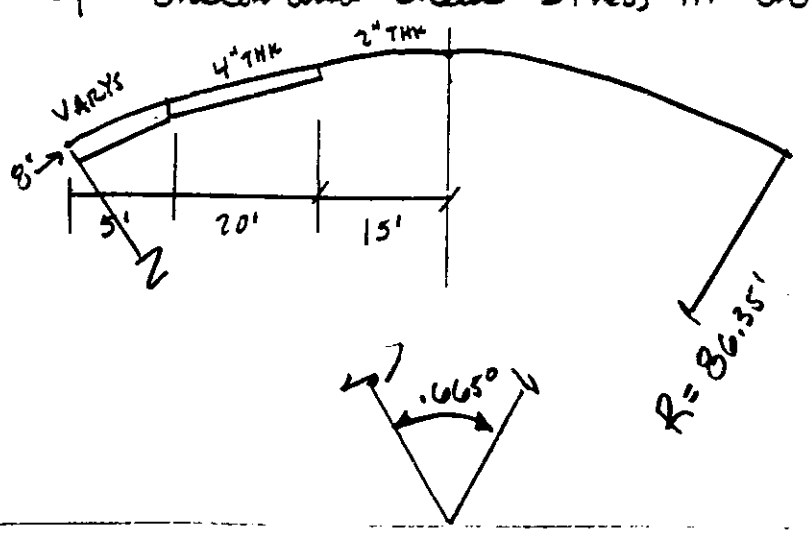
Due to the fact that the core samples and petrographic examinations indicate that the concrete in the dome is extremely fractured Its behavior under loading and its ability to resist applied loads is hard to predict.

It is felt that if it can be shown that the load is carried through compression with no tensile stress and minimal shear stress we can be fairly sure that the dome can carry the load.

Take a 1 foot wide slice out of the dome. Assume Ring Girder Provides horizontal resistance to Radial loads. and ignore walls.

That leaves us with an arch structure — supporting a uniform DL and any specified Live load —

Evaluate stress in the arch due to element compression and flexure to ascertain magnitude of tension and shear stress in dome.



Jenny cons.

$E_c = 57\sqrt{2000}$

$= \underline{2550 \text{ ksi}}$

$\mu = \underline{0.10}$

$G = \dfrac{E}{2(1+\nu)}$

$= \underline{1159 \text{ ksi}}$

FS-F-78 B (REV 2/

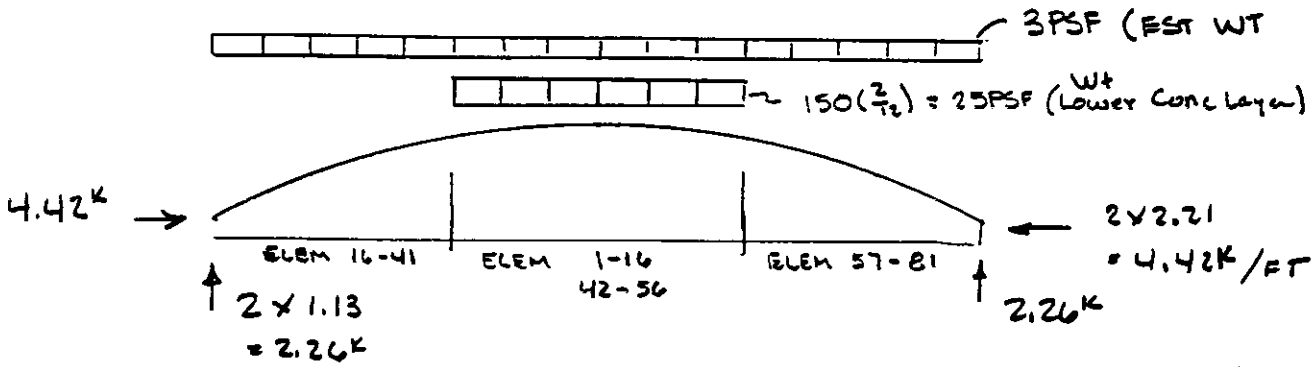
Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04424331
BY:	P Grant / M. [illegible]
DATE:	March 7 1998
PAGE.	9 OF 18
REVISED:	

SUBJECT: SILO DOME LIVE LOAD LIMITS

Case 1: SELF Wt PLUS FOAM.



All elements in compression ranging from 4.42K at dome center to 4.94K at wall –

max bending moment = .1'-K ← at 2" thick section
= .27'-K ← at 4" thick SECTION

$f_a = P/A = 4.42/(2\times12) = .184$ ksi

$f_b = M/S = 12(.10)/8 = .150$ ksi } No Tension

$S = \frac{1}{6}bt^2 = \frac{1}{6}(12)(2)^2 = 8 in^3$ (2" thk section)

$S = \frac{1}{6}(b)t^2 = \frac{1}{6}(12)(4)^2 = 32 in^3$

$f_b = 12(.27)/32 = .101 < .184$ No Tension –

NOTE: These are untactored stresses No Safety factor applied.

Max shear = 2.26K/FT $\quad v = 2.26/2(12)$
= .094 ksi OK

FS-F-76 B (REV 2/

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04424331
BY:	P Grant / M. Tay
DATE:	March 9 1998
PAGE:	10 OF 18
REVISED:	

SUBJECT: Silo Dome Live Load Limits –

similarly

Case 3 Self Wt plus Foam plus Snow (20PSF)

Reactions at ring = $2 \times 1.53 = \underline{3.06^k}$ Vert
$2 \times 3.04 = \underline{6.04}$ Horiz –

All elements in compression.

$P = 6.1^k$ in center dome area
$= 6.8^k$ elsewhere

Bending Moment = .13'-K in center dome
.4'-K elsewhere

Center Dome = $f_a = \frac{6.1}{2 \times 12} = .254$ ksi
$f_b = 12(.13)/8 = .20$ ksi } No Tension

elsewhere = $f_a = 6.8/4 \times 12 = .142$
$f_b = 12(.4)/32 = .150$ } 8 psi tension

shear = $6^k/FT = 6/4(12) = \underline{.125 \text{ ksi}}$

Note these are stresses due to unfactored Loads.

No Factor of Safety Applied :

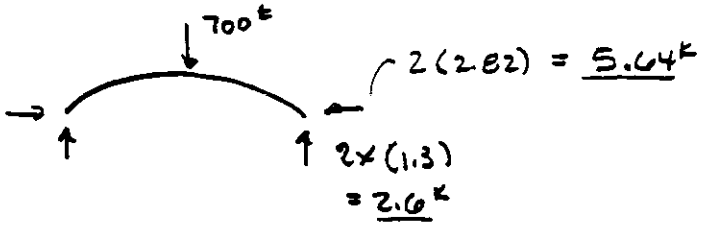
FS-F-76 B (REV 2/2

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04424331
BY:	P Drant / M. Tay
DATE:	March 9 1998
PAGE:	11 OF 18
REVISED:	
SUBJECT:	

Case 7. : Self Wt plus Foam plus 700# at center



700# Applied over a 1 FT SQ AREA (Very Conservative)

All elements in compression –

for Section Properties see previous –

Center Dome P = 5.6k → 5.75k
M = 2.2'-k → 0'-k } element #1

fa = 5.6/2(12) = .233 ksi
fb = 12(2.2)/8 = 3.3 ksi } lots of tension –

Note: These are unfactored Stresses – No Safety Factor Applied.

else where – P = 5.7k to 6.2k
M = 2.22'-k

fa = 5.7/4(12) = .119 ksi
fb = 12(2.22)/32 = .833 ksi } 714 psi tension

Graphical Depiction of Element Moments AND FORCES can be found in APPENDIX A

FS-F-78 (REV 2/2)

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

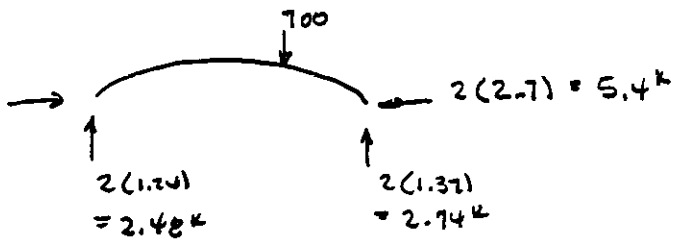
ENGINEERING CALCULATION

PROJECT NUMBER:	04424331
BY:	P Grant/M Ty
DATE:	March 9 1998
PAGE:	12 OF 18
REVISED:	

SUBJECT:

Case 8: Self Wt Plus Foam Plus 700# @ R=15'-0

700# on a 1 FT SQ AREA -



Center Dome $P = 5.36^k \rightarrow 5.45^k$, $M = 3.78'\text{-}k$ } elem #56

$f_a = 5.36/2(12) = .223$ ksi
$f_b = 12(3.78)/8 = 5.67$ ksi

Else Where

$P = 5.45^k \rightarrow 6^k$
$M = 3.63'\text{-}k$

$f_a = 5.45/4(12) = .114$ ksi
$f_b = 12(3.63)/32 = 1.36$ ksi

Untactored Stresses No Safety Factor Applied

Case 9: Self Wt Plus Foam Plus 700# @ R=7'-0

in center dome
$P = 5.6^k$, $M = 2.59'\text{-}k$ } element #48

$f_a = 5.6/2(12) = .233$ ksi
$f_b = 12(2.59)/32 = 3.92$ ksi

else where $M = 2.81'\text{-}k$
$P = 6.25^k$

FS-F-76 B (REV 2/

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	0442331
BY:	P. Grant / M. Tracy
DATE:	March 1998
PAGE:	13 OF 18
REVISED:	
SUBJECT:	

Case 10 Self Wt plus foam plus 700# @ R = 24'-0

in center dome M = 2.38'-K, P = 5K } element #54

elsewhere M = 4.5'-K, P = 5.8K

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04424331
BY:	PBrant/M.Tu
DATE:	March 9 1998
PAGE:	14 OF 18
REVISED:	
SUBJECT:	

Distribute 700# over 3'-0 ø circular area -

$A = \pi r^2 = \pi(1.5)^2 \approx 7\ FT^2$

uniform pressure $\approx 700/7 = 100\ PSF$ -

Again No Safety Factor Included - Unfactored Applied Loads

Re-evaluate Dome for 100 PSF over 3 consecutive plate elements -

Revise Case 7 to place load over elements 1, 2, 42

$P = 5^K$ $\quad f_a = 5/2(12) = .208\ ksi$

$M = .94$ $\quad f_{by} = 12(.94)/8 \approx 1.5\ ksi$

Revise Case 8 to place load over elements 54, 55, 56 (R = 15'-0)

$P \approx 5^K$ $\quad f_a = 5/2(12) = .208$

$M \approx 1.46$ $\quad f_b = 12(1.46)/8 = 2.2\ ksi$

Revise Case 9 to place load over elements 47, 48, 49 R = 7 1/2'

$P = 5^K$ $\quad$ N.G.

$M = 1.0'\text{-}K$

Revise Case 10 place load over elements

$P = 4.75$

$M = .97'\text{-}K$ $\quad$ N.G

FS-F-76 B (REV 2/

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	04424531
BY:	P Grant / M. Tay
DATE:	March 9 1988
PAGE:	15 OF 18
SUBJECT:	
REVISED:	

DISTRIBUTE OVER A 4'-0 diameter Area —

$A = \pi(2)^2 = 12.6 \text{ FT}^2$

Pressure = $700/12.6 = 56$ PSF

Review Model

Ld Case 7 distribute to 1, 2, 42, 3

$P_{max} = 4.8^k$ $f_a = 4.8/2 \times 12 = 0.2$ ksi

$M \cong .68$ $f_b = 12(.68)/8 = 1.05$ ksi

Ld Case 8 R = 15'-0

$P_{max} = 4.8^k$

$M \cong .91'^k$ N.G

Ld Case 9 R = 7'-0

$P_{max} = 4.8^k$

$M = .7'^k$

Ld Case 10 R = 24

$P_{max} = 4.7$

$M = .6'^k$ $f_b \cong 1$ ksi N.G

FS-F-76 B (REV 2/

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
(513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER:	0442331
BY:	P Brand / M.T.
DATE:	March 15 1998
PAGE:	16 OF 18
REVISED:	

SUBJECT: SILO DOME LIVE LOAD LIMITS

Tabulate Data Developed on Shts 9 thru 12

RADIUS	CONC THK	M/P	1 FT SQ	3 FT Ø	4 FT Ø
R=0	2"	M_x	2.2'-K	.94'-K	.63'-K
	2"	P_x	5.6K	5K	4.8K
	4"	M_x	2.2'-K	1.09'-K	.8'-K
	4"	P_x	6.2K	5.2K	5.0K
R=7'	2"	M_x	2.59'-K	1.11'-K	.7'-K
	2"	P_x	5.6K	4.9K	4.8K
	4"	M_x	2.83'-K	1.35'-K	1.0'-K
	4"	P_x	6.25K	5.3K	4.9K
R=15'	2"	M_x	3.79'-K	1.46'-K	.91'-K
	2"	P_x	5.45'-K	5K	4.8K
	4"	M_x	3.63'-K	1.28'-K	.95'-K
	4"	P_x	6.0K	5K	4.8K
R=24'	2"	M_x	2.38'-K	.97	.64
	2"	P_x	5K	4.75K	4.7K
	4"	M_x	4.5'-K	1.74'-K	1.05'-K
	4"	P_x	5.8K	5K	4.8K

MOST CRITICAL AREA —

FS-F-78 B (REV 2/

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

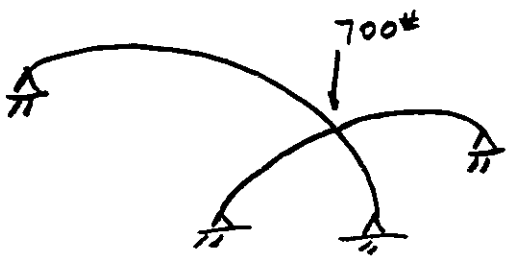
ENGINEERING CALCULATION

PROJECT NUMBER:	0442331
BY:	P Brant/M.T.
DATE:	March 15 1998
PAGE:	17 OF 18
REVISED:	

SUBJECT: SILO DOME LWE LOAD LIMITS -

NOTE: THE 1 FOOT WIDE STRIP USED IN THE PRECEDING ANALYSIS PROVIDES A GOOD REPRESENTATION OF THE INTERNAL DOME MOMENTS AND FORCES DUE TO UNIFORM SYMETRICAL GRAVITY LOADS. IT IS VERY CONSERVATIVE WITH RESPECT TO UNSYMETRICAL CONCENTRATED LOADS.

THERE ARE 2 - PERPENDICULAR ARCHES ACTING TO SUPPORT CONCENTRATED LOADS AT ANY GIVEN PT.



FROM PREVIOUS ANALYSIS - CRITICAL LOCATION for APPLICATION OF CONCENTRATED LOAD IS AT ~ 15'-0 FROM CENTER OF DOME -

REMODEL W/ 2 - 1 FT WIDE ARCHES AS SHOWN ABOVE. DISTRIBUTE LOAD OVER A 3'-0 Ø CIRCULAR AREA JUST INSIDE THE 15'-0 RADIOUS DETERMINE LOCAL ELEMENT LOADS AND COMBINE WITH ELEMENT LOADS DUE TO GRAVITY LOADINGS SHOWN ON SHT 7.

REMODEL AND DISTRIBUTE LOAD OVER A 3'-0 CIRCULAR AREA JUST BELOW (OUTSIDE) THE 15'-0 RADIOUS. AGAIN COMBINE RESULTS WITH GRAVITY LOADS.

FS-F-78 (REV 2/)

Fernald
Environmental Restoration
Management Corporation
PO Box 398704
Cincinnati, Ohio 45239-8704
513) 738 6200

ENGINEERING CALCULATION

PROJECT NUMBER: 04424331
BY: P Grant / M. Fry
DATE: MARCH 15 1998

REVISED:

SUBJECT: SILO DOME LIVE LOADS

ELEM No	MOMENT / AXIAL	SELF WT + FOAM	700 lb DIST INSIDE 15' RAD	TOTAL (ABS SUM)	700 lb DIST OUTSIDE 15'-RAD	TOTAL	
54	M	-.07	-.13	.20	.01	.08	2" THK CONC
	P	-6.15	—	6.2			
55	M	-.10	.13	.26	.02	.12	
	P	-6.15	—	6.2			
56	M	-.13	.163	.29	.02	.13	
	P	-6.17	—	6.2			
57	M	-.16	.11	.27	.08	.24	4" THK CONC
	P	-6.19	—	6.2			
58	M	-.18	.08	.26	.27	.45	
	P	-6.2	—	6.2			
59	M	-.21	.05	.26	.07	.28	
	P	-6.22	—	6.2			
60	M	-.24	.03	.27	.02	.26	
	P	-6.23	—	6.2			

for 2" thick center Dome area

Mmax = .26'-k
P = 6.2k

fbx = 12(.26)/8 = .390 ksi } .53 comp
fa = 6.2/2(12) = .258 } .132 TEN

530 #/in² COMP
130 #/in² TENS

Allowable Tension = $5\phi\sqrt{f_c'} = 5(.65)[2000]^{1/2} = 145$ psi
OK

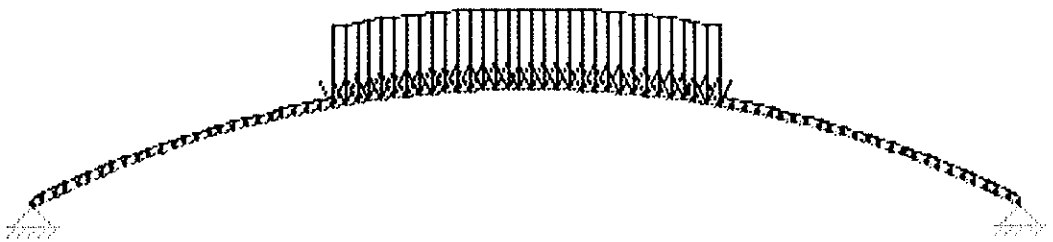
FS-F-78 (REV 2/

Appendix A

K-65 Silo Dome Live Load Analysis fc=2000psi

Single Strip - 700 lbs over 1 ft sq area

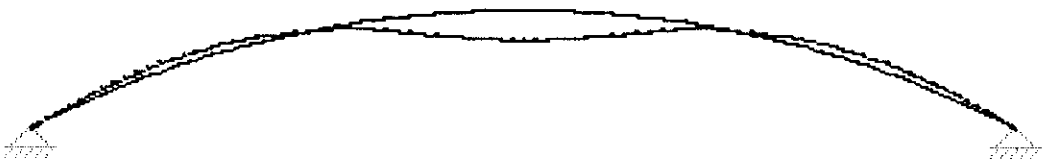
Y Grav: -1



Solution: LC 1 self wt with foam

K-65 Silo Dome Live Load Analysis fc=2000psi

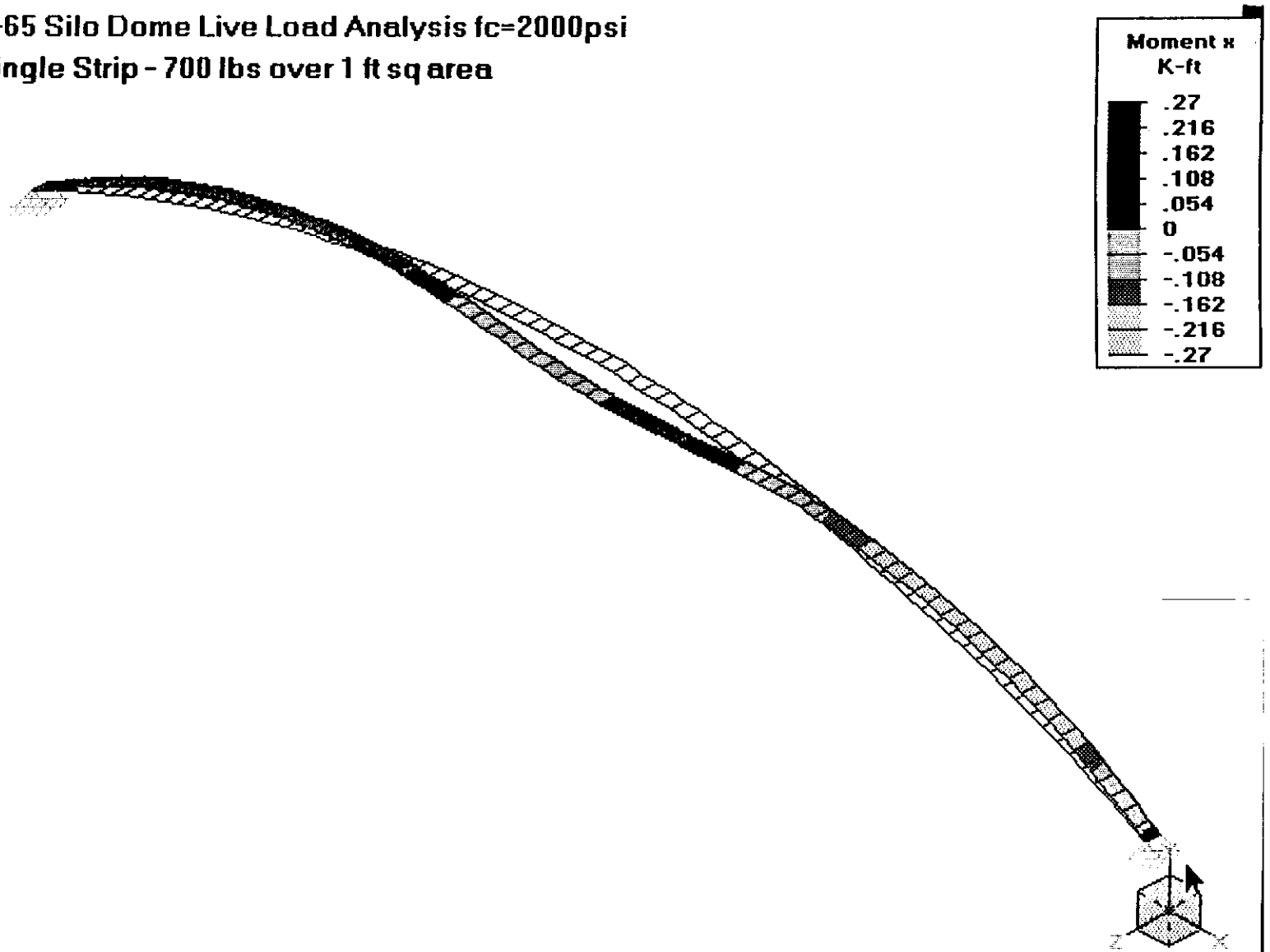
Single Strip - 700 lbs over 1 ft sq area



