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Report No. 2059-L

West Virginia University

STEEL SHEAR DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

November 19, 1985

Test Report

for

Hilti, Inc.
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Project Director:

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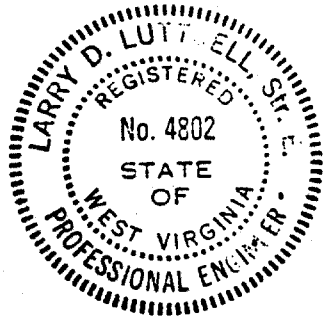


PREFACE

The Major Units Laboratory at West Virginia has been involved in full-scale diaphragm studies for the past twenty years. The work has covered tests on a wide range of deck panel types, metal building wall systems, panels with insulating concrete fill, and plywood assemblies, all used as diaphragms, and under static, cyclic, and dynamic loading. Connection performance, critical to diaphragm behavior, has been evaluated through an extensive test program covering arc-spot (puddle) welds, different types of screws, and power driven pins. These have established fastener strength limits and have been especially important for defining fastener flexibility factors.

The work has led to logical formulas for both diaphragm strength and stiffness predictions with panels of any common configuration once fastener types are specified. Shear response can be determined for any diaphragm with a new type connector system through simple tests involving only the connectors. This is apparent in all general formulas where panel geometry, diaphragm layout and fastener response are identified as independent variables.

LARRY D. LUTTRELL
PROFESSOR OF CIVIL ENGINEERING

Table of Contents

STEEL SHEAR DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

Introduction

Steel deck panels may be used as roof or floor diaphragms when properly interconnected using arc-spot welds, screws, or various driven fasteners. The Steel Deck Institute Diaphragm Design Manual (SDI/DDM) contains a series of design formulas which are dependent on several variables including panel configuration, the panel span, methods of attachment to support frames, and fasteners interconnecting the panel units.

The SDI/DDM formulas have been developed from several hundred full scale tests having the range of expected variables including, particularly, the quality and response of fasteners loaded in shear. Those formulas, as will be presented later, generally take the form,

$$S_u = (A + B)Q_f/L \qquad (1)$$

where: S_u = shear strength (plf)

L = average deck panel length (feet)

A,B = geometry factors describing layout

Q_f = fastener strength in shear (lbs)

It is clear from this type of formula that the diaphragm strength is directly dependent on those fasteners connecting the deck to the support frame.

The purpose of this study and test program, made in the Major Units Laboratory of West Virginia University, was to evaluate the Hilti fastener and test it in a series of full-scale diaphragms systems. The results from such studies were then to be the bases for establishing design load table for steel deck diaphragms using the fastener and standard SDI/DDM formulas.

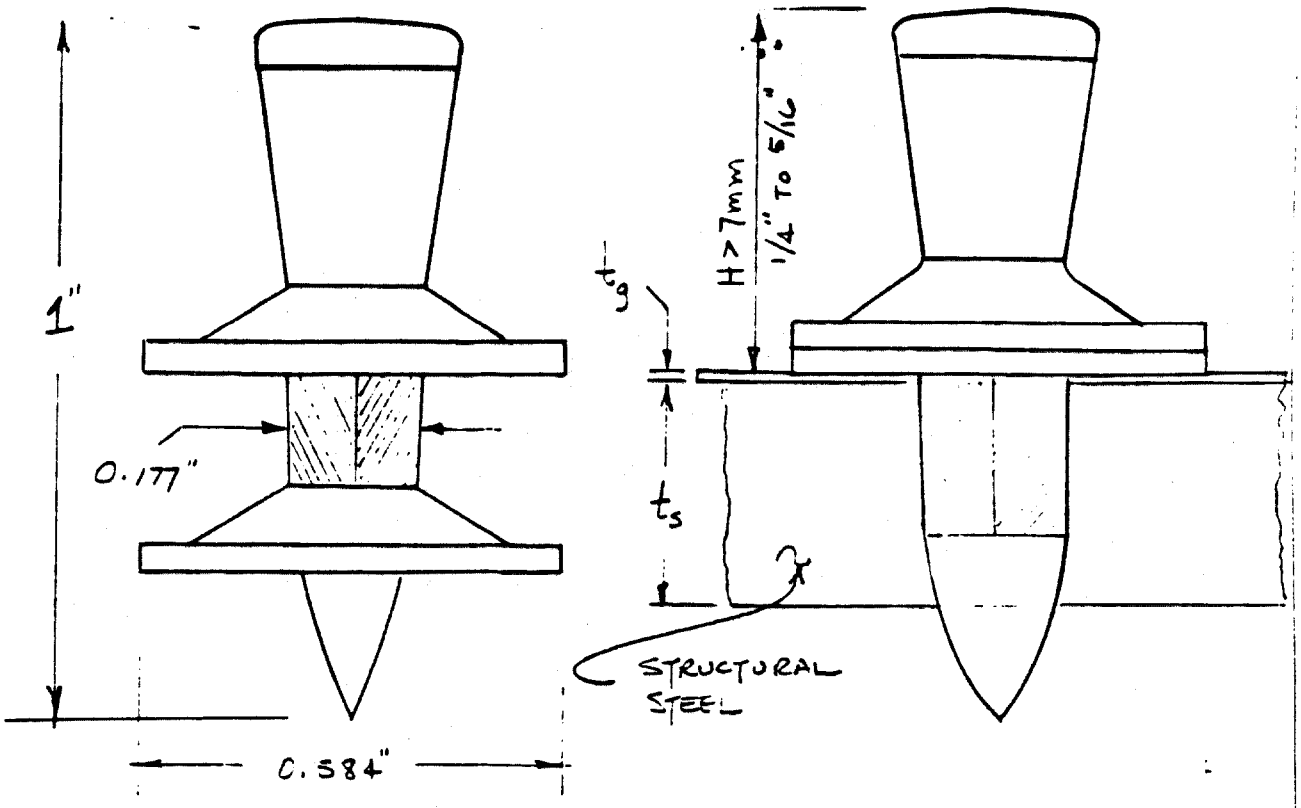
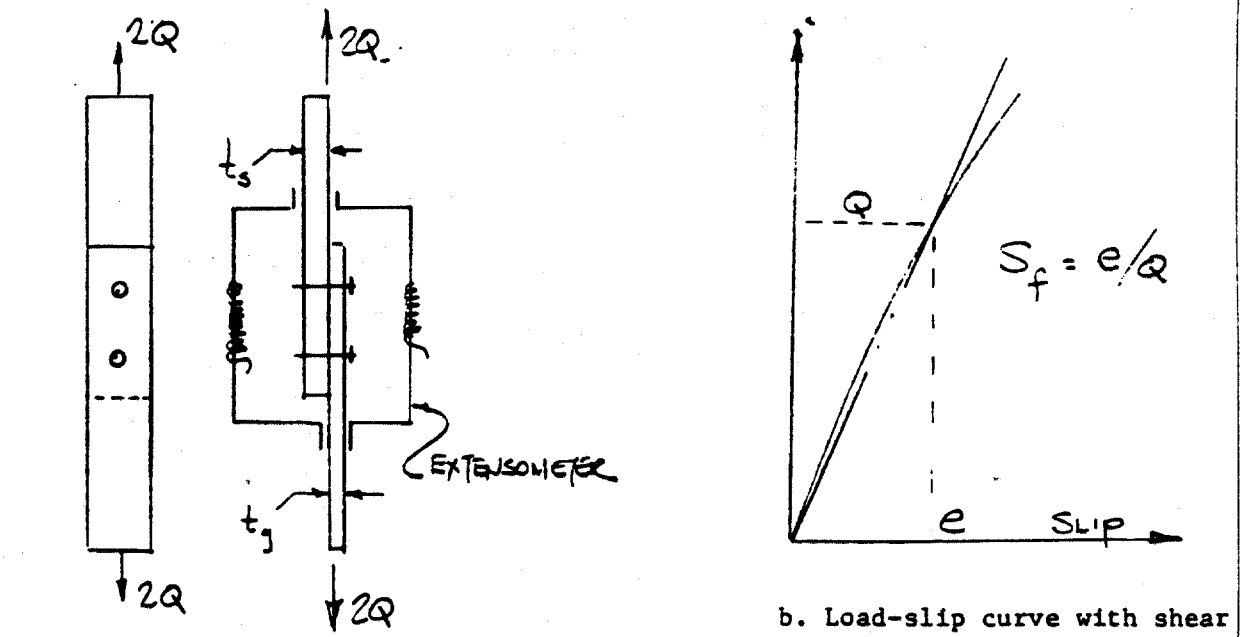


Figure 1. Hilti ENP2-21L15 fastener.



a. Fastener test specimen.

b. Load-slip curve with shear load Q per fastener.

Figure 2. Fastener shear test.

Fastener Description

The Hilti ENP2-21L15 fastener is a powder-actuated device designed for the purposes of attaching thin steel sheet metal to structural steel. It is a nail-like device the details of which are shown in Figure 1. It is manufactured from hardened steel, has a knurled shank, and is fitted with two slightly cupped washers.

The response of an individual fastener in shear can be established following the test arrangement in Figure 2. Direct loads can be applied and continued until an ultimate strength value Q_f is reached. During the loading, slip across the connected parts can be measured indicating the fastener flexibility S_f.

These fasteners present a shank diameter such that, in the common range of deck thicknesses of 22 and 18 gage, the shear strength is controlled by the sheet thickness bearing against the shank. Further, the cupped washers and tapered shank serve to control the driving depth and the washers then act as a clamp on the attached sheet material to keep it flat around the fastener.

The "shear-bearing" strength will increase slightly as the fastener is driven to a greater depth due to the shank taper presenting a progressively larger diameter to the connected sheet, but the total depth is controlled by selecting a booster level such that H in Figure 1 is limited.

Fastener Tests

A series of forty specimens were tested in direct shear as indicated in Figure 2. The purpose was to study the influence of attached sheet thickness, back-up plate thickness, and power of booster on fastener performance. All gage material was ASTM A446-C except for thicknesses less than 0.0271" which were from harder Grade D steels. The back-up plates were ASTM A36. Table 1 shows the strength Q_f and flexibility factors S_f for all cases tested.

Generally, for lighter back-up plates lighter boosters were used. For each group in Table 1, the plate sizes and booster levels are in Column 1, sheet thicknesses in Column 2, and other columns show strength and flexibility.

TABLE 1. Shear Strength Test Summary

Plate Thickness (in)	Sheet Thickness (in)	Q_f (lbs)	Avg. Q_f (lbs)	Avg. $S_f \times 10^{-3}$ (in/k)
3/16 Plate	0.0279	1408	-	-
No. 4 Booster	0.0269	1380	-	-
(yellow)	0.0270	1200	1330	11.5
	0.0280	1600	-	-
	0.0280	1700	-	-
	0.0280	1600	1635	4.7
	0.0340	2800	-	-
	0.0340	2200	2500	5.7
	0.0496	2252	-	-
	0.0510	2250	2250	5.9
	0.0611	2950	-	-
	0.0602	3060	3005	7.0
	0.1063	3500	-	-
	0.1063	3200	3350	6.3

(continued on next page)

TABLE 1. Shear Strength Test Summary (continued)

Plate Thickness (in)	Sheet Thickness (in)	Q_f (lbs)	Avg. Q_f (lbs)	Avg. $S_f \times 10^{-3}$ (in/k)
1/4 Plate	0.0271	1390	-	-
No. 4 Booster	0.0265	1396	1395	6.3
(yellow)				
	0.0290	1600	-	-
	0.0290	1400	1500	6.1
	0.0390	2300	-	-
	0.0390	2400	2350	4.1
	0.0520	2260	-	-
	0.0505	2298	2280	5.5
	0.0608	2696	-	-
	0.0607	2700	2700	4.6
	0.1068	3500	-	-
	0.1068	2800	3150	3.6
5/16 Plate	0.0270	1500	-	-
No. 6 Booster	0.0270	1380	1440	8.0
(purple)				
	0.0280	1600	-	-
	0.0280	1760	1680	4.9
	0.0340	2900	-	-
	0.0340	2900	2900	3.7
	0.0510	2640	-	-
	0.0508	2580	2610	3.3
	0.0611	3120	-	-
	0.0608	2950	3035	4.8
	0.1068	4060	-	-
	0.1068	4292	-	-
	0.1068	4300	4220	5.4

Notes:
1. All gage material ASTM A446-C galvanized except t = 0.0271 and less which was painted and Grade D.
2. S_f flexibility factors are low and compare to those in arc-puddle welding (See SDIM p. 58).
3. Average Q_f values rounded to 5's.

Figure 3 and 4 show general trends in strength and stiffness. Note particularly, in Figure 4, the scale difference in stitch screw stiffness

The S_f values shown in Figure 4 are quite low being similar to those for welds. The scatter is so narrow (note the screw curve) and the values so low that the same values as for welds are recommended. Note that a constant value of $S_f = 5 \times 10^{-3}$ in/k could have been used with no significant effect.

The values are comparable to the flexibility factors for other similar fasteners (See SDI/DDM p. 58). S_f simply defines the slip rate. For example in the above case with a one kip load, the connected parts would show a relative slip of 0.005 inches. This quantity is important in establishing the overall stiffness for a diaphragm.

Fastener Summaries

When assembling a diaphragm, it often is necessary to interconnect adjacent steel panels by using stitch screws. In these studies, a No. 12 and 14 TEKS screws were used and strength values Q_s as well as flexibility factors S_s for them are contained in SDI/DDM, pages 55 and 58.

