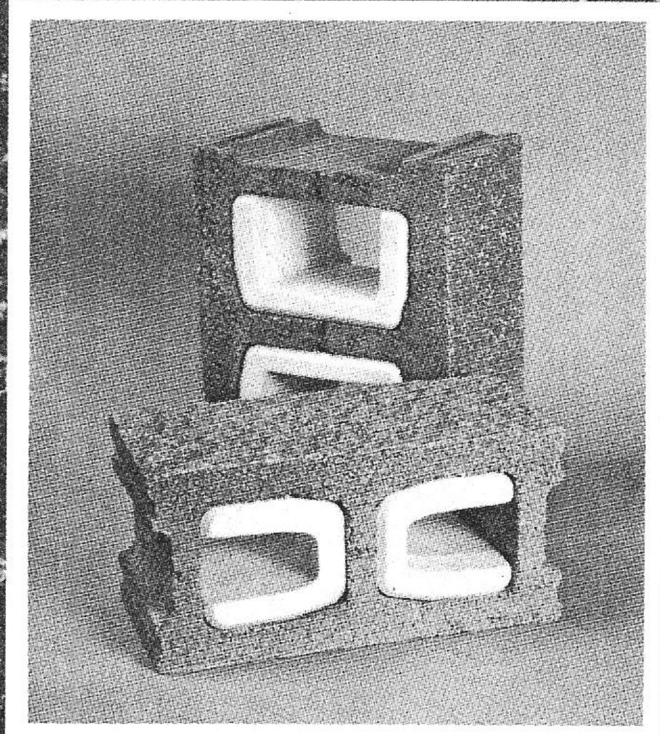
Technical Report 82-2

Korfil®

BLOCK INSULATION



The Use of Korfil In Reinforced Concrete Masonry Construction

International Conference of Building Officials

EVALUATION REPORT

Report No. 3773
May, 1985

Filing Category: DESIGN—Masonry

KORFIL I AND II INSULATED HOLLOW CONCRETE MASONRY UNITS
KORFIL, INCORPORATED
POST OFFICE BOX 123
CHICOPEE, MASSACHUSETTS 01014

I. Subject: Korfil I and II Insulated Hollow Concrete Masonry Units.

II. Description: Korfil I polystyrene insulation inserts are designed for use in standard hollow masonry units that comply as Grade N units under U.B.C. Standard No. 24-4. See Figure No. 2. The Korfil II polystyrene insulation inserts are designed for use in hollow masonry units that comply as Grade N units under U.B.C. Standard No. 24-4, with dimensions as shown in Figure No. 1. The inserts are installed at the time of manufacture of the masonry units.

Design: Structures are designed in accordance with Chapter 24 of the Uniform Building Code with the following provisions:

1. The allowable working stress in unreinforced grouted masonry is 80 percent of that specified in Table No. 24-B of the code.
2. For reinforced masonry, the net cross-sectional area of the masonry units must exclude the insert area. See Tables Nos. I and II.
3. Allowable shear on bolts is as specified for solid masonry in Table No. 24-G of the code.
4. Korfil inserts are not located in bond beams.
5. Buildings are limited to 65 feet in height or four stories, whichever is less.

Identification: Each Korfil I and II shipping container is identified by the product name, date of manufacture, container number, ICBO report number, the Class I flame-spread and smoke-developed rating, and the name of the quality control agency (RADCO, NER-204). The hollow concrete masonry units are palletized and bear the manufacturer's name and address.

III. Evidence Submitted: Reports on transverse, diagonal tension, compression, flexural load tests and quality control manual.

Findings

IV. Findings: That the Korfil I and II Insulated Hollow Concrete Masonry Units described in this report are alternate methods of construction to that specified in the 1982 Uniform Building Code, subject to the following conditions:

1. Plans and calculations for each project are submitted to the building official for approval.
2. The design and construction complies with this report, the Uniform Building Code and the manufacturer's instructions.
3. Minimum 8-inch block is recognized as two-hour fire-resistive wall construction.
4. The Korfil I and II polystyrene inserts are manufactured at the following locations:

   A. Energy Performance Systems, Freighthouse Road, West Brookfield, Massachusetts 01585.

   B. Military Packaging, Inc., 637 West 3560 South, Salt Lake City, Utah 84119.

This report is subject to re-examination in one year.

TABLE NO.I—NET CROSS-SECTIONAL AREA OF VARIOUS CONCRETE MASONRY UNITS INSULATED WITH KORFIL I BLOCK INSULATION

BLOCK UNIT SIZE	NET CROSS-SECTIONAL AREA (In Square Inches)		
	NO GROUT	ONE CELL GROUTED	BOTH CELLS GROUTED
8-inch	65.96	81.02	96.08
10-inch	81.29	103.25	125.21
12-inch	92.76	124.31	155.86

TABLE NO.II—NET CROSS-SECTIONAL AREA OF VARIOUS CONCRETE MASONRY UNITS INSULATED WITH KORFIL II BLOCK INSULATION

BLOCK UNIT SIZE	NET CROSS-SECTIONAL AREA (In Square Inches)		
	NO GROUT	ONE CELL GROUTED	BOTH CELLS GROUTED
8-inch	65.05	85.92	106.79
10-inch	81.29	103.25	125.21
12-inch	91.38	130.02	168.66

The Use of Korfil In Reinforced Concrete Masonry Construction

Introduction

Korfil pre-insulated concrete masonry is composed of individually molded inserts of expanded polystyrene designed to fit in two-core concrete block of 6, 8, 10, and 12-inch thicknesses. The inserts are installed at the block manufacturing plant prior to delivery to the construction site. This report describes tests conducted on reinforced and grouted concrete masonry walls to demonstrate that the presence of Korfil II inserts does not significantly affect the structural characteristics of this type of construction. The physical tests were conducted* in the National Concrete Masonry Association Research and Development Laboratory in 1978 and 1979 under a contract with Korfil, Inc.

