



LACY & EBELING ENGINEERING, INC.

FIBERGLASS TANK TESTS - AASHTO LOADING TEST
FOR
FIBERGLASS SEPTIC TANKS
BY FIBER ENTERPRISES
1450 VISTA WAY, RED BLUFF, CA

LOAD TESTING

This report reviews the load test performed by Engle & Associates, on the 1000 and 1500 gallon fiberglass septic tanks. The test parameters and the test results are listed in the Engle & Associates' Test Report of October 23, 1992.

AASHTO LOAD TEST CRITERIA

The tanks were load tested for standard AASHTO HS20-44 wheel loads. Figure 3.7.7A represents the standard AASHTO design wheel/axle loads. Figure 2 further refines the AASHTO HS20-44 wheel loads showing the distribution per wheel as well as per axle. Therefore, the test wheel load of 31,900 lb distributed as shown in the Engle report is in accord with a standard AASHTO HS20-44 load.

TEST RESULTS

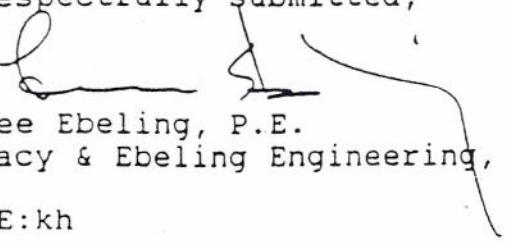
The full load and creep test results indicate a net tank deflection as follows:

1/4" nominal wall thickness - max deflection = 0.117"
5/16" nominal wall thickness - max deflection = 0.07"

For a project specification requiring the maximum tank deflection to be limited to 2% of the tank diameter and using a load of two times the design load, the allowable deflection for a 66" diameter tank is 0.66".

Thus the fiberglass tanks as tested for the AASHTO HS20-44 loads passed the maximum deflection criteria for a minimum depth of bury of three feet for either a 1/4" nominal or 5/16" nominal wall thickness tank.

Respectfully submitted,

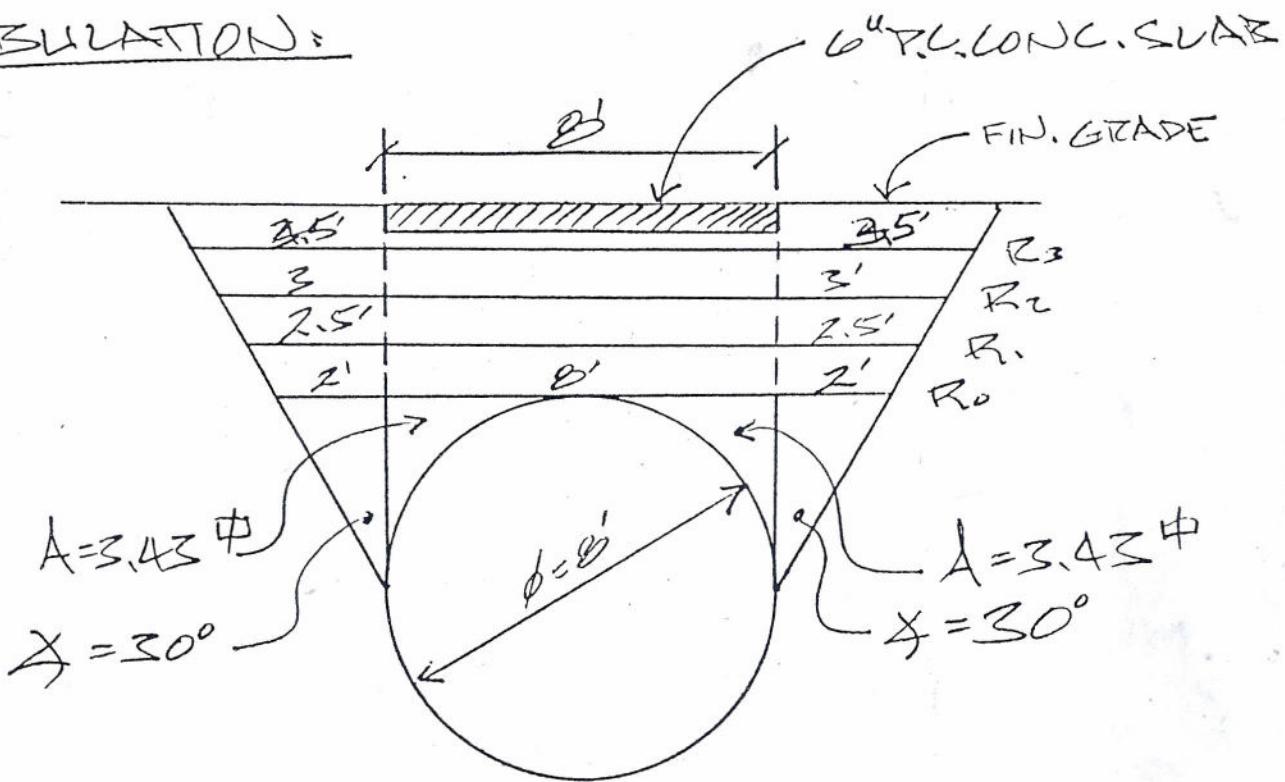

Lee Ebeling, P.E.
Lacy & Ebeling Engineering, Inc.