TABLE 2. Fastener Summary

Metal Thickness t (inches)	Gage	HILTI ENP2-21L15 Q_f(lbs)	HILTI ENP2-21L15 S_f(in/k)	No. 12 TEKS Q_s(lbs)	No. 12 TEKS S_s(in/k)	No. 14 TEKS Q_s(lbs)	No. 14 TEKS S_s(in/k)
0.0295	22	1594	0.0070	560	0.033	565	0.025
0.0358	20	1859	0.0058	747	0.027	860	0.023
0.0474	18	2345	0.0041	1110	0.020	1400	0.020

As indicated earlier, the shear strength is somewhat dependent on the fastener dimension H as it controls the steel sheet to fastener contact diameter. The above values represent a series of average conditions expected in a typical application and are used in comparisons in the present test program.

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JOB FIG1 -ASTENER

SHEET NO. 1 OF 1

CALCULATED BY _____ DATE _____

CHECKED BY LDL DATE _____

SCALE _____

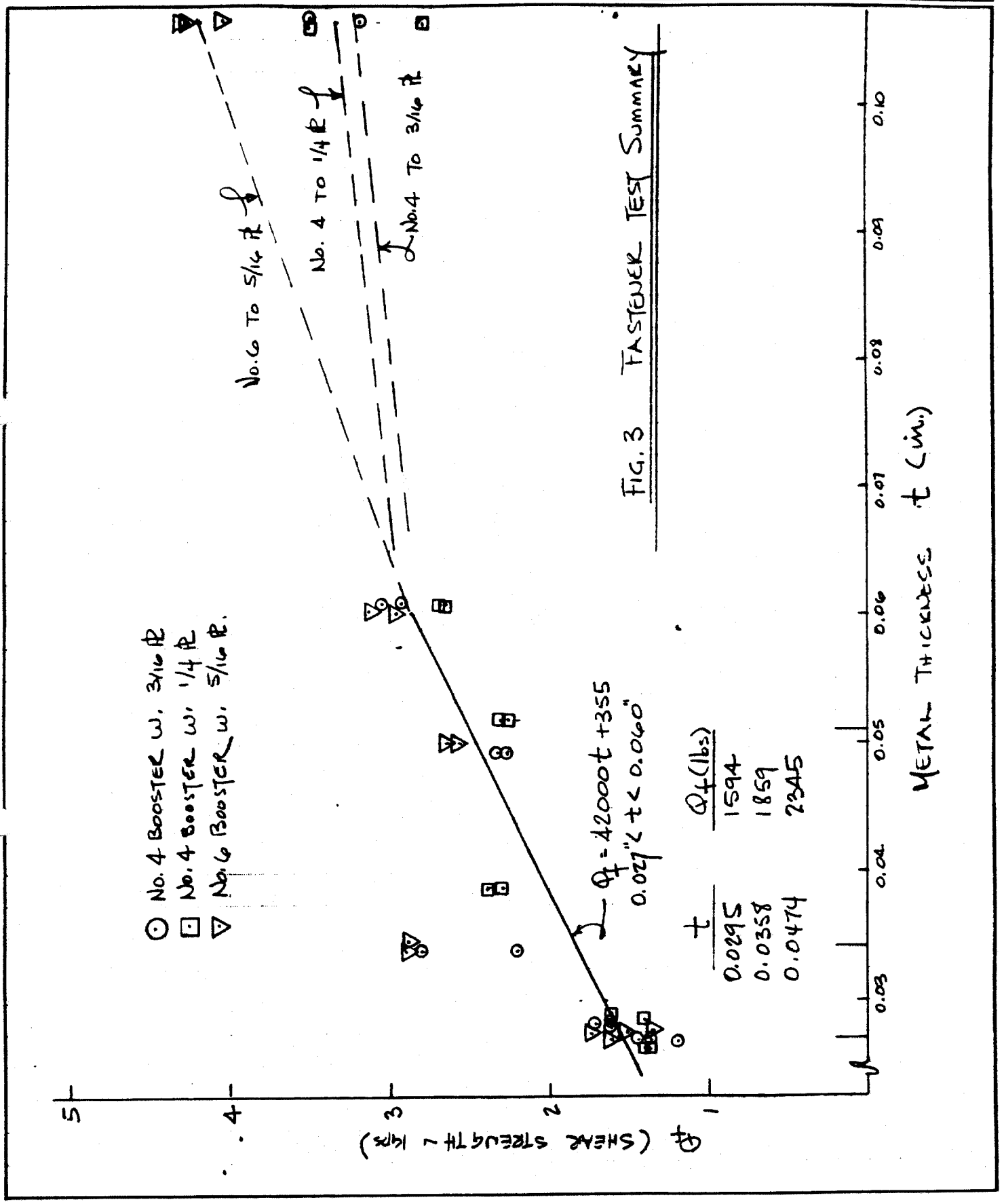

FIG. 3 FASTENER TEST SUMMARY

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JOB T-1-1 FASTENERS
SHEET NO _____ OF _____
CALCULATED BY JL DATE _____
CHECKED BY _____ DATE _____
SCALE _____

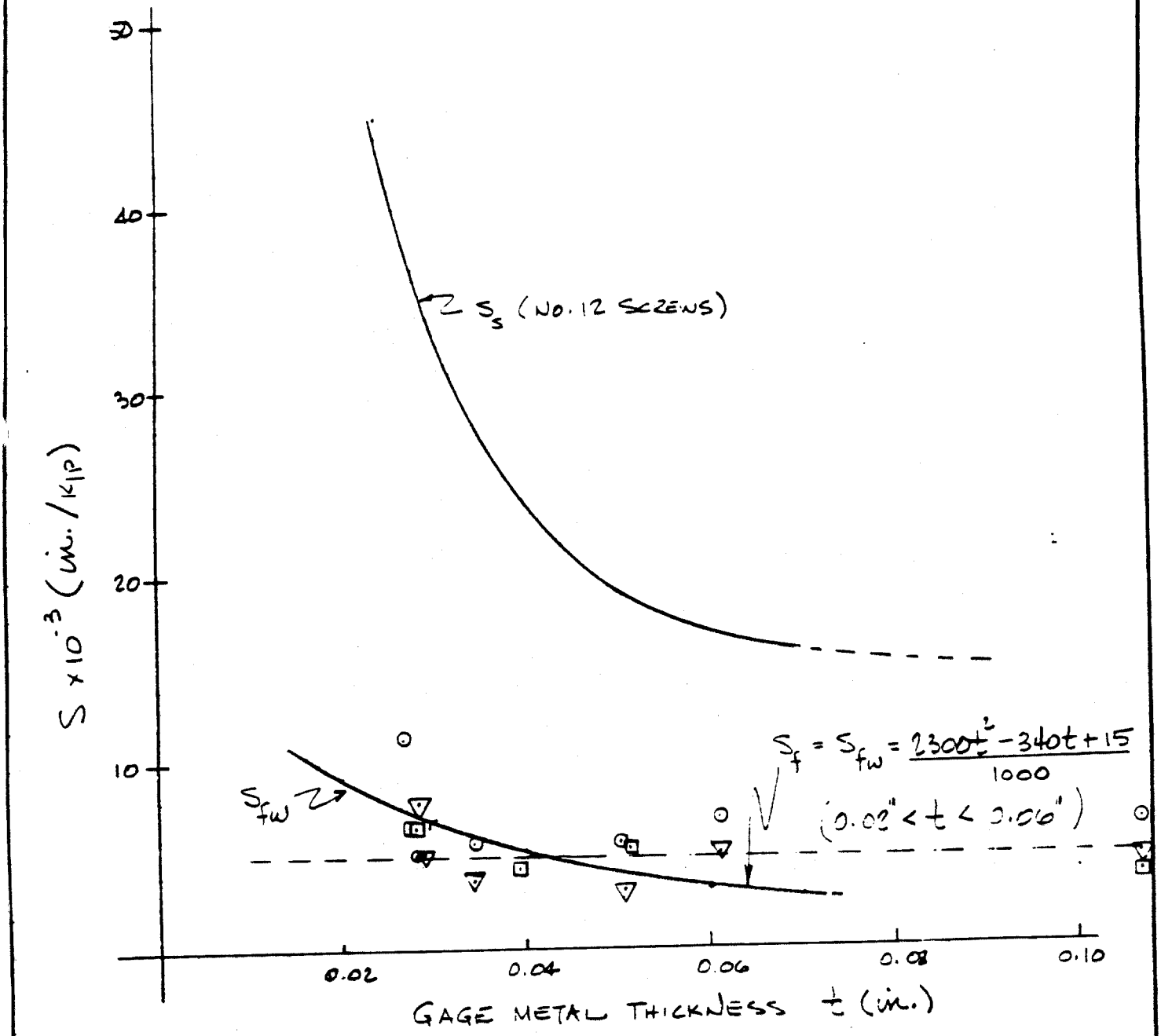

FIGURE 4. FLEXIBILITY FACTOR, S_f

DRIVING RECOMMENDATION. Select the booster level such that H lies between 1/4 and 5/16 inches. (See Figure 1.)

SCREW INSTALLATION. Install all stitch screws such that sidelaps are in intimate contact but without overdriving and stripping threads.

Full Scale Diaphragm Tests.

Three full scale diaphragms were assembled using Standard Intermediate Rib deck. These deck shapes were in conformance with the Steel Deck Institute Design Manual for Floor and Roof Decks and were rolled by an SDI member company.

Using the SDI data developed for screws and the present data for Hilti fasteners, the three tests were designed to cover the widest range of variables in common decks and to evaluate the applicability of the SDI formulas to the use of Hilti fasteners in diaphragms.

The SDI/DDM separates several factors that influence both strength and stiffness, one set of those being the fastener shear strength Q_f and the flexibility factor S_f. Three general formulas then are developed and the design value is taken as the lower of the three.

The typical test layout is shown in Figure 5 where the entire assembly may represent a one bay area in a building. Shear loads P induce average shears of S = P/L. Note that, for equilibrium, R = Pa/L and then shear across the system is S = R/a = P/L.

"The system is in shear; the whole system involves deck, joists, and frames. The average S is the same in both directions."

1. Diaphragm Edge Parallel to Panel Spanning Direction

This limiting condition usually will occur at one end wall or other load transfer zone and usually at joists ends. (Certain of the symbols and use of the formulas will be clearer after a review of the test data.)

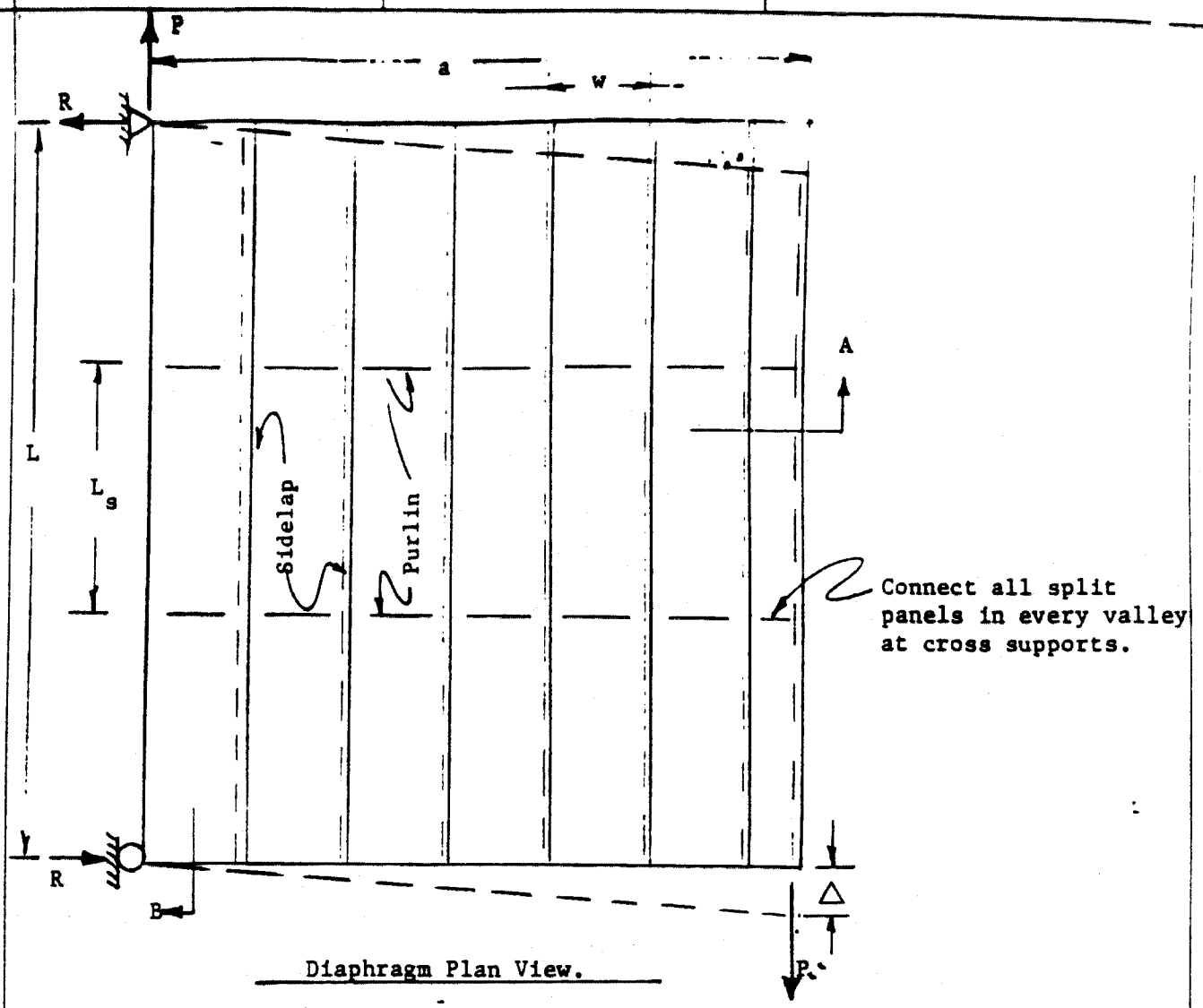

Figure 5. Typical test layout.

$$S_u = (2\alpha_1 + n_p\alpha_2 + n_e)Q_f/L \qquad (2)$$

where

S_u = diaphragm shear strength (lbs/ft or kips/ft).