Results from the test program were reviewed by the Research and Development Civil and Structural Engineering firm of Ruthroff, Englekirk, and Hart, Los Angeles, California, and their findings are included in this report. Test results and the review by Ruthroff, Englekirk, and Hart were also submitted to the Research Committee of the International Conference of Building Officials (ICBO) as part of an application for a Research Approval. (Korfil II was approved as an alternate method of construction in 1981 and Korfil I was approved in 1985.)

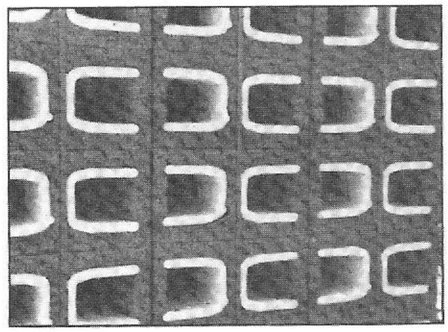


Figure 1 - Korfil inserts are installed at the block Manufacturing Plant prior to delivery.

*"Structural Tests of 8 inch Grouted Concrete Masonry Walls Containing Korfil inserts", NCMA, January, 1978 and "Structural Tests for the Determination of Comparative Characteristics Between Grouted Concrete Masonry Specimens Containing Korfil II Inserts and Conventional Construction, NCMA, January, 1979.

Table 1 - Summary of Tests on Korfil II Reinforced Walls and Beams

Type of Test	Number of Specimens	Type of Unit	Reinforcement Horizontal	Reinforcement Vertical	Grout	Specimen Size
Flexural Strength in Vertical Span, ASTM E 72	3	Kor. II	Bond Beam Top & Bottom W/ #4 Rebar	#4 @ 24″	Partial*	4′ x 8′
	3	Conv.		#4 @ 24″	Partial	4′ x 8′
	3	Kor. II		#6 @ 24″	Partial	4′ x 8′
	3	Conv.		#6 @ 24″	Partial	4′ x 8′
	3	Kor. II	(**)	#4 @ 24″	Partial	4′ x 8′
	3	Kor. II	(***)	#7 @ 48″	Full*	4′ x 8′
Compressive Strength e=t/6 ASTM E 72	3	Kor. II	None	#4 @ 24″	Partial	4′ x 8′
Diagonal Shear (Tension) ASTM E 72	3	Kor. II	None	#4 @ 24″	Partial	4′ x 4′
	3	Conv.	None	#4 @ 24″	Partial	4′ x 4′
	3	Kor. II	None	#6 @ 24″	Partial	4′ x 4′
	3	Conv.	None	#6 @ 24″	Partial	4′ x 4′
Prism Strength ASTM E 447	3	Kor. II	None	None	Full	16″ x 16″
	3	Kor. II	None	None	None	16″ x 16″
Flexural Strength of Beams ASTM 518 (Mod). 1/3 pt. loading	3	Kor. II	1# 4 bar	None	Full	8″ x 8″ x 48″
	3	Conv.	1# 4 bar	None	Full	8″ x 8″ x 48″
	3	Kor. II	1# 6 bar	None	Full	8″ x 8″ x 48″
	3	Conv.	1# 6 bar	None	Full	8″ x 8″ x 48″
	3	Kor. II	None	None	None	8″ x 8″ x 48″
Total	54					

*Partial means grouted only where steel occurs. Full means all cells grouted.

**Bond beam at top, midheight, and bottom each with 1 #4 rebar.

***3/16 inch joint reinforcement spaced at 8″ o.c.

Test Program

All told, two test programs at the NCMA laboratory resulted in tests on 54 wall, prism, or beam specimens. Korfil II specimens were compared with companion walls, prisms, and beams constructed with conventional non-insulated concrete block.

The preliminary program, conducted in 1978, investigated the effect of the reduced grout-to-block interface with the Korfil inserts in fully* grouted reinforced construction. This program included three 4′ x 8′ walls tested for flexural strength in the vertical span, and six 2-block high prisms, three of which were grouted, and three of which were not.

The preliminary program indicated that the presence of the Korfil II inserts in the reinforced, grouted construction is not detrimental. As a result, the more comprehensive 1979 program was designed to provide numerical parameters suitable for safe construction of reinforced Korfil II pre-insulated concrete masonry walls. Thirty full-scale walls and 15 beams were included in this phase of the study, see Table 1. Walls were partially* grouted, and tests included: (1) flexural strength in the vertical span, (2) compressive strength, and (3) diagonal shear. Twelve of the 30 walls were constructed using conventional 8-inch hollow concrete block, and 18 were constructed using Korfil II units. Steel reinforcement ratio was varied and ranged from one No. 4 bar at 24 inches to one No. 7 at 48 inches. In addition, 15, 8″ x 8″ x 48″ reinforced and grouted concrete masonry beams were tested over a span of 24 inches with 1/3-point loading. Nine beams were Korfil II units and six were conventional.

All test specimens were constructed with Type S mortar (ASTM C 270) with an average compressive strength of 1500 to 1800 psi. Grout was similar in composition to the coarse grout of ASTM C 476 with a strength of 3400-3800 psi. Concrete block complied with the requirements of ASTM C 90; had an average net area of 50 percent, and a gross area compressive strength of 1400-1600 psi. Steel reinforcement was grade 60. Grouting of wall specimens was accomplished by the high lift method with four-foot high lifts vibrated with a one inch pencil vibrator.

All specimens were tested at an age of 28 days, plus or minus two days.

*Fully grouted means that all cells of the block are filled. Partially grouted means that only those cells containing steel are grouted.