Solution: LC 1 self wt with foam

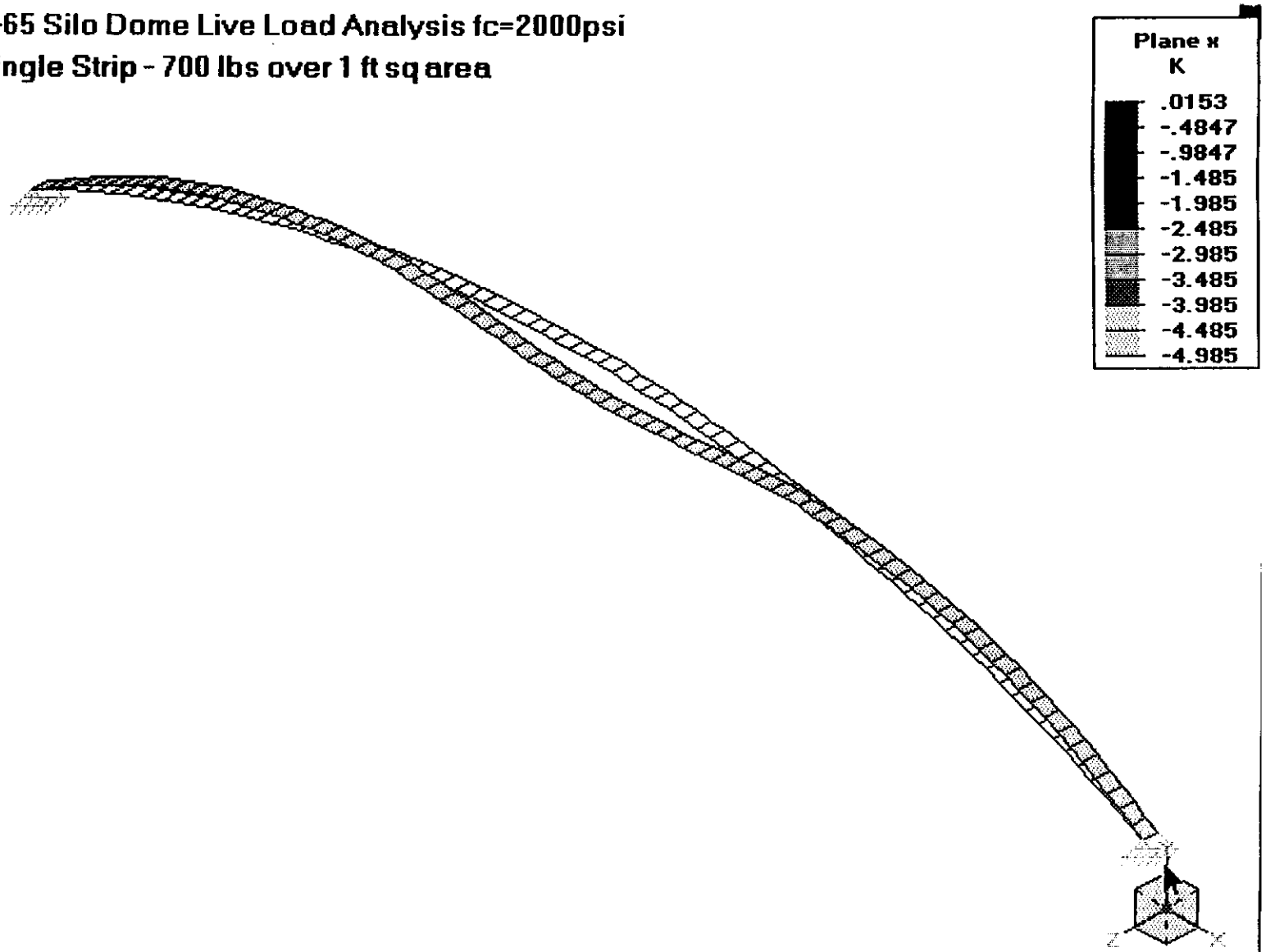
K-65 Silo Dome Live Load Analysis fc=2000psi

Single Strip - 700 lbs over 1 ft sq area



Solution: LC 1 self wt with foam

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area

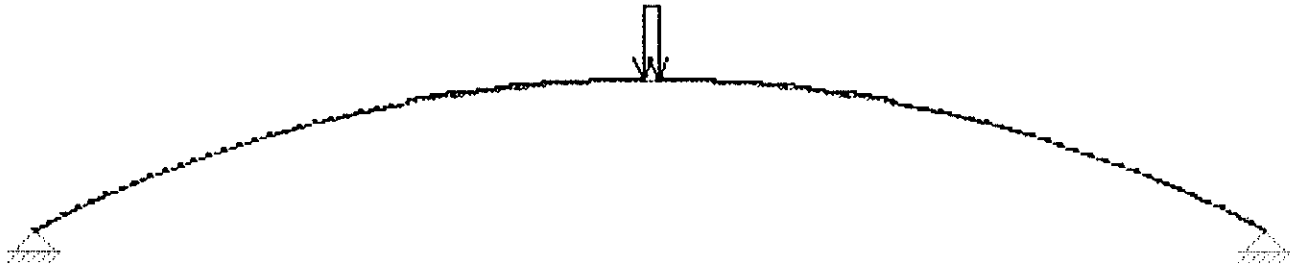


Solution: LC 1 self wt with foam

K-65 Silo Dome Live Load Analysis fc=2000psi

Single Strip - 700 lbs over 1 ft sq area

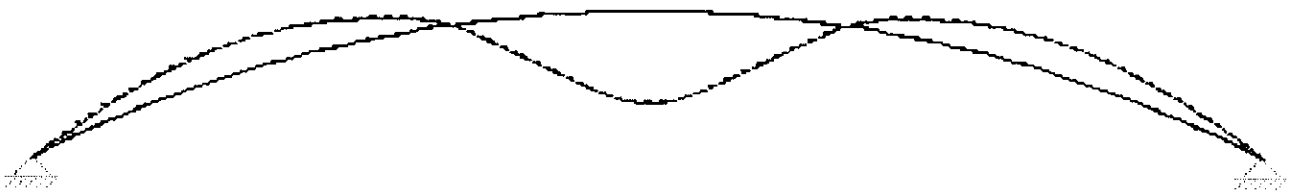
Y Grav: -1

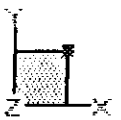


Solution: LC 7 Self w/700lb R=0

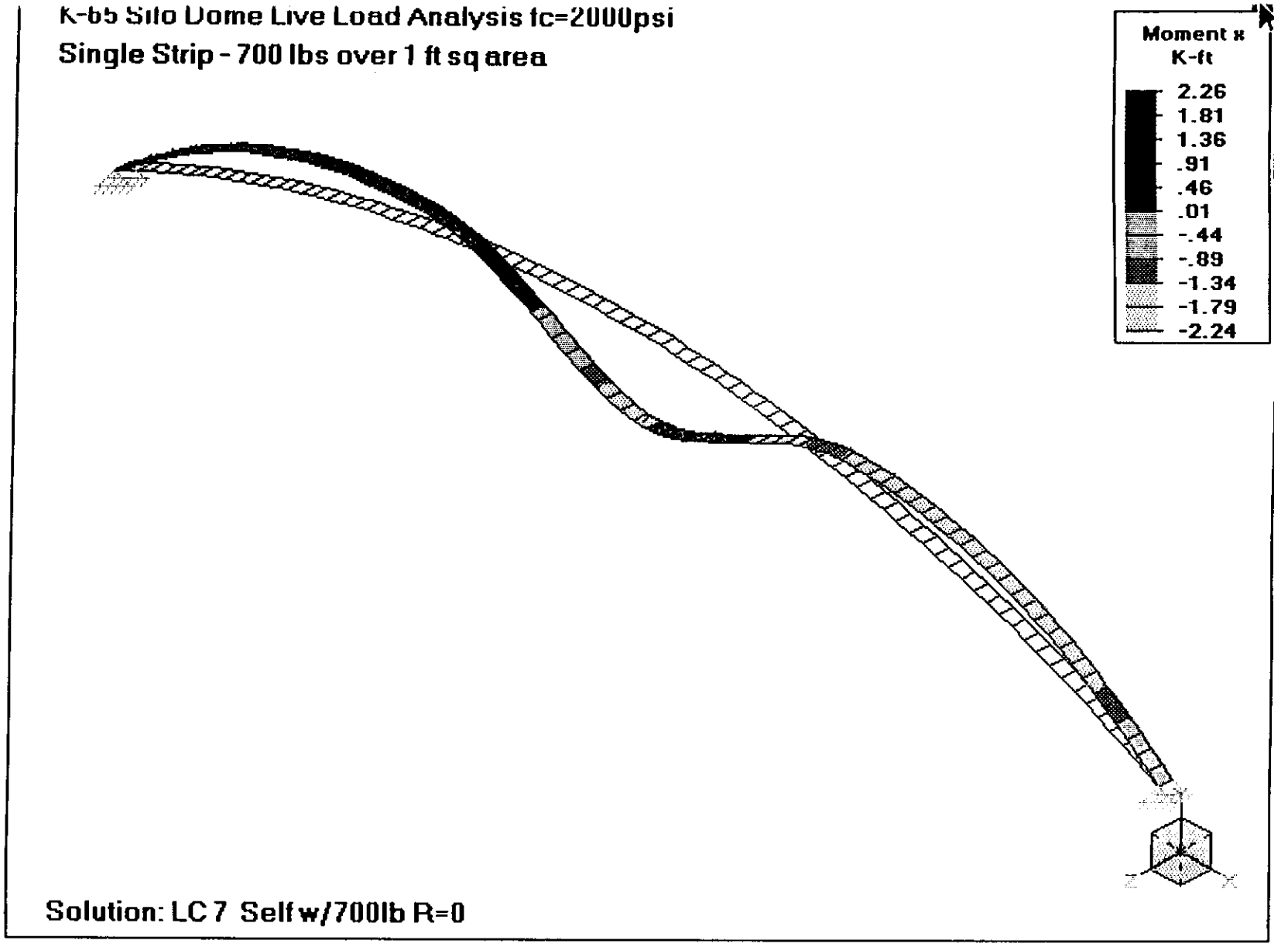
K-65 Silo Dome Live Load Analysis fc=2000psi

Single Strip - 700 lbs over 1 ft sq area

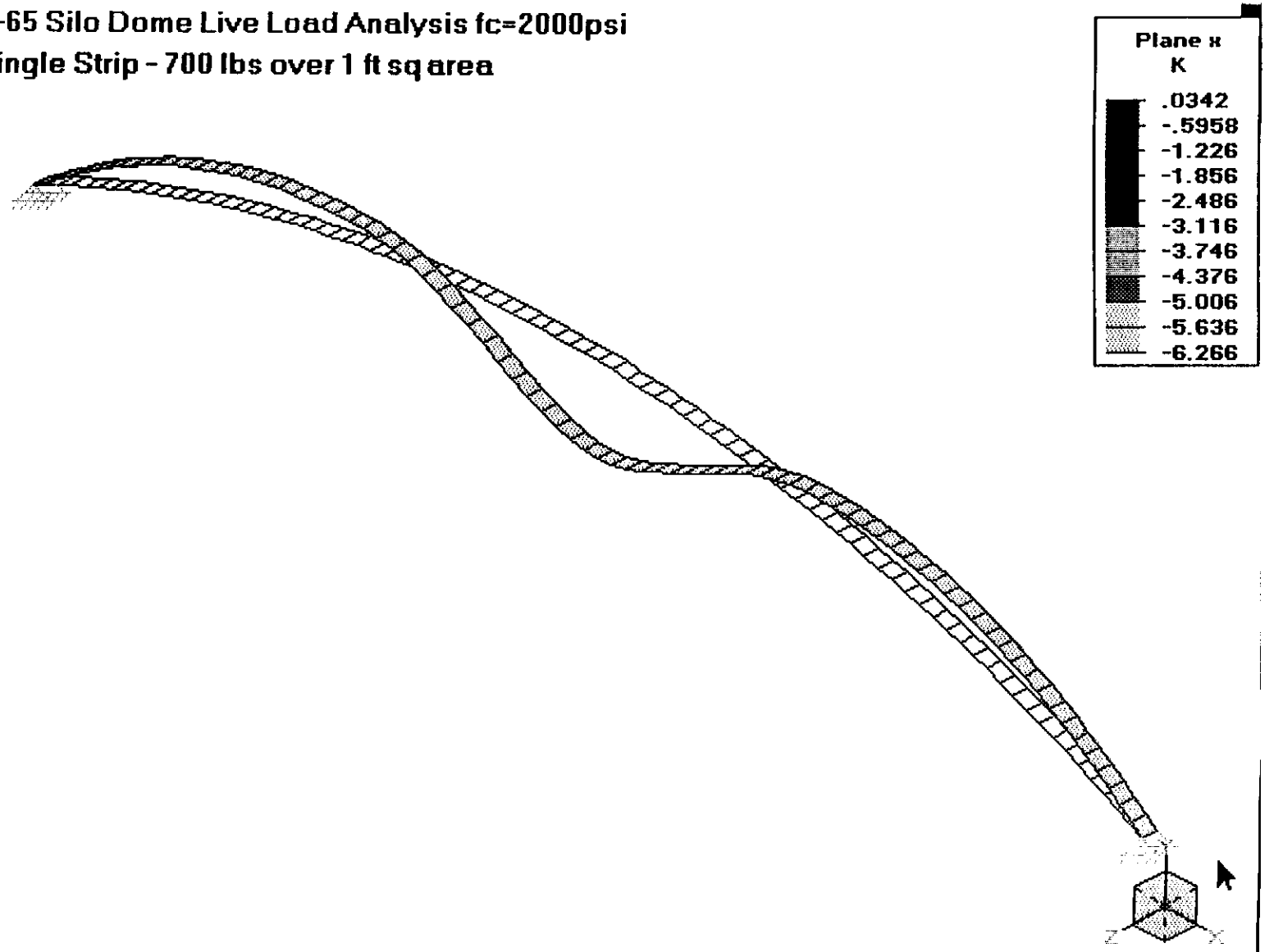




Solution: LC 7 Self w/700lb R=0

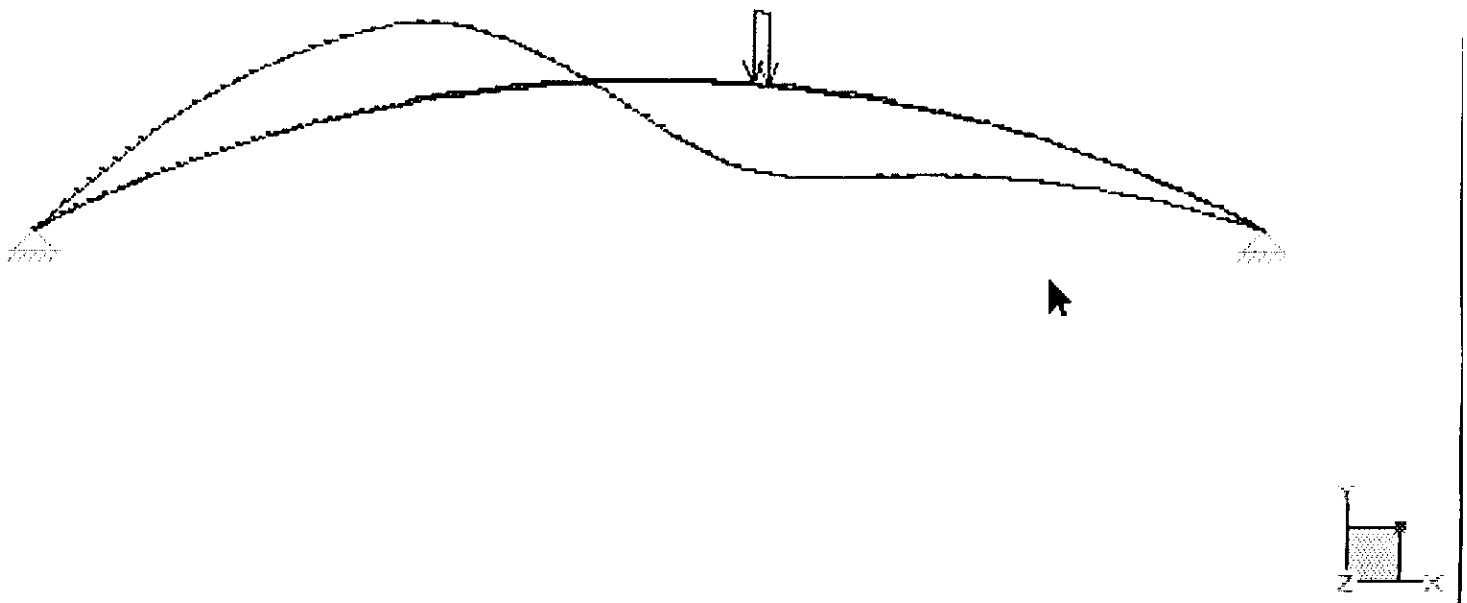

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area
Moment x
K-ft
2.26
1.81
1.36
.91
.46
.01
-.44
-.89
-1.34
-1.79
-2.24
Solution: LC 7 Self w/700lb R=0