$\alpha_1 = (\Sigma\, x_e)/w$

x_e = end of panel fastener position from panel centerline (in.).

w = panel width (inches).

n_p = number of interior purlins in a panel length (excludes the two at ends).

n_e = number of edge fasteners per panel length L excluding those at joists.

Q_f = sheet-to-frame fastener strength (lbs).

L = Panel length (feet).

2. Limitations at Interior Panels.

This formula addresses equilibrium of interior deck panel units and particularly the force transfer capacity along panel sidelaps.

$$S_u = [2A(\lambda_1 - 1) + B]Q_f/L \qquad (3)$$

where

A = 1 for cases with a single fastener on edge laps at purlins and 2 for doubled fasteners at purlin edge laps.

$\lambda_1 = 1/[1 + (L_s/135)^2]$

L_s = purlin spacing (in.)

$B = n_s\alpha_s + [2n_p\Sigma x_p^2 + 4\Sigma x_e^2]/w^2$

n_s = number of stitch screws per sheet length L — does not include fasteners at purlins.

$\alpha_s = Q_s/Q_f$ where Q_s = stitch screw strength.

x_p = fastener position from panel centerline.

3. Limitations at Panel Ends

Direct shears and interior panel couples can result in critical loads on fasteners at panel corners. Thus, strength may be limited by

$$S_u = Q_f NB/(B^2 + N^2L^2)^{0.5} \qquad (4)$$

where

N = average number of fasteners per foot across the ends of individual panels.

In any of the three equations above, Q_f is the fastener strength as presented in the previous section and Q_s is the stitch connector strength from Figure 3.4 of the SDI Manual as summarized in Table 2.

4. Diaphragm Stiffness G'.

Formulas for stiffness are complex but may be reduced to fairly simple forms for typical deck profiles and nominal thickness. From those formulas below, linear interpolation between gages produces satisfactory results.

The stiffness G' in kips/in. for

$$t = 0.0295", \quad G'_{22} = \frac{870}{3.78 + D_n\lambda + C}$$

$$t = 0.0358", \quad G'_{20} = \frac{1056}{3.78 + D_n\lambda + C}$$

$$t = 0.0474", \quad G'_{18} = \frac{1398}{3.78 + D_n\lambda + C} \qquad (5)$$

where λ ranges from 1.00 to 0.58 as shown below

n_p	0	1	2	3	4	5	6
λ	1.00	1.00	0.90	0.80	0.71	0.64	0.58

and n_p = number of interior purlins supporting a single panel length.

Then D_n term measures panel warping depending on the fastener spacing at panel ends. It is found from the following table with

$$D_n = D/12L$$

TABLE 3.

Panel Type	Gage	D Values for End Valley Spacing		
		D_1 One	D_2 Two	D_3 Three
Wide Rib (WR)	22	1549	12864	26504
	20	1159	9263	19825
	18	761	6316	13013
Int. Rib (IR)	22	2712	14589	29131
	20	2028	10913	21790
	18	1331	7163	14303
Narrow Rib (NR)	22	4271	15388	29303
	20	3195	11511	21919
	18	2097	7555	14387

The final parameter C is easy to generate in any computer listing for a specified pattern of connections, and is defined as

$$C = 12LK_1$$

where

$$K_1 = \frac{2Et}{w}\left(\frac{1}{2\alpha_1 + n_p\alpha_2 + 2n_sS_f/S_s}\right) \qquad S_f = \frac{59000\ t\ S_f/w}{2\alpha_1 + n_p\alpha_2 + 2n_sS_f/S_s} \qquad (6)$$

where

S_f/S_s = ratio of structural to stitch fastener flexibilities

E = 29500 ksi

t = sheet base metal thickness (in.)

The use of these formulas is illustrated in the following data evaluations for both strength and stiffness.

Diaphragm Test Program.

The three tests were assembled from 20' long IR deck panels in three different gages. The test frame, shown in Figure 5, has flexible corner clips and virtually no resistance to lateral displacement prior to attaching the diaphragm panels.

Two different purlin spacings were used with various connector patterns at cross supports and different stitch fastener layouts along sidelaps. The 16' x 20', frame, supported on rollers, was squared up and leveled and the deck panel layout then proceeded as in any normal installation. Refer to the evaluations for Hilti No. 1 in the appendix for a typical layout.

In Hilti No. 1, panels were attached in every valley at panel ends. The filled circles represent structural fasteners and the small x marks indicate positions of the stitch screws. Note particularly the edge fasteners, opposite the x-marks, which always are equal in number to the number of x-marked stitch screws. Should the purlins have been setting atop the structural frame, it would have been necessary to have added blocking to allow the edge connectors n_e (See SDI/DDM p. 37).

In all tests where a partial panel was required to finish out the assembly width, that panel always was attached at cross supports by structural fasteners in every valley but otherwise stitched, as any other panel, along the edges.

The data reductions show the expected strength and stiffness values following the previously presented Equations 3 through 7. In these sections,

P_{ut} = theoretical strength (lbs)

P_{uo} = tested strength (lbs)

G' = theoretical shear stiffness (kips/inch)

Each third page in the set shows the resultant load-deflection curve for each test with the stiffness curve plotted and labeled as G'_t.

TABLE 4. Test Summaries

Test No.	Gage	P_{ut} (lbs)	P_{uo} (lbs)	P_{uo}/P_{ut}	G'_t K/in)
1	22	16320	16800	1.03	46.1
2	20	18140	20280	1.12	27.9
3	18	25960	23242	0.90	89.3
				Average =	1.02

Noting that the average values for P_{uo}/P_{ut} are in excellent agreement with tested values, the use of such formulas is recommended.

Recommendations

As indicated in earlier sections, the Equations 3 through 7 have been tested against hundreds of test data sets and found to be suitable. The only principal difference here and in other similar diaphragm systems is the attaching method. The Hilti fastener strength values of Table 2 are recommended for use in the SDI formulas.

1. Booster Level. It is recommended that booster level be selected such that the dimension H in Figure 1 be maintained between 1/4 and 5/16 inches or about 7mm. Whether the fastener then penetrates the structural steel, or not, is of no consequence since strength Q_f is controlled by sheet bearing on the fastener shank for the 18 to 22 gage thickness range.
2. Edge Distance. The best practice for driving fasteners at side laps is to keep them away from the leading edge of the sheet. These tests were conducted with fasteners centered at an average 5/16 inches from the leading edge and one inch from sheet ends along the spanning direction.

3. Factor of Safety. These fasteners fall within the mechanical type presented by the SDI. Quality control is relatively easy compared say to welds. Thus

   Design Shears $S = S_u/SF$

   Where $SF = 2.35$

4. Design Tables. Allowable shear values are dependent on the fastener layout and not on deck profile. Thus the attached load tables are for narrow, intermediate, or wide rib decks providing that edge and end distances can be met for fastener installation.

Respectfully submitted,

L.D. Luttrell, Ph.D., P.E.
Professor, Structural Engineer

HILTI Diaphragm Test No. 1

This diaphragm was fabricated using nominal 22 gage - 36" cover width panels on a 16' x 20' test frame as shown in Figure 5. The system was assembled using Hilti fasteners at all structural supports and No. 12 TEKS as stitch screws. Typical layouts and data reductions are given on the following three pages.

Data:

Coated Panel Thickness:	t_c	= 0.031"
Gage Metal Thickness:	t	= 0.0295
ENP2-21L15 Strength:	Q_f	= 1594 lbs.
TEKS No. 12 Stitch Screw:	Q_s	= 560 lbs.
Test Shear Strength:	S_o	= 840 lbs/ft.
Predicted Shear Strength:	S_u	= 816 lbs/ft.

Comments: During the early part of the test, a support roller was found to be misaligned. The system was unloaded, realignment made, and the test continued. G' is plotted relative to the "new origin" and near the "reload" curve. The diaphragm performance was quite close to that predicted by the SDI Formulas with reference both to strength (S_u) and stiffness (G'). Driven fasteners at panel sidelaps were placed such that the washer edges were not overhanging the upper panel edge at the sidelaps. Strength was limited by sheet yielding around fasteners. No fastener failed in shear and none were "torn out" due to being too close to panel edges or ends.

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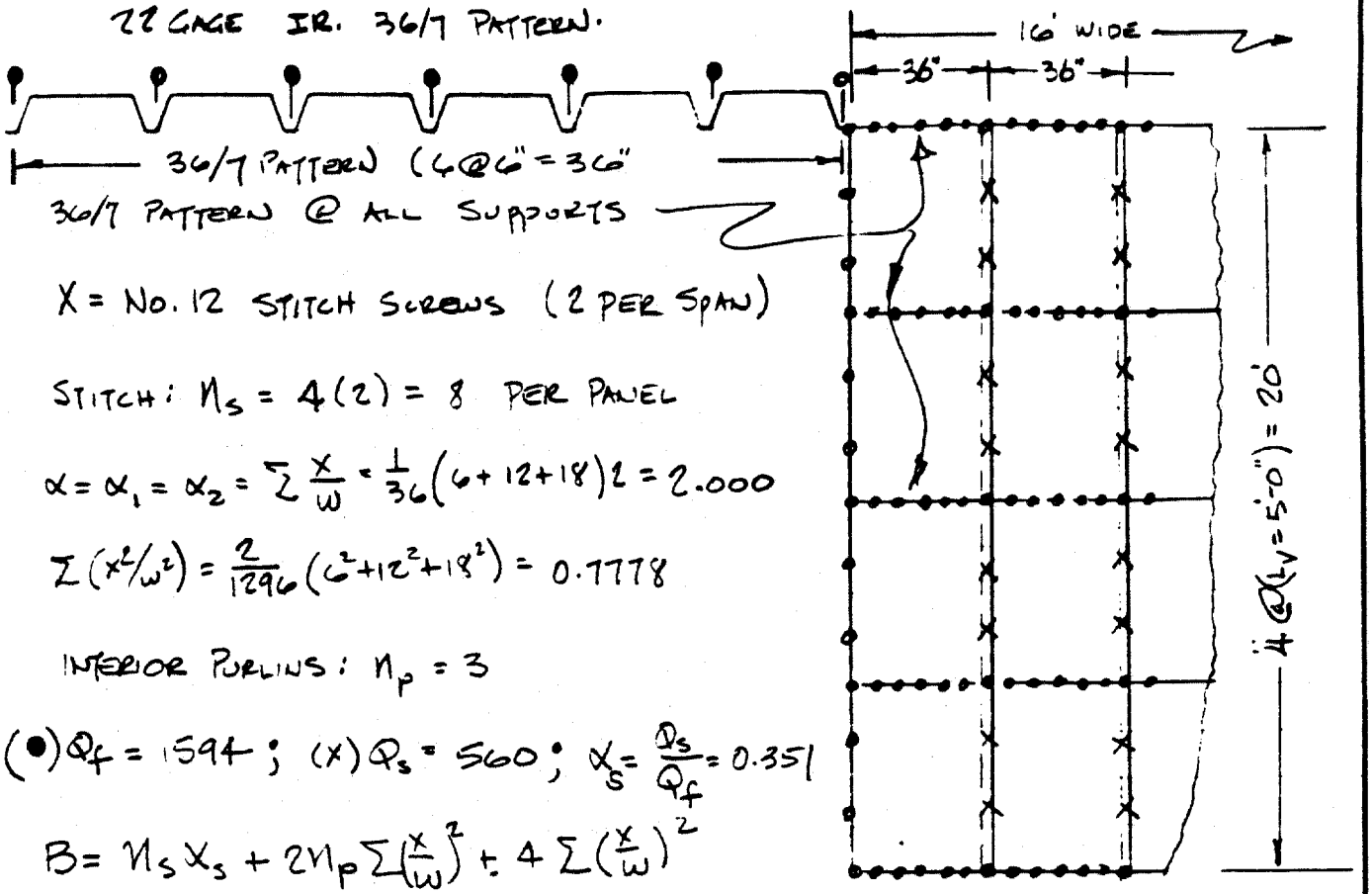
JOB #1 DIAPHRAGM TEST 1/8"
SHEET NO 1 OF 3
CALCULATED BY L.D.L. DATE
CHECKED BY DATE
SCALE NONE

TEST No. 1

22 GAGE IR. 36/7 PATTERN.



X = No. 12 STITCH SCREWS (2 PER SPAN)

STITCH: $N_s = 4(2) = 8$ PER PANEL

$\alpha = \alpha_1 = \alpha_2 = \sum \frac{x}{w} = \frac{1}{36}(6+12+18)2 = 2.000$

$\sum (x^2/w^2) = \frac{2}{1296}(6^2+12^2+18^2) = 0.7778$

INTERIOR PURLINS: $N_p = 3$

(•) $Q_f = 1594$; (X) $Q_s = 560$; $X_s = \frac{Q_s}{Q_f} = 0.351$

$B = N_s X_s + 2N_p \sum \left(\frac{x}{w}\right)^2 + 4 \sum \left(\frac{x}{w}\right)^2$

$= 8(0.351) + (6+4)(0.7778) = 10.586$

$\lambda_1 = 1/\left[1 + (L_v/135)^2\right]$ WHERE $L_v = 60'$; $\lambda_1 = 0.835$

THEN $S_u = \left[2(\lambda_1 - 1) + B\right] Q_f / L =$

$= \left[2(0.835-1) + 10.586\right](1594/20) = 817$ lbs/FT

OBSERVED $S_o = 16800$ lbs $/ 20' = 840$ lbs/FT.