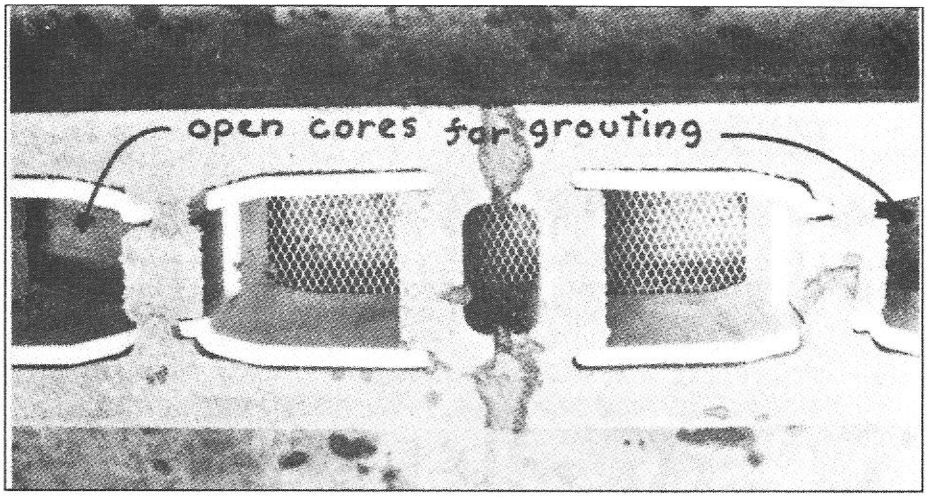


Figure 2 - Construction of test wall illustrating area to be grouted and Korfil II units.

Test Results

Results of flexural strength, shear strength, and compressive strength tests on wall specimens are summarized by load-deflection curves, sketches and photographs in Figures 3 thru 9.

Flexural Strength

In vertical span flexure, Fig. 3, the maximum horizontal load carried by the reinforced Korfil II and conventional CMU walls without failure was the same for both types, i.e., a uniform load on the 8-ft. span of 312 lb/sf. This loading represents a resisting moment without failure some 2.25 to 3.0 times the maximum design moment permitted by codes. Since the walls did not fail, the ultimate safety factor of Korfil II pre-insulated construction is uncertain, except to state that it would exceed 3.0 in value.

The firm of Ruthroff, Englekirk, & Hart compared the 312 lb/sf. loading on the Korfil II walls with lateral load levels expected from a major earthquake movement and found the expected seismic load (46 lb/sf.) to be about one-seventh the lateral test load. They further concluded from the test data that a Korfil II pre-insulated reinforced concrete masonry wall with a slenderness ratio (h/t) as great as 25 would have sufficient moment capacity to resist lateral seismic loads.

Although the maximum flexural strength of the Korfil II and conventional walls is the same, Fig. 3, initial cracking of the Korfil II walls occurs at a slightly lower value than that for conventional construction. Figure 4, compares the measured deflection of one Korfil II wall reinforced with No. 4 bars every 24 inches with the calculated deflection based upon: (1) the uncracked section moment of inertia, and (2) the cracked section moment of inertia. The measured deflection both before and after cracking appears predictable. The reason Korfil II walls undergo initial cracking at lesser horizontal load than conventional, Fig. 3 may be due to the location of the Korfil II insert with respect to the neutral axis of the wall. For most common reinforcement ratios, the neutral axis of the wall will lie above the Korfil II insert, Fig. 5. The Korfil II insulation insert is entirely in the "cracked" section of the wall. It will have a minor effect upon the moment of inertia of the uncracked section (I-unc.), and no effect on the cracked section (I-cr.), or the wall's flexural capacity. Ruthroff, Englekirk, & Hart concluded after performing both working stress theory and Whitney stress block (ultimate strength theory) that the Korfill II insert has minimal, if any, impact on the stress distribution within the concrete block.

Figure 3 - Load Deflection Curves - Vertical Span Flexural Tests

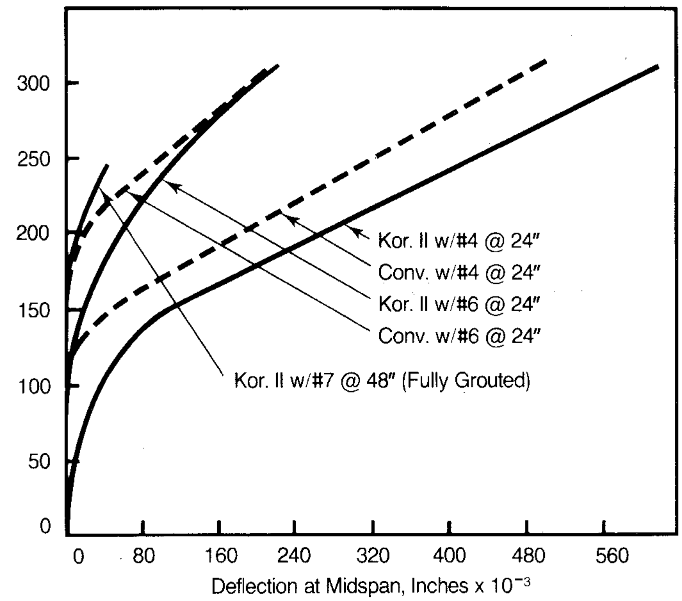
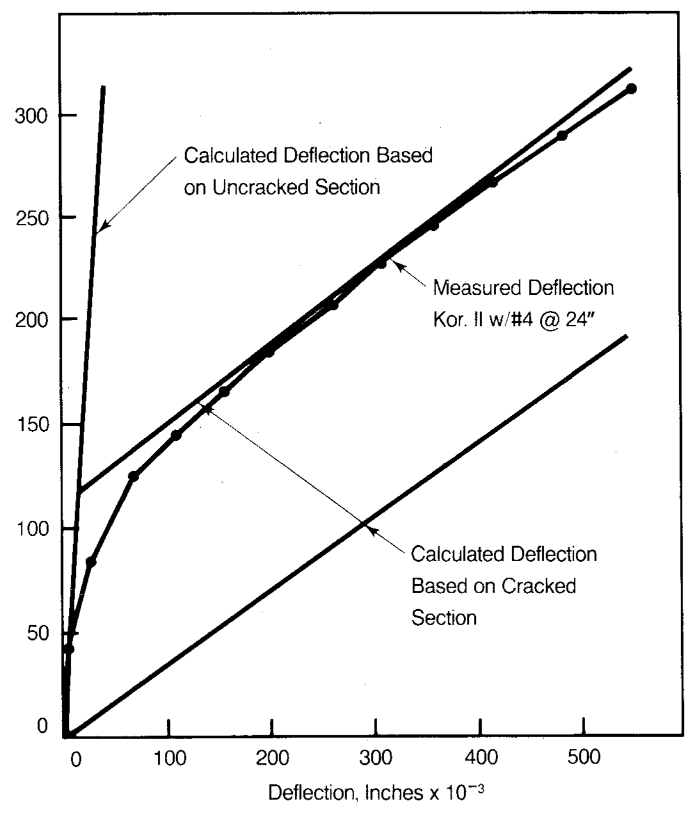