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area

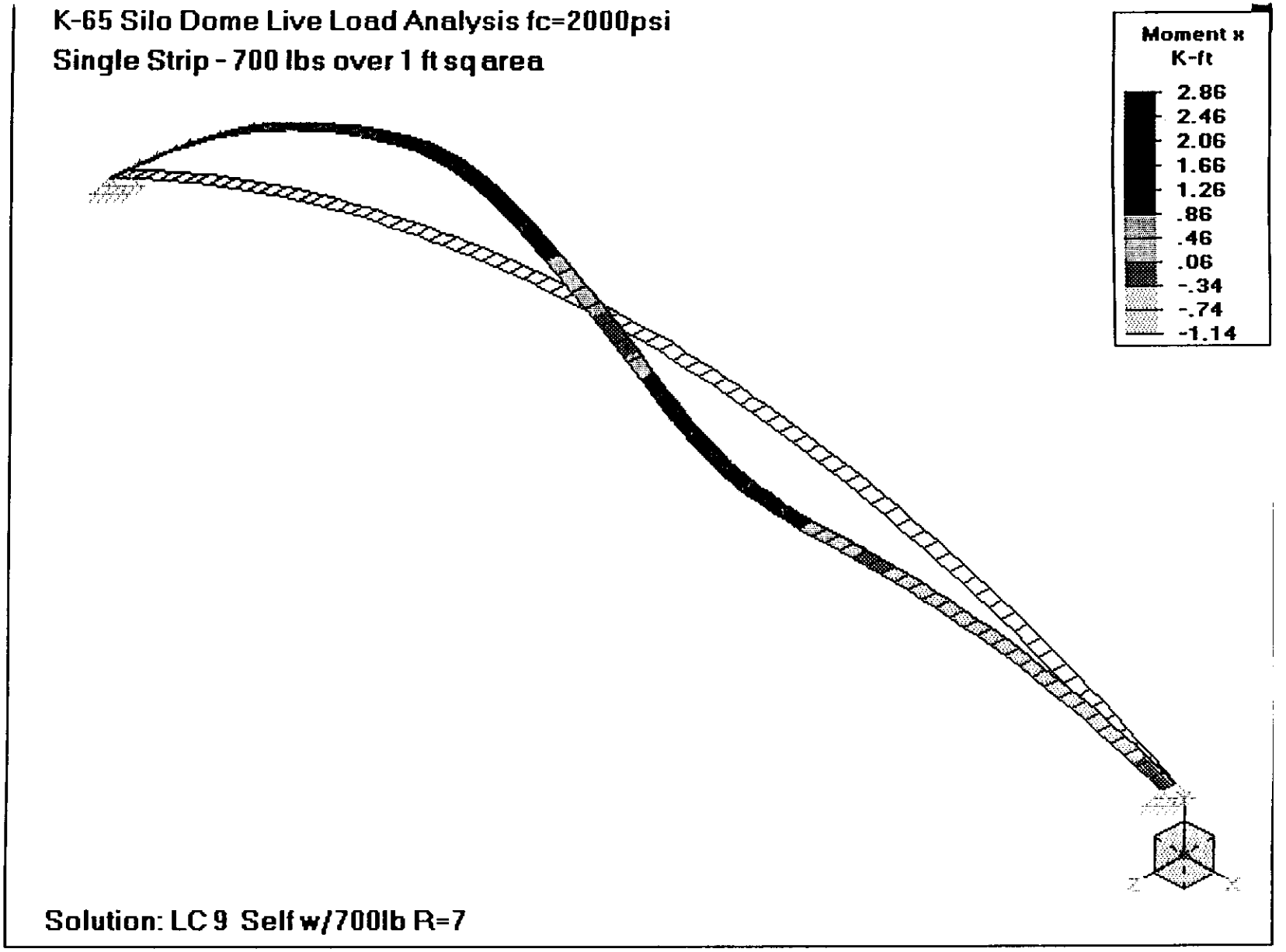


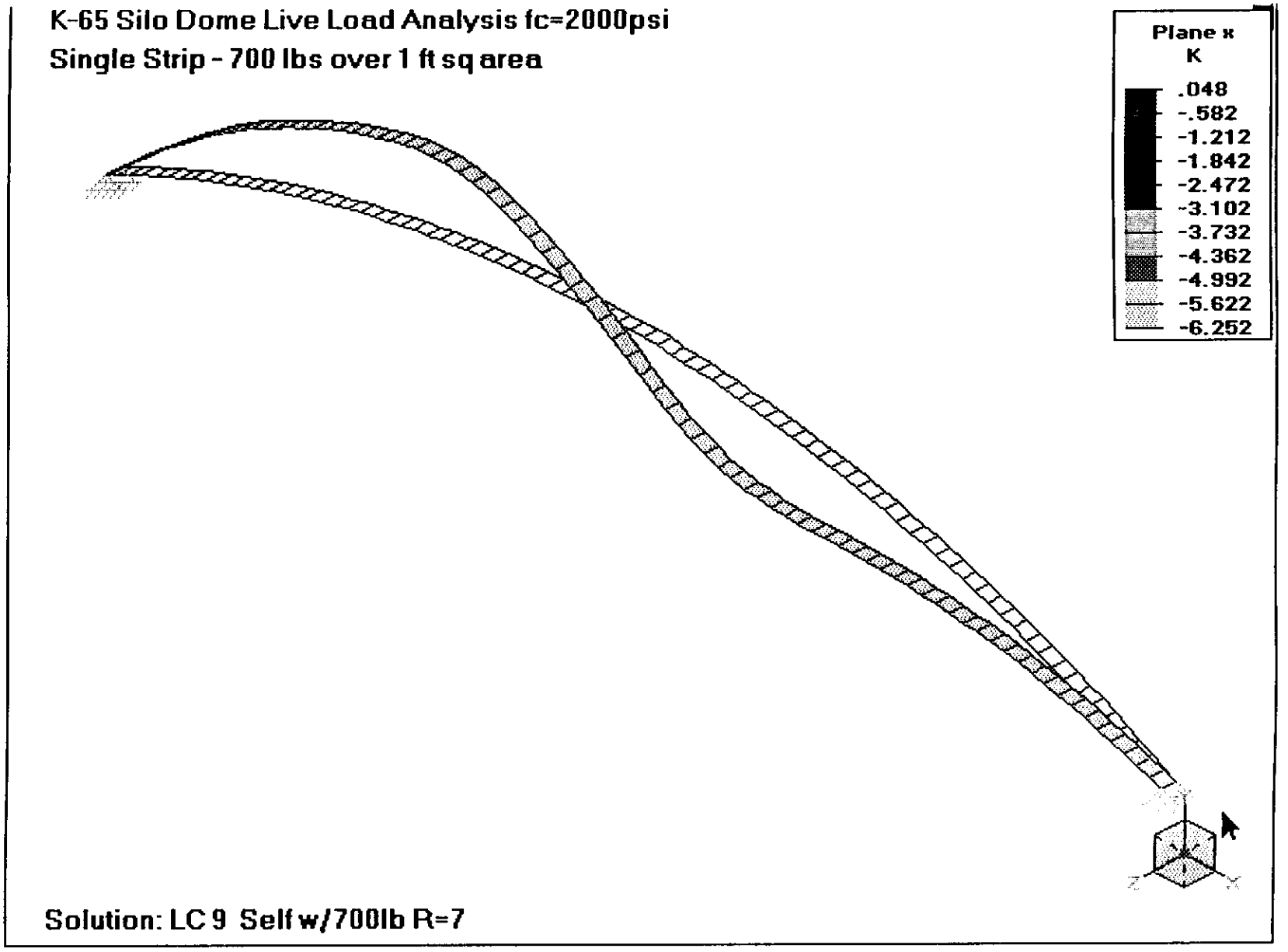
Solution: LC 7 Self w/700lb R=0

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area
Y Grav: -1



Solution: LC 9 Self w/700lb R=7

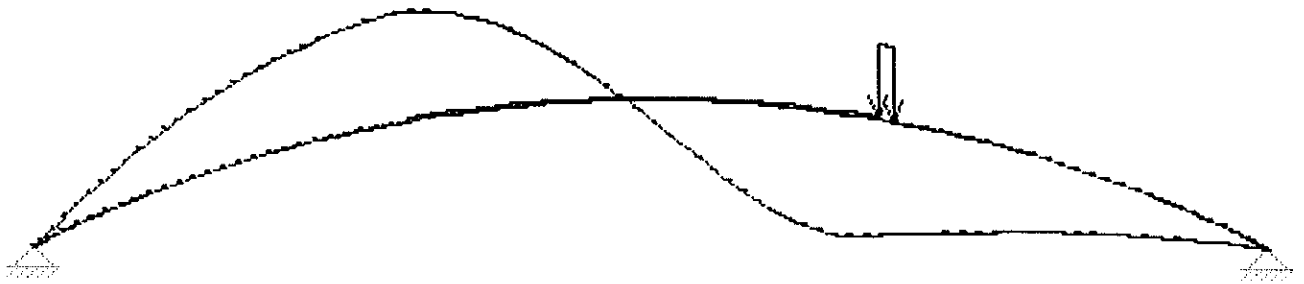

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area
Moment x
K-ft
2.86
2.46
2.06
1.66
1.26
.86
.46
.06
-.34
-.74
-1.14
Solution: LC 9 Self w/700lb R=7


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area
Plane x
K
.048
-.582
-1.212
-1.842
-2.472
-3.102
-3.732
-4.362
-4.992
-5.622
-6.252
Solution: LC 9 Self w/700lb R=7

K-65 Silo Dome Live Load Analysis fc=2000psi

Single Strip - 700 lbs over 1 ft sq area

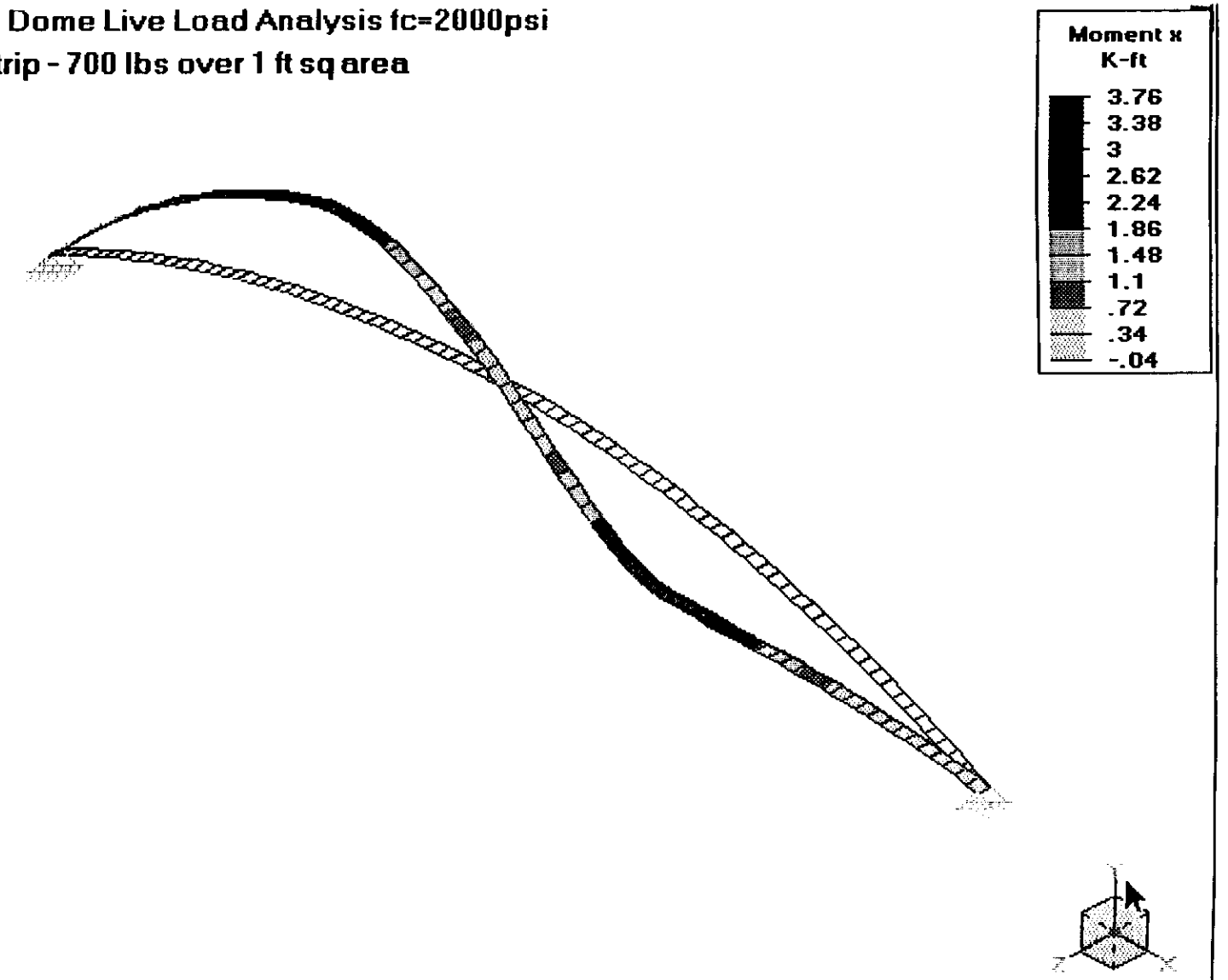
Y Grav: -1



Solution: LC 8 Self w/700lb R=15

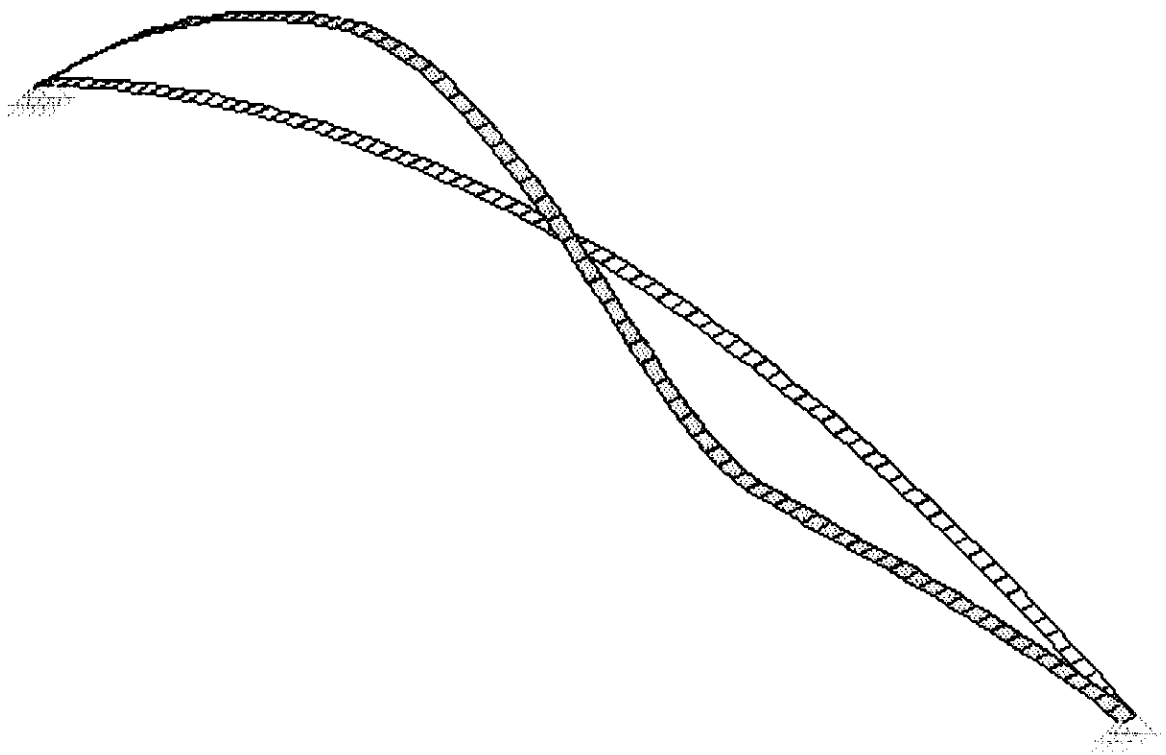
K-65 Silo Dome Live Load Analysis fc=2000psi

Single Strip - 700 lbs over 1 ft sq area



Solution: LC 8 Self w/700lb R=15

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area

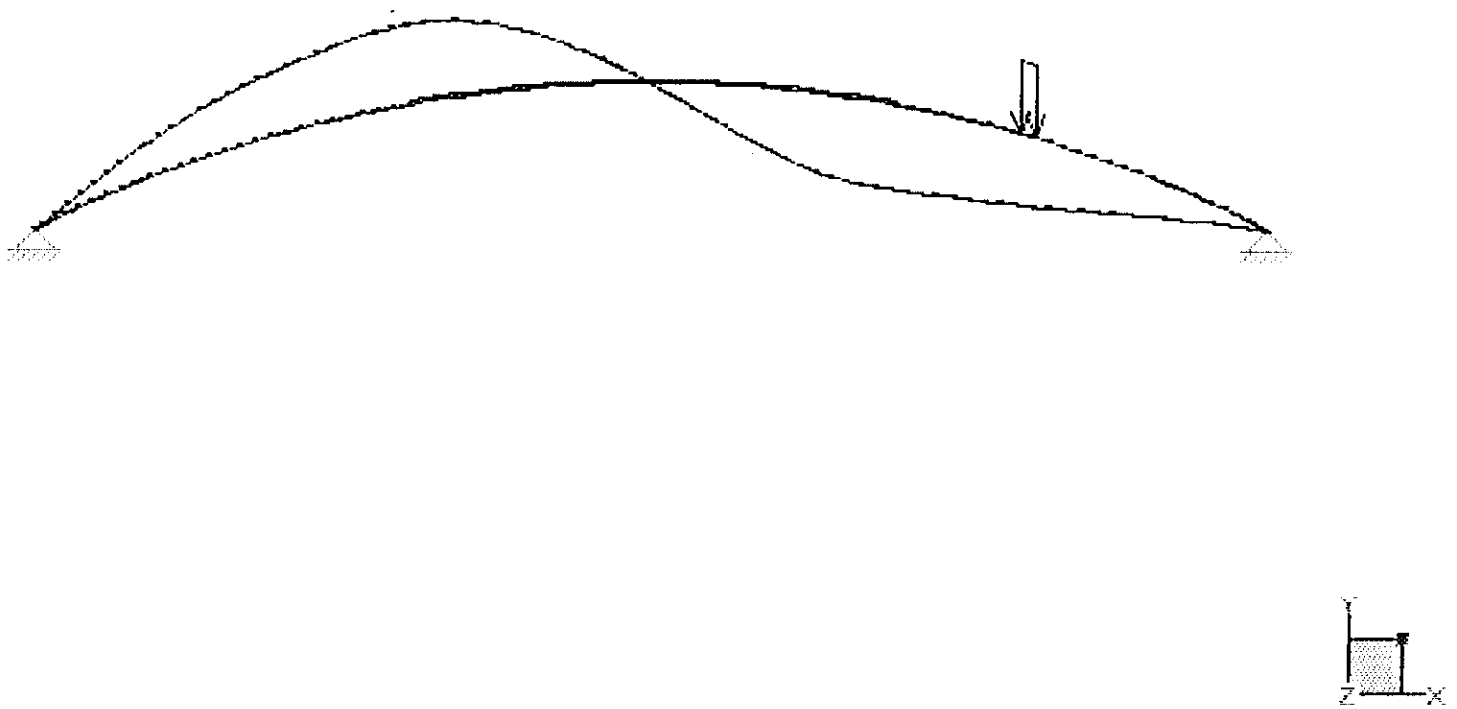


Plane x
K

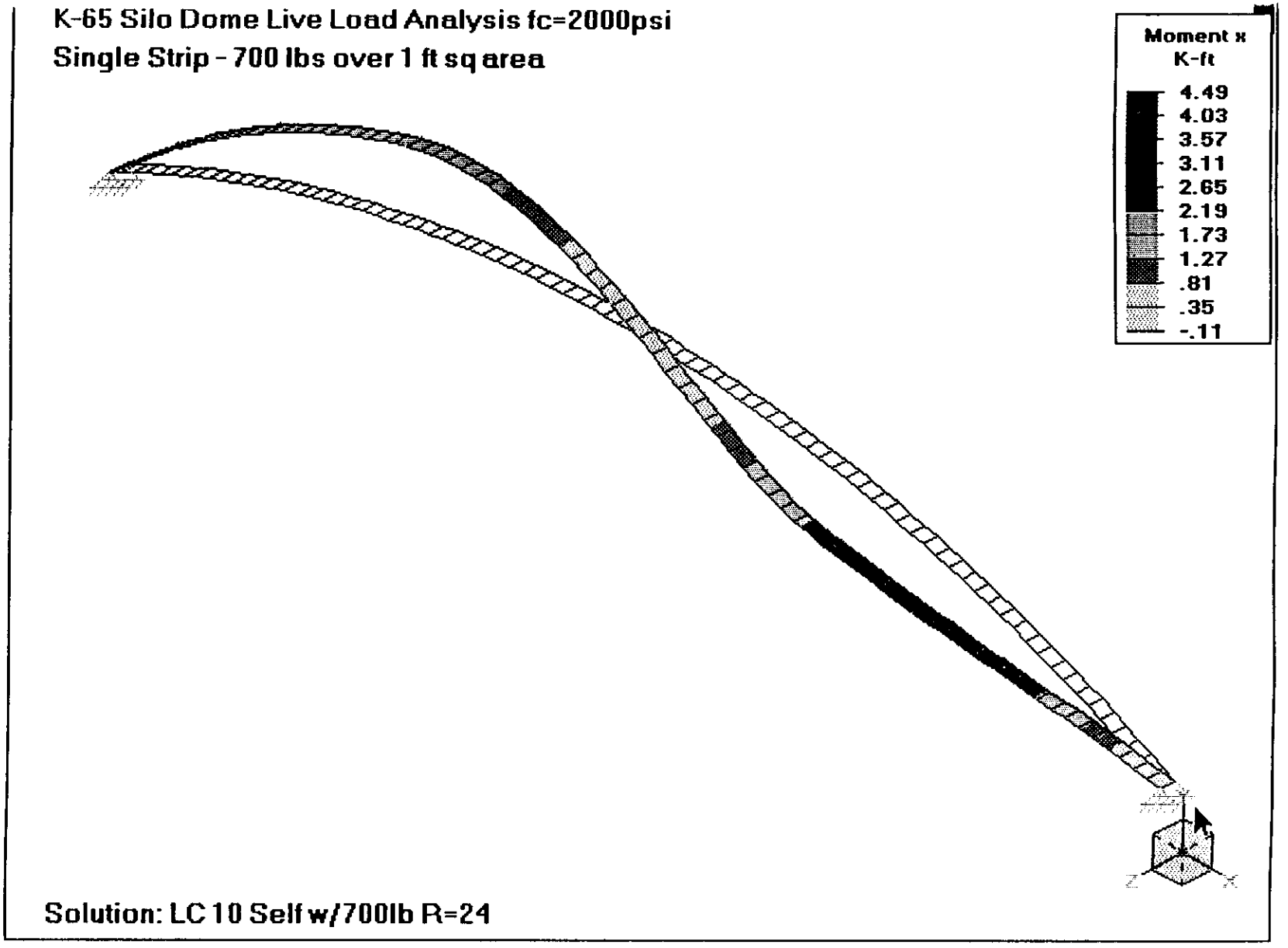
.0275
-.5825
-1.192
-1.803
-2.412
-3.022
-3.632
-4.242
-4.852
-5.463
-6.073