LE:kh



511 CENTRAL AVE PO BOX 2464 GREAT FALLS, MT 59401 406-761-1088

TABULATION:



DEPTH	R (FT.)	A _{IRL}	WT. IRL ↓	NET ↓ (lb.)
0.5	φ	14.86	1486 lb.	<446.8> NG.
1.5	1.0	27.36	2736 lb.	803.2 ok
2.5	2.0	40.86	4086 lb.	2153.2 ok
3.5	3.0	55.36	5536 lb.	3603.2 ok

(CONSERVATIVE: SLAB ABOVE SURFACE)



ENGLE & ASSOCIATES
ENGINEERING - PLANNING - SURVEYING
P.O. BOX 923 — 5301 527-6810
RED BLUFF, CA 96080

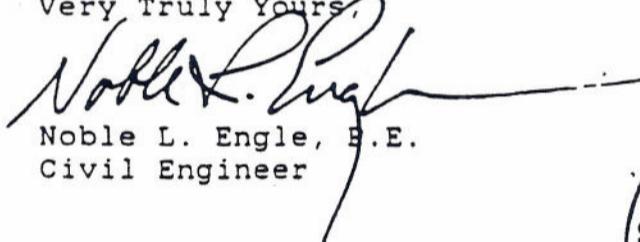
To Fiber Enterprises/ All concerned
1450 Vista Way
Red Bluff, California, 96080

March 12, 1992

Gentlemen,

This letter is to provide you with the written assurance that the FIBER ENTERPRISES tanks which we have designed or considered is adequate for all anticipated loading conditions, including floatation, provided minimum burial or other anti-floatation measures are taken. Anticipated floatation conditions can adequately be resisted using a minimum burial of 24" from top of tank to finished grade. This gives a safety factor in excess of 1.5 using soils shown (see attached graph). If the tanks are to be placed in a condition where the water table is above the invert elevation of the tank inlet then use 50 pounds per cubic foot for resisting weight for calculations and use a minimum burial of 36" from top of tank to finished grade. Let us know if we may be of further service in this matter.

Very Truly Yours,


Noble L. Engle, B.E.
Civil Engineer

NLE/le.



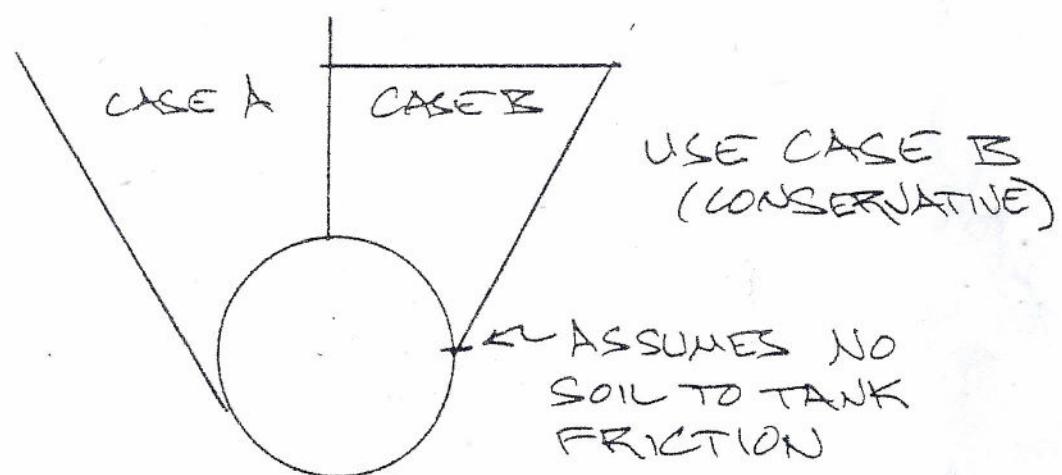
MAY '98

ASSUMPTIONS (CONT'D)

3. ϕ (SHEAR ANGLE) OF SOIL = 30°

4. WEIGHT OF SOIL BACKFILL = 100 p.c.f.

5. DIAMETER OF TANK IS 8'-0".



SEE ATTACHED PAGE 1-X *

TRY MIN BURR OF 8" SOIL COVER

OVER TANK: $0.67'' > 0.6''$ * DR→ USE MIN. 8" SOIL COVER OVER 8' TANKS

LACY & EBELING ENGINEERING, INC.
GREAT FALLS, MONTANA 59401
(406) 761-1088

•CB _____
SHEET NO. _____ OF _____
CALCULATED BY E.S. DATE 2/25/81
CHECKED BY _____ DATE _____
SUBJECT EBERGLASS TUNIS - 1000 ml / 500

Max. Load - PSF

$$P_{LL} = 1221 \text{ psf} \quad (\text{PER ATTACHED ASHTO LL TABLE})$$

$$P_{DL} = (3')(120 \text{ psf})(1.0) = 360 \text{ psf}$$

$$P_{TL} = 1221 + 360 = \underline{1581 \text{ psf}} \quad (\text{or psf on 1' strip})$$

MAX. SPECIFIED PIPE DEFLECTION

(A.) TOTAL $\Delta = 2\% \times 0.0$
 $\Delta = (0.02)(66") = 1.32"$

(B.) Allowable Δ to Account for Load Testing of 2 Times
ASHTO Wheel Loads.

$$\Delta_{allow.} = \left(\frac{0.02}{2} \right)(66") = \underline{\underline{0.66"}}$$
 ← Max. allowed
Δ criterion per
Specs.