Figure 4 - Compare Measured Deflection with Calculated Based on Uncracked and Cracked Moment of Inertia (I)



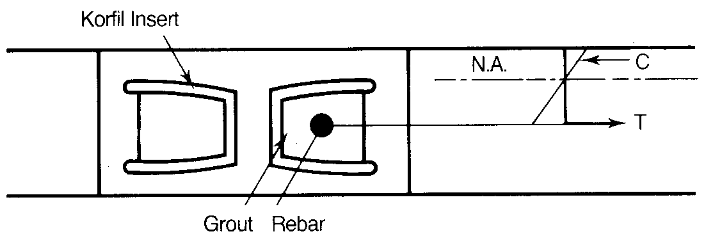


Figure 5 -
For Most Common Reinforcement Ratios, the Neutral Axis Lies Above the Korfil II Insert

Compressive Strength

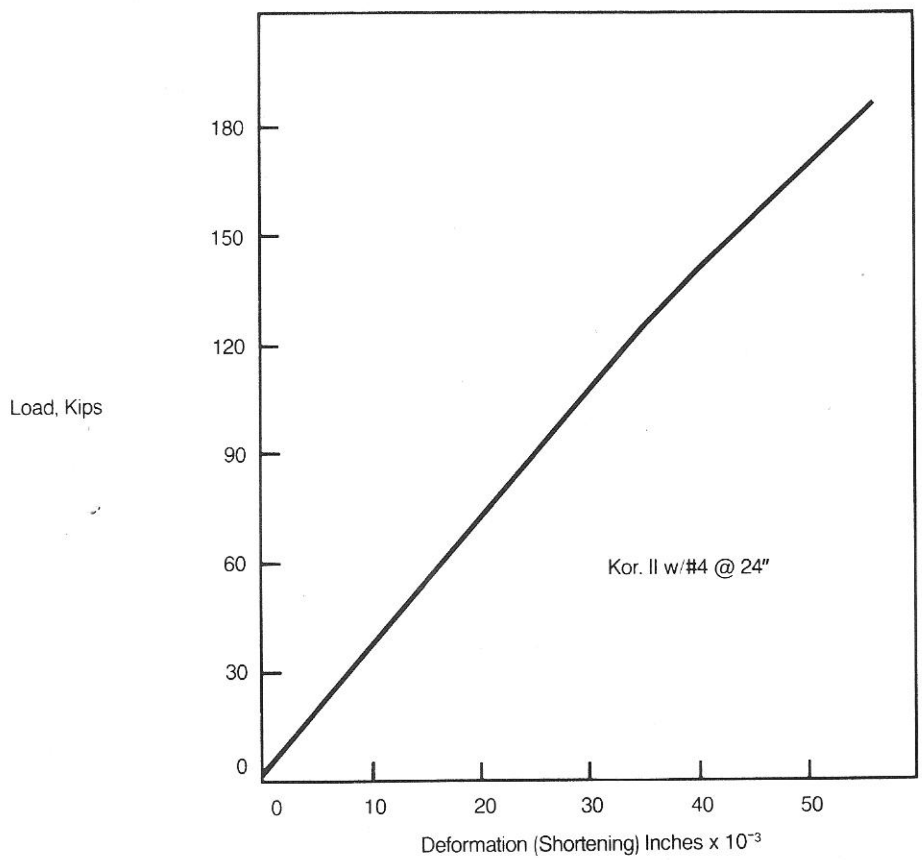
Three 8-ft. high by 4-ft. wide Korfil II pre-insulated walls were tested in compression with the load applied at an eccentricity equal to 1/6 the wall thickness. The walls contained No. 4 rebars spaced at 24 inches o.c. The average load-deflection curve for these three walls is shown in Fig. 6.

The average ultimate gross area compressive strength for the eccentrically (t/6) loaded walls was 780 psi. One wall, however, apparently failed prematurely through crushing of the top corner block. Eliminating this wall from the average increases it to 880 psi. Net area strength based upon the lower gross area value of 780 psi is 1192 psi. This is a safety factor of about 4 when compared to the allowable compressive stress that would be permitted by the codes. Calculations for compressive stress are based upon the net section of the masonry excluding the area of the Korfil II inserts.

As may be noted in Fig. 6, the load-deformation curve for the eccentrically loaded walls is linear, and yields an indicated modulus of elasticity (E_m) of 1.168 x 10^6 psi. This value compares with an assumed modulus as determined by most codes of 1.35 x 10^6 psi.

Compression tests on grouted and ungrouted Korfil II prisms also suggest that the compressive strength of Korfil II masonry is predictable in design. For the ungrouted prisms, comparison of the unit net area strength, excluding insert area, yields a prism strength (2490 psi) about 80 percent that of the individual block (3110 psi).

Figure 6 - Load Deformation Curve, Compressive Strength Tests



Net area compressive strength of ungrouted prisms averaged about 20 percent higher than the gross area strength of the fully grouted prisms when inserts were included in the area. Neglecting the area of the inserts in the calculation resulted in comparable net area strength for the two prism types since the inserts comprise about 20 percent of the area in compression.

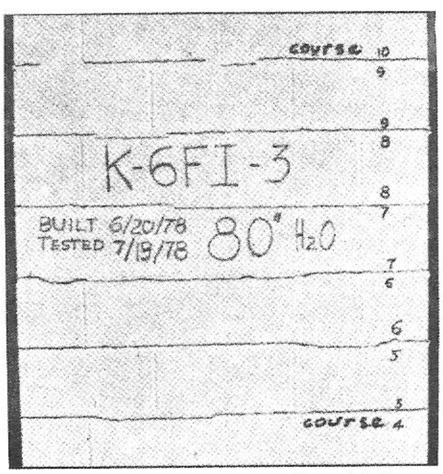


Figure 7 - Typical Mortar Bond failure for Specimens with and without Korfil II inserts.