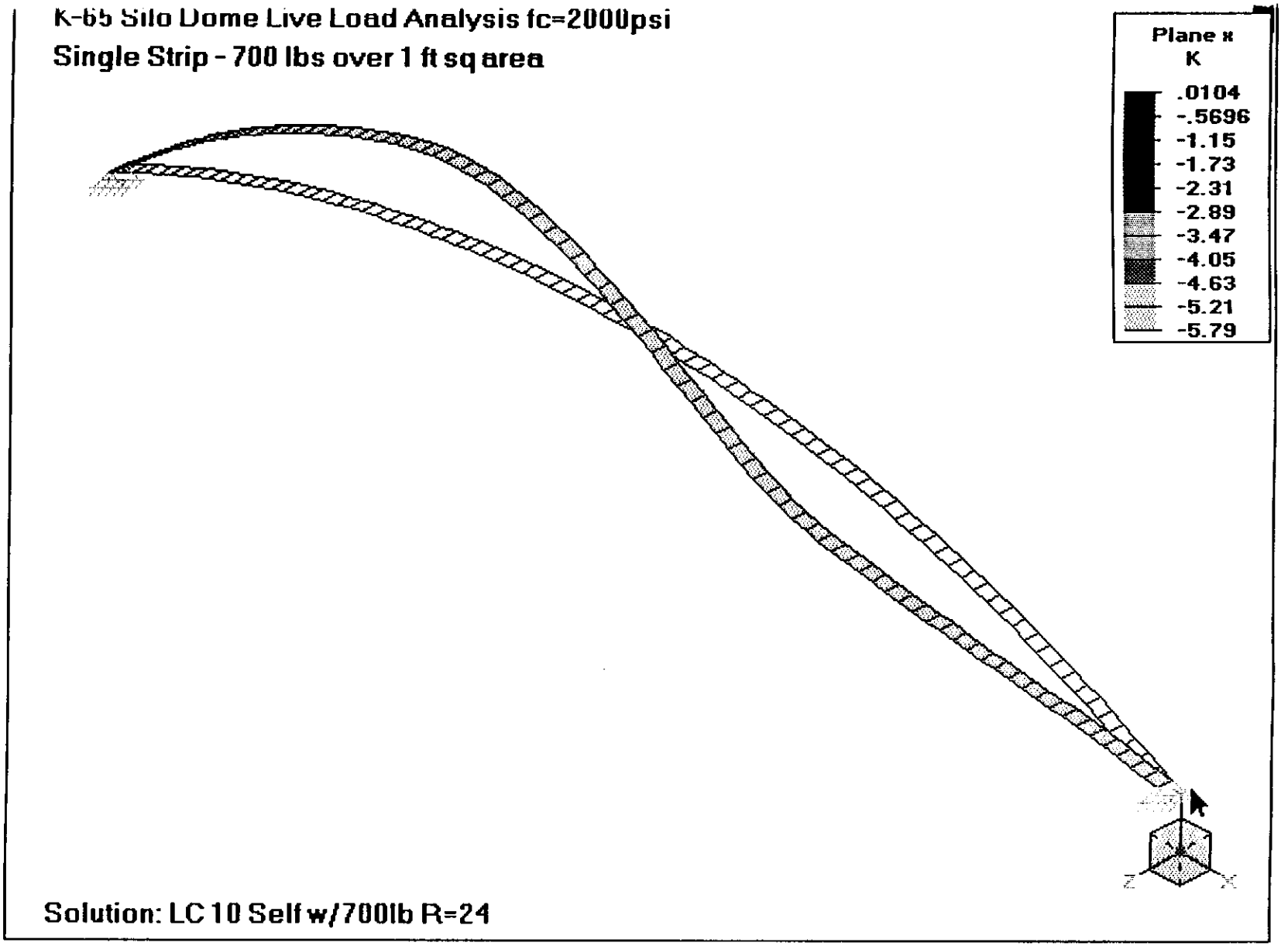
Solution: LC 8 Self w/700lb R=15

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area
Y Grav: -1



Solution: LC 10 Self w/700lb R=24

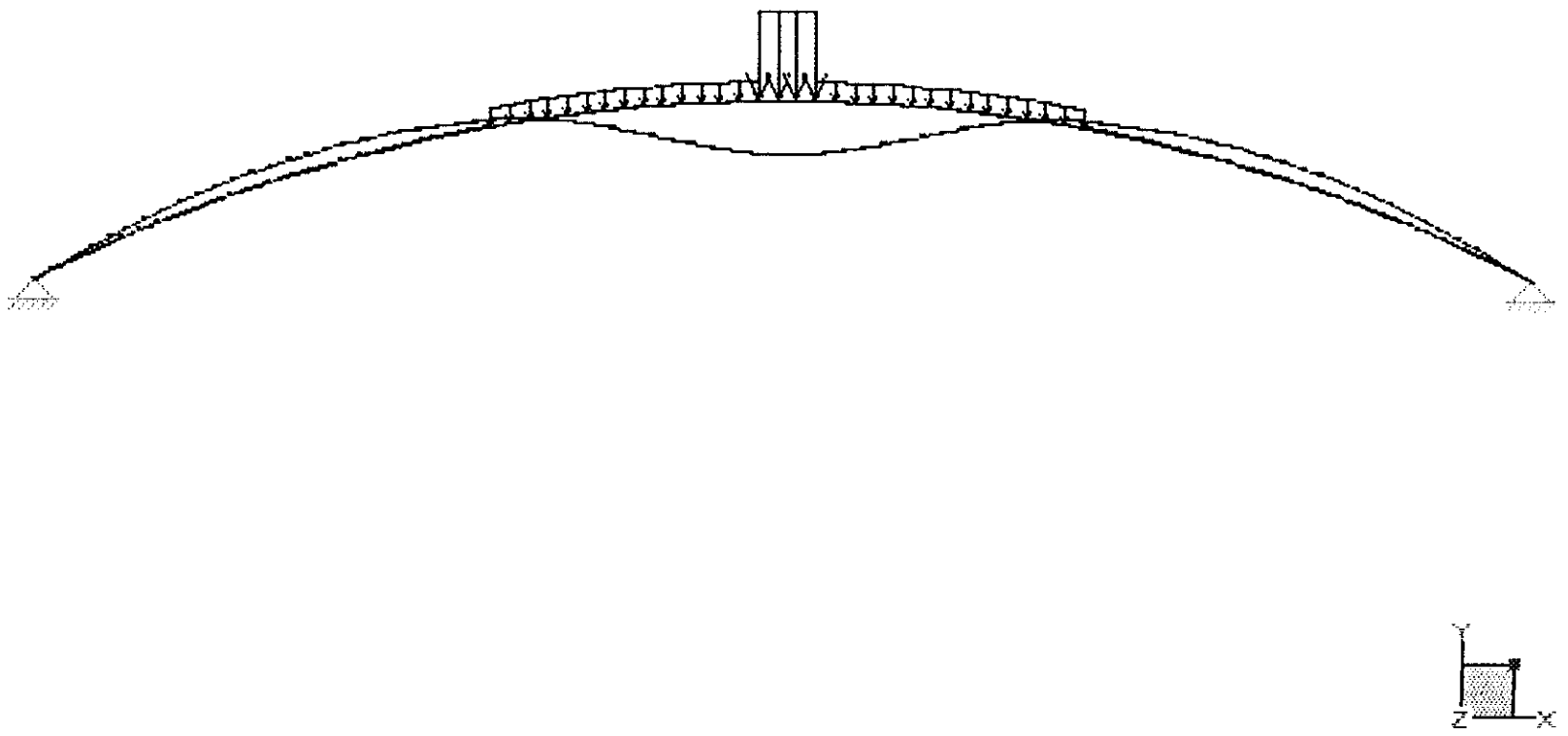

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area
Moment x
K-ft
4.49
4.03
3.57
3.11
2.65
2.19
1.73
1.27
.81
.35
-.11
Solution: LC 10 Self w/700lb R=24


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 1 ft sq area
Plane x
K
.0104
-.5696
-1.15
-1.73
-2.31
-2.89
-3.47
-4.05
-4.63
-5.21
-5.79
Solution: LC 10 Self w/700lb R=24

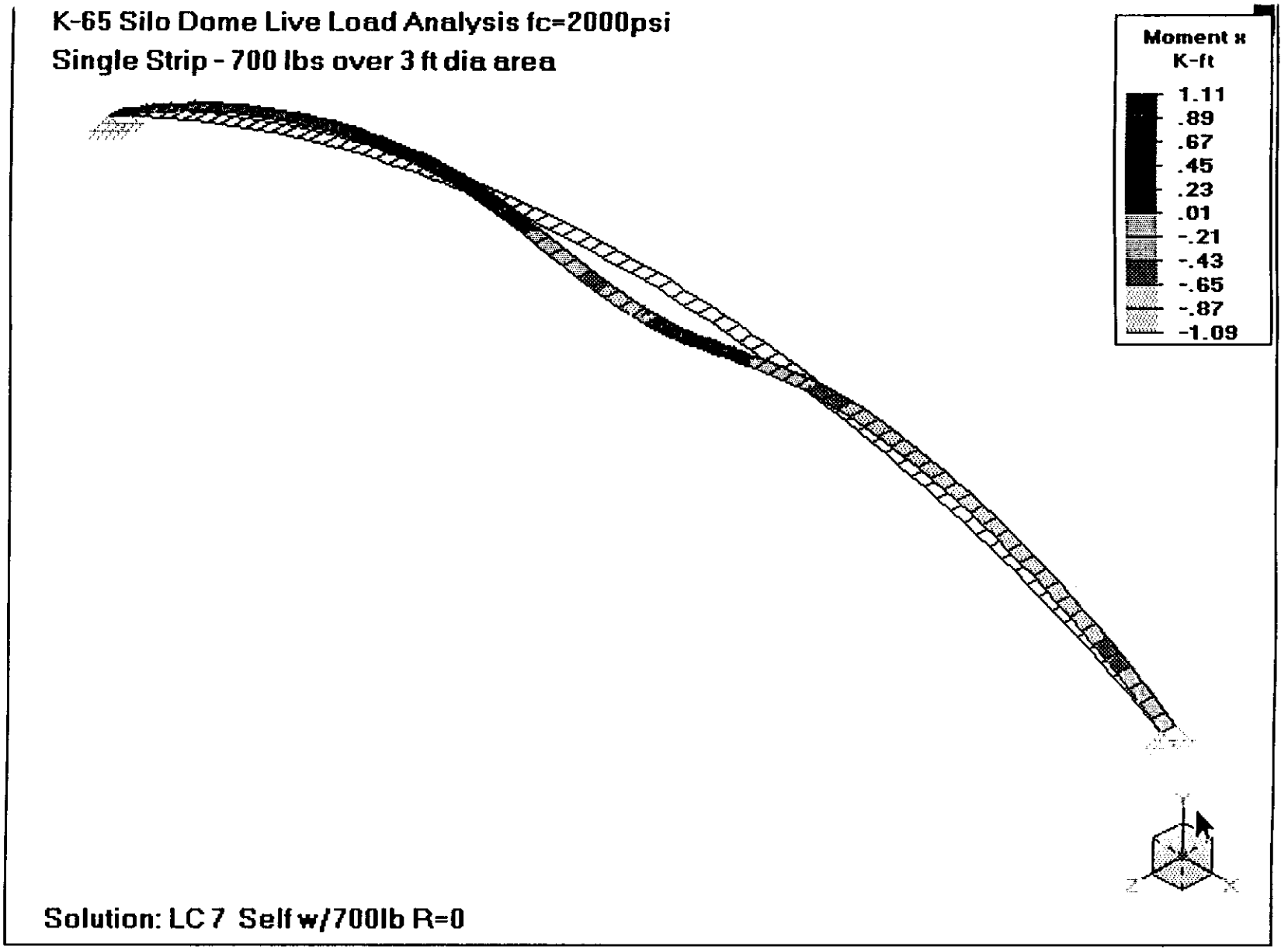
K-65 Silo Dome Live Load Analysis fc=2000psi

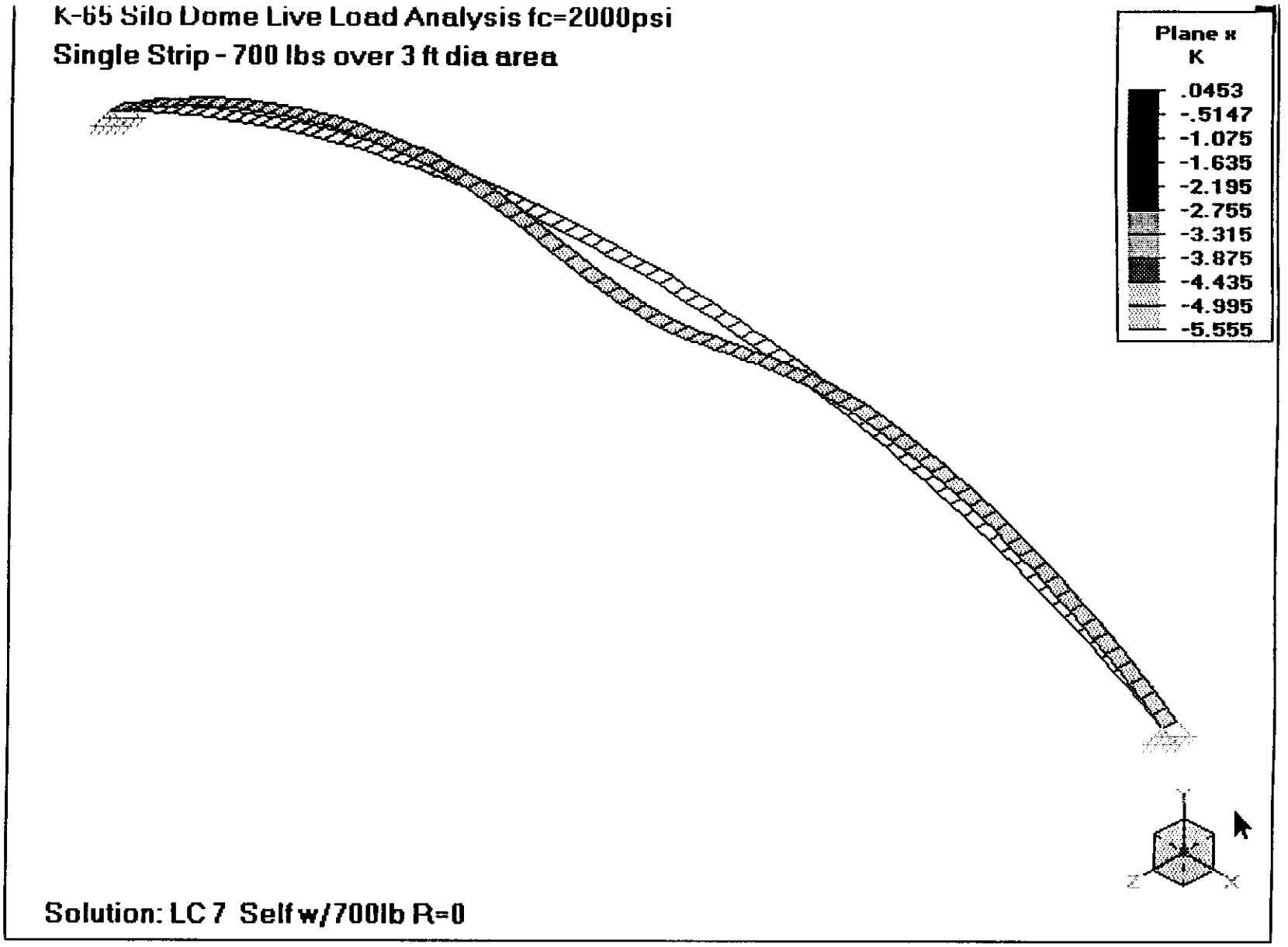
Single Strip - 700 lbs over 3 ft dia area

Y Grav: -1



Solution: LC 7 Self w/700lb R=0

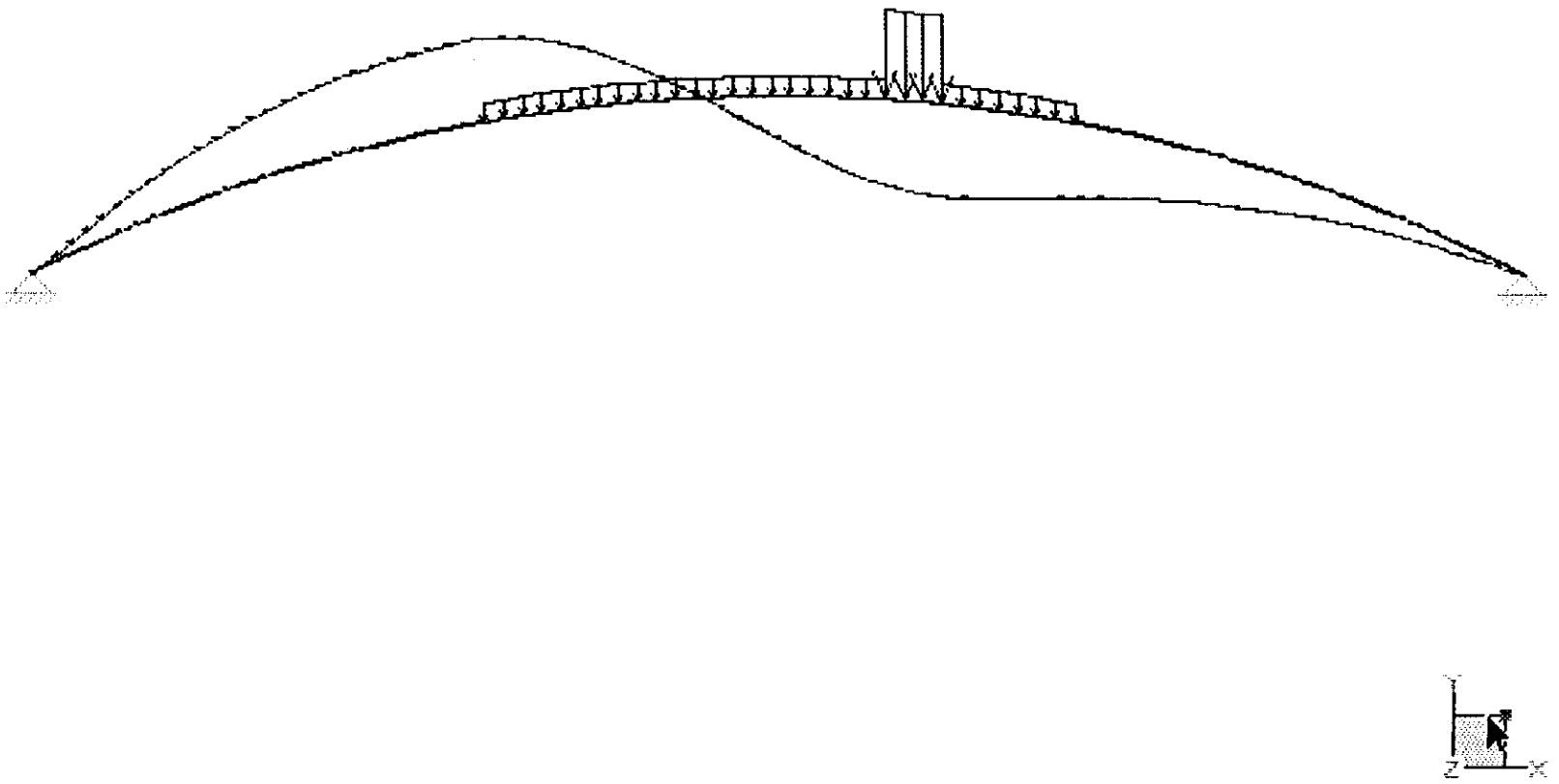

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Moment x
K-ft
1.11
.89
.67
.45
.23
.01
-.21
-.43
-.65
-.87
-1.09
Solution: LC 7 Self w/700lb R=0


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Plane x
K
.0453
-.5147
-1.075
-1.635
-2.195
-2.755
-3.315
-3.875
-4.435
-4.995
-5.555
Solution: LC 7 Self w/700lb R=0

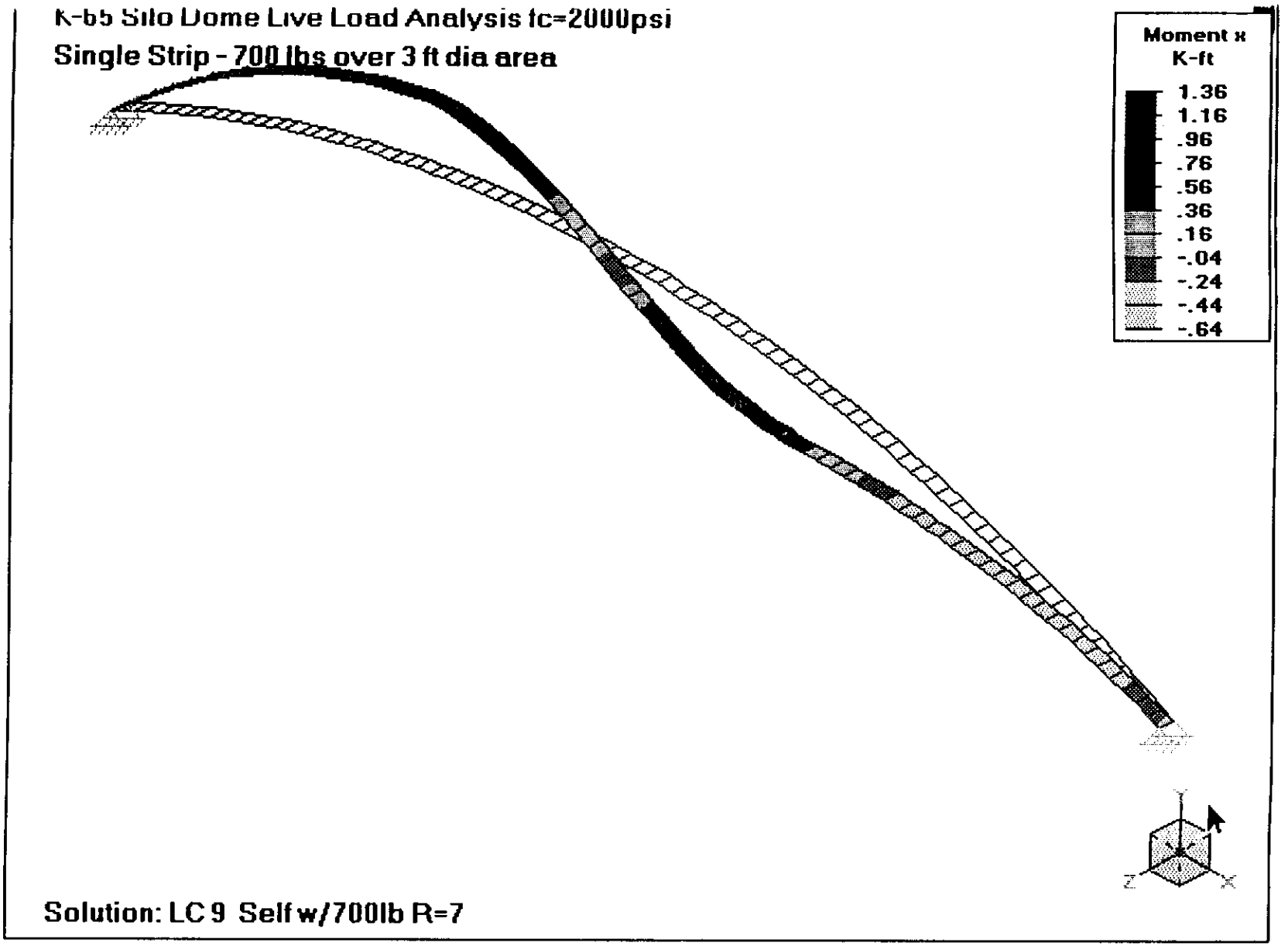
K-65 Silo Dome Live Load Analysis fc=2000psi

