LEGACY REPORT

ER-3081

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Legacy report on the 1997 *Uniform Building Code*™

DIVISION: 03—CONCRETE
Section: 03520—Lightweight Concrete Roof Insulation

STEEL DECKS WITH ELASTIZELL

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1.0 SUBJECT

Steel Decks with Elastizell.

2.0 DESCRIPTION

2.1 General:

Elastizell is placed on polystyrene foam plastic boards supported by steel roof decking. The systems, when constructed according to this report, function as structural diaphragms that resist earthquake and wind forces. See Figures 1 to 3 for typical details.

2.2 Materials:

2.2.1 Elastizell: The Elastizell cellular concrete is as specified in evaluation report ER-1381 and is controlled by testing according to ASTM C 796. The minimum 28-day concrete compressive strength (f'_c) must be 200 psi (1.4 MPa). All concrete must have a dry density of 30 ± 3 pcf (207 ± 21 kPa). The deck surface must be clear of all standing water, dirt, ice and other deleterious materials. The Elastizell is blended with Type I, II or III portland cement and no more than 6 gallons (22.7 L) of water per sack of cement. Placement must occur when temperatures are above 32˚F (0˚C). The Elastizell cellular concrete is normally cured by air drying one to two days prior to roofing. No more than five to seven days can lapse between Elastizell placement and roofing. The compatibility of the roof covering with Elastizell substrates must be verified by the roof covering manufacturer, including the need for sealers. Where reinforcing is provided, a Keydeck Style No. 2160-2-1619 wire mesh (No. 19 gage and No. 16 gage line wires) is used. Reinforcing is placed over the top flutes for systems without insulating board and in the top layer of insulating concrete for systems with insulation board. The mesh must be completely embedded in the concrete.

2.2.2 Foam Plastic: The polystyrene insulation board has a density of 0.9 pcf (14.42 kg/m^3) minimum and is $^3/_4$ to 8 inches (19 to 203 mm) thick with 3-inch-diameter (76 mm) holes. Hole spacings and board dimensions are shown in Figure 3. Proper board placement requires the long side perpendicular to corrugations, with end joints staggered. The polystyrene board must be recognized in a current ICC-ES report for the thickness used.

2.2.3 B [$1^1/_2$-inch (38 mm)] Decks: The steel must conform to ASTM A 653 SS Grade 33 or Grade 40. The deck has maximum 36-inch (914 mm) cover width, with 6-inch (152 mm) flute pitch. The decks are cold formed from steel sheets galvanized in accordance with ASTM A 924, Coating Class G-60. Deck profiles are shown in Figure 2.

2.3 Deck Attachments: B [$1^1/_2$-inch (138 mm)] Decks:

2.3.1 General: For attachments at interior lines, shear transfers between diaphragms and interior ties, or at strut lines perpendicular to the deck, corrugations must not exceed the diaphragm values in current evaluation reports for bare decks without concrete fill, using attachments at the line of shear transfer identical to those used for exterior support connections. Two lines of exterior support connections may be used to develop the total shear transfer. Where individual panels are cut, the partial panel shall be connected at that point to the adjacent full panels to fully transfer shears, that are within the allowable shear values noted in diaphragm load tables.

Weld washers are not required for deck attachments. Deck welding must comply with Figure 2. Arc spot welds to chords or struts parallel to corrugations must have a spacing in feet equal to 32,000 (t)/v (where t = deck thickness in inches, and v = actual shear in pounds per foot to be transferred to chord or strut members). In no case shall the spacing of welds exceed the deck span divided by three.

2.3.2 Welding Requirements: Welding electrodes must have a minimum $^1/_8$-inch (3.2 mm) diameter. Spot weld fusion to supports is $^1/_2$-inch (12.7 mm) diameter, minimum. The filler metal is E60XX or E70XX complying with the appropriate AWS standard. Other weld requirements must comply with AWS D1.3-98.