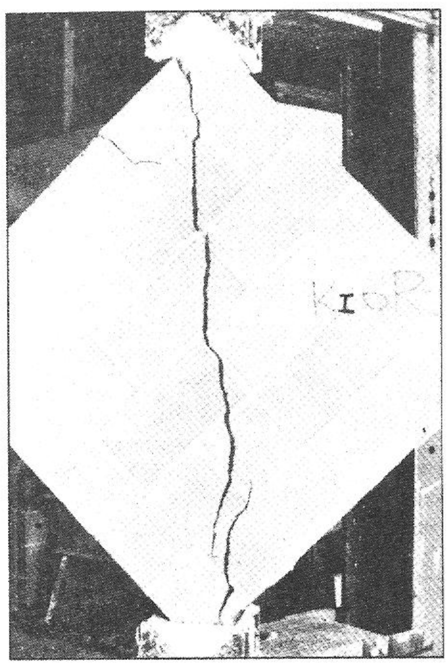


Figure 8 - Racking Test at failure.

Diagonal Tension (Shear)

The shear strain at various increments of load for the 4′ x 4′ walls is shown in Fig. 9. Shear strain was computed as follows:

$$\delta = \frac{\Delta V}{g_v} + \frac{\Delta H}{g_h} \quad \text{where:}$$

δ = Shearing Strain, inches/inch

ΔV = Vertical Shortening, inches

ΔH = Horizontal Extension, inches

g_v & g_h = Gage Length, inches

The amount of vertical steel appears to have minimal effect on the load carrying capacity and load strain characteristics. The average maximum load at failure was about the same for both Korfil II pre-insulated samples, and close to the same for all walls built with conventional non-insulated units, regardless of the amount of vertical steel.

Sample	Max. Load
Korfil II w/#4 @ 24"	51.1 kips
Korfil II w/#6 @ 24"	52.2 kips
Conventional w/#4 @ 24"	72.8 kips
Conventional w/#6 @ 24"	77.1 kips

The net section for shear calculations on Korfil II walls, Table 4 is 40.58 in^2/ft of wall length, or 4 x 40.58 = 162.32 in^2 for the four foot long test wall. For the conventional, non-insulated walls, the net section in shear is 190 in^2. Ultimate shear stress on the horizontal plane may then be calculated as follows:

Korfil II walls:

w/#4 @ 24"

$$f_v = \frac{0.707 \times 51100}{162.32} = 223 \text{ psi}$$

$$\text{S.F.} = \frac{223}{50} = 4.45$$

w/#6 @ 24"

$$f_v = \frac{0.707 \times 52200}{162.32} = 227 \text{ psi}$$

$$\text{S.F.} = \frac{227}{50} = 4.55$$

Conventional Walls:

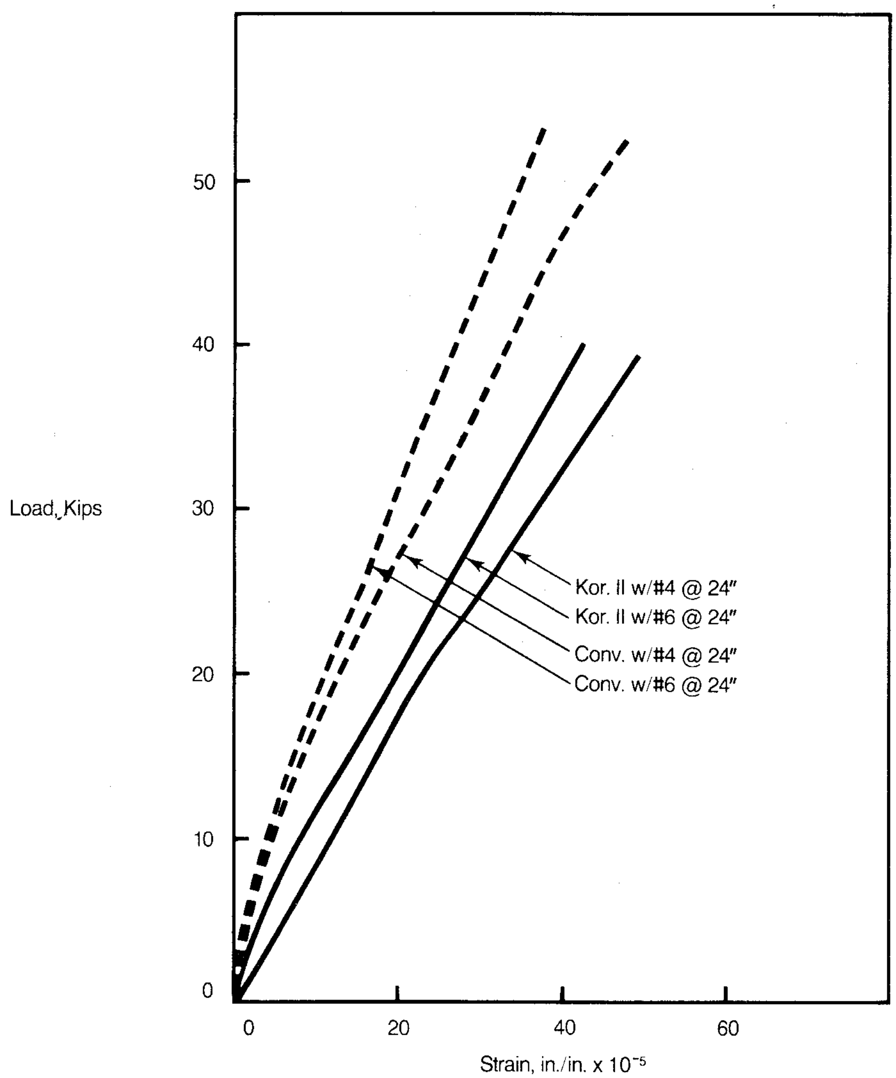
w/#4 @ 24"

$$f_v = \frac{0.707 \times 72800}{190} = 271 \text{ psi}$$

w/#6 @ 24"

$$f_v = \frac{0.707 \times 77100}{190} = 287 \text{ psi}$$

Figure 9 - Load Strain Curves — Shear Tests (Diagonal Tension)