CHECK: $S_u = Q_f N B / (B^2 + N^2 L^2)^{0.5}$ WITH $N = 2$ PER FOOT
$L = 20'$

$S_u = 1594(2)(10.586)/41.373 = 816$ lbs FT <CK>

$S_o / S_u = 840/816 = 1.03$

3% ABOVE EXPECTED

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JOB [illegible]
SHEET NO. 2 OF 3
CALCULATED BY LDL DATE
CHECKED BY DATE
SCALE NONE

STIFFNESS CALCULATIONS ($t = 0.0295$")

$$G' = \frac{Et}{3.78 + D_n\lambda + C} = \frac{870}{12.82 + C}$$

WHERE $\lambda = 0.8$ (4 SPANS); $D_n = 27.2/12(20) = 11.30$; $L = 20'$ (SEE PAGES 12 & 13)

$$C = 12K_1L = 240K_1; \quad K_1 = \frac{2Et S_f/w}{2\alpha_1 + n_p\alpha_2 + 2n_s(S_f/S_s)}$$

$$S_f = (2300t^2 - 340t + 15)10^{-3} = 6.97 \times 10^{-3} \text{ in/k.}$$

$S_s = 33 \times 10^{-3}$ in./k. (SEE PAGE 6); $n_s = 8$; $n_p = 3$

$\alpha_1 = \alpha_2 = 2.000$ (SEE 36/7 PATTERN ON PAGE 29)

$$K_1 = \frac{2(29500)(0.0295)(6.97 \times 10^{-3})/36}{5(2) + 2(8)(0.211)} = 0.0252$$

$$G' = \frac{870}{12.82 + 240(0.0252)} = 46.1 \text{ K/in}$$

NOTE: IN COMPUTER TABLES, THE DECK LENGTH IS PRESUMED FOR THE TYPICAL "3 OR MORE SPANS" CASE TO BE $L = 3$(SPAN LENGTH). THEN:

$$G': GP = \frac{870}{3.78 + 0.3\,D/\text{SPAN} + 3(K1)\,\text{SPAN}}$$

WHERE D IS USED AS: D = DNW FOR W.R. DECK
= DNI FOR I.R. DECK
= DNN FOR N.R. DECK

K1 IS LISTED WITH 12" UNITS INCLUDED.

SEE PAGE 32 FOR TYPICAL LISTINGS

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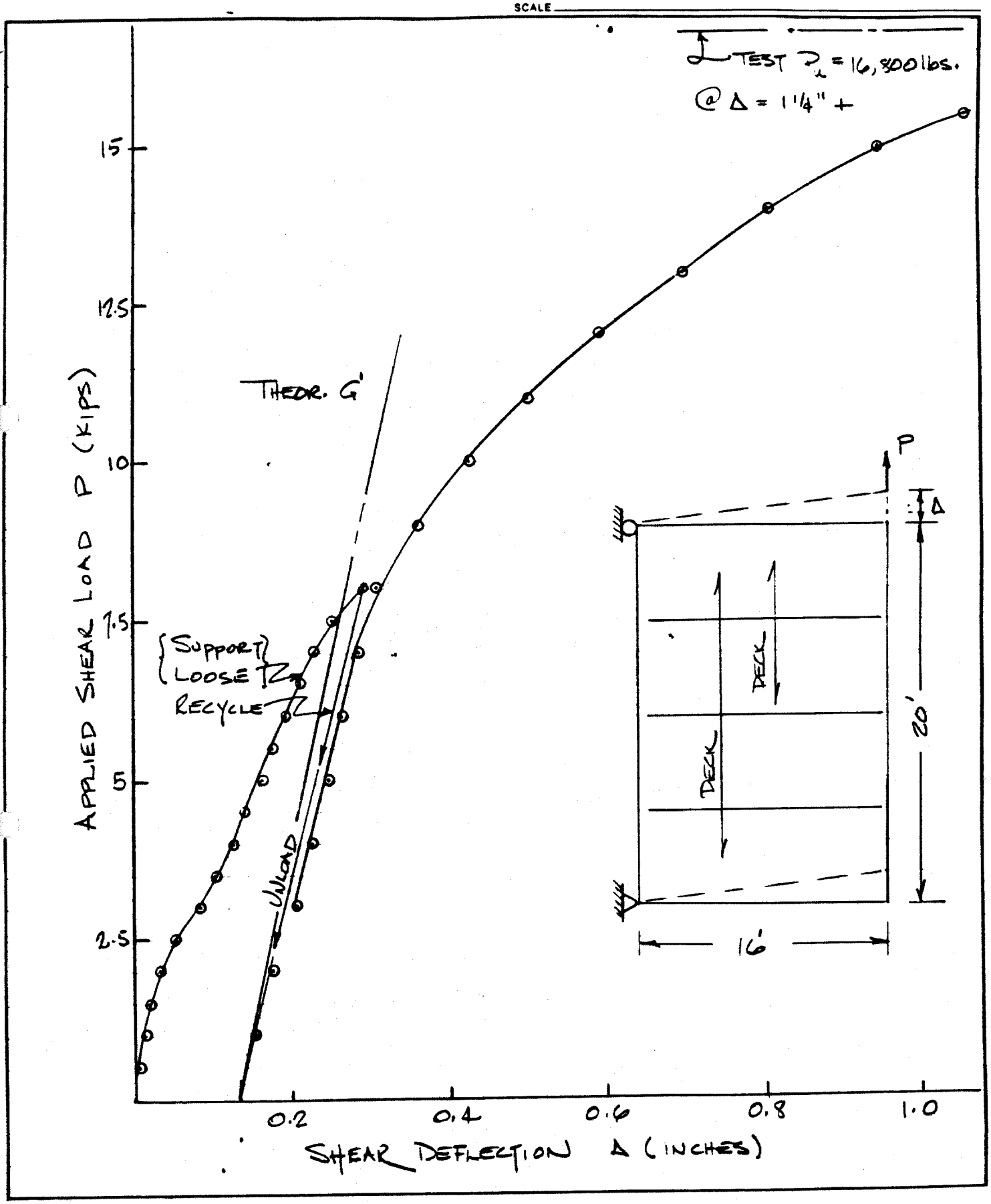
JOB

SHEET NO 3 OF 3

CALCULATED BY DATE

CHECKED BY DATE

SCALE



HILTI Diaphragm Test No. 2

This diaphragm was assembled using nominal 20 gage - 36" cover width Intermediate Rib Panels on a 16' x 20' test frame. Hilti ENP2-21L15 fasteners were used at all panel-to-frame connections and No. 12 TEKS were used as stitch connectors. Test results and data evaluations are presented on the following three pages.

Data:	Coated Panel Thickness:	t_c = 0.0367"
	Gage Metal Thickness:	t = 0.0352"
	ENP2-21L15 Strength:	Q_f = 1859 lbs.
	No. 12 TEKS Strength:	Q_s = 747 lbs.
	Test Shear Strength:	S_o = 1014 lbs/ft.
	Predicted Shear Strength:	S_u = 907 lbs/ft.

Comments: Hilti fasteners at panel sidelaps were driven at an angle of about 10° off the vertical letting the washer set slightly into the radius at the deck web. Strength was limited by yielding around connectors along a sidelap. It was found on the lap that one Hilti fastener had failed across its diameter apparently having been damaged during installation. The strength S_o was, non-the-less, some 11% greater than expected.

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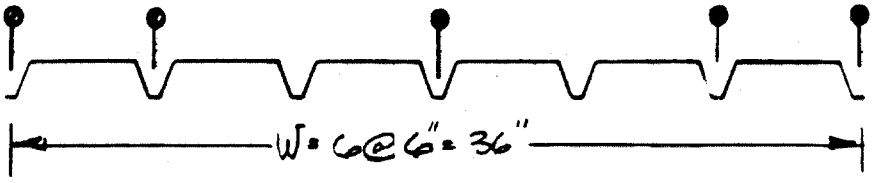
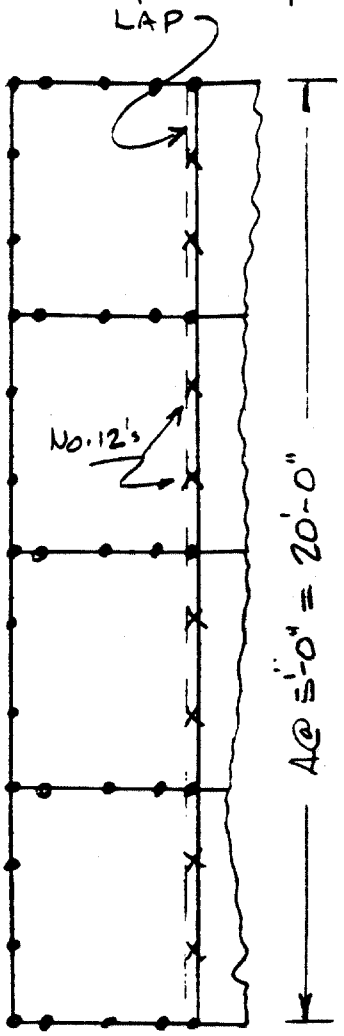
JOB HILTI DIAPHRAGM No 2.
SHEET NO 1 OF 3
CALCULATED BY LDL DATE
CHECKED BY DATE
SCALE

TEST No. 2

20 GAGE, 36/5 PATTERN AT ALL SUPPORTS.





$\alpha_s = Q_s/Q_f = 747/1859 = 0.402$; $n_p = 3$

$n_s = A(2) = 8$; $n_s x_s = 3.216$;

$\alpha_1 = \alpha_2 = \frac{1}{w}(2)(12+18) = 1.667$ <SEE 36/5 PAT. p 29>

$\Sigma(x/w)^2 = \frac{1}{(36)^2}(2)(12^2+18^2) = 0.722$

$B = n_s x_s + \Sigma(\frac{x}{w})^2(2n_p + 4) = 10.436$

$\lambda_1 = 1/[1 + (60/135)^2] = 0.835$

$S_u = [2(\lambda_1 - 1) + B]\, Q_f/L = 10.106\,(1859/20) = 939\ ^{\#}/_{FT}$

$P_u = 20 S_u = 18789$ lbs ($P_o = 20280$ lbs)

CHECK: $S_u = Q_f N B / (B^2 + N^2 L^2)^{0.5}$ {WHERE $N = 4/3 = 1.333$ THE AVG. NO. OF SUPPORT CONN/FT.}

THEN: $S_u = 1859\,(4/3)(10.436/28.517 = 907$ lbs/FT.

THEOR $P_u = 907\,(20) = 18,140$ lbs

$P_o/P_u = 1.12$

12% ABOVE EXPECTED VALUE

SEE PAGE 34 FOR SIMILAR 3 SPAN LISTING.
$n = 2$ <$t = 0.0358$> SPAN = 5'-0" $S = 400$ PLF
EXPECT $P_u = SF(400)L = 2.35\,(400)(20) =$ 18800 lbs

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JOB HILTI DIAPHRAGM NO 2
SHEET NO 2 OF 3
CALCULATED BY LR DATE
CHECKED BY DATE
SCALE NONE

STIFFNESS CALCULATIONS.

$t = 0.0352''$

$$G' = \frac{Et}{3.78 + D_n\lambda + 12(K_1)L} = \frac{1038}{3.78 + D_n\lambda + 240\,K_1}$$

FROM PREVIOUS PAGE (2/6)ths OF THE PANEL WARPS WITH D_1 CONSTANTS & (4/6)ths WITH D_2. THUS.

$$D = \frac{2}{6}D_1 + \frac{4}{6}D_2 = \frac{1}{6}(2\times 2028 + 4\times 10913) = 7951 \quad \langle \text{SEE p 3} \rangle$$

$\lambda = 0.8$ (FOUR SPAN); $D_n\lambda = 0.8(7951/12L) = 26.5$

$$K_1 = \frac{2(29500)(0.0352)(5.88\times10^{-3})/36}{(2+n_p)(1.667) + 2(8)(0.218)} = 0.0287$$