TEST DATA - ASHTO 4520-44 TEST PERFORMED 0/23/92

TRAIL. NO. 1/4" WAT TV (TRAIL. NO. 1 - TESTED 10/13/92)

Max. DEFLECTION = 0.117"

ALLOWABLE $\Delta = 0.66"$

$$\text{Ratio} \frac{\text{Allowable } \Delta}{\text{Actual } \Delta} = \frac{0.66"}{0.117"} = \underline{\underline{5.64}}$$

BELINGLOSS DESG Solutions

CASE 1

$$\Delta P = \frac{P}{z^2} J$$

$$\Delta P = \frac{32 k}{(3)^2} (0.477)$$

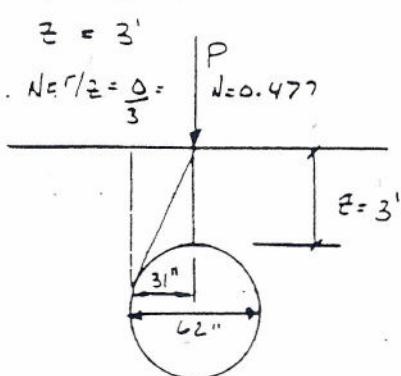
$$\Delta P = 1696 \text{ psf}$$

$$P = 32 k$$

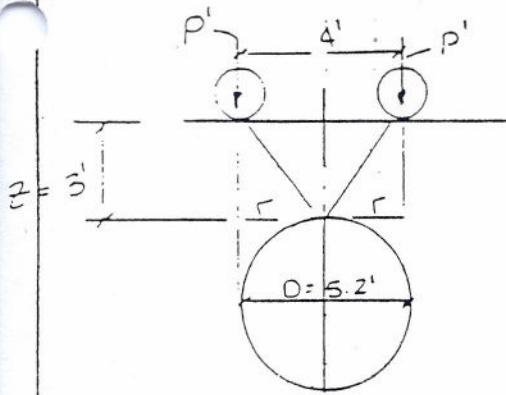
$$r = 0$$

$$z = 3'$$

$$N = r/z = \frac{0}{3} = 0 \quad J = 0.477$$



CASE 2



$$P' = 32,000 \text{ lb}/z = 16,000 \text{ lb} \quad (\text{DASHTO wheel load})$$

$$r = 2'$$

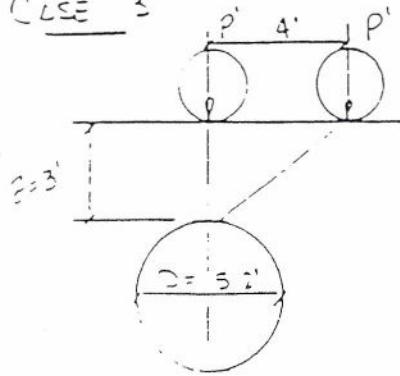
$$z = 3'$$

$$r/z = 0.67 \quad J = 0.2$$

$$\Delta P' = \frac{P'}{z^2} J = (16,000 \text{ lb}) / (0.2) = 355 \text{ lb/sf}$$