Designing With Korfil II

The tests showed conclusively that reinforced concrete masonry can be designed and constructed with Korfil II pre-insulated units using the design criteria found in most building codes. Table 2 contains a summary of the safety factors obtained when results of the Korfil II test walls and beams are compared with the allowable stresses of the Uniform Building Code. ICBO Research Report No. 3773, reproduced on the inside front cover, permits Korfil II design in reinforced masonry the same allowable stresses as are employed for conventional non-insulated concrete block. These allowables are listed in Table 3 for inspected workmanship. Research report 3773 does require:

1. The allowable working stress in **unreinforced** grouted masonry shall be 80 percent of that given in Table No. 24-B of the code.
2. For **reinforced** masonry, the net cross sectional area of the masonry units and net section shall be computed excluding the area of the insert.
3. Allowable shear on bolts shall be as specified for solid masonry in Table No. 24-G.
4. No Korfil II inserts shall be installed in horizontal bond beams.
5. Buildings shall be limited to 65 feet in height or four stories, whichever is least.

Table 4 contains uncracked section properties per foot of wall length for 8-inch and 12-inch Korfil II pre-insulated concrete masonry walls. The areas shown can be used for compression and shear calculations of partially and solidly grouted Korfil II walls.

Example 1 — Assume a 12-inch Korfil II wall has reinforcement and grout at 24" o.c. and carries an axial load of 30 kips per foot. What is the calculated axial stress?

From Table 4 Area = 89.62 in^2/ft

$$fa = 30000/89.62 = 335 \text{ psi}$$

Example 2 — Assume an 8-inch Korfil II wall with grout and steel spaced at 48 inches is 10 feet long and has a shear or racking load of 10 kips. What is the shear stress?

From Table 4 Shear Area = 40.58 in^2/ft

$$f_v = \frac{10000}{10 \times 40.58} = 25 \text{ psi}$$

The third column in Table 4 lists the uncracked moment of inertia (Iuncr.) of the various wall sections. The moment of inertia can be employed in deflection calculations and for stress calculations in the expression:

$$fm = MC/I_{uncr.}$$

Example 3 — In Fig. 4 which compares measured deflection with calculated for a Korfil II pre-insulated wall with steel (#4 bar) at 24" o.c., what deflection would one expect at midheight if the wall is uncracked at 50 lb/sf loading?

From Table 4, the uncracked or gross area moment of inertia (Iuncr.) is 364.16 in^4/ft of wall length.

The bending moment (M) for a simple span of 7.5' (90 inches) is:

$$M = 12/8 \times 50 \times (7.5)^2 = 4218 \text{ in-lb/ft.}$$

The maximum deflection at midheight is:

$$\Delta max = \frac{5 \times M \times L^2}{48 \times E \times I} \quad E = 1.168 \times 10^6$$

$$\Delta max = \frac{5 \times 4218 \times (90)^2}{48 \times 1.168 \times 10^6 \times 364.16}$$

$$= 0.008 \text{ inches}$$

Table 2 — Summary of Safety Factors with Korfil II Pre-insulated Reinforced Concrete Masonry and UCB Allowable Stresses

Test Sample	Safety Factor
Flexural Tests (Walls):	
With #4 bars:	
Compression, fm	3.00
Shear, v_m	2.00
With #6 bars:	
Compression, fm	2.25
Shear, v_m	2.10
Compression (Walls):	
With #4 bars, f_a	4.55
Diagonal Tension (Walls):	
With #4 bars, v_m	4.45
With #6 bars, v_m	4.55
Flexural Tests (Beams):	
With #4 bars:	
Compression, fm	5.48
Shear, v_m	5.60
With #6 bars:	
Compression, fm	5.87
Shear, v_m	7.95
AVERAGE SAFETY FACTOR	4.35

Example 4 — What is the maximum flexural stress (fm) in compression on the masonry in the preceeding example?

$$fm = \frac{Mc}{I} = \frac{4218 \times (7.625''/2)}{364.16} = 44 \text{ psi}$$

Tables 5 & 6 list flexural coefficients and other data for 8-inch and 12-inch reinforced Korfil II walls based on the straight line theory of stress-strain for two different prism strengths (f'm = 1350 psi & f'm = 2500 psi). The coefficients "j" and "k" are the familiar ratios for locating the neutral axis "x" and the moment couple arm "jd". The fourth column contains the product:

$(1/2 \cdot j \cdot k \cdot b \cdot d^2)$

which may be employed in design or review calculations.

Example 5 — What is the maximum compressive fiber stress (fm) and steel stress (fs) for the wall illustrated in Fig. 4 when the load on the wall is 200 lb/sf?

From Table 5:

$As = 0.2 @ 24'' = 0.1 \text{ in}^2 @ 12''$

$d = 7.625/2 = 3.81''$

$k = 0.26$

$x = 1.00''$

$j = 0.91$

$1/2\ jkbd^2 = 20.93$

$M = 12/8 \times 200 \times (7.5)^2 = 16875$ in-lb/ft

$fm = 16875/20.93 = 806$ psi

$fs = M/jdAs = 16875/0.91 \times 3.81 \times 0.1 = 48670$ psi

The final column in Tables 5 & 6 contains the moment of inertia (Icr.) of the cracked section which can be used in stiffness and deflection calculations.

Example 6 — What deflection would one expect in the preceeding example based upon the moment of inertia of the cracked section, and why doesn't this calculated value agree with the actual measured deflection?