WHERE $S_f = 5.88\times10^{-3}$ & $S_s = 27\times10^{-3}$

THEN $G' = \dfrac{1038}{3.78 + 26.5 + 240(0.0287)} = 27.92\ K/in.$

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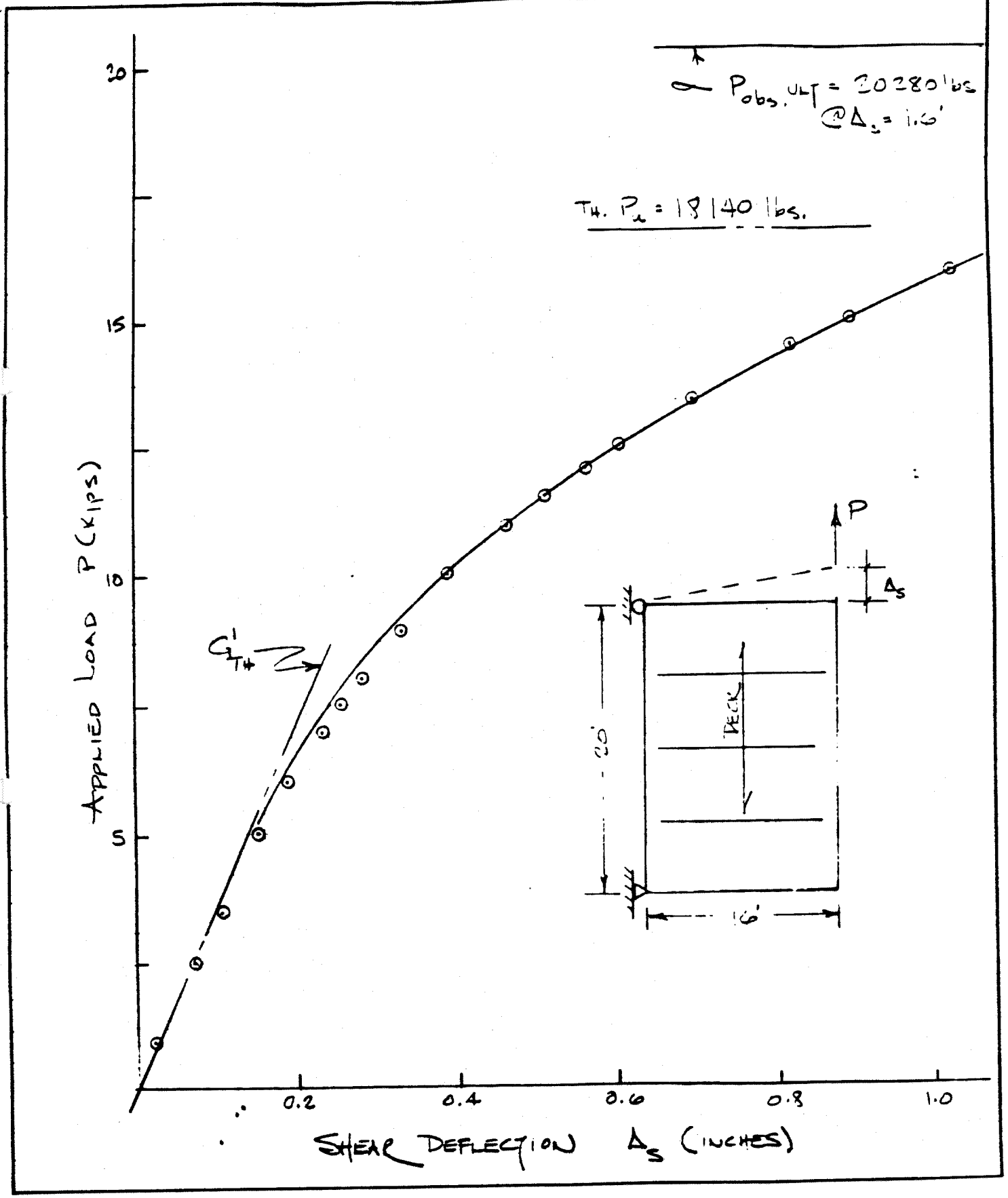
JOB Hi-Fi DIAPHRAGM TEST No. 2
SHEET NO 3 OF 3
CALCULATED BY LDL DATE
CHECKED BY DATE
SCALE



HILTI Diaphragm Test No. 3

This diaphragm was fabricated using 18 gage Intermediate Rib Panels having a 36" cover width. The 20' long panels were assembled over a set of 6'-8" spans as shown in the following three pages. To check the SDI formulas against more general stitch connector data, TEKS No. 14 stitch screws were used in instead of No. 12 TEKS. SDI fastener strengths are reported for No. 12 TEKS on page 6 of this report.

Data:	Gage Metal Thickness:	t = 0.0462"
	ENP2-21L15 Strength:	Q_f = 2345 lbs.
	TEKS No. 12 Strength:	Q_s = 1400 lbs.
	Test Shear Strength:	S_o = 1162 lbs/ft.
	Predicted Shear Strength:	S_u = 1298 lbs/ft.

Comments: The ultimate strength was limited by stitch screw strength along the sidelaps. No Hilti connector failures were observed. The observed strength S_o was slightly below that expected but well within test scatter ranges expected.

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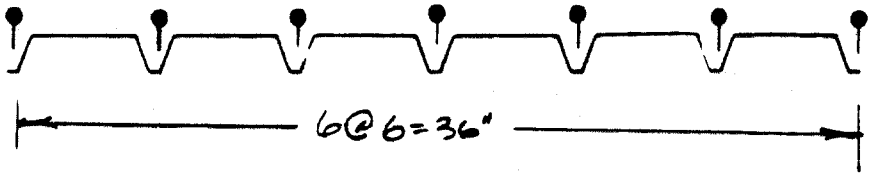
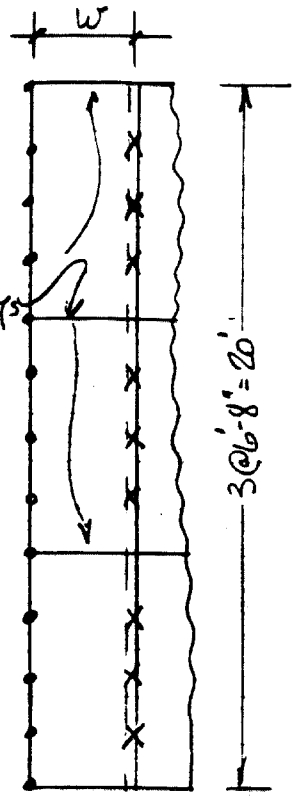
JOB HILTI EXPERIMENT No. 3
SHEET NO. 1 OF 3
CALCULATED BY LDL DATE
CHECKED BY DATE
SCALE

TEST No. 3. (18 GAGE)

18GA 36/7 CONN. PATTERN





STITCH SCREWS No. 14 $Q_s = 1400$ (SEE pg 6)
$Q_f = 2345$

<SEE TEST No. 1 & PAGE 29.>

$\alpha = 2.000$; $\Sigma (x/w)^2 = 0.7778$

$n_s = 3(3) = 9$; $\alpha_s = Q_s/Q_f = 0.597$

$n_p = 2$; $n_s \alpha_s + (2n_p + 4)\Sigma x^2/w^2 = 11.595 = B$

$1/[1 + (4/135)^2] = 0.740$ THEN

$S_u = [2(0.740 - 1) + 11.595]\,2345/20$

$= 25970/20 = 1298$ lbs/FT.

$S_u = Q_f N B/(B^2 + N^2 L^2)^{0.5}$ WHERE WITH, 6" SPACING, N = 2

$= 2345\,(2)(11.595)/(41.64) = 1306$ lbs/FT

$P_{ut} = 25960$ lbs $\qquad P_{uo} = 23242$ lbs

COMPUTER LISTING ON PAGE 33.
< FOR NO. 12 STITCH SCREWS >

SPAN	S (PLF)	
6.5	509	
6'-8"	496	INTERPOLATE
7.0	470	

WITH 2.35 S.F., $P_u = 2.35(496)(20') = 23312$ lbs.

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JOB HILTI DIAPHRAGM NO.3
SHEET NO. 2 OF 3
CALCULATED BY _____ DATE _____
CHECKED BY LDL DATE _____
SCALE _____

STIFFNESS CALCULATIONS ($t = 0.0462''$)

$$G' = \frac{Et}{3.78 + D_n\lambda + 12K_1L} = \frac{1363}{3.78 + 0.9D_n + 240K_1}$$

WHERE $D_1 = 1331$ & $D_n = 1331/12(20) = 5.55$

$\lambda = 0.9$ FOR THREE SPANS.

$S_f = 4.2 \times 10^{-3}$ $\quad S_s \approx 20 \times 10^{-3}$ $\quad S_f/S_s = 0.21$

$$K_1 = \frac{2(29500)(0.0462)(4.2\times10^{-3})/36}{(2+N_p)(2) + 2(9)(0.21)} = 0.0270$$

$$G' = \frac{1363}{3.78 + 5.00 + 6.48} = 89.3 \text{ k/in}$$

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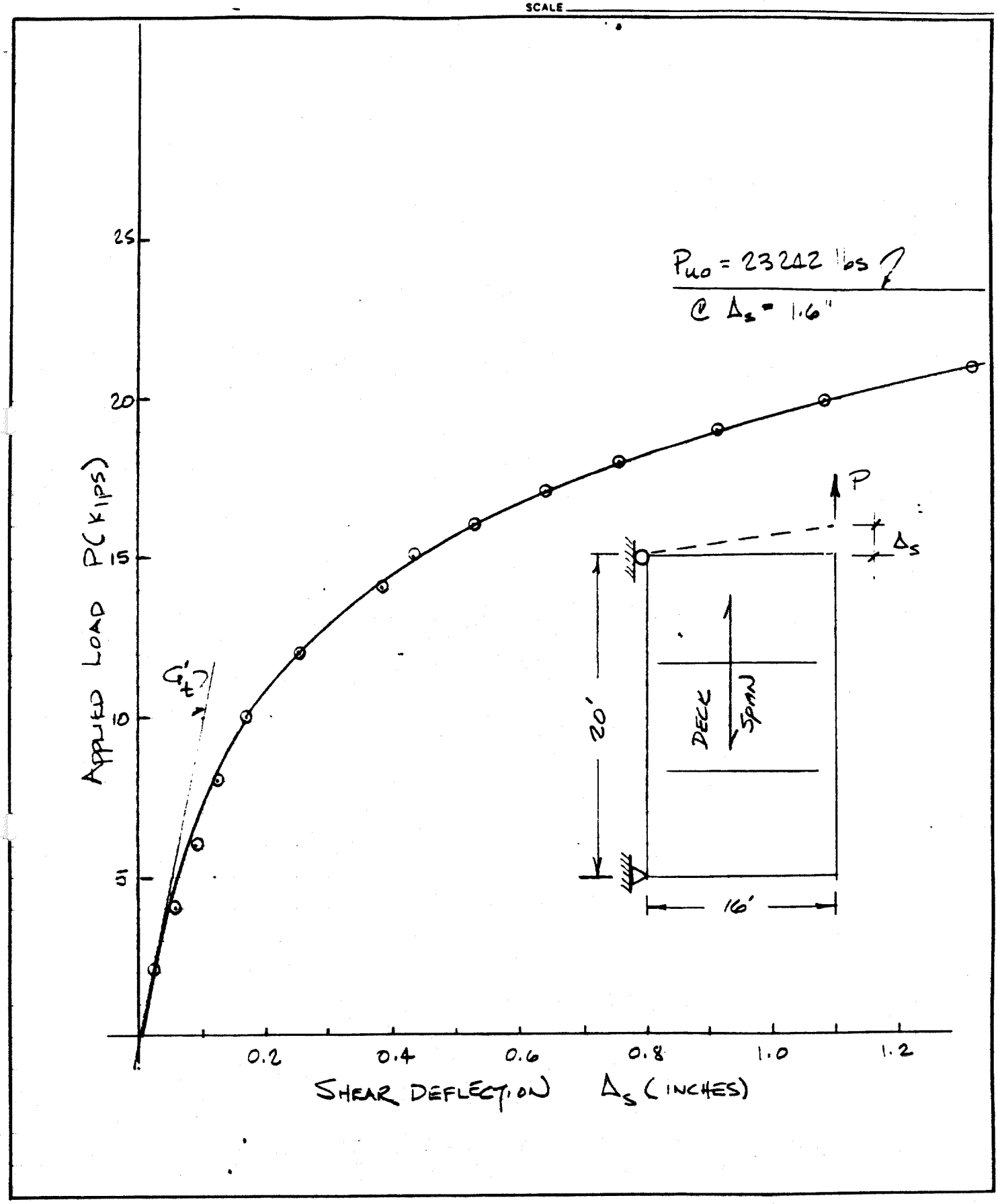
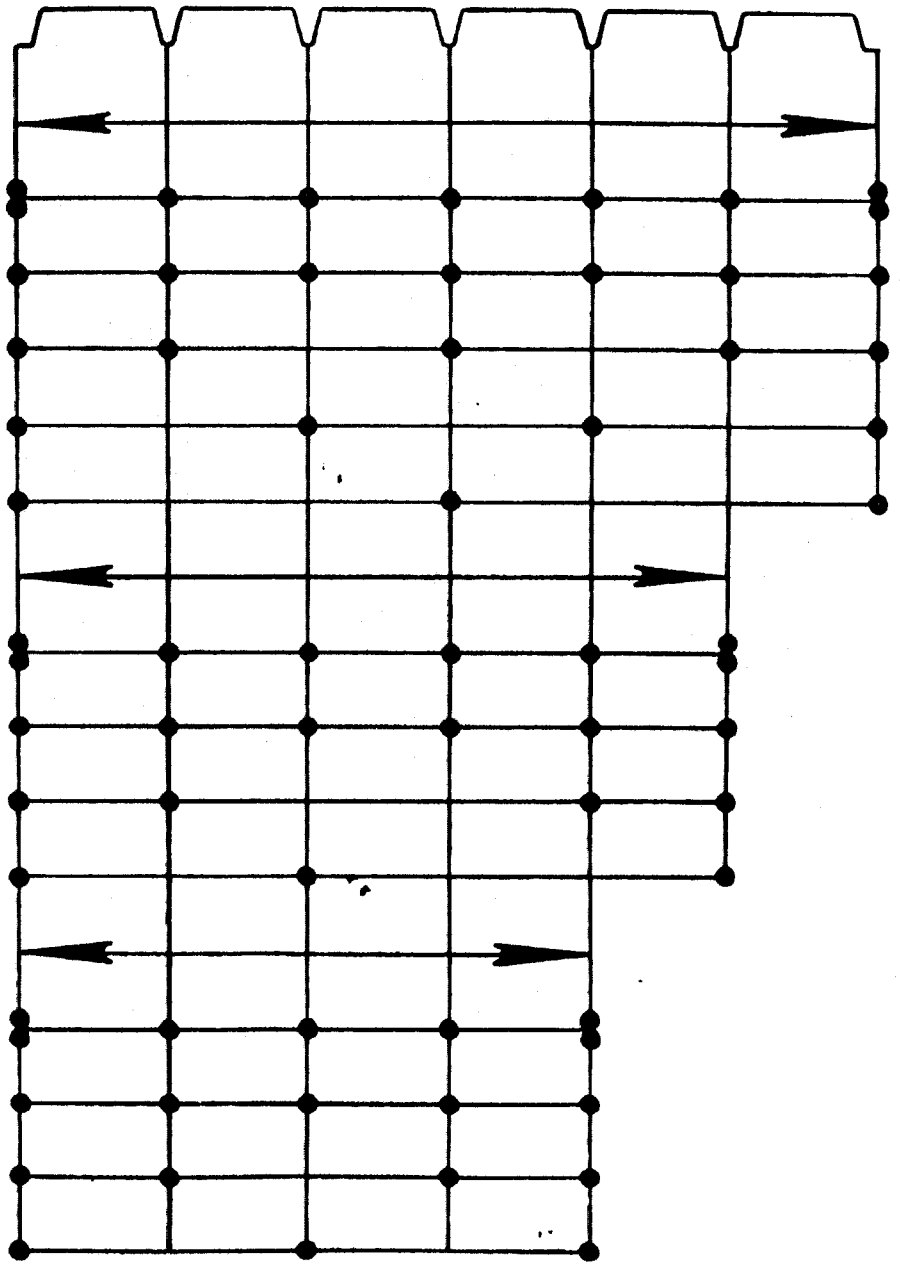
JOB HILTI DIAPHRAGM V1 S
SHEET NO 3 OF 3
CALCULATED BY ____ DATE ____
CHECKED BY LDL DATE ____
SCALE ____