$$\Delta P_{NET} = 2 \Delta P = 12(355) = 711 \text{ psf}$$

CASE 3



$$\Delta P_1 \quad r = 4' \quad r/z = 1.33 \quad J = 0.04$$

$$z = 3'$$

$$\Delta P_1 = \Delta P_1 - \Delta P_2$$

$$\Delta P_1 = 848.71$$

$$= 919 \text{ psf}$$

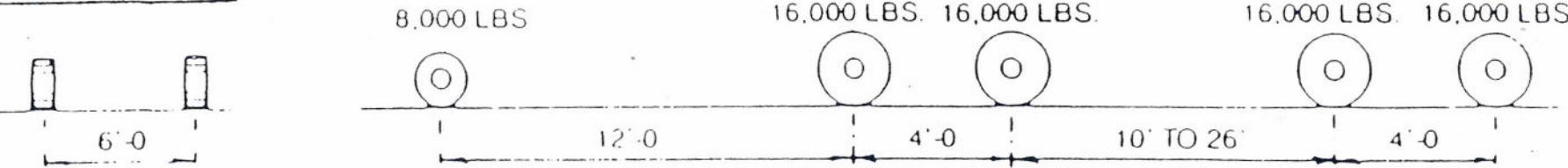
$$\Delta P_1 = r = 0 \quad P = 16 k$$

$$\Delta P_1 = \frac{16,000}{9} (0.477) =$$

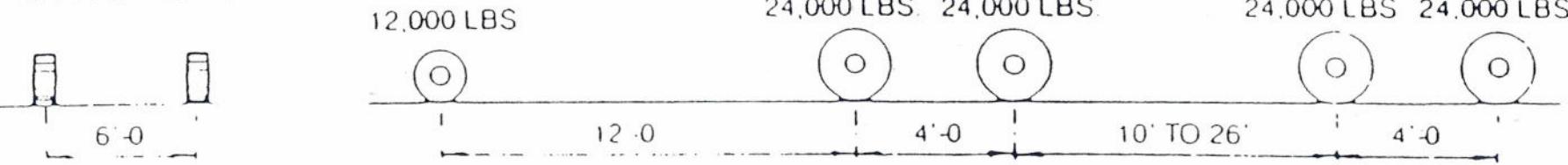
$$\Delta P_2 = (16,000 / (0.04)) = 71$$

BRIDGE DESIGN VEHICLES

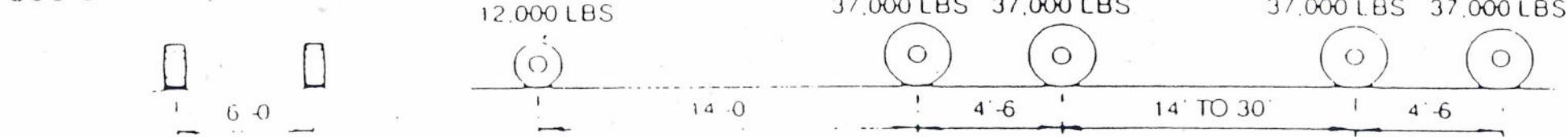
HS 20-44 - GVW 36 TONS



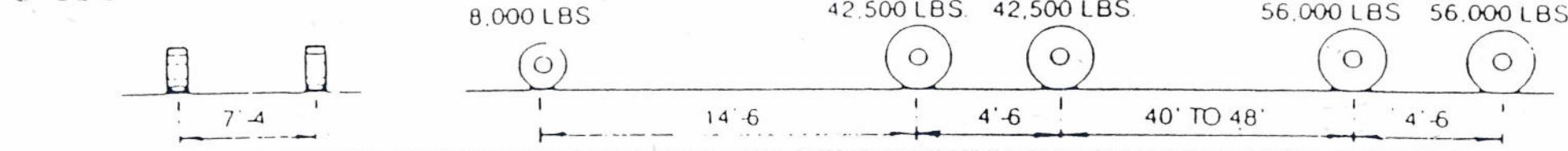
HS 30-44 - GVW 54 TONS



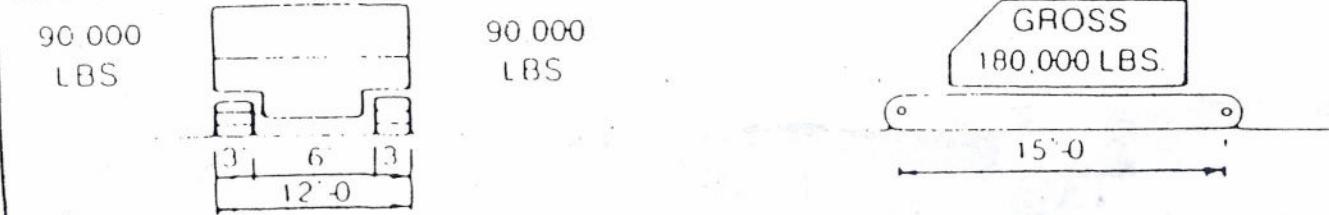
U80 OFF HIGHWAY TRUCK - GVW 80 TONS



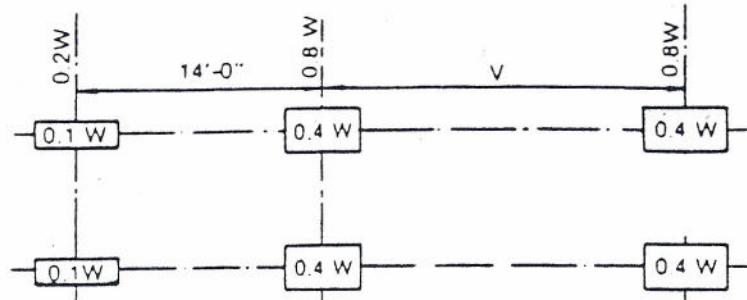
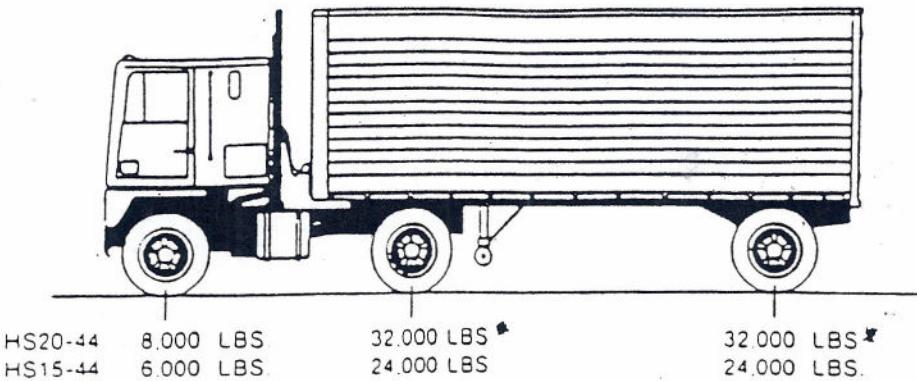
U102 OFF HIGHWAY TRUCK - GVW 102.5 TONS



L90 OFF HIGHWAY LOG LOADER - GVW 90 TONS



24



W = COMBINED WEIGHT ON THE FIRST TWO AXLES WHICH IS THE SAME AS FOR THE CORRESPONDING H TRUCK.

V = VARIABLE SPACING — 14 FEET TO 30 FEET INCLUSIVE. SPACING TO BE USED IS THAT WHICH PRODUCES MAXIMUM STRESSES

CLEARANCE AND LOAD LANE WIDTH

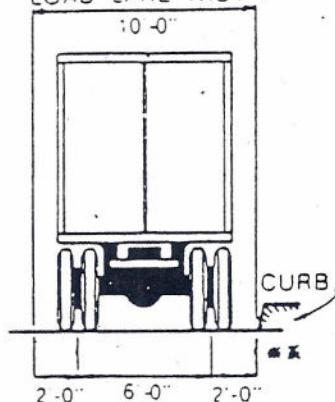


Figure 3.7.7A. Standard HS Trucks

* In the design of timber floors and orthotropic steel decks (excluding transverse beams) for HS 20 loading, one axle load of 24,000 pounds or two axle loads of 16,000 pounds each, spaced 4 feet apart may be used, whichever produces the greater stress, instead of the 32,000-pound axle shown.