From Table 5:

$I_{cracked} = 20.99 \text{ in}^4/\text{ft}$

$$\Delta_{max} = \frac{5 \times 16875 \times (90)^2}{48 \times 1.168 \times 10^6 \times 20.99} = 580 \times 10^{-3}$$

As may be seen in Fig. 4, the measured deflection at 200 lb/sf loading was considerably less than the calculated value (approx. 230×10^{-3} vs. 580×10^{-3}). The reason for this difference is that the specimen did not deflect as a cracked wall until it reached a loading of between 50 and 100 lb/sf. Note that the calculated value falls on a line which originates at the origin. In order to obtain more realistic deflection calculations, ACI for reinforced concrete uses an effective I-value which is greater than that of the cracked section, but smaller than the uncracked:

$I_{eff} = (K)\ I_{uncr} + (1 - K)\ I_{cr.}$

where K is a function of the cracking moment and the ultimate moment.

Table 3 — Maximum Working Stresses in Net Area Psi for Inspected* Korfil II Concrete Masonry

Type of Stress	Allowable Stress
Compression Axial - Walls	$F_a = 0.2f'm(R)$*
Compression Column - Axial	$F_a = A_g (.18f'm + .65p_g f_s) (R)$*
Compression Flexural	.33f'm but not to exceed 900 psi
Shear:	
No shear steel:	
Flexural	$1.1\sqrt{f'm}$ maximum = 50 psi
Shear Walls:	
$M/Vd \geq 1$	$.9\sqrt{f'm}$ maximum = 34 psi
$M/Vd = 0$	$2.0\sqrt{f'm}$ maximum = 50 psi
Reinforcement taking all shear:	
Flexural	$3.0\sqrt{f'm}$ maximum = 150 psi
Shear Walls:	
$M/Vd \geq 1$	$1.5\sqrt{f'm}$ maximum = 75 psi
$M/Vd = 0$	$2.0\sqrt{f'm}$ maximum = 120 psi
Modulus of Elasticity	1000 f'm maximum = 3×10^6
Modulus of Rigidity	400 f'm maximum = 1.2×10^6
Bearing on Full Area	0.25 f'm maximum = 900 psi
Bearing on 1/3 or less area	0.30 f'm maximum = 1200 psi
Bond-Plain Bars	60 psi
Bond-Deformed	140 psi

*Reduce allowable stresses 50 percent if work is uninspected.

*WHERE:
$R = [1 - (h/40t)^3]$ = a reduction factor for slenderness

f'm = Prism Strength

Table 4 — Uncracked Section Properties Per Foot of Wall Length for Korfil II Pre-Insulated Concrete Masonry Walls

Grout Space, inches	8-inch Units (55% Solid)			12-inch Units (50% Solid)		
	Net Compression Area, in^2/ft	Net Shear Area, in^2/ft	Moment of Inertia, in^4/ft	Net Compression Area, in^2/ft	Net Shear Area, in^2/ft	Moment of Inertia, in^4/ft
48	55.65	40.58	357.78	79.68	55.37	1216.37
40	56.71	42.24	359.06	81.67	58.79	1224.52
32	58.31	44.74	360.97	84.65	63.93	1236.74
24	60.97	48.91	364.16	89.62	72.49	1257.11
16	66.29	57.24	370.54	99.55	89.60	1297.84
8	80.25	80.25	389.69	129.35	129.35	1420.04

Table 5 — Flexural Coefficients and Cracked-Section Moment of Inertia (I) for Eight-Inch Korfil II Pre-Insulated Reinforced Concrete Masonry Walls

Rebar Size and area	Space, in.	f'm = 1350 psi (N = 21.48)					f'm = 2500 psi (N = 11.60)				
		k	x in.	j	$1/2jkbd^2$ per ft.	I-crack in^4 per ft.	k	x in.	j	$1/2jkbd^2$ per ft.	I-crack in^4 per ft.
	48	.19	.74	.94	15.86	11.76	.15	.56	.95	12.20	6.84
	40	.21	.80	.93	17.10	13.74	.16	.61	.95	13.20	8.05
#4	32	.23	.89	.92	18.71	16.58	.18	.67	.94	14.52	9.79
	24	.26	1.00	.91	20.93	20.99	.20	.77	.93	16.37	12.56
As = 0.2	16	.31	1.19	.90	24.34	28.90	.24	.92	.92	19.28	17.67
	8	.41	1.56	.86	30.76	47.85	.32	1.23	.89	25.02	30.65
	48	.24	.90	.92	18.95	17.03	.18	.68	.94	14.72	10.08
	40	.26	.97	.91	20.35	19.79	.19	.74	.94	15.89	11.80
#5	32	.28	1.07	.91	22.16	23.68	.22	.82	.93	17.41	14.28
	24	.32	1.20	.89	24.63	29.64	.24	.93	.92	19.53	18.16
As = .31	16	.37	1.41	.88	28.33	40.04	.29	1.10	.90	22.81	25.17
	8	.48	1.82	.84	35.02	63.39	.38	1.46	.87	29.06	42.29
	48	.27	1.04	.91	21.70	22.66	.21	.80	.93	17.03	13.63
	40	.30	1.13	.90	23.23	26.18	.23	.87	.92	18.33	15.89
#6	32	.32	1.23	.89	25.18	31.08	.24	.95	.92	20.02	19.11
	24	.36	1.38	.88	27.82	38.48	.28	1.08	.91	22.34	24.09
As = .44	16	.42	1.61	.86	31.68	51.01	.33	1.27	.89	25.88	32.94
	8	.54	2.04	.82	38.40	77.30	.43	1.66	.86	32.43	53.66
	48	.31	1.19	.90	24.34	28.90	.24	.92	.92	19.28	17.67
	40	.34	1.28	.89	25.97	33.19	.26	.99	.91	20.70	20.52
#7	32	.37	1.40	.88	28.03	39.11	.29	1.09	.90	22.53	24.53
	24	.41	1.56	.86	30.76	47.85	.32	1.23	.89	25.02	30.65
As = .60	16	.47	1.80	.84	34.70	62.12	.38	1.44	.87	28.75	41.32
	8	.59	2.25	.80	41.29	90.25	.48	1.85	.84	35.45	65.08
	48	.35	1.33	.88	26.82	35.55	.27	1.03	.91	21.45	22.11
	40	.37	1.42	.88	28.51	40.59	.29	1.11	.90	22.97	25.55
#8	32	.41	1.55	.86	30.64	47.44	.32	1.22	.89	24.91	30.36
	24	.45	1.72	.85	33.43	57.30	.36	1.37	.88	27.53	37.62
As = .79	16	.52	1.97	.83	37.37	72.85	.42	1.59	.86	31.38	49.97
	8	.64	2.43	.79	43.72	101.91	.53	2.02	.82	38.11	76.03