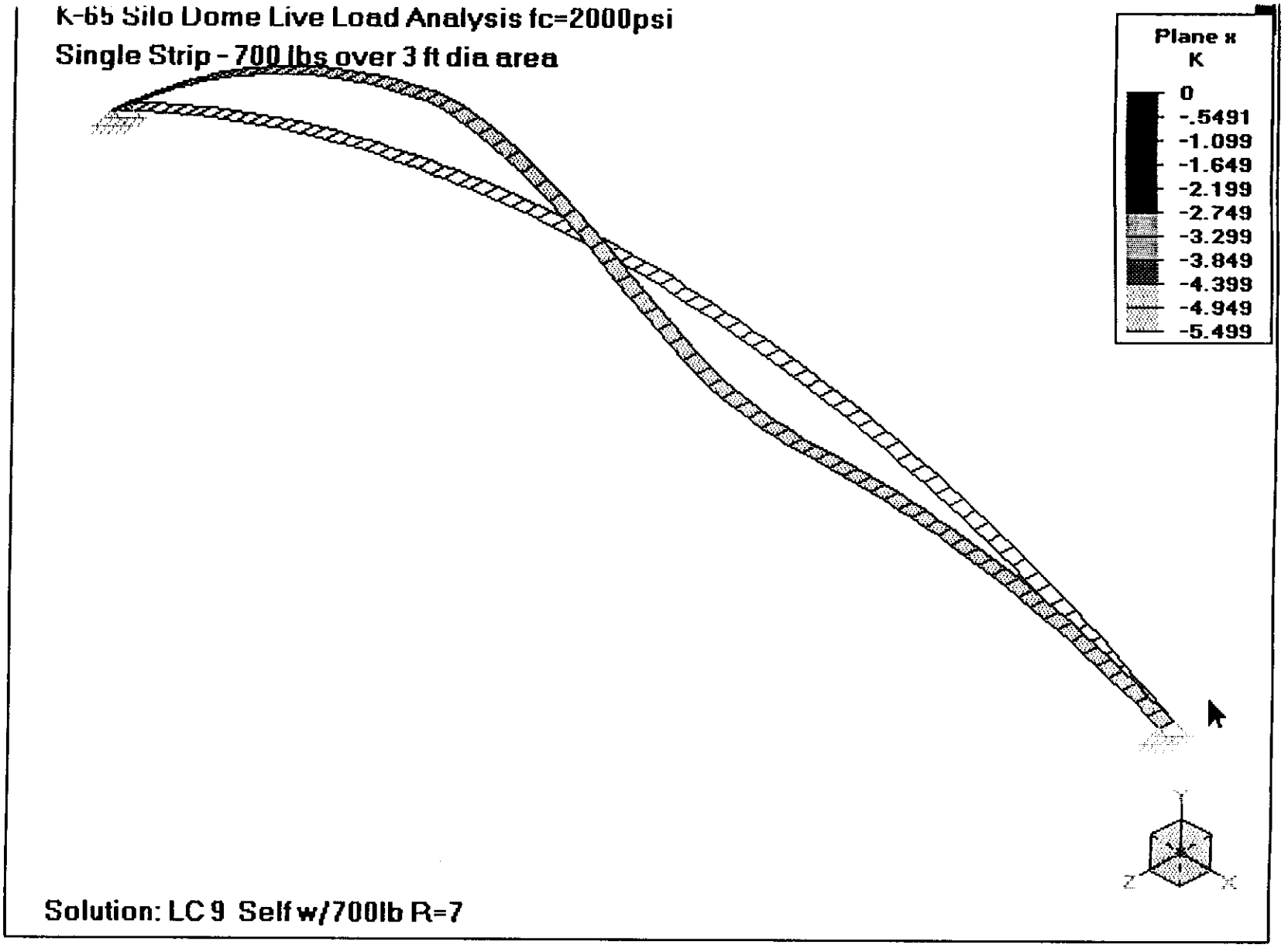
Single Strip - 700 lbs over 3 ft dia area

Y Grav: -1

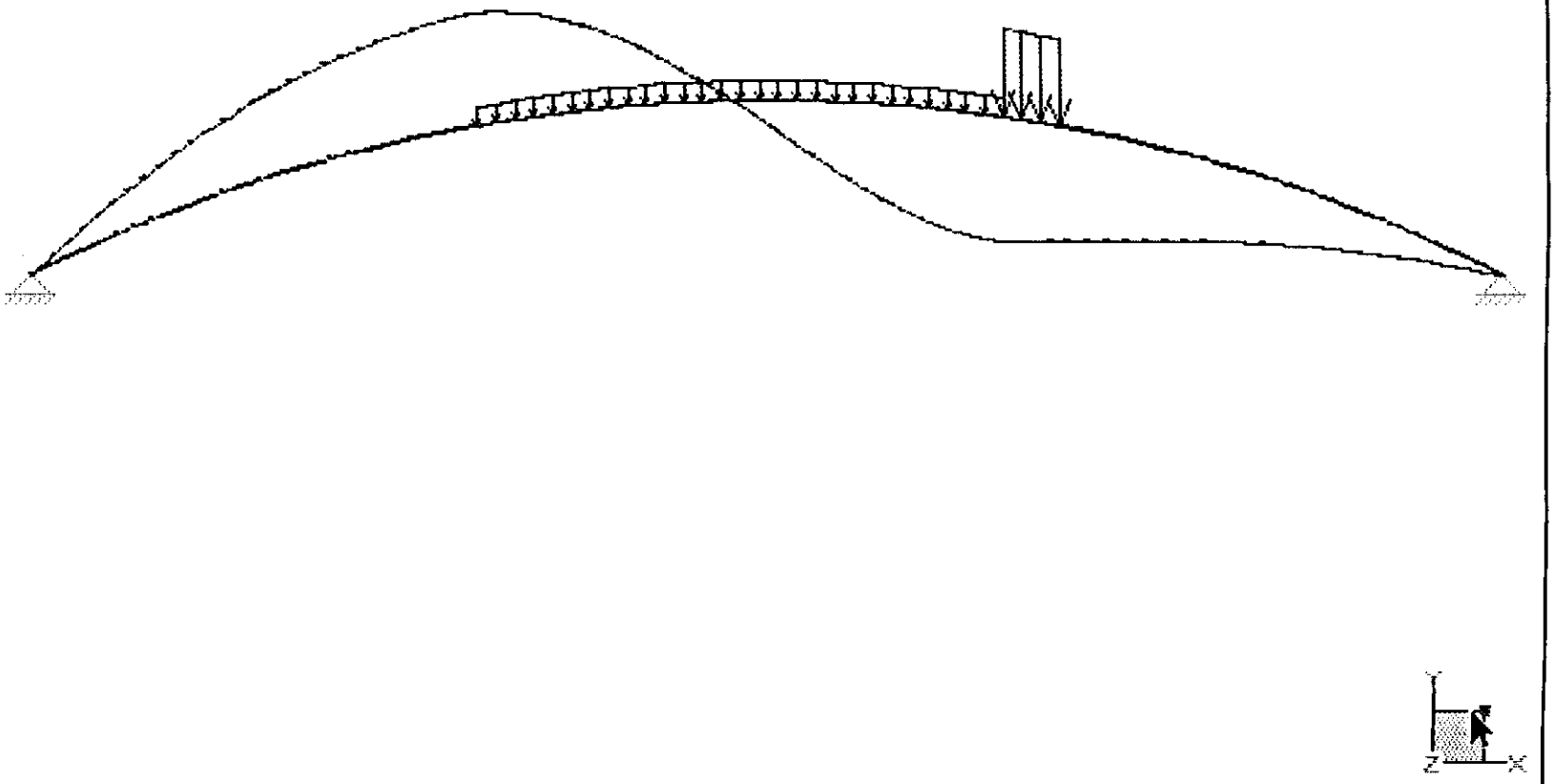


Solution: LC 9 Self w/700lb R=7

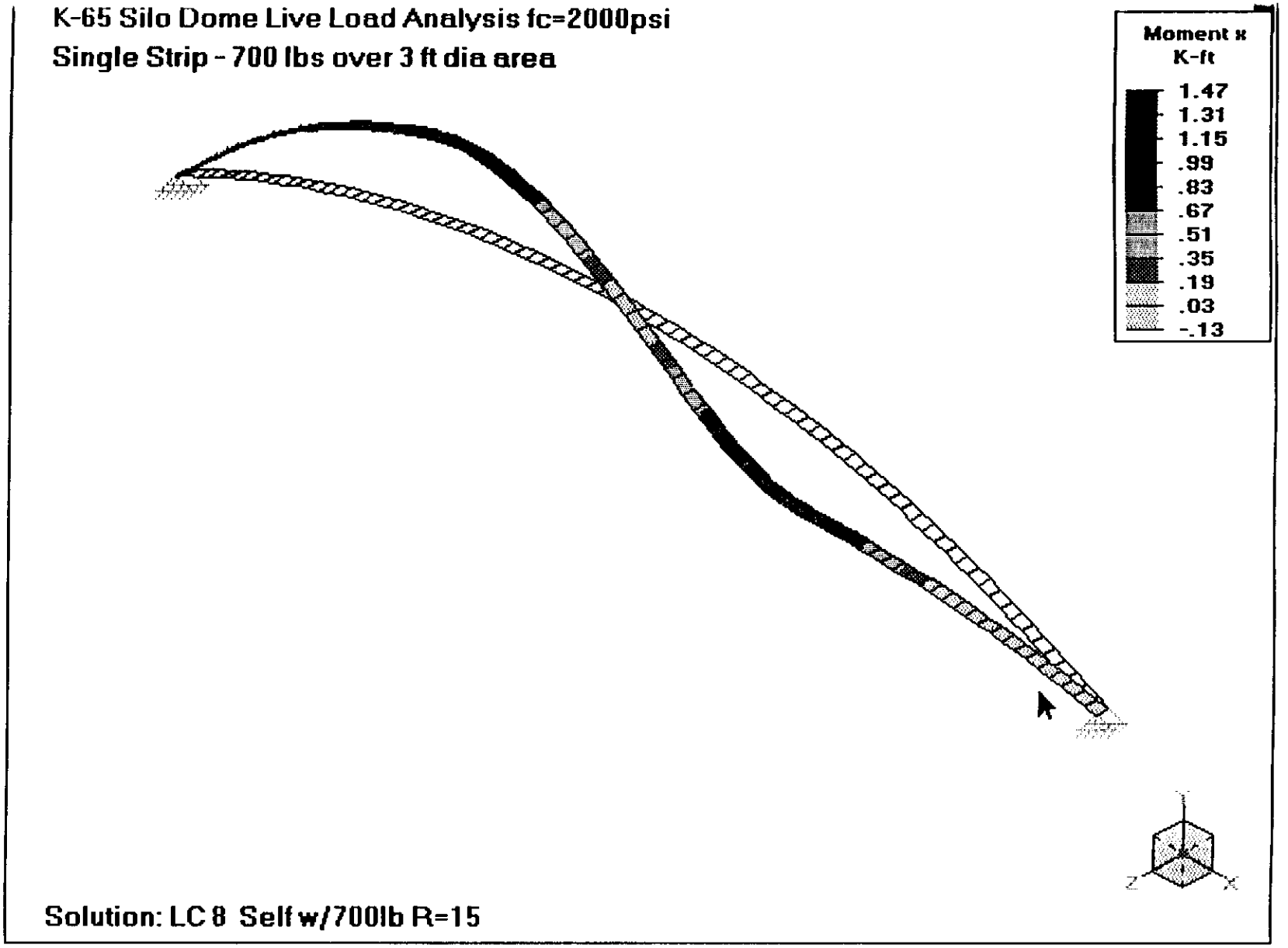

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Moment x
K-ft
1.36
1.16
.96
.76
.56
.36
.16
-.04
-.24
-.44
-.64
Y
Z
X
Solution: LC 9 Self w/700lb R=7

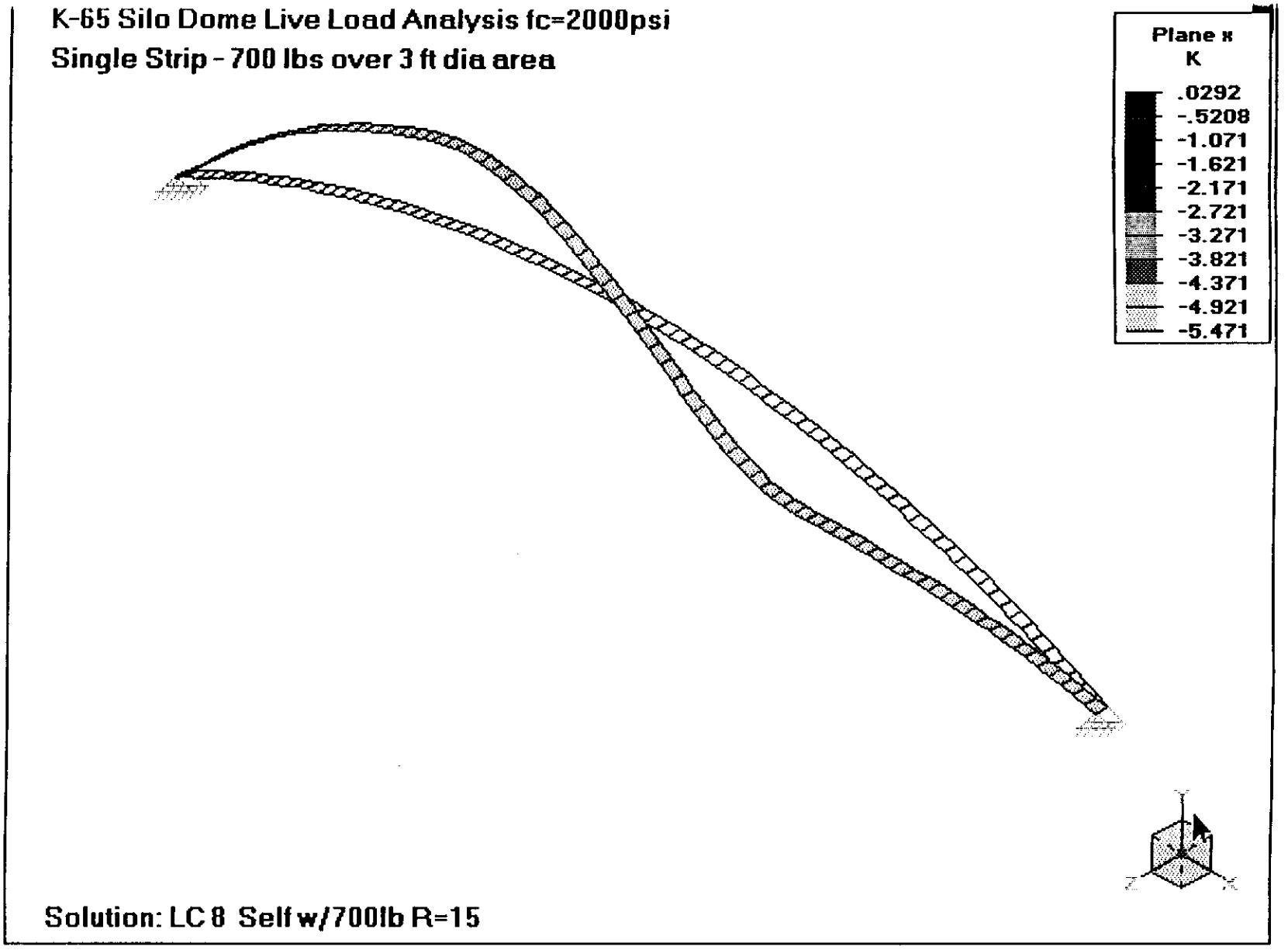

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Plane x
K
0
-.5491
-1.099
-1.649
-2.199
-2.749
-3.299
-3.849
-4.399
-4.949
-5.499
Y
Z
X
Solution: LC 9 Self w/700lb R=7

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Y Grav: -1



Solution: LC 8 Self w/700lb R=15

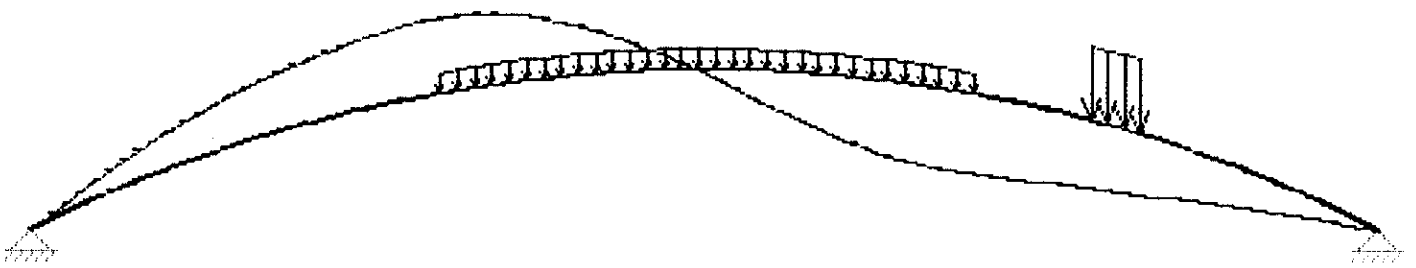

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Moment x
K-ft
1.47
1.31
1.15
.99
.83
.67
.51
.35
.19
.03
-.13
Y
Z
X
Solution: LC 8 Self w/700lb R=15

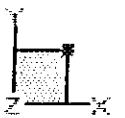

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Plane x
K
.0292
-.5208
-1.071
-1.621
-2.171
-2.721
-3.271
-3.821
-4.371
-4.921
-5.471
Solution: LC 8 Self w/700lb R=15

K-65 Silo Dome Live Load Analysis fc=2000psi

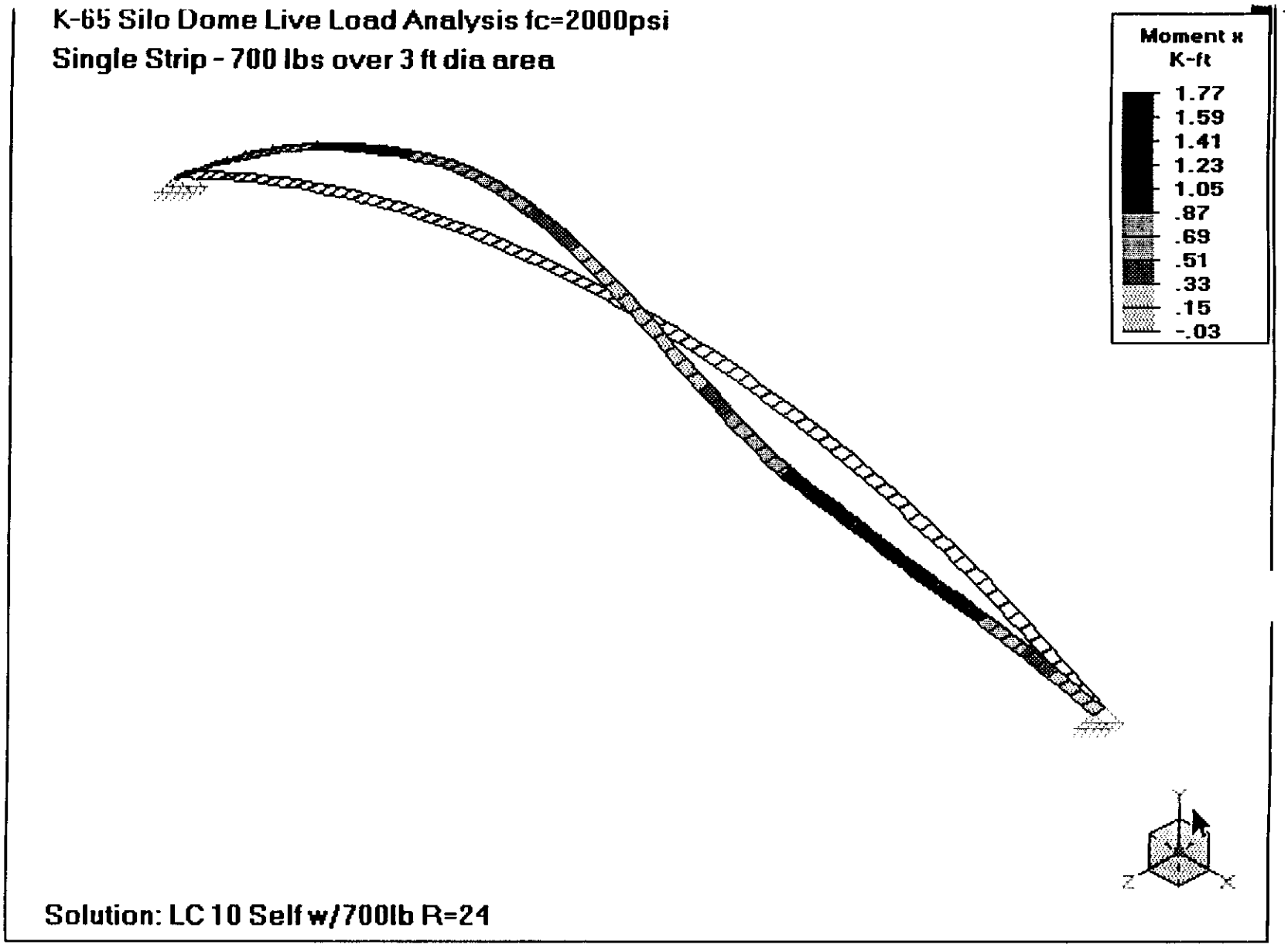
Single Strip - 700 lbs over 3 ft dia area