2.4 Applicable Uses:

2.4.1 Fire-resistive Roof Construction: For fire-resistive roof construction, refer to evaluation report ER-1381.

2.4.2 Roof Construction with Restrained B [$1^1/_2$-inch (38 mm)] Deck and Polystyrene Insulation Board: This restrained deck system is constructed in accordance with Figure 2 and as described in evaluation reports ER-2078 and ESR-1414. For diaphragm shear values, see Tables 2 and 3.

Wire reinforcement is optional, but must be completely embedded into the top layer of cellular concrete when used.

See Figure 1 or 2. The concrete must be covered with a classified roof covering complying with Chapter 15 of the 1997 *Uniform Building Code*™ (UBC).

2.5 Special Inspection:

2.5.1 Concrete: Continuous special inspection for concrete and concrete reinforcement complies with Sections 1701.1 and 1701.4 of the UBC. Responsibilities include sampling and testing, verification of concrete mixes, verification of reinforcement and placement, and concrete placement.

2.5.2 Welding: Continuous or periodic special inspection for welding complies with Section 1701.5 of the UBC. Before proceeding, the welder must demonstrate his ability to produce the prescribed weld to the special inspector's satisfaction.Other inspector responsibilities include verification of materials, weld preparation, welding procedures and welding processes.

2.6 Diaphragm Design Considerations:

The diaphragm design must take into account the following considerations:

1. Diaphragm classification (flexible or rigid) must comply with Section 1630.6 of the UBC; the diaphragm deflection (Δ) must be calculated using the equations noted in the Diaphragm Flexibility Limitations table (Table 1).
2. Diaphragm flexibility limitations shall comply with Table 1.
3. Diaphragm deflection limits shall comply with Section 1633.2.9 of the UBC.
4. Horizontal shears must be distributed in accordance with Sections 1630.6 and 1630.7 of the UBC.

2.7 Identification:

Each project must have a card that is presented to the building official noting the date and the applicator's name and address. The insulation board is identified in accordance with the pertinent evaluation report.

3.0 EVIDENCE SUBMITTED

Diaphragm load test reports and calculations.

4.0 FINDINGS

That the Elastizell cellular concrete, where used with steel decks installed by the Cell-Crete Corporation complies with the 1997 *Uniform Building Code*™, subject to the following conditions:

4.1 Diaphragm and cellular concrete fill are installed in accordance with this report and the manufacturer's instructions.

4.2 Allowable spans for vertical loading are based on steel deck section properties only.

4.3 Maximum allowable diaphragm shears comply with this report, with no increase for short-term loading.

4.4 Consideration is given to diaphragm deflection requirements in Table 1.

4.5 Special inspection for welding and concrete in accordance with Section 2.5 is provided.

This report is subject to re-examination in two years.

TABLE 1—DIAPHRAGM FLEXIBILITY LIMITATION[1,2,3,5]

F	MAXIMUM SPAN IN FEET FOR MASONRY OR CONCRETE WALLS	SPAN-DEPTH LIMITATION			
		Rotation Not Considered in Diaphragm Design		Rotation Considered in Diaphragm Design	
		Masonry or Concrete Walls	Flexible Walls[4]	Masonry or Concrete Walls	Flexible Walls[4]
1-10	No limitation	3:1 or as required for deflection	5:1	As required for deflection	3:1

For **SI:** 1 inch = 25.4 mm, 1 pound = 4.45 N.

[1]Roof diaphragms are to be investigated regarding their flexibility and recommended span-depth limitations.

[2]Roof diaphragms supporting masonry or concrete walls are to have their deflections limited to the following amount:

$$\Delta wall = \frac{H^2 f_c}{0.01Et}$$

where:

H = Unsupported height of wall in feet.
t = Thickness of wall in inches.
E = Modulus of elasticity of wall material for deflection determination in pounds per square inch.
f_c = Allowable compressive strength of wall material in flexure in pounds per square inch. For concrete, $f_c = 0.45 f_c$. For masonry, $f_c = F_b = 0.33 f'_m$.

[3]The total deflection of the diaphragm