Table 6 — Flexural Coefficients and Cracked-Section Moment of Inertia (I) for Twelve-Inch Korfil II Pre-Insulated Reinforced Concrete Masonry Walls

Rebar Size and area	Space, in.	f'm = 1350 psi (N = 21.48)					f'm = 2500 psi (N = 11.60)				
		k	x in.	j	1/2jkbd² per ft.	I-crack in⁴ per ft.	k	x in.	j	1/2jkbd² per ft.	I-crack in⁴ per ft.
	48	.16	.93	.95	30.84	28.82	.12	.70	.96	23.52	16.53
	40	.17	1.02	.94	33.34	33.85	.13	.77	.96	25.51	19.52
#4	32	.19	1.12	.94	36.62	41.10	.15	.85	.95	28.15	23.88
	24	.22	1.27	.93	41.20	52.52	.17	.97	.94	31.88	30.85
As = .2	16	.26	1.52	.91	48.35	73.42	.20	1.16	.93	37.81	43.91
	8	.35	2.02	.88	62.25	125.39	.27	1.57	.91	49.79	78.12
	48	.20	1.14	.93	37.12	42.27	.15	.86	.95	28.55	24.59
	40	.21	1.23	.93	40.01	49.40	.16	.94	.95	30.90	28.93
#5	32	.23	1.36	.92	43.76	59.57	.18	1.04	.94	33.99	35.21
	24	.26	1.54	.91	48.96	75.39	.20	1.18	.93	38.32	45.16
As = .31	16	.31	1.82	.86	56.92	103.68	.24	1.41	.92	45.12	63.49
	8	.41	2.39	.86	71.87	169.87	.32	1.88	.89	58.50	109.91
	48	.23	1.33	.92	42.81	56.89	.17	1.01	.94	33.20	33.55
	40	.25	1.44	.92	46.01	66.16	.19	1.10	.94	35.85	39.33
#6	32	.27	1.58	.91	50.14	79.27	.21	1.21	.93	39.32	47.63
	24	.31	1.78	.90	55.79	99.38	.24	1.37	.92	44.14	60.65
As = .44	16	.36	2.10	.88	64.30	134.27	.28	1.63	.91	51.62	84.29
	8	.47	2.71	.84	79.78	211.54	.37	2.16	.88	65.98	141.82
	48	.26	1.52	.91	48.34	73.42	.20	1.16	.93	37.81	43.91
	40	.28	1.64	.91	51.81	84.96	.22	1.26	.93	40.73	51.28
#7	32	.31	1.80	.90	56.25	101.11	.24	1.39	.92	44.54	61.79
	24	.35	2.02	.88	62.25	125.37	.27	1.57	.91	49.79	78.12
As = .60	16	.41	2.36	.86	71.14	166.13	.32	1.86	.89	57.82	107.22
	8	.52	3.01	.83	86.78	252.34	.42	2.43	.86	72.86	174.84
	48	.29	1.70	.90	53.63	91.40	.23	1.31	.92	42.28	55.44
	40	.32	1.84	.89	57.31	105.20	.24	1.42	.92	45.46	64.50
#8	32	.35	2.01	.88	61.98	124.22	.27	1.56	.91	49.55	77.33
	24	.39	2.25	.87	68.24	152.19	.30	1.76	.90	55.17	97.04
As = .79	16	.45	2.61	.85	77.34	197.83	.36	2.07	.88	63.63	131.34
	8	.56	3.28	.81	92.84	290.80	.46	2.68	.85	79.08	207.66
	48	.32	1.88	.89	58.41	109.54	.25	1.45	.92	46.42	67.39
	40	.35	2.02	.88	62.25	125.36	.27	1.57	.91	49.79	78.12
#9	32	.38	2.20	.87	67.09	146.85	.30	1.72	.90	54.13	93.20
	24	.42	2.45	.86	73.50	177.85	.33	1.94	.89	60.02	116.03
As = 1.0	16	.49	2.83	.84	82.68	227.19	.39	2.27	.87	68.79	154.82
	8	.60	3.51	.80	97.85	324.75	.50	2.90	.83	84.41	238.13
	48	.36	2.06	.88	63.47	130.60	.28	1.61	.91	50.87	81.74
	40	.38	2.22	.87	67.44	148.46	.30	1.73	.90	54.44	94.36
#10	32	.41	2.41	.86	72.41	172.33	.33	1.90	.89	59.00	111.89
	24	.46	2.67	.85	78.91	206.12	.37	2.13	.88	65.13	137.96
As = 1.27	16	.53	3.06	.82	88.04	258.54	.43	2.48	.86	74.14	181.15
	8	.65	3.75	.78	102.66	359.37	.54	3.14	.82	89.75	270.82
	48	.38	2.26	.87	67.96	150.85	.30	1.75	.90	54.91	96.09
	40	.41	2.39	.86	72.02	170.38	.32	1.89	.89	58.64	110.44
#11	32	.45	2.60	.85	77.05	196.13	.35	2.06	.88	63.36	130.13
	24	.49	2.87	.84	83.56	231.95	.40	2.30	.87	69.66	158.94
As = 1.56	16	.56	3.27	.81	92.57	286.31	.46	2.67	.85	78.79	205.64
	8	.68	3.95	.77	106.55	388.76	.58	3.34	.81	94.23	299.99

Korfil®
Incorporated

Concrete Block
Insulating Systems, Inc.
P.O. Box 1000
W. Brookfield, MA 01585

K-1986-3-5000