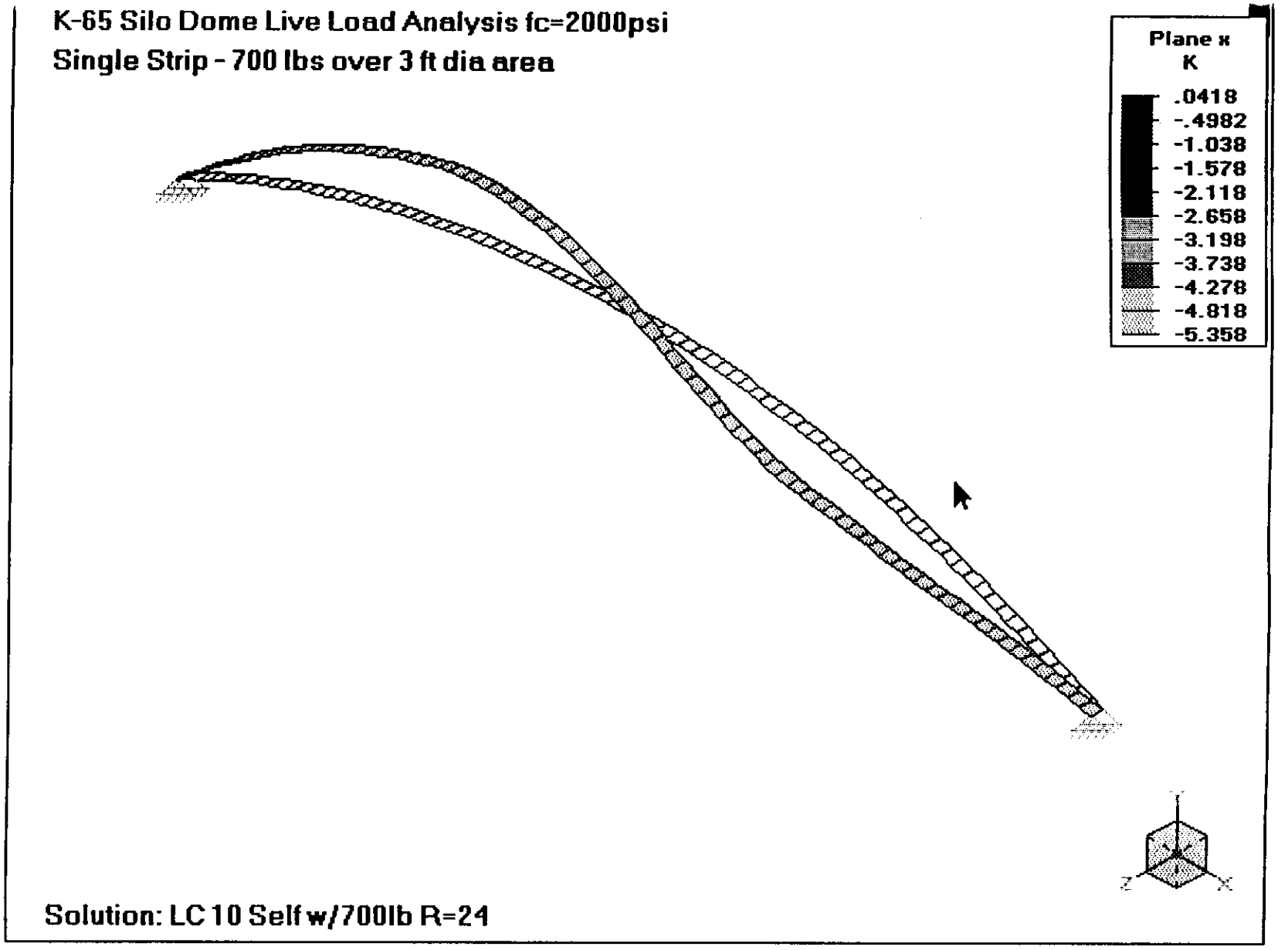
Y Grav: -1

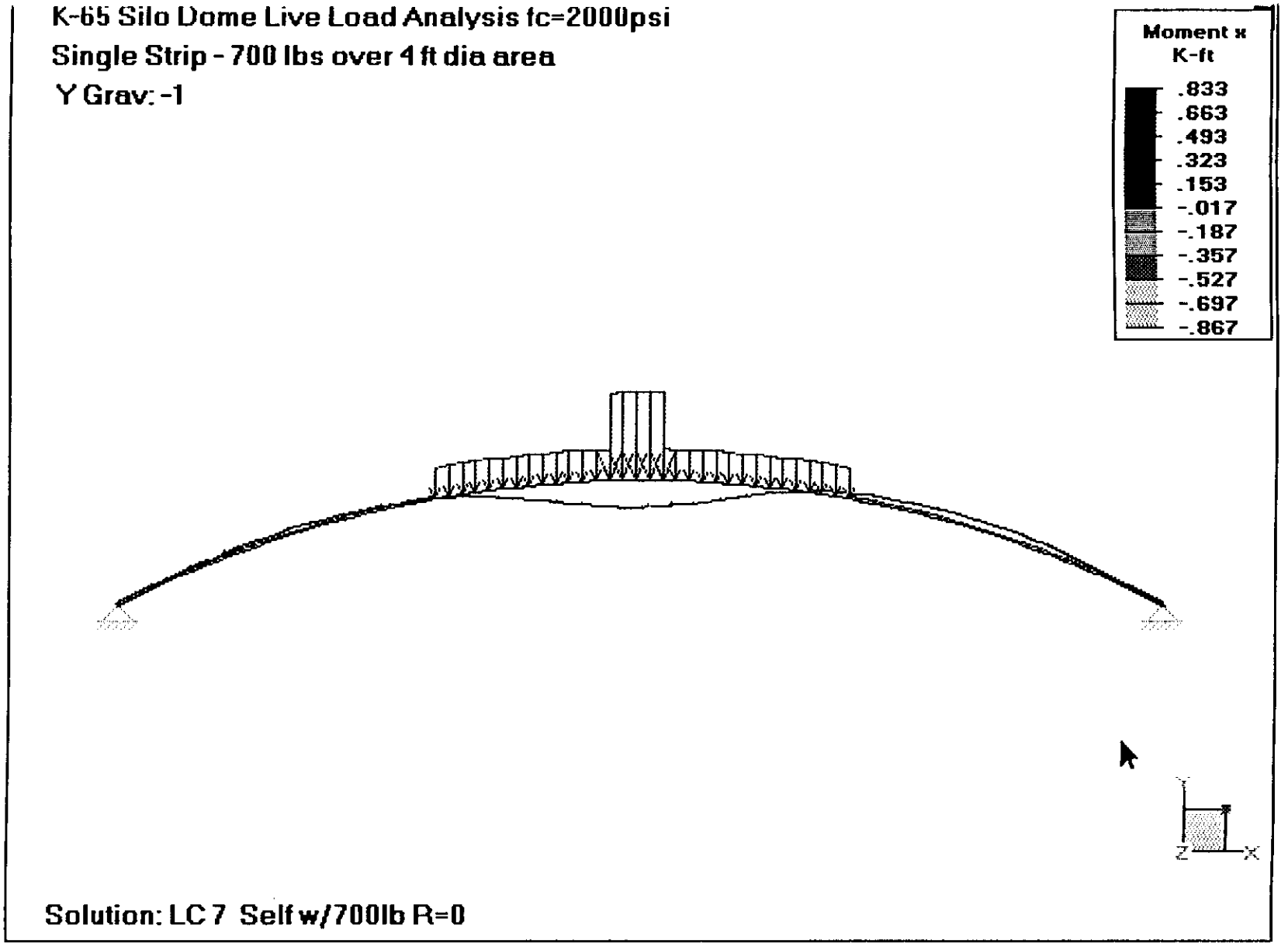


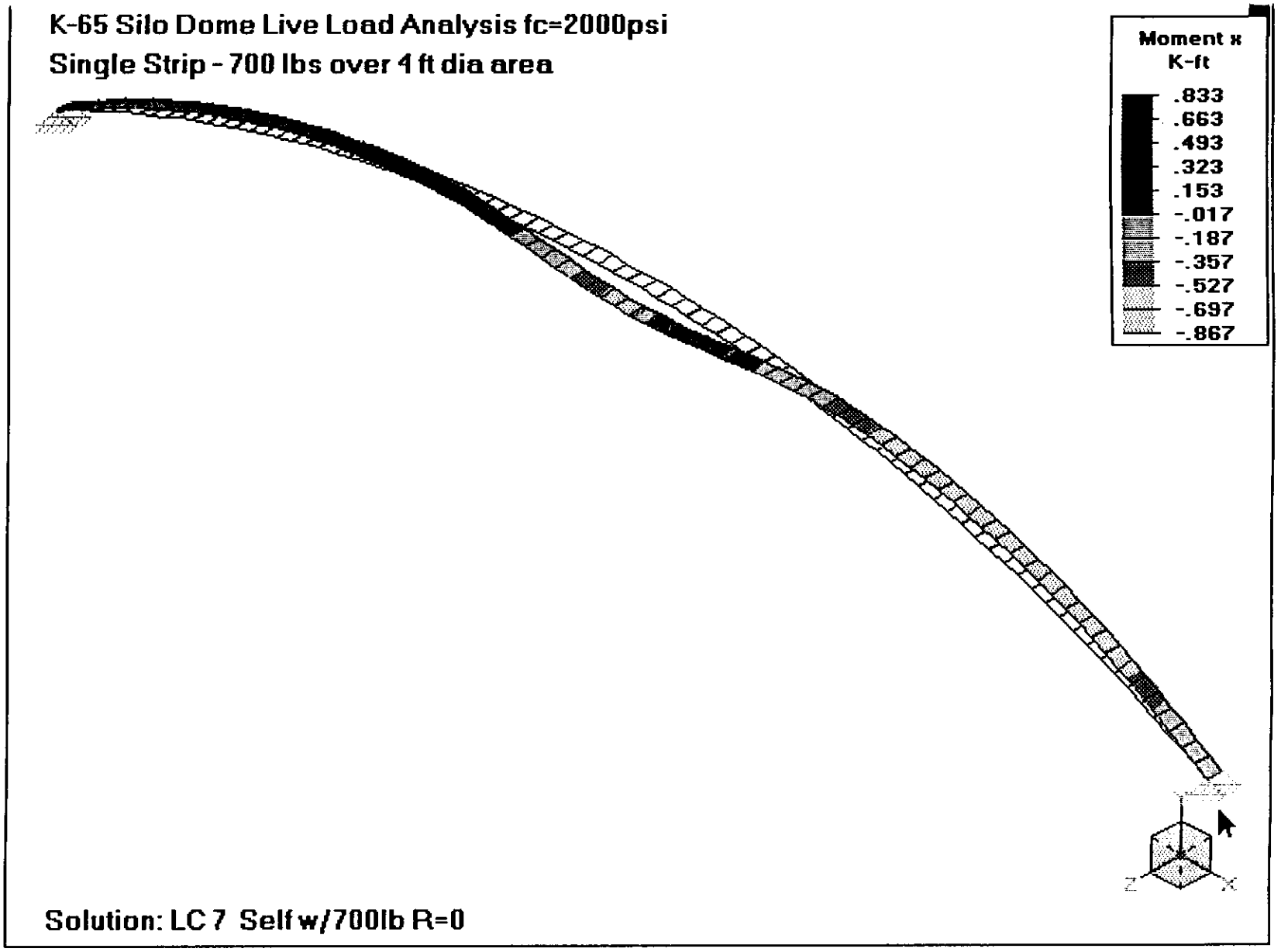


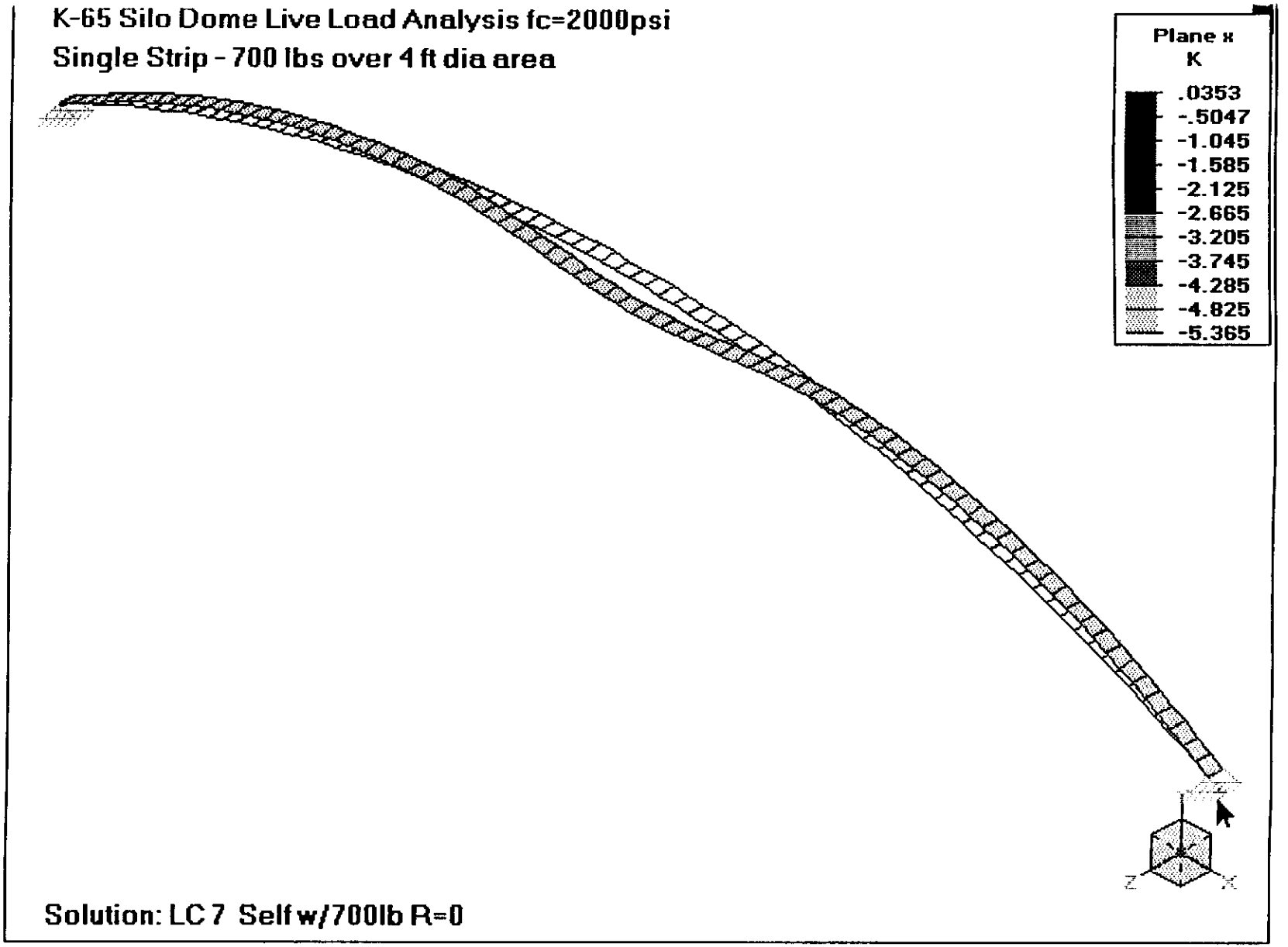
Solution: LC 10 Self w/700lb R=24


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Moment x
K-ft
1.77
1.59
1.41
1.23
1.05
.87
.69
.51
.33
.15
-.03
Y
Z
X
Solution: LC 10 Self w/700lb R=24


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 3 ft dia area
Plane x
K
.0418
-.4982
-1.038
-1.578
-2.118
-2.658
-3.198
-3.738
-4.278
-4.818
-5.358
Solution: LC 10 Self w/700lb R=24


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Y Grav: -1
Moment x
K-ft
.833
.663
.493
.323
.153
-.017
-.187
-.357
-.527
-.697
-.867
Y
Z
X
Solution: LC 7 Self w/700lb R=0

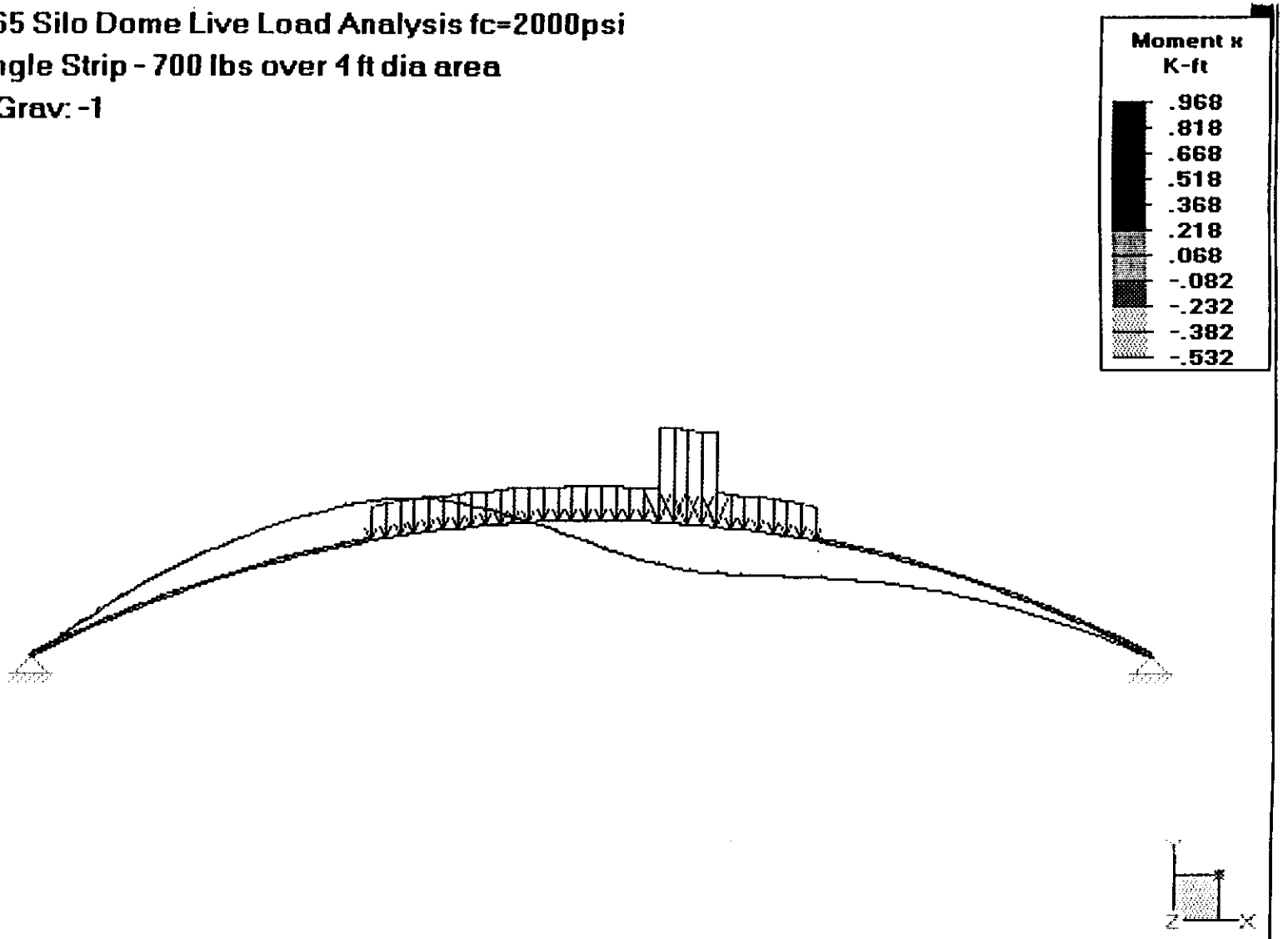

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Moment x
K-ft
.833
.663
.493
.323
.153
-.017
-.187
-.357
-.527
-.697
-.867
Solution: LC 7 Self w/700lb R=0


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Plane x
K
.0353
-.5047
-1.045
-1.585
-2.125
-2.665
-3.205
-3.745
-4.285
-4.825
-5.365
Z
X
Solution: LC 7 Self w/700lb R=0