** For slab design, the center line of wheels shall be assumed to be 1 foot from face of curb. (See Article 3.24.2.)

T RATIO

Settlement Factor	
Usual Range	Design Value
0.0 to +1.0	
+1.0 to +1.0	-1.0
-0.5 to -0.8	-0.7
0.0 to -0.5	-0.3
	0.0
-1.0 to 0.0	
	-0.1
	-0.3
	-0.5
	-1.0
±0 to ±0	
	-0.5
	-0.7
	-1.0
	-2.0

E COHESION

Values of C	
40	
250	
1,000	
0	
100	
300	
100	
100	

TABLE 44

HIGHWAY LOADS

POUNDS PER LINEAR FOOT

CIRCULAR PIPE

HEIGHT OF FILL H ABOVE TOP OF PIPE IN FEET

	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	
12	4849	2730	1524	954	574	361	216	127	68	46	12
15	5915	3322	1872	1163	700	441	358	269	205	56	15
18	3926	2196	1369	825	520	454	341	242	66	18	
21	4498	2525	1580	950	599	522	392	279	77	21	
24	2856	1788	1077	679	592	444	316	87	24		
27	3096	1998	1201	757	660	496	353	97	27		
30		2204	1328	837	731	548	390	107	30		
33		2370	1452	915	798	599	426	117	33		
36			1580	996	869	652	463	127	36		
42				1679	1154	1007	755	537	147	42	
48					1221	1146	859	611	168	48	
54						1185	962	684	188	54	
60							998	758	208	60	
66								832	228	66	
72								857	249	72	
78									269	78	
84									275	84	

HORIZONTAL ELLIPTICAL PIPE

HEIGHT OF FILL H ABOVE TOP OF PIPE IN FEET

	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	
14 x 23	5915	4498	2716	1699	1022	644	561	422	300	82	14 x 23
19 x 30		3096	2177	1309	825	719	551	384	105	53	
22 x 34			2370	1471	927	808	607	402	118	22 x 34	
24 x 38				1631	1028	896	674	479	131	24 x 38	
27 x 42					1679	1119	975	733	521	143	27 x 42
29 x 45						1221	1064	800	569	156	29 x 45
32 x 49							1152	866	516	169	32 x 49
34 x 53								1185	933	663	182
38 x 60									998	748	205
43 x 68										842	231
48 x 76										857	257
53 x 83											275

ARCH PIPE

HEIGHT OF FILL H ABOVE TOP OF PIPE IN FEET

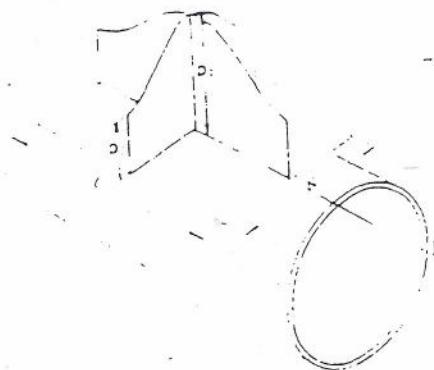
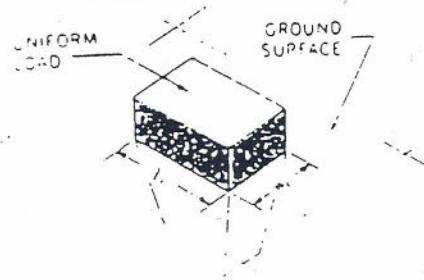
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	
11 x 18	5915	3540	2144	1342	807	509	443	333	237	65	11 x 18
13 1/2 x 22		4498	2570	1610	968	520	532	400	284	78	13 1/2 x 22
15 1/2 x 26			3000	1879	1130	712	671	467	332	91	
18 26 1/2				3096	2058	1238	850	580	351	100	18 26 1/2
22 1/2 x 36 1/2					2370	1523	966	842	633	450	22 1/2 x 36 1/2
26 1/2 x 43 1/2						1679	1170	1019	766	543	150
31 1/2 x 51 1/2							1221	1185	981	603	174
36 58 1/2								998	721	198	36 58 1/2
40 65									500	220	40 65
45 73									857	246	45 73
54 88										275	54 88

Unsurfaced Roads—4,600 Pound Wheel Load, Dual Tires, 80 psi. Tire Pressure Impact included. Last number in each column (bold type) indicates maximum load for any given fill height. Interpolations for intermediate fill heights.

ciently so that the live load transmitted to the pipe is negligible. In the case of flexible pavements designed for light-duty traffic but subjected to heavy truck traffic, the flexible pavement should be considered as the material over the top of the pipe.

The total live load transmitted to a pipe underground can be determined by calculating the volume of the pressure intensity diagram shown in Illustration 4.5. This volume is closely approximated by an elliptical

Illustration 4.5—Highway Live Load Pressure Distribution



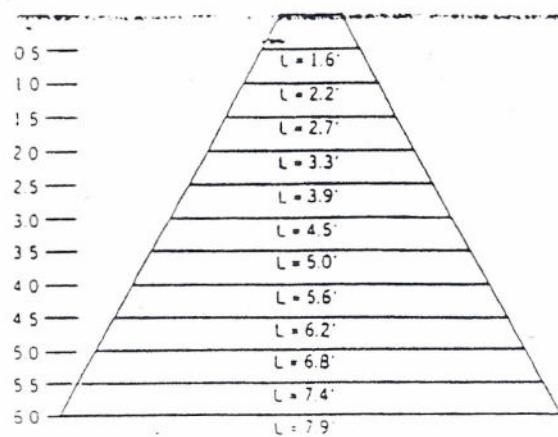
cylinder and elliptical. Based on this type of loading configuration, the total live load per unit length of pipe is computed by the equation:

$$W = \frac{4(1 + 2\beta)}{1 - \beta} P$$

The pressure intensities p_1 and p_2 are determined by the Boussinesq equation for stresses in a semi-infinite elastic medium:

The stress σ at any horizontal plane in the subsoil subjected to a rectangular load can be defined by planes descending from the edge of the contact area at an angle of α to the surface of the earth at 30 degree angle with the vertical. Based on these principles, the limitations of the effects of real highway truck loading with dual tires, the limitations of the effects of the pressure distribution for various heights of cover are shown in Illustration 4.6.