	$\alpha = \Sigma(\frac{x}{w})$	$\Sigma (\frac{x}{w})^2$
A. 36" cover width		
1. 36/9 pattern	3.000	1.2778
2. 36/7 pattern	2.000	0.7778
3. 36/5 pattern	1.667	0.7222
4. 36/4 pattern	1.333	0.5556
5. 36/3 pattern	1.000	0.5000
B. 30" cover width		
1. 30/8 pattern	2.800	1.2000
2. 30/6 pattern	1.800	0.7000
3. 30/4 pattern	1.600	0.6800
4. 30/3 pattern	1.100	0.5100
C. 24" cover width		
1. 24/7 pattern	2.500	1.125
2. 24/5 pattern	1.500	0.625
3. 24/4 pattern	1.500	0.625
4. 24/3 pattern	1.000	0.500

Fastener Patterns at Supports

The following pages contain load tables developed following the Steel Deck Institute Standards and the studies developed in this report.

L.D.L.

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/9 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT)									
NO. OF STITCH CONNS./SPAN	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	420.	378.	342.	312.	286.	263.	244.	227.	211.	0.33843
1.	468.	421.	382.	348.	320.	295.	274.	255.	238.	0.30598
2.	513.	464.	421.	385.	354.	327.	303.	283.	264.	0.27921
3.	553.	508.	461.	422.	388.	359.	333.	311.	291.	0.25674
4.	591.	544.	501.	458.	422.	391.	363.	339.	317.	0.23762

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/9 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT)									
NO. OF STITCH CONNS./SPAN	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	504.	453.	410.	374.	343.	316.	293.	272.	254.	0.34030
1.	568.	511.	463.	423.	388.	359.	332.	309.	289.	0.30729
2.	627.	569.	516.	472.	434.	401.	372.	347.	324.	0.28012
3.	679.	624.	569.	521.	479.	443.	412.	384.	360.	0.25737
4.	729.	672.	622.	570.	525.	486.	452.	422.	395.	0.23803

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/9 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT)									
NO. OF STITCH CONNS./SPAN	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	636.	572.	518.	472.	433.	399.	369.	343.	320.	0.31850
1.	730.	657.	596.	544.	500.	461.	428.	398.	372.	0.28889
2.	813.	742.	674.	616.	566.	524.	486.	453.	424.	0.26432
3.	888.	818.	752.	688.	633.	586.	545.	508.	476.	0.24360
4.	961.	886.	822.	760.	700.	648.	603.	563.	528.	0.22589

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT)									
NO. OF STITCH CONNS./SPAN	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	259.	233.	212.	193.	178.	164.	152.	142.	133.	0.50765
1.	307.	276.	251.	230.	212.	196.	182.	170.	159.	0.43797
2.	354.	320.	291.	267.	246.	228.	212.	198.	186.	0.38511
3.	397.	363.	331.	303.	280.	260.	242.	226.	212.	0.34364
4.	438.	402.	371.	340.	314.	291.	272.	254.	239.	0.31023

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	311.	280.	254.	232.	213.	197.	183.	170.	159.	0.51045
1.	374.	338.	307.	281.	259.	240.	223.	208.	195.	0.43962
2.	438.	395.	360.	330.	304.	282.	262.	245.	230.	0.38605
3.	493.	452.	413.	379.	350.	324.	302.	283.	265.	0.34412
4.	547.	502.	464.	428.	395.	367.	342.	320.	301.	0.31041

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	392.	353.	320.	293.	269.	249.	231.	215.	201.	0.47775
1.	486.	438.	398.	365.	336.	311.	289.	270.	253.	0.41409
2.	576.	523.	476.	437.	403.	373.	348.	325.	305.	0.36539
3.	656.	602.	554.	509.	470.	436.	406.	380.	357.	0.32695
4.	733.	675.	624.	580.	537.	498.	465.	435.	409.	0.29582

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	239.	215.	195.	178.	164.	151.	140.	131.	122.	0.60916
1.	285.	259.	235.	215.	198.	183.	170.	159.	148.	0.51151
2.	325.	299.	275.	252.	232.	215.	200.	187	175.	0.44084
3.	362.	334.	310.	288.	266.	247.	230.	215.	201.	0.38733
4.	397.	367.	341.	319.	299.	278.	259.	243.	228.	0.34540

DNW= 758. DNI= 886. DNN= 974. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	287.	258.	234.	214.	197.	181.	168.	157.	146.	0.61253
1.	348.	316.	287.	263.	242.	224.	208.	194.	182.	0.51329
2.	400.	368.	340.	312.	287.	266.	248.	231.	217.	0.44173
3.	448.	414.	384.	358.	333.	309.	287.	269.	252	0.38768
4.	494.	458.	426.	398.	373.	351.	327.	306.	288.	0.34541

DNW= 567. DNI= 663. DNN= 728. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	362.	326.	296.	270.	248.	229.	212.	198.	185.	0.57329
1.	450.	411.	374.	342.	315.	291.	271.	253.	237.	0.48400
2.	525.	484.	448.	414.	382.	354.	329.	308.	289.	0.41877
3.	595.	551.	512.	478.	447.	416.	388.	363.	341.	0.36903
4.	659.	612.	571.	535.	502.	473.	446.	418.	393.	0.32986

DNW= 372. DNI= 435. DNN= 478. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	181.	162.	147.	133.	122.	112.	104.	96.	89.	0.76149
1.	228.	205.	186.	170.	156.	144.	133.	124.	116.	0.61478
2.	266.	245.	226.	207.	190.	176.	163.	152.	142	0.51546
3.	301.	279.	259.	242.	224.	208.	193.	180.	169.	0.44378
4.	333.	310.	289.	271.	254.	239.	223.	208.	195.	0.38959

DNW= 1072. DNI= 1216. DNN= 1282. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	217.	195.	176.	160.	146.	135.	124.	115.	107.	0.76569
1.	279.	252.	229.	209.	192.	177.	164.	153.	143.	0.61666
2.	329.	304.	282.	258.	237.	219.	204.	190.	178.	0.51619
3.	374.	347.	323.	302.	283.	262.	244.	228.	213.	0.44387
4.	416.	387.	362.	340.	319.	301.	283.	265.	249.	0.38933

DNW= 802. DNI= 909. DNN= 959. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	274.	245.	222.	202.	185.	170.	157.	145.	135.	0.71665
1.	363.	331.	300.	274.	252.	232.	215.	201.	187.	0.58234
2.	435.	402.	373.	346.	318.	295.	274.	256.	239.	0.49043
3.	499.	464.	433.	405.	381.	357.	332.	311.	291.	0.42358
4.	556.	520.	487.	458.	432.	408.	386.	366.	343.	0.37276

DNW= 526. DNI= 597. DNN= 630. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	161.	144.	130.	118.	108.	99.	91.	85.	79.	1.01529
1.	199.	184.	170.	155.	142.	131.	121.	113.	105.	0.77022
2.	231.	215.	201.	188.	176.	163.	151.	141.	132.	0.62046
3.	258.	242.	227.	214.	202.	191.	181.	169.	158.	0.51945
4.	281.	266.	251.	237.	225.	214.	203.	194.	185.	0.44673

DNW= 2209. DNI= 2428. DNN= 2442. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	194.	173.	156.	142.	130.	119.	110.	102.	94.	1.02090
1.	244.	226.	209.	191.	175.	161.	149.	139.	130.	0.77211
2.	285.	266.	249.	233.	220.	204.	189.	176.	165.	0.62082
3.	320.	300.	283.	267.	252.	239.	227.	214.	200.	0.51910
4.	349.	330.	312.	296.	281.	267.	255.	243.	232.	0.44602

DNW= 1652. DNI= 1816. DNN= 1827. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT)									
NO. OF STITCH CONNS./SPAN	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	244.	219.	197.	179.	164.	150.	138.	128.	119.	0.95550
1.	316.	294.	273.	251.	230.	213.	197.	183.	171.	0.73079
2.	375.	350.	329.	309.	291.	275.	255.	238.	223.	0.59164
3.	423.	398.	376.	356.	337.	320.	304.	290.	275.	0.49701
4.	462.	438.	416.	396.	377.	359.	343.	328.	314.	0.42848

DNW= 1084. DNI= 1192. DNN= 1199. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/8 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT)									
NO. OF STITCH CONNS./SPAN	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	393.	353.	319.	291.	266.	245.	227.	211.	196.	0.43512
1.	441.	396.	359.	327.	300.	277.	257.	239.	223.	0.39072
2.	488.	439.	399.	364.	334.	309.	286.	267.	249.	0.35455
3.	532.	483.	438.	401.	368.	340.	316.	295.	276.	0.32450
4.	571.	525.	478.	437.	402.	372.	346.	323.	302.	0.29915

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/8 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	471.	423.	383.	349.	320.	294.	272.	253.	236.	0.43753
1.	535.	481.	436.	398.	365.	337.	312.	290.	271.	0.39237
2.	599.	539.	489.	447.	410.	379.	352.	328.	306.	0.35567
3.	654.	597.	542.	496.	456.	421.	391.	365.	341.	0.32524
4.	706.	650.	595.	544.	501.	464.	431.	402.	377.	0.29961

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/8 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	595.	534.	483.	440.	403.	371.	343.	319.	297.	0.40950
1.	688.	619.	561.	512.	470.	434.	402.	374.	349.	0.36898
2.	781.	704.	639.	584.	537.	496.	460.	429.	401.	0.33576
3.	858.	789.	717.	656.	604.	558.	519.	484.	453.	0.30802
4.	933.	860.	795.	728.	671.	621.	577.	539.	505.	0.28452

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/6 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	232.	208.	189.	172.	158.	146.	135.	126.	118.	0.67686
1.	279.	252.	229.	209.	192.	178.	165.	154.	144.	0.57519
2.	327.	295.	268.	246.	226.	210.	195.	182.	171.	0.50007
3.	373.	338.	308.	282.	260.	241.	225.	210.	197.	0.44231
4.	415.	380.	348.	319.	294.	273.	255.	238.	224.	0.39650

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/6 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	278.	250.	227.	207.	190.	175.	162.	151.	141.	0.68060
1.	342.	308.	280.	256.	235.	218.	202.	189.	177.	0.57726
2.	405.	366.	333.	305.	281.	260.	242.	226.	212.	0.50117
3.	465.	423.	386.	354.	326.	302.	282.	263.	247.	0.44280
4.	519.	476.	439.	402.	372.	345.	321.	301.	282.	0.39661

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/6 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	351.	315.	286.	261.	240.	221.	205.	191.	178.	0.63700
1.	444.	400.	364.	333.	306.	283.	263.	246.	230.	0.54406
2.	538.	486.	442.	405.	373.	346.	322.	301.	282.	0.47478
3.	621.	569.	520.	477.	440.	408.	380.	356.	334.	0.42116
4.	700.	643.	594.	549.	507.	471.	439.	411.	386.	0.37842

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	225.	202.	183.	167.	153.	141.	131.	122.	114.	0.76147
1.	270.	245.	223.	204.	187.	173.	161.	150.	140.	0.63516
2.	308.	284.	262.	240.	221.	205.	191.	178.	167.	0.54479
3.	344.	318.	295.	275.	255.	237.	220.	206.	193.	0.47693
4.	378.	350.	326.	305.	286.	268.	250.	234.	220.	0.42411

DNW= 1377. DNI= 1547. DNN= 1608. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	269.	242.	220.	200.	184.	170.	157.	146.	137.	0.76567
1.	329.	300.	273.	249.	229.	212.	197.	184.	172.	0.63732
2.	380.	350.	324.	298.	275.	254.	237.	221.	207.	0.54583
3.	427.	395.	367.	343.	320.	297.	276.	258.	242.	0.47730
4.	470.	437.	407.	381.	358.	337.	316.	296.	278.	0.42406