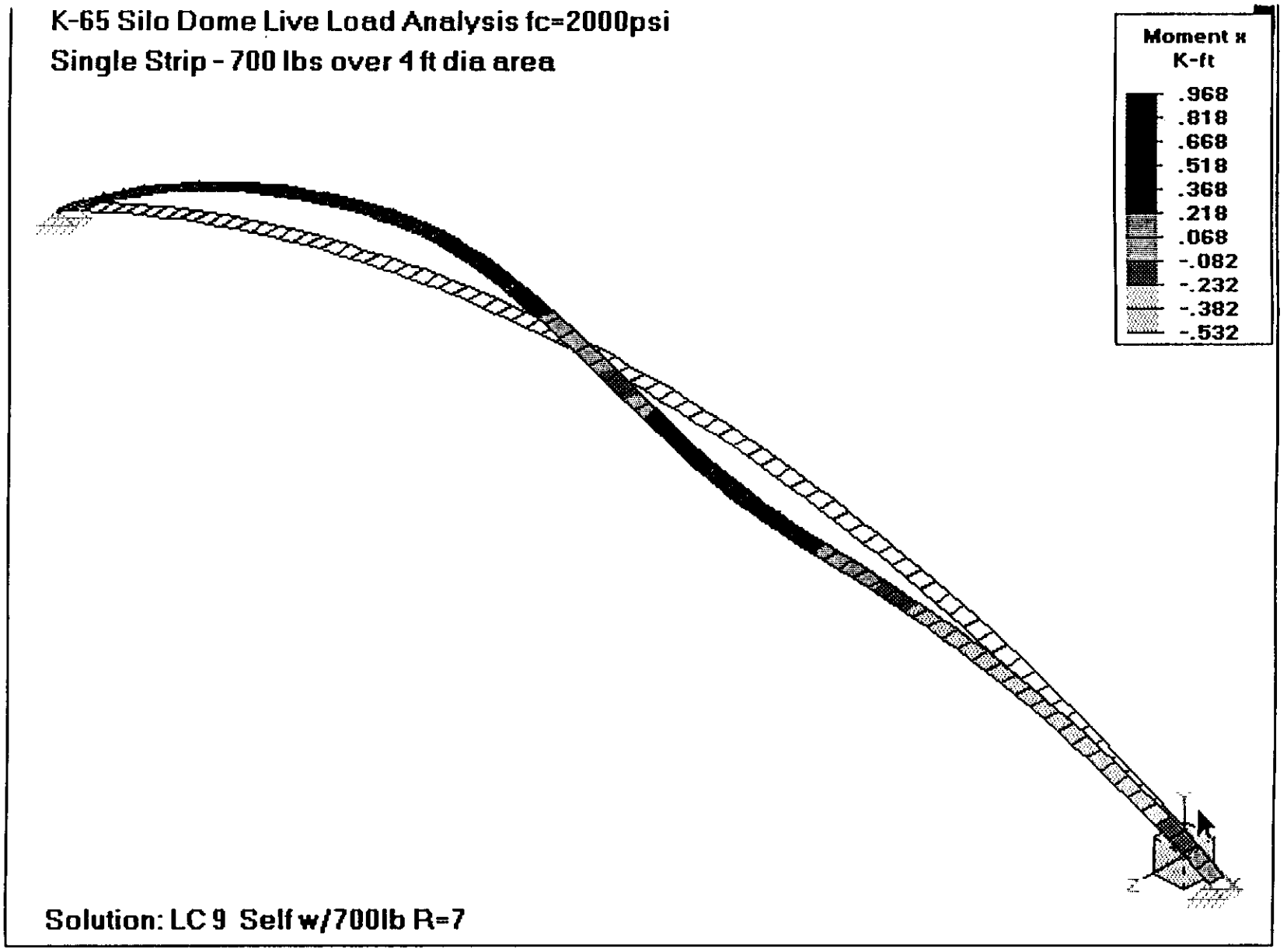
K-65 Silo Dome Live Load Analysis fc=2000psi

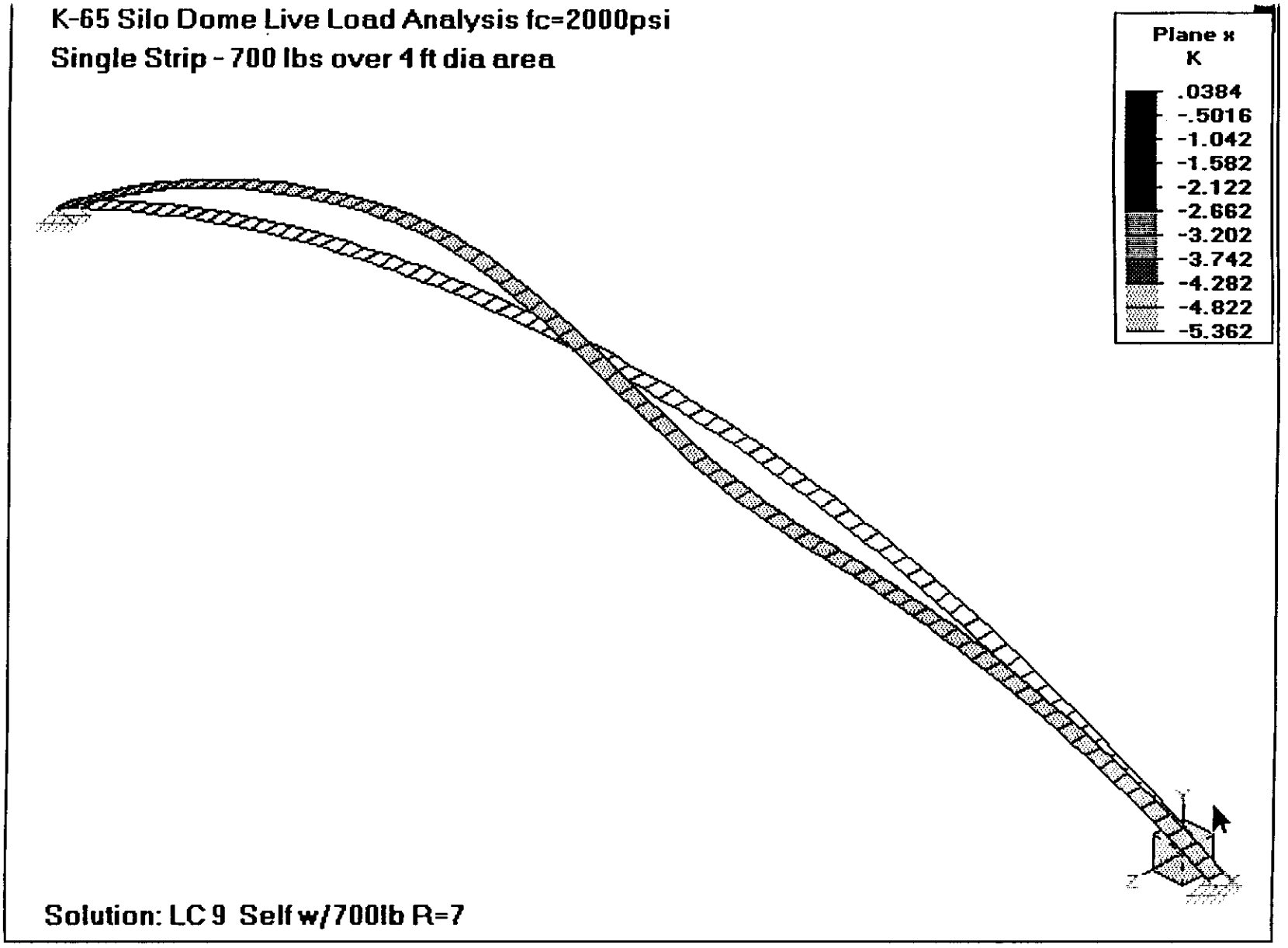
Single Strip - 700 lbs over 4 ft dia area

Y Grav: -1



Solution: LC 9 Self w/700lb R=7

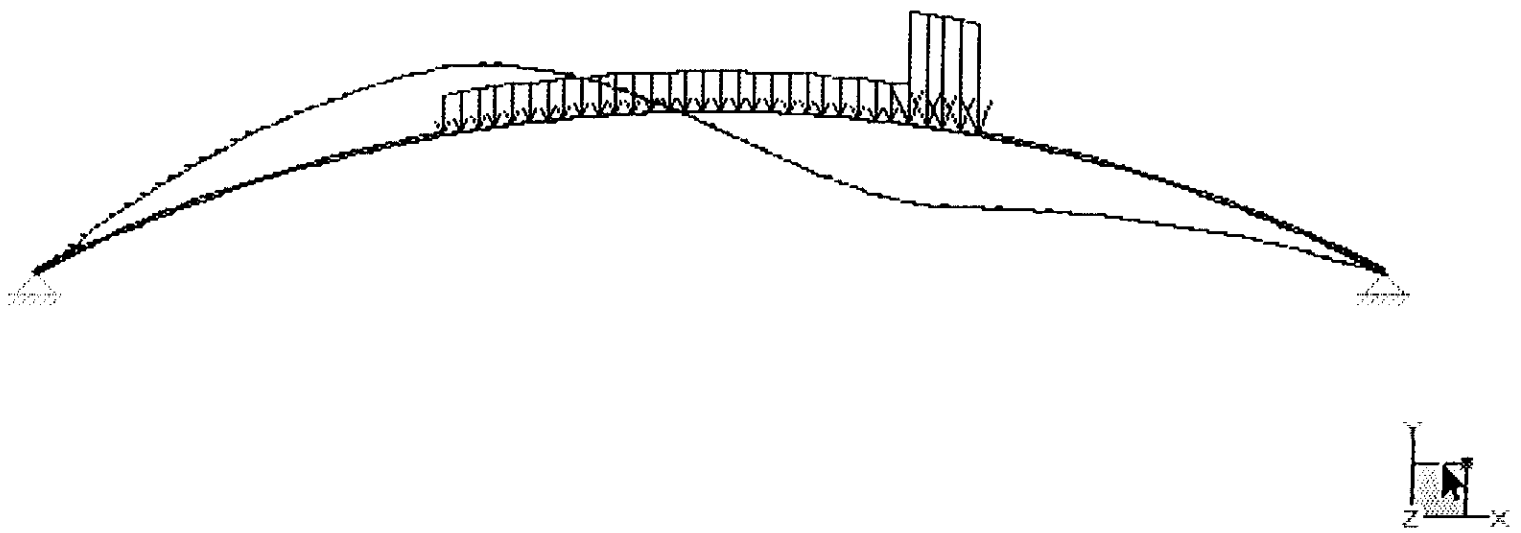

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Moment x
K-ft
.968
.818
.668
.518
.368
.218
.068
-.082
-.232
-.382
-.532
Solution: LC 9 Self w/700lb R=7


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Plane x
K
.0384
-.5016
-1.042
-1.582
-2.122
-2.662
-3.202
-3.742
-4.282
-4.822
-5.362
Y
Z
X
Solution: LC 9 Self w/700lb R=7

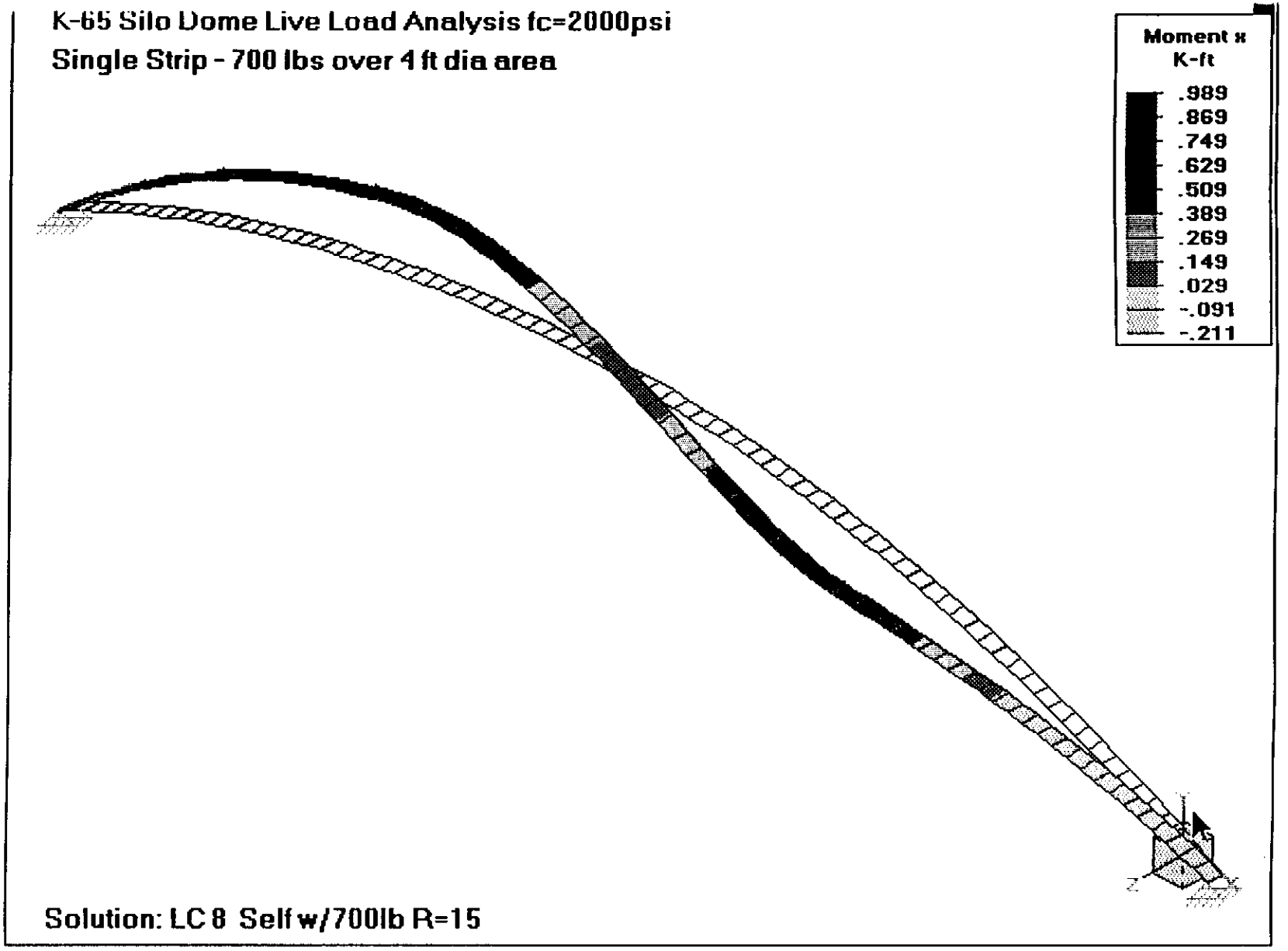
K-65 Silo Dome Live Load Analysis fc=2000psi

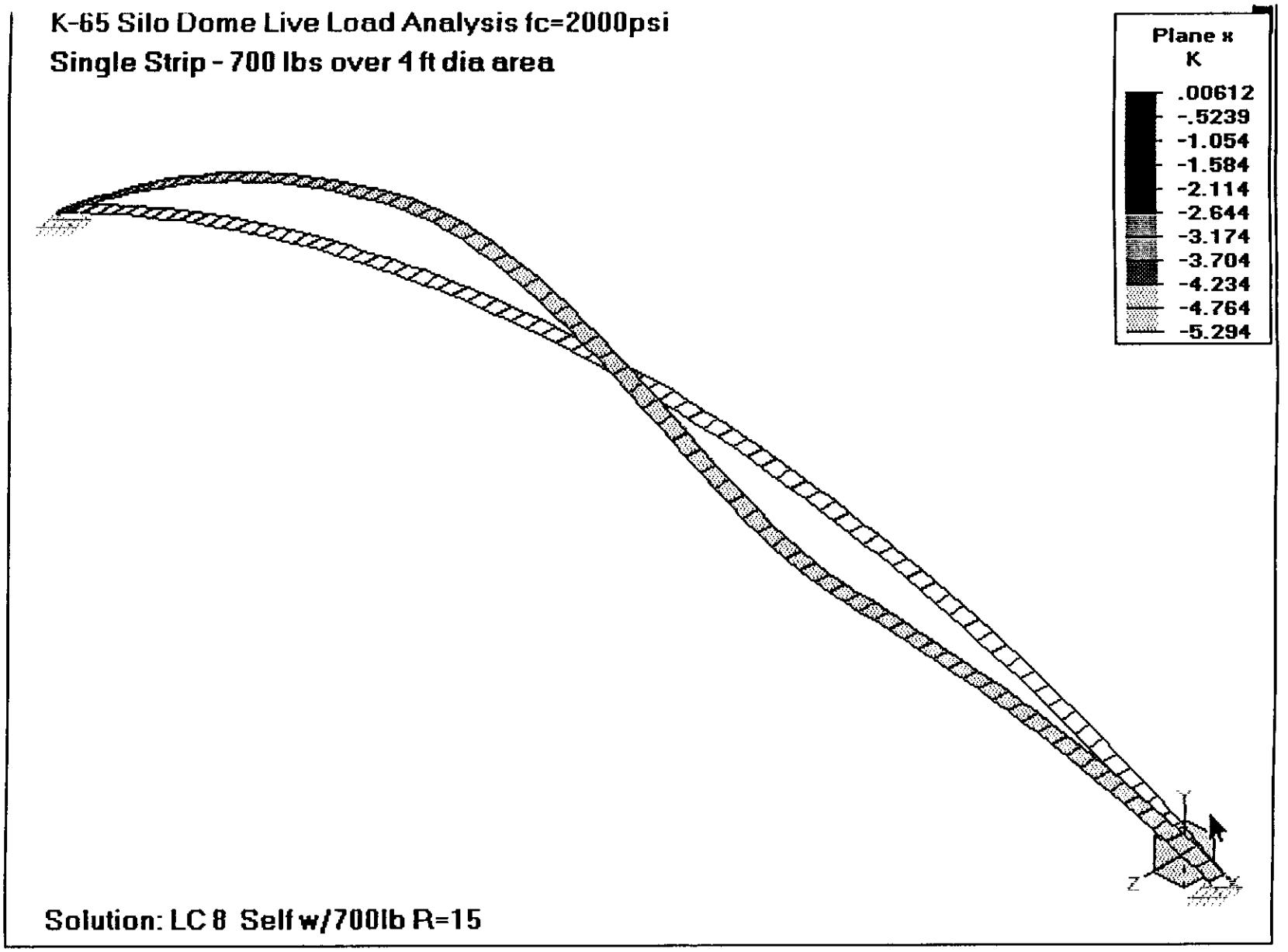
Single Strip - 700 lbs over 4 ft dia area

Y Grav: -1

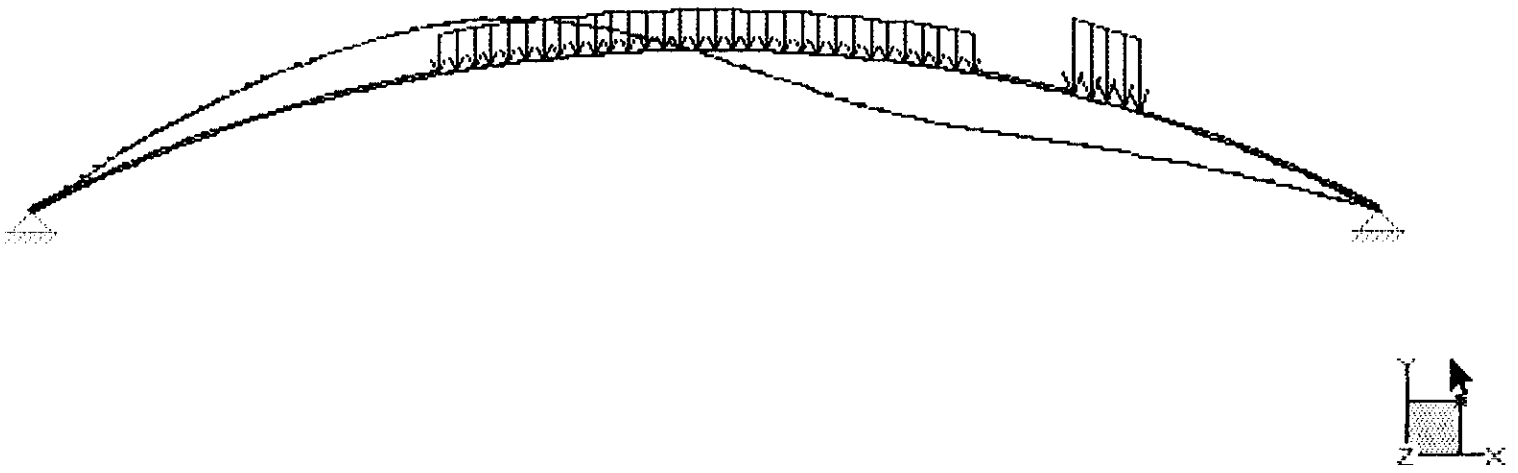


Solution: LC 8 Self w/700lb R=15

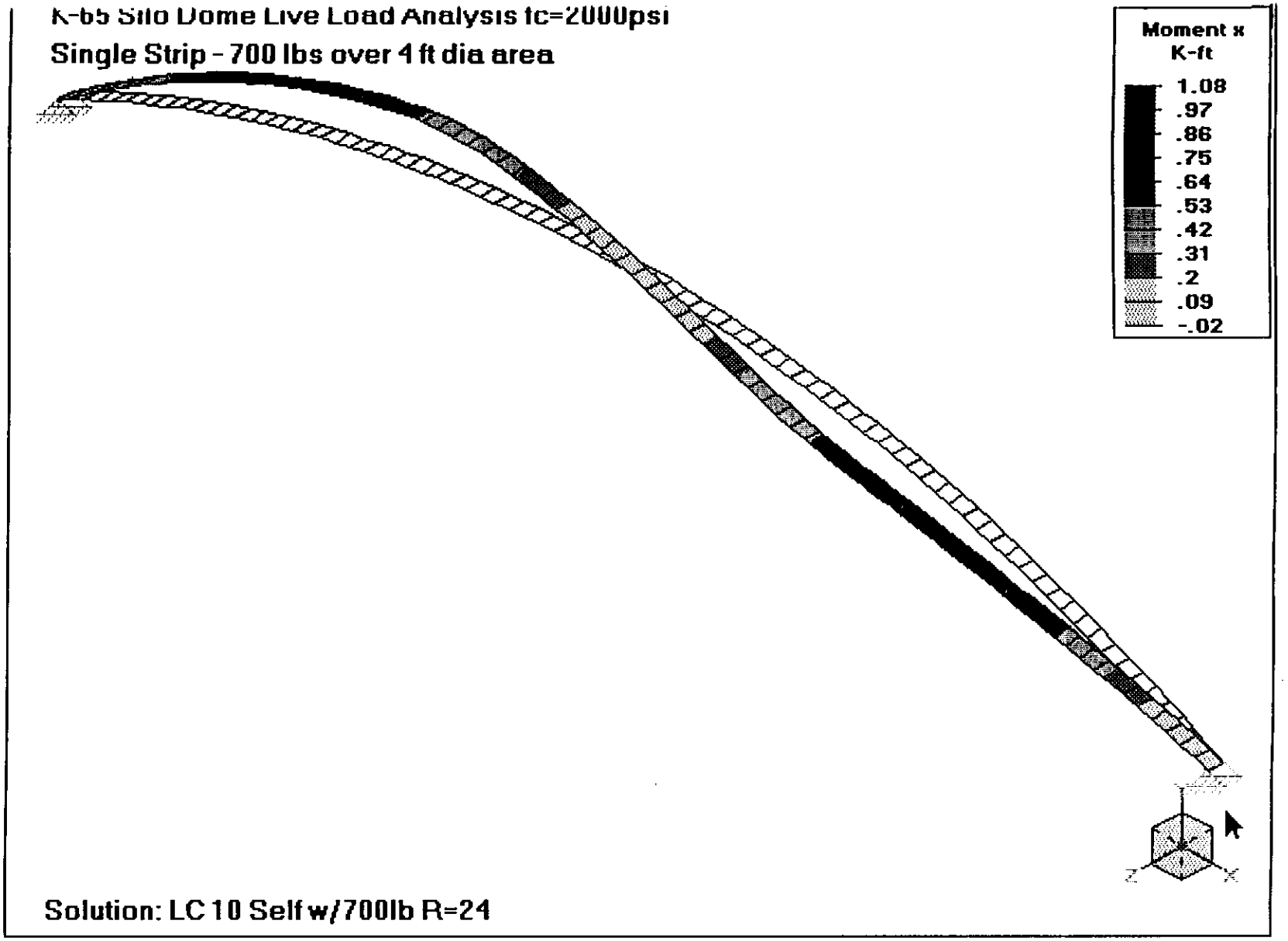

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Moment x
K-ft
.989
.869
.749
.629
.509
.389
.269
.149
.029
-.091
-.211
Solution: LC 8 Self w/700lb R=15