Illustration 4.6 — Limiting Load Distribution for Typical Dual Tire Truck Loading



The width of the loaded area is limited to the outside horizontal span of the pipe B_e and the length in the longitudinal direction is computed by the equation:

$$L = 1.0 + 1.155H \quad (21)$$

Table 44 presents total live loads in pounds per linear foot for circular, horizontal elliptical and arch pipe. The tables are based on a 16,000-pound, dual-tire wheel load (32,000-pound axle load) and 80 pounds per square inch tire pressure. Recommended impact factors to be used in designing pipe with less than 3 feet of cover when subjected to dynamic traffic loads are listed in the accompanying Table.

Impact Factors for Highway Truck Loads

HEIGHT OF COVER H	IMPACT FACTOR I _I
0'-0" to 1'-0"	1.0
1'-1" to 2'-0"	1.2
2'-1" to 2'-11"	1.1
3'-0" and greater	1.0

NOTE: Impact factors recommended by the American Association of State Highway Officials in "Standard Specifications for Highway Bridges"

¹ Depending on the height of fill and outside horizontal span of the pipe under consideration, the width of the loaded area is given by equation (21) up to a maximum dimension corresponding to the outside horizontal span of the pipe, B_e .



ENGLE & ASSOCIATES
ENGINEERING - PLANNING - SURVEYING
P.O. BOX 923 - 530 527-6810
RED BLUFF, CA. 96080

REPORT OF TESTING
FOR
FIBERGLASS SEPTIC TANKS
BY FIBER ENTERPRISES
1450 VISTA WAY
RED BLUFF, CALIFORNIA

OCTOBER 23, 1992

AT THE REQUEST OF ED HURST & STEVE CHAMNESS

This report is a report of the performance under load of the 1,500 gallon fiberglass tanks being produced by the FIBER ENTERPRISES plant located at 1450 Vista Way, Red Bluff, California.

Summary: from October 12th through October 23 of 1992 a load test program was done by Engle & Associates for the type of tanks presently being produced by FIBER ENTERPRISES. Both tanks tested passed all required load testing and measurements for quality control.

The full load and creep tests were conducted on two production tanks one with the standard 1/4" wall thickness and standard configuration (tank #1) and the other with a heavy duty 5/16" wall thickness and standard configuration. Both tanks were checked and inspected for construction, configuration, empty weight and thickness. The tanks as presently produced with the 18 minute gel and the reinforcing fiber as observed pass all stated and required quality control requirements.

Technical Specifications are as follows:

Septic Tank Wall Thickness = 0.250" (nominal)

Resin cured at 73 (+/- 15) degrees Farenheit.

Ultimate tensile strength = 12,000 p.s.i.

Flexural Strength = 19,000 p.s.i.

Modulus of Elasticity = 800,000 p.s.i.

Compressive strength = 24,000 p.s.i. minimum at break surface

Barcol Hardness = 40 (both interior and exterior)

Collapsing strength = 3.5" vacuum = 261 p.s.f. (minimum)

Note. One tank from a previous lot was tested to approximately 2" of vacuum which is over 500 p.s.f. without collapsing.

page one of two

REPORT OF TESTING
FOR
FIBERGLASS SEPTIC TANKS
BY FIBER ENTERPRISES
1450 VISTA WAY
RED BLUFF, CALIFORNIA.

OCTOBER 23, 1992

septic tank	dimensions	approximate weight
1,000 gallon	62" Hx 72" Wx 10' 0" L	300 pounds (+/- 30)
1,250 gallon	62" Hx 72" Wx 11' 8" L	360 pounds (+/- 36)
1,500 gallon	62" Hx 72" Wx 13' 2" L	420 pounds (+/- 42)

I hereby certify that the foregoing is true and correct to the best of my knowledge