DNW= 1030. DNI= 1157. DNN= 1202. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	340.	306.	277.	253.	232.	214.	198.	184.	172.	0.71663
1.	426.	391.	355.	325.	299.	276.	257.	240.	224.	0.60110
2.	499.	461.	427.	397.	366.	339.	315.	295.	276.	0.51765
3.	566.	525.	489.	457.	429.	401.	374.	350.	328.	0.45455
4.	627.	584.	546.	512.	482.	454.	430.	405.	380.	0.40516

DNW= 676. DNI= 760. DNN= 789. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	165.	148.	133.	121.	111.	101.	94.	87.	81.	1.10759
1.	208.	191.	173.	158.	145.	133.	123.	115.	107.	0.85909
2.	244.	226.	210.	194.	179.	165.	153.	143.	134.	0.70167
3.	275.	256.	239.	224.	211.	197.	183.	171.	160.	0.59300
4.	303.	284.	266.	250.	236.	223.	212.	199.	186.	0.51348

DNW= 1754. DNI= 1943. DNN= 1978. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	198.	177.	160.	145.	133.	122.	112.	104.	97.	1.11370
1.	255.	235.	213.	194.	178.	164.	152.	141.	132.	0.86138
2.	301.	279.	260.	243.	223.	207.	192.	179.	167.	0.70227
3.	342.	319.	298.	280.	264.	249.	232.	216.	203.	0.59278
4.	377.	354.	333.	314.	296.	281.	266.	253.	238.	0.51282

DNW= 1312. DNI= 1453. DNN= 1480. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	249.	223.	202.	183.	167.	154.	142.	131.	122.	1.04237
1.	332.	306.	280.	255.	234.	216.	200.	186.	174.	0.81464
2.	398.	370.	345.	323.	301.	278.	259.	241.	226.	0.66857
3.	454.	425.	399.	375.	354.	334.	317.	296.	278.	0.56692
4.	502.	473.	446.	422.	399.	379.	360.	343.	327.	0.49211

DNW= 861. DNI= 954. DNN= 971. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	366.	329.	297.	270.	247.	228.	210.	195.	182.	0.60917
1.	414.	372.	337.	307.	281.	259.	240.	223.	208.	0.54040
2.	462.	415.	377.	344.	316.	291.	270.	251.	235.	0.48557
3.	509.	459.	416.	380.	350.	323.	300.	279.	261.	0.44085
4.	552.	502.	456.	417.	384.	355.	329.	307.	288.	0.40367

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	440.	394.	357.	324.	297.	273.	252.	234.	218.	0.61254
1.	503.	452.	410.	373.	342.	316.	292.	272.	253.	0.54260
2.	567.	510.	463.	422.	388.	358.	332.	309.	289.	0.48700
3.	631.	568.	516.	471.	433.	400.	372.	346.	324.	0.44173
4.	684.	626.	569.	520.	479.	443.	411.	384.	359.	0.40417

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	555.	498.	450.	409.	375.	345.	318.	295.	275.	0.57330
1.	648.	583.	528.	481.	441.	407.	377.	350.	327.	0.51051
2.	742.	668.	606.	553.	508.	469.	435.	405.	379.	0.46011
3.	830.	753.	684.	625.	575.	532.	494.	461.	431.	0.41877
4.	907.	834.	762.	697.	642.	594.	552.	516.	483.	0.38425

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE / NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	205.	184.	167.	152.	139.	128.	119.	110.	103.	1.01529
1.	253.	228.	207.	189.	173.	160.	149.	138.	129.	0.83762
2.	301.	271.	246.	225.	208.	192.	178.	167.	156.	0.71286
3.	348.	314.	286.	262.	242.	224.	208.	195.	182.	0.62046
4.	392.	358.	326.	299.	276.	256.	238.	223.	209.	0.54926

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE / NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	246.	221.	200.	183.	167.	154.	143.	133.	124.	1.02090
1.	310.	279.	253.	231.	213.	197.	182.	170.	159.	0.84037
2.	373.	337.	306.	280.	258.	239.	222.	207.	194.	0.71410
3.	437.	395.	359.	329.	304.	281.	262.	245.	230.	0.62082
4.	492.	451.	412.	378.	349.	324.	302.	282.	265.	0.54909

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS./LIN.FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	311.	279.	253.	230.	211.	194.	180.	167.	156.	0.95550
1.	404.	364.	331.	302.	278.	257.	238.	222.	208.	0.79295
2.	498.	449.	409.	374.	345.	319.	297.	277.	260.	0.67766
3.	586.	534.	487.	446.	412.	382.	355.	332.	312.	0.59164
4.	666.	612.	565.	518.	479.	444.	414.	387.	364.	0.52500

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS./LIN.FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	205.	184.	167.	152.	139.	128.	119.	110.	103.	1.01529
1.	253.	228.	207.	189.	173.	160.	149.	138.	129.	0.83762
2.	300.	271.	246.	225.	208.	192.	178.	167.	156.	0.71286
3.	341.	313.	286.	262.	242.	224.	208.	195.	182.	0.62046
4.	379.	349.	323.	299.	276.	256.	238.	223.	209.	0.54926

DNW= 601. DNI= 721. DNN= 819. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT)									
NO. OF STITCH CONNS./SPAN	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	246.	221.	200.	183.	167.	154.	143.	133.	124.	1.02090
1.	310.	279.	253.	231.	213.	197.	182.	170.	159.	0.84037
2.	371.	337.	306.	280.	258.	239.	222.	207.	194.	0.71410
3.	424.	390.	359.	329.	304.	281.	262.	245.	230.	0.62082
4.	475.	438.	406.	378.	349.	324.	302.	282.	265.	0.54909

DNW= 449. DNI= 539. DNN= 613. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT)									
NO. OF STITCH CONNS./SPAN	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	311.	279.	253.	230.	211.	194.	180.	167.	156.	0.95550
1.	404.	364.	331.	302.	278.	257.	238.	222.	208.	0.79295
2.	491.	449.	409.	374.	345.	319.	297.	277.	260.	0.67766
3.	568.	523.	484.	446.	412.	382.	355.	332.	312.	0.59164
4.	639.	591.	548.	511.	479.	444.	414.	387.	364.	0.52500

DNW= 295. DNI= 354. DNN= 402. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	161.	144.	130.	118.	108.	99.	91.	85.	79.	1.52294
1.	209.	188.	170.	155.	142.	131.	121.	113.	105.	1.15533
2.	251.	231.	210.	192.	176.	163.	151.	141.	132.	0.93068
3.	287.	265.	246.	228.	210.	194.	181.	169.	158.	0.77918
4.	320.	297.	277.	259.	243.	226.	211.	197.	185.	0.67009

DNW= 1072. DNI= 1216. DNN= 1282. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	194.	173.	156.	142.	130.	119.	110.	102.	94.	1.53134
1.	257.	231.	209.	191.	175.	161.	149.	139.	130.	1.15816
2.	311.	286.	262.	240.	220.	204.	189.	176.	165.	0.93122
3.	358.	332.	308.	288.	266.	246.	229.	214.	200.	0.77865
4.	401.	373.	348.	326.	306.	289.	269.	251.	236.	0.66903

DNW= 802. DNI= 909. DNN= 959. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

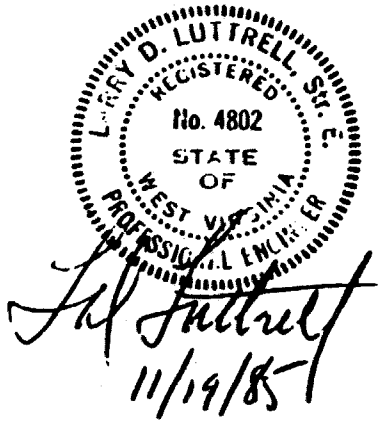
DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.35 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	244.	219.	197.	179.	164.	150.	138.	128.	119.	1.43326
1.	338.	304.	275.	251.	230.	213.	197.	183.	171.	1.09618
2.	413.	381.	353.	323.	297.	275.	255.	238.	223.	0.88747
3.	480.	445.	415.	388.	364.	337.	314.	293.	275.	0.74552
4.	539.	503.	471.	442.	416.	393.	372.	348.	327.	0.64272

DNW= 526. DNI= 597. DNN= 630. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$



DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/9 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	380.	341.	309.	282.	258.	238.	220.	205.	191.	0.33843
1.	423.	380.	345.	315.	289.	267.	247.	230.	215.	0.30598
2.	464.	420.	381.	348.	320.	296.	274.	256.	239.	0.27921
3.	499.	459.	417.	381.	351.	324.	301.	281.	263.	0.25674
4.	534.	492.	453.	414.	381.	353.	328.	306.	287.	0.23762

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/9 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	456.	410.	371.	338.	310.	286.	265.	246.	229.	0.34030
1.	513.	462.	419.	382.	351.	324.	300.	280.	261.	0.30729
2.	566.	514.	467.	427.	392.	362.	336.	313.	293.	0.28012
3.	613.	564.	515.	471.	433.	401.	372.	347.	325.	0.25737
4.	659.	607.	562.	515.	474.	439.	408.	381.	357.	0.23803

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/9 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	575.	517.	468.	427.	391.	360.	334.	310.	289.	0.31850
1.	660.	594.	538.	492.	452.	417.	387.	360.	336.	0.28889
2.	735.	670.	609.	557.	512.	473.	439.	410.	383.	0.26432
3.	803.	739.	679.	622.	572.	530.	492.	459.	430.	0.24360
4.	868.	801.	743.	687.	633.	586.	545.	509.	477.	0.22589

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	234.	211.	191.	175.	161.	148.	138.	128.	120.	0.50765
1.	277.	250.	227.	208.	191.	177.	165.	154.	144.	0.43797
2.	320.	289.	263.	241.	222.	206.	192.	179.	168.	0.38511
3.	359.	328.	299.	274.	253.	235.	219.	204.	192	0.34364
4.	396.	363.	335.	307.	284.	263.	245.	230.	216.	0.31023

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	281.	253.	230.	210.	193.	178.	165.	154.	144.	0.51045
1.	338.	305.	277.	254.	234.	216.	201.	188.	176.	0.43962
2.	395.	357.	325.	298.	275.	255.	237.	222.	208.	0.38605
3.	446.	409.	373.	342.	316.	293.	273.	255.	240.	0.34412
4.	494.	454.	419.	387.	357.	331.	309.	289.	272.	0.31041

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	354.	319.	290.	265.	243.	225.	209.	194.	182.	0.47775
1.	439.	396.	360.	330.	304.	281.	261.	244.	229.	0.41409
2.	520.	473.	431.	395.	364.	338.	314.	294.	276.	0.36539
3.	593.	544.	501.	460.	425.	394.	367.	344.	323.	0.32695
4.	663.	610.	564.	524.	485.	450.	420.	393.	370.	0.29582

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	216.	195.	177.	161.	148.	137.	127.	118.	110.	0.60916
1.	258.	234.	212.	194.	179.	165.	154.	143.	134.	0.51151
2.	293.	270.	248.	227.	210.	194.	181.	169.	158.	0.44084
3.	327.	302.	280.	261.	240.	223.	208.	194.	182.	0.38733
4.	359.	332.	309.	288.	270.	252.	234.	219.	206.	0.34540

DNW= 758. DNI= 886. DNN= 974. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	260.	234.	212.	193.	178.	164.	152.	142.	132.	0.61253
1.	314.	286.	260.	238.	219.	202.	188.	175.	164.	0.51329
2.	361.	333.	308.	282.	260.	241.	224.	209.	196.	0.44173
3.	405.	374.	347.	324.	301.	279.	260.	243.	228.	0.38768
4.	446.	414.	385.	360.	338.	317.	296.	277.	260.	0.34541

DNW= 567. DNI= 663. DNN= 728. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	328.	295.	267.	244.	224.	207.	192.	179.	167.	0.57329
1.	407.	372.	338.	309.	285.	263.	245.	228.	214.	0.48400
2.	475.	437.	405.	374.	345.	320.	298.	278.	261.	0.41877
3.	538.	498.	462.	432.	404.	376.	351.	328.	308.	0.36903
4.	596.	554.	516.	483.	454.	427.	403.	378.	355.	0.32986

DNW= 372. DNI= 435. DNN= 478. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	163.	147.	132.	121.	110.	101.	94.	87.	81.	0.76149
1.	206.	186.	168.	154.	141.	130.	121.	112.	105.	0.61478
2.	240.	222.	204.	187.	172.	159.	148.	138.	129.	0.51546
3.	272.	252.	234.	219.	203.	188.	174.	163.	153.	0.44378
4.	301.	280.	261.	245.	230.	216.	201.	188.	177.	0.38959

DNW= 1072. DNI= 1216. DNN= 1282. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	196.	176.	159.	145.	132.	122.	112.	104.	97.	0.76569
1.	252.	228.	207.	189.	173.	160.	148.	138.	129.	0.61666
2.	297.	274.	254.	233.	214.	198.	184.	172.	161.	0.51619
3.	338.	314.	292.	273.	255.	237.	220.	206.	193.	0.44387
4.	376.	350.	327.	307.	289.	272.	256.	239.	225.	0.38933

DNW= 802. DNI= 909. DNN= 959. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	247.	222.	201.	182.	167.	154.	142.	132.	122.	0.71665
1.	328.	299.	271.	248.	227.	210.	195.	181.	169.	0.58234
2.	393.	363.	337.	313.	288.	266.	248.	231.	216.	0.49043
3.	451.	419.	391.	366.	344.	323.	300.	281.	263.	0.42358
4.	503.	470.	440.	414.	390.	369.	349.	331.	310.	0.37276