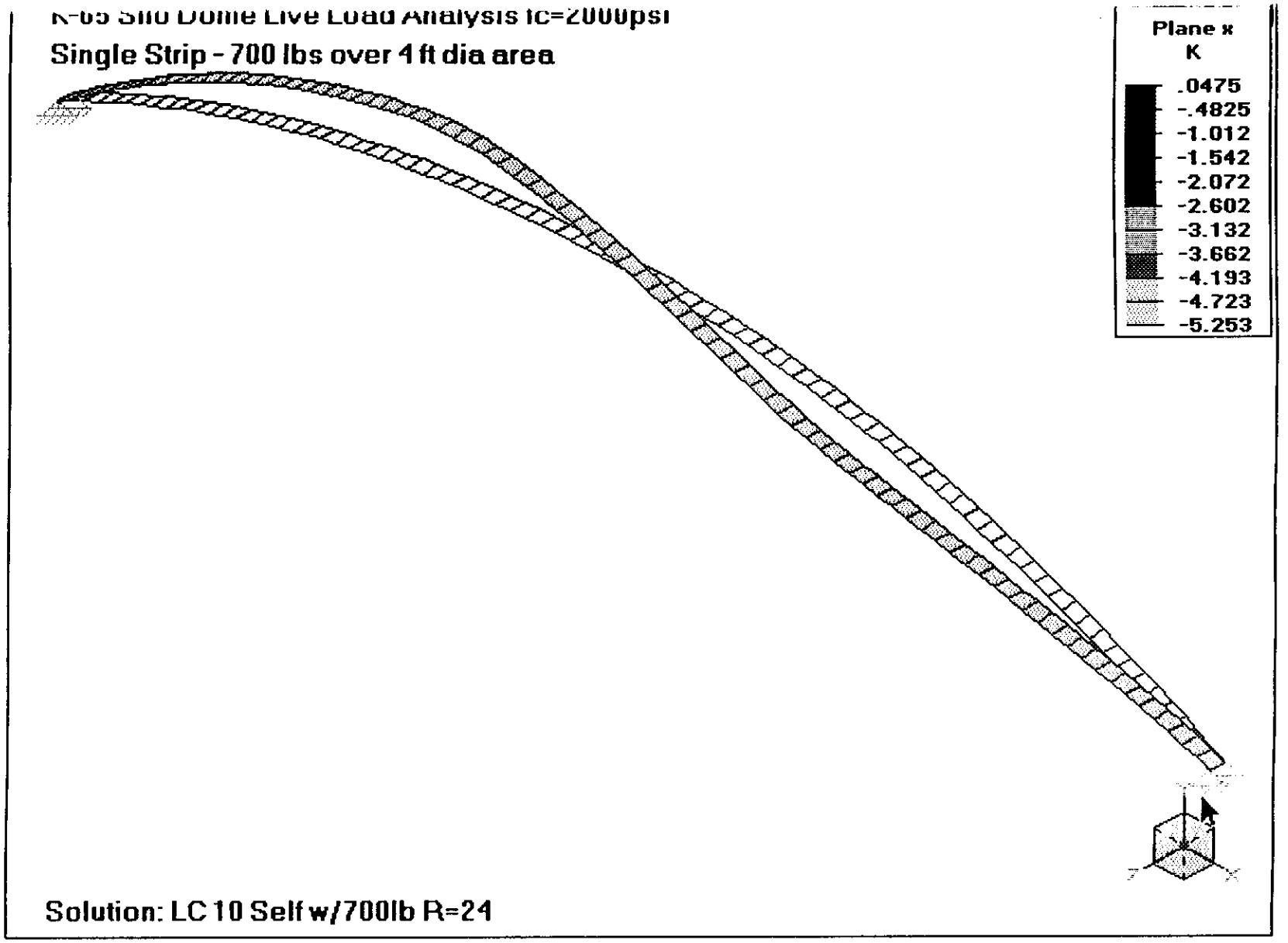

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Plane x
K
.00612
-.5239
-1.054
-1.584
-2.114
-2.644
-3.174
-3.704
-4.234
-4.764
-5.294
Y
Z
X
Solution: LC 8 Self w/700lb R=15

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Y Grav: -1



Solution: LC 10 Self w/700lb R=24

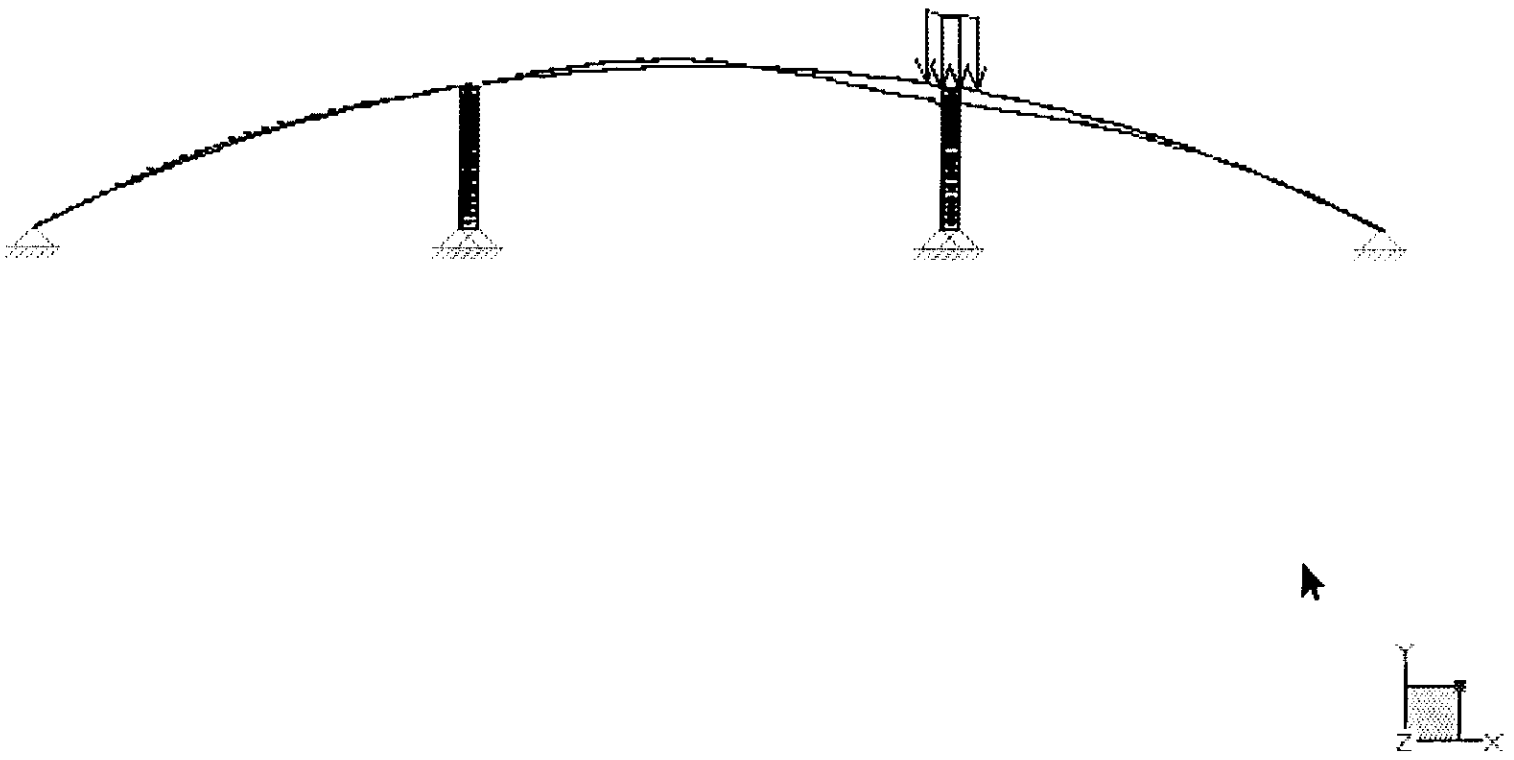

K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Moment x
K-ft
1.08
.97
.86
.75
.64
.53
.42
.31
.2
.09
-.02
Z
X
Solution: LC 10 Self w/700lb R=24


K-65 Silo Dome Live Load Analysis fc=2000psi
Single Strip - 700 lbs over 4 ft dia area
Plane x
K
.0475
-.4825
-1.012
-1.542
-2.072
-2.602
-3.132
-3.662
-4.193
-4.723
-5.253
Solution: LC 10 Self w/700lb R=24

APPENDIX B

K-65 Silo Dome Live Load Analysis fc=2000psi

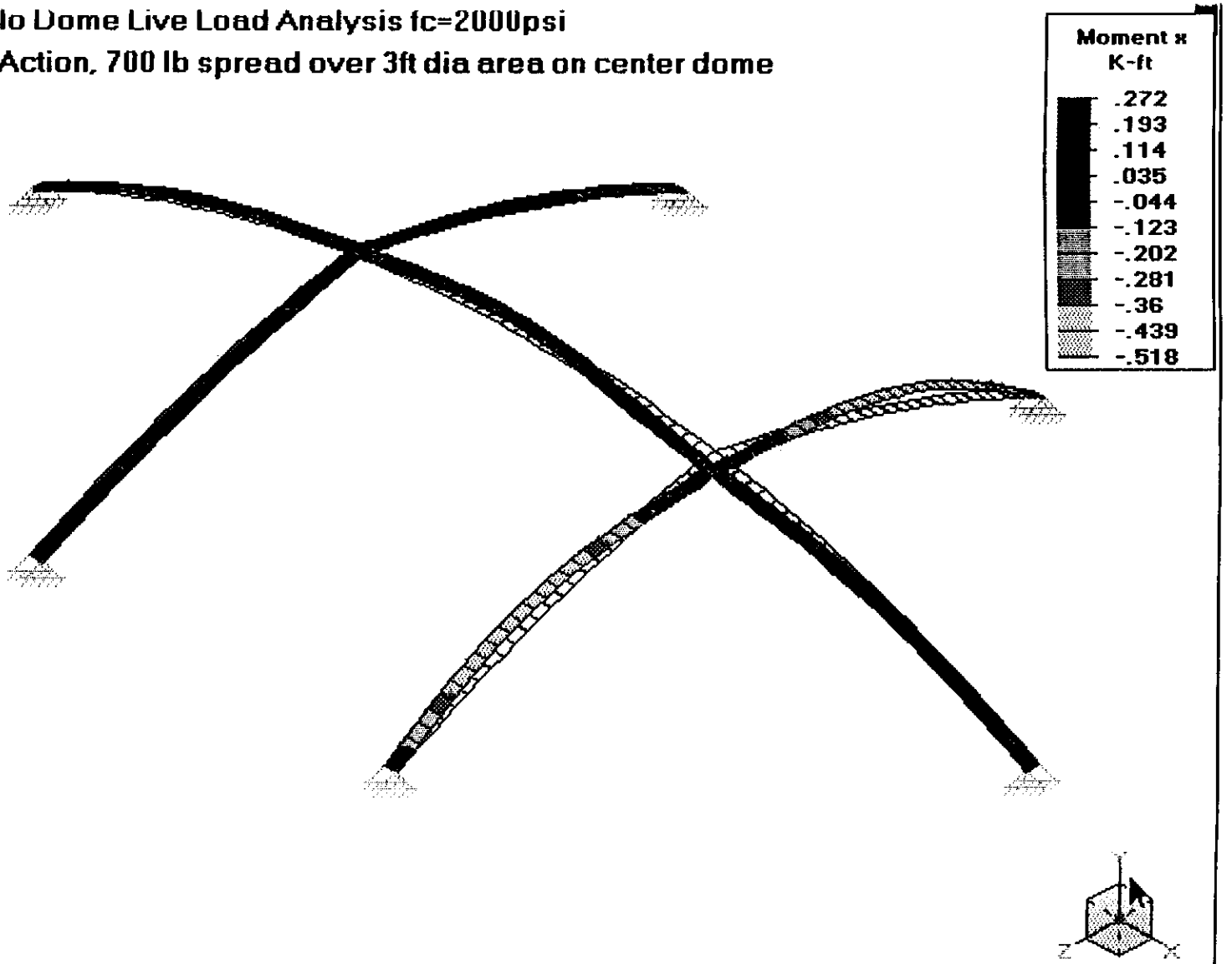
2-Way Action, 700 lb spread over 3ft dia area on center dome



Solution: LC 5 700 lb at R=15ft

K-65 Silo Dome Live Load Analysis fc=2000psi

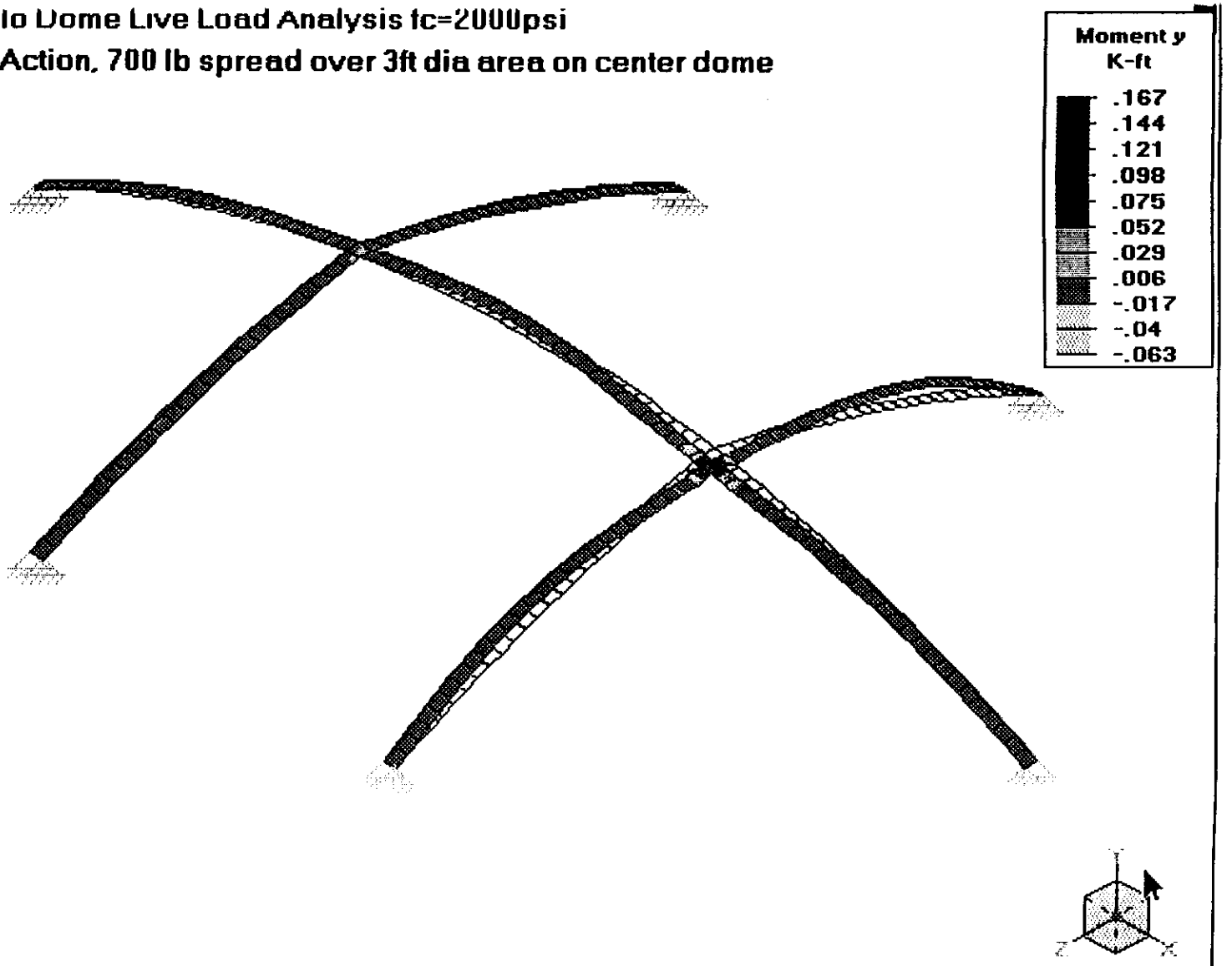
2-Way Action, 700 lb spread over 3ft dia area on center dome



Solution: LC 5 700 lb at R=15ft

K-65 Silo Dome Live Load Analysis fc=2000psi

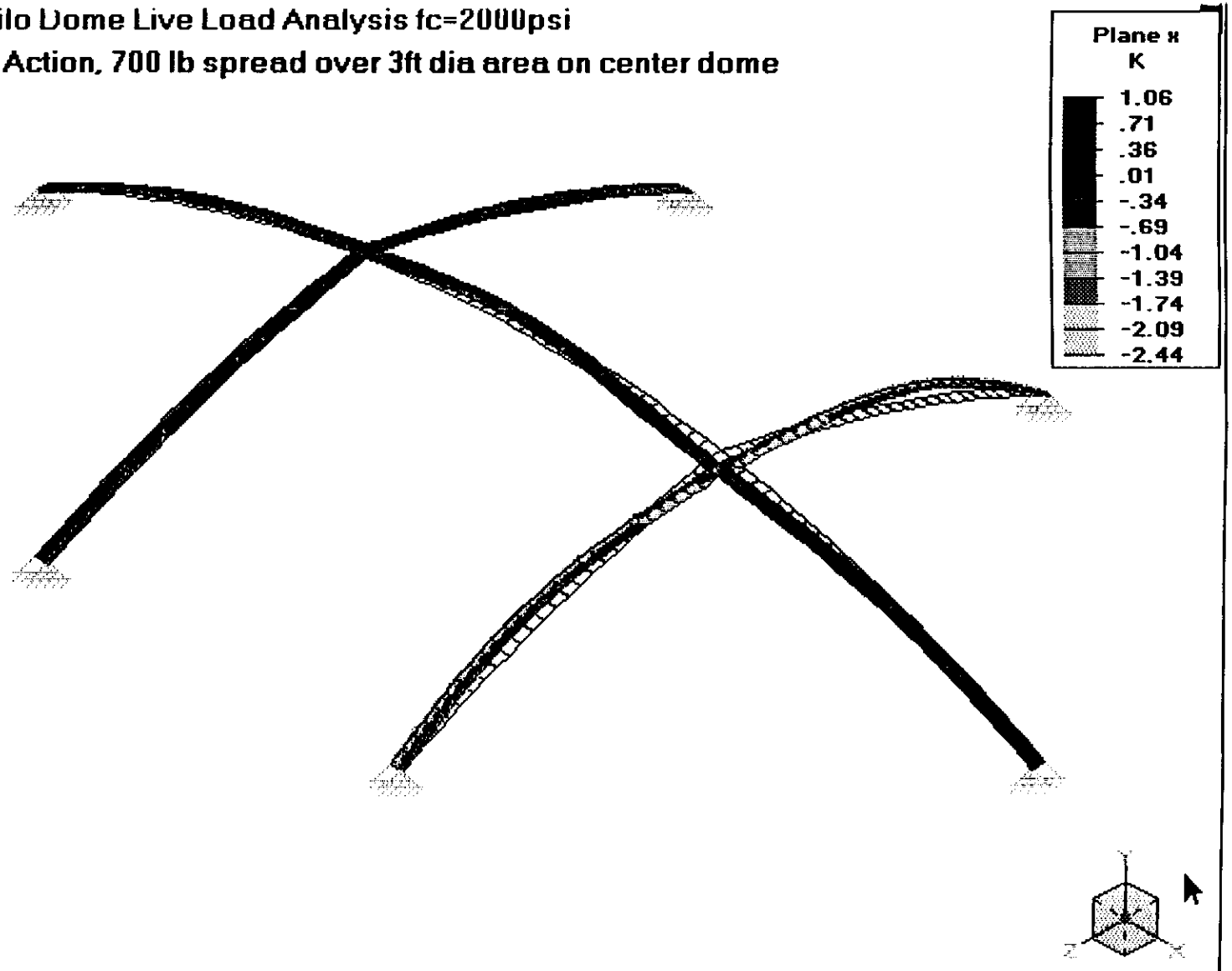
2-Way Action, 700 lb spread over 3ft dia area on center dome



Solution: LC 5 700 lb at R=15ft

K-65 Silo Dome Live Load Analysis fc=2000psi

2-Way Action, 700 lb spread over 3ft dia area on center dome



Solution: LC 5 700 lb at R=15ft