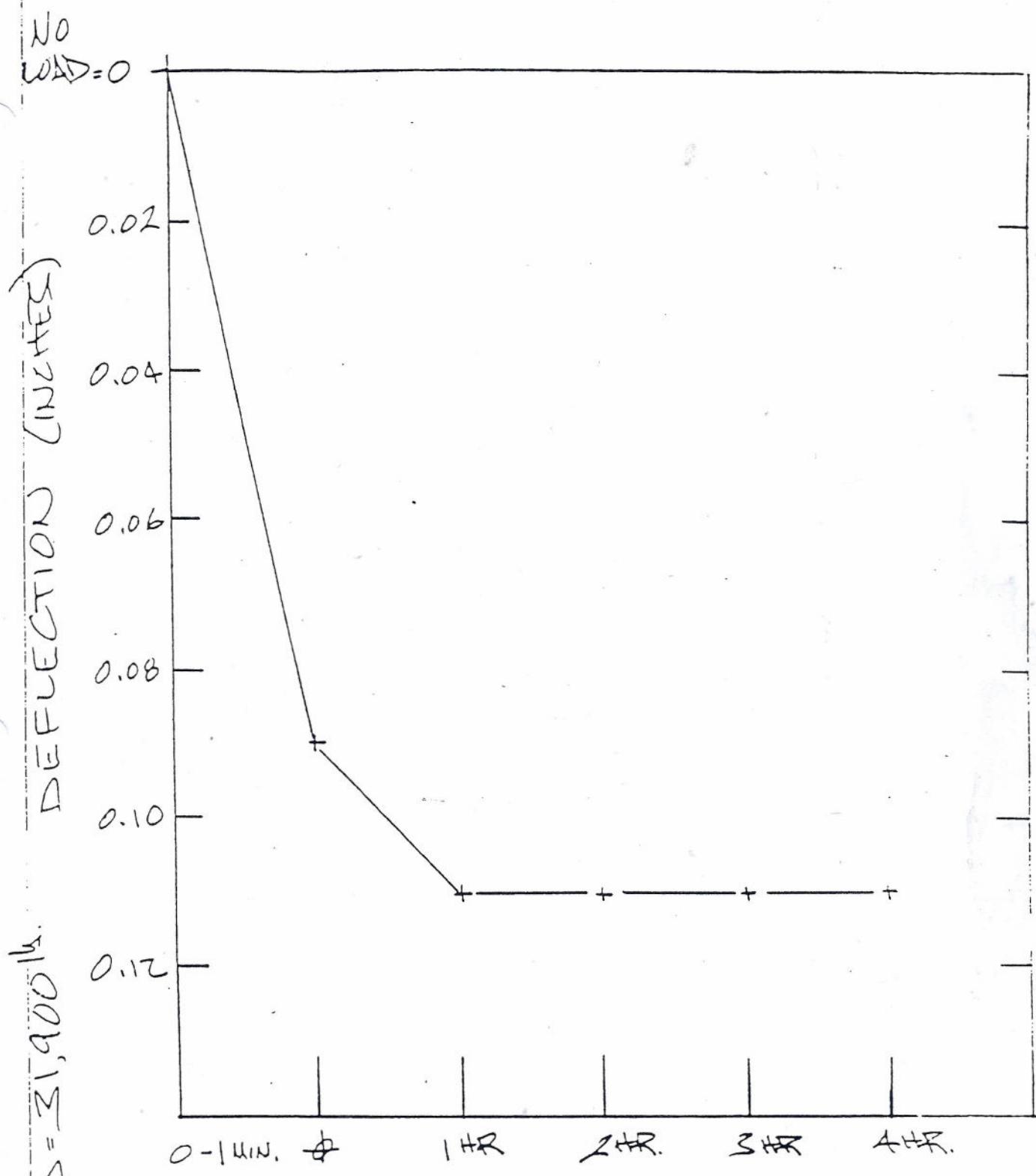
by,

Noble L. Engle
Noble L. Engle, P.E.
Civil Engineer

exp. 9-30-1993



TANK #1 ($\frac{1}{4}$ " WALL τ)



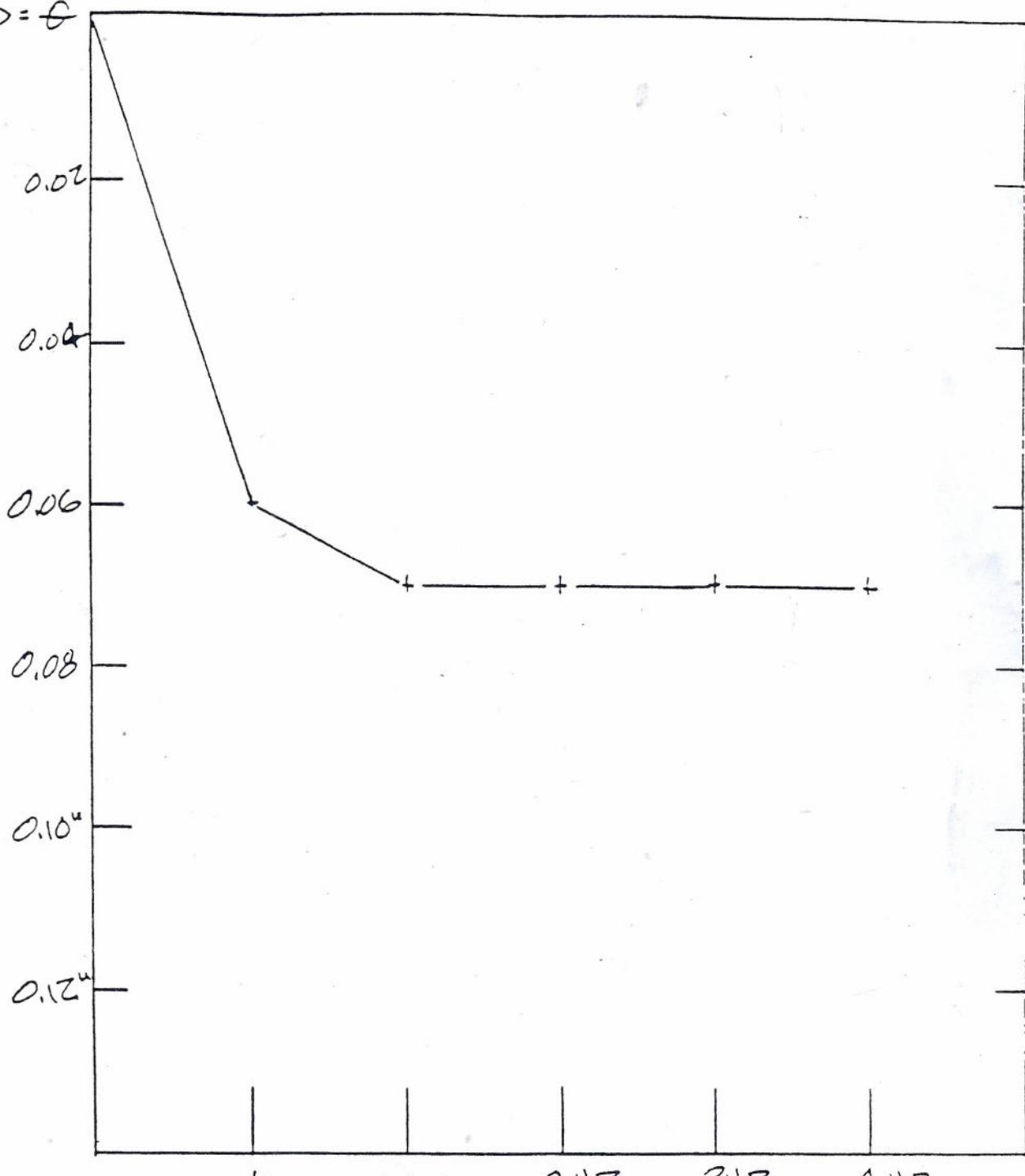
TIME
LOAD = 31,900 lb.