DNW= 526. DNI= 597. DNN= 630. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	146.	130.	118.	107.	98.	90.	83.	76.	71.	1.01529
1.	180.	167.	154.	140.	128.	118.	110.	102.	95.	0.77022
2.	209.	194.	182.	170.	159.	147.	136.	127.	119.	0.62046
3.	233.	219.	205.	194.	183.	173.	163.	152	143.	0.51945
4.	254.	240.	227.	214.	203.	193.	184.	175.	167.	0.44673

DNW= 2209. DNI= 2428. DNN= 2442. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 36/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	175.	157.	141.	128.	117.	108.	99.	92.	85.	1.02090
1.	220.	204.	189.	173.	158.	146.	135.	126.	117.	0.77211
2.	257.	240.	225.	211.	198.	184.	171.	159.	149.	0.62082
3.	289.	271.	255.	241.	228.	216.	205.	193.	181.	0.51910
4.	315.	298.	282.	268.	254.	242.	230.	220.	210.	0.44602

DNW= 1652. DNI= 1816. DNN= 1827. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 36/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	221.	198.	178.	162.	148.	136.	125.	116.	108.	0.95550
1.	286.	265.	247.	227.	208.	192.	178.	166.	155.	0.73079
2.	339.	317.	297.	279.	263.	248.	231.	215.	202.	0.59164
3.	382.	360.	340.	321.	305.	289.	275.	262.	249.	0.49701
4.	417.	396.	376.	358.	341.	325.	310.	296.	284.	0.42848

DNW= 1084. DNI= 1192. DNN= 1199. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/8 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	355.	319.	288.	263.	241.	222.	205.	190.	177.	0.43512
1.	398.	358.	324.	296.	271.	250.	232.	216.	201.	0.39072
2.	441.	397.	360.	329.	302.	279.	259.	241.	225.	0.35455
3.	481.	436.	396.	362.	333.	308.	286.	266.	249.	0.32450
4.	516.	475.	432.	395.	364.	336.	313.	292.	273.	0.29915

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/8 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	426.	383.	346.	315.	289.	266.	246.	228.	213.	0.43753
1.	484.	435.	394.	359.	330.	304.	282.	262.	245.	0.39237
2.	541.	487.	442.	404.	371.	343.	318.	296.	277.	0.35567
3.	591.	539.	490.	448.	412.	381.	354.	330.	309.	0.32524
4.	638.	587.	538.	492.	453.	419.	390.	364.	341.	0.29961

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/8 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	538.	483.	437.	398.	364.	335.	310.	288.	269.	0.40950
1.	622.	559.	507.	463.	425.	392.	363.	338.	316.	0.36898
2.	706.	636.	578.	528.	485.	448.	416.	388.	363.	0.33576
3.	776.	713.	648.	593.	546.	505.	469.	437.	410.	0.30802
4.	843.	777.	719.	658.	606.	561.	522.	487.	457.	0.28452

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/6 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	209.	188.	171.	156.	143.	132.	122.	114.	106.	0.67686
1.	252.	227.	207.	189.	174.	161.	149.	139.	130.	0.57519
2.	295.	267.	242.	222.	205.	189.	176.	165.	154.	0.50007
3.	337.	306.	278.	255.	235.	218.	203.	190.	178.	0.44231
4.	375.	344.	314.	288.	266.	247.	230.	215.	202.	0.39650

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/6 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	251.	226.	205.	187.	172.	158.	147.	137.	128.	0.68060
1.	309.	278.	253.	231.	213.	197.	183.	170.	160.	0.57726
2.	366.	330.	301.	275.	254.	235.	219.	204.	191.	0.50117
3.	420.	383.	349.	320.	295.	273.	255.	238.	223.	0.44280
4.	469.	431.	396.	364.	336.	312.	290.	272.	255.	0.39661

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/6 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	317.	285.	258.	236.	217.	200.	185.	172.	161.	0.63700
1.	401.	362.	329.	301.	277.	256.	238.	222.	208.	0.54406
2.	486.	439.	399.	366.	337.	313.	291.	272.	255.	0.47478
3.	561.	515.	470.	431.	398.	369.	344.	322.	302.	0.42116
4.	632.	581.	537.	496.	458.	425.	397.	371.	349.	0.37842

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$OP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	203.	182.	165.	151.	138.	128.	118.	110.	103.	0.76147
1.	244.	222.	201.	184.	169.	156.	145.	135.	127.	0.63516
2.	278.	256.	237.	217.	200.	185.	172.	161.	151.	0.54479
3.	311.	287.	267.	249.	231.	214.	199.	186.	175.	0.47693
4.	341.	317.	295.	276.	259.	243.	226.	211.	199.	0.42411

DNW= 1377. DNI= 1547. DNN= 1608. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$OP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	244.	219.	198.	181.	166.	153.	142.	132.	123.	0.76567
1.	297.	271.	246.	225.	207.	192.	178.	166.	155.	0.63732
2.	343.	316.	293.	270.	248.	230.	214.	200.	187.	0.54383
3.	386.	357.	332.	310.	289.	268.	250.	234.	219.	0.47730
4.	425.	395.	368.	345.	324.	305.	286.	267.	251.	0.42406

DNW= 1030. DNI= 1157. DNN= 1202. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS./SPAN	DESIGN SHEAR (LBS./LIN.FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	307.	276.	250.	228.	210.	193.	179.	167.	156.	0.71663
1.	385.	353.	321.	294.	270.	250.	232.	216.	203.	0.60110
2.	451.	416.	386.	359.	331.	306.	285.	266.	250.	0.51765
3.	512.	475.	442.	413.	387.	363.	338.	316.	297.	0.45455
4.	567.	528.	494.	463.	435.	411.	388.	366.	344.	0.40516

DNW= 676. DNI= 760. DNN= 789. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	149.	133.	120.	109.	100.	92.	85.	78.	73.	1.10759
1.	188.	173.	156.	142.	131.	120.	112.	104.	97.	0.85909
2.	220.	204.	190.	176.	161.	149.	138.	129.	121.	0.70167
3.	249.	231.	216.	203.	191.	178.	165.	154.	145.	0.59300
4.	274.	256.	241.	226.	214.	202.	191.	180.	169.	0.51348

DNW= 1754. DNI= 1943. DNN= 1978. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 30/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	179.	160.	144.	131.	120.	110.	102.	94.	87.	1.11370
1.	231.	212.	192.	175.	161.	148.	137.	128.	119.	0.86138
2.	272.	252.	235.	220.	202.	187.	173.	162.	151.	0.70227
3.	309.	288.	270.	253.	238.	225.	209.	195.	183.	0.59278
4.	341.	320.	301.	283.	268.	254.	241.	229.	215.	0.51282

DNW= 1312. DNI= 1453. DNN= 1480. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 30/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	225.	202.	182.	166.	151.	139.	128.	119.	110.	1.04237
1.	300.	277.	253.	231.	212.	195.	181.	168.	157.	0.81464
2.	359.	334.	312.	292.	272.	252.	234.	218.	204.	0.66857
3.	411.	384.	360.	339.	320.	302.	286.	268.	251.	0.56692
4.	454.	428.	403.	381.	361.	343.	326.	310.	296.	0.49211

DNW= 861. DNI= 954. DNN= 971. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	331.	297.	269.	244.	224.	206.	190.	176.	164.	0.60917
1.	374.	336.	304.	278.	254.	234.	217.	202.	188.	0.54040
2.	417.	375.	340.	311.	285.	263.	244.	227.	212.	0.48557
3.	460.	415.	376.	344.	316.	292.	271.	252.	236.	0.44085
4.	499.	454.	412.	377.	347.	321.	298.	278.	260.	0.40367

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	398.	357.	322.	293.	268.	247.	228.	212.	197.	0.61254
1.	455.	409.	370.	337.	309.	285.	264.	245.	229.	0.54260
2.	512.	461.	418.	382.	351.	324.	300.	279.	261.	0.48700
3.	570.	513.	466.	426.	392.	362.	336.	313.	293.	0.44173
4.	618.	566.	514.	470.	433.	400.	372.	347.	325.	0.40417

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/7 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	501.	450.	407.	370.	339.	311.	288.	267.	248.	0.57330
1.	586.	527.	477.	435.	399.	368.	341.	317.	296.	0.51051
2.	671.	604.	548.	500.	459.	424.	394.	366.	343.	0.46011
3.	750.	681.	618.	565.	520.	481.	446.	416.	390.	0.41877
4.	819.	754.	689.	630.	580.	537.	499.	466.	437.	0.38423

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + .3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	185.	167.	151.	137.	126.	116.	107.	100.	93.	1.01529
1.	229.	206.	187.	171.	157.	145.	134.	125.	117.	0.83762
2.	272.	245.	223.	204.	188.	174.	161.	151.	141.	0.71286
3.	315.	284.	259.	237.	218.	202.	188.	176.	165.	0.62046
4.	354.	323.	294.	270.	249.	231.	215.	201.	189.	0.54926

DNW= 129. DNI= 226. DNN= 356. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = 3.0 OR MORE NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	223.	200.	181.	165.	151.	139.	129.	120.	112.	1.02090
1.	280.	252.	229.	209.	192.	178.	165.	154.	144.	0.84037
2.	338.	304.	277.	253.	233.	216.	201.	187.	176.	0.71410
3.	395.	357.	325.	298.	274.	254.	237.	221.	208.	0.62082
4.	445.	408.	373.	342.	315.	293.	273.	255.	239.	0.54909

DNW= 97. DNI= 169. DNN= 266. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$GP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/5 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	281.	252.	228.	208.	191.	176.	163.	151.	141.	0.95550
1.	365.	329.	299.	273.	251.	232.	216.	201.	188.	0.79295
2.	450.	406.	369.	338.	312.	289.	268.	251.	235.	0.67766
3.	530.	483.	440.	403.	372.	345.	321.	300.	282.	0.59164
4.	602.	553.	510.	468.	433.	401.	374.	350.	329.	0.52500

DNW= 63. DNI= 111. DNN= 175. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP' = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	185.	167.	151.	137.	126.	116.	107.	100.	93.	1.01529
1.	229.	206.	187.	171.	157.	145.	134.	125.	117.	0.83762
2.	271.	245.	223.	204.	188.	174.	161.	151.	141.	0.71286
3.	308.	283.	259.	237.	218.	202.	188.	176.	165.	0.62046
4.	343.	315.	292.	270.	249.	231.	215.	201.	189.	0.54926

DNW= 601. DNI= 721. DNN= 819. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	223.	200.	181.	165.	151.	139.	129.	120.	112.	1.02090
1.	280.	252.	229.	209.	192.	178.	165.	154.	144.	0.84037
2.	336.	304.	277.	253.	233.	216.	201.	187.	176.	0.71410
3.	384.	353.	325.	298.	274.	254.	237.	221.	208.	0.62082
4.	429.	396.	367.	341.	315.	293.	273.	255.	239.	0.54909

DNW= 449. DNI= 539. DNN= 613. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/4 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	281.	252.	228.	208.	191.	176.	163.	151.	141.	0.93550
1.	365.	329.	299.	273.	251.	232.	216.	201.	188.	0.79295
2.	444.	406.	369.	338.	312.	289.	268.	251.	235.	0.67766
3.	513.	472.	437.	403.	372.	345.	321.	300.	282.	0.59164
4.	578.	534.	496.	462.	433.	401.	374.	350.	329.	0.52500

DNW= 295. DNI= 354. DNN= 402. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0295 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	146.	130.	118.	107.	98.	90.	83.	76.	71.	1.52294
1.	189.	170.	154.	140.	128.	118.	110.	102.	95.	1.15533
2.	227.	209.	190.	173.	159.	147.	136.	127.	119.	0.93068
3.	259.	240.	223.	206.	190.	176.	163.	152.	143.	0.77918
4.	289.	269.	250.	234.	220.	204.	190.	178.	167.	0.67009

DNW= 1072. DNI= 1216. DNN= 1282. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{870.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

HILTI 24/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0358 INCHES

NO. OF SPANS = NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) 3.0 OR MORE SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	175.	157.	141.	128.	117.	108.	99.	92.	85.	1.53134
1.	232.	209.	189.	173.	158.	146.	135.	126.	117.	1.15816
2.	281.	259.	237.	217.	199.	184.	171.	159.	149.	0.93122
3.	324.	300.	279.	260.	240.	222.	207.	193.	181.	0.77865
4.	362.	337.	315.	295.	277.	261.	243.	227.	213.	0.66903

DNW= 902. DNI= 909. DNN= 959. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1056.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

DIAPHRAGMS USING HILTI ENP2-21L15 FASTENERS

HILTI 24/3 PATTERN WITH NO. 12 STITCH SCREWS AND 2.6 SAFETY FACTOR
DESIGN THICKNESS = 0.0474 INCHES

NO. OF SPANS = 3.0 OR MORE / NO. OF STITCH CONNS. /SPAN	DESIGN SHEAR (LBS. /LIN. FT.) SPAN (FT) 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	K1
0.	221.	198.	178.	162.	148.	136.	125.	116.	108.	1.43326
1.	305.	274.	249.	227.	208.	192.	178.	166.	155.	1.09618
2.	373.	344.	319.	292.	269.	248.	231.	215.	202.	0.88747
3.	434.	402.	375.	350.	329.	305.	284.	265.	249.	0.74552
4.	487.	455.	425.	399.	376.	355.	336.	315.	296.	0.64272

DNW= 526. DNI= 597. DNN= 630. SUBSTITUTE THESE FOR D AS APPROPRIATE

$$QP = \frac{1398.}{3.78 + 0.3D/SPAN + 3*K1*SPAN}$$

LARRY D. LUTTRELL, SR. E
REGISTERED
No. 4502
STATE OF
WEST VIRGINIA
PROFESSIONAL ENGINEER

11/19/85