DEPTH TO TOP = 3.0 FT.

4/5

TANK #2 ($\frac{\text{in}}{\text{in}} \text{WALL}$)

No
LOAD = 0



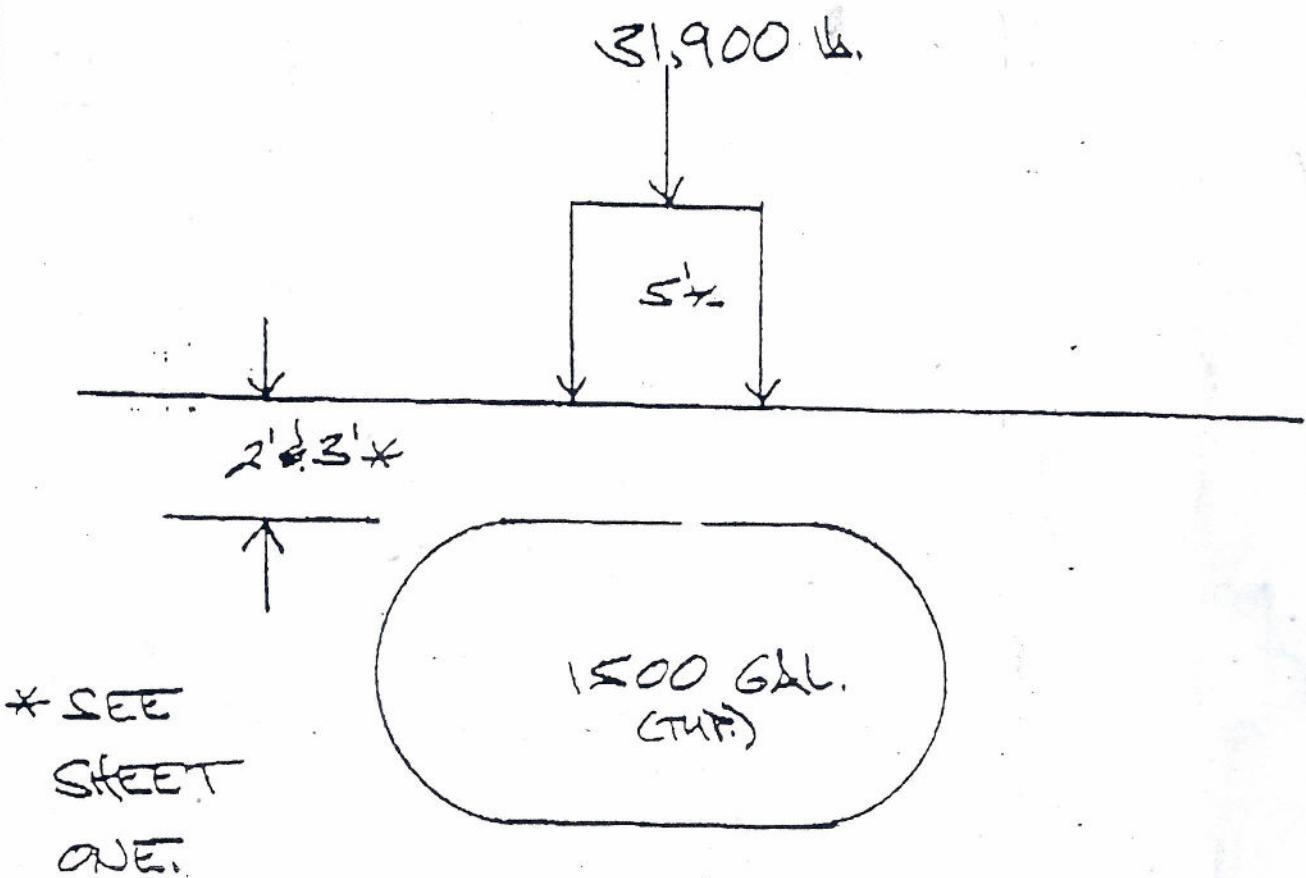
0-1 MIN 0
(BEFORE
LOADING)

TIME

LOAD = 31,900 lb_f

DEPTH TO TOP = 2.0 FT.

FIBER ENTERPRISE
OCT. '92



* SEE
SHEET
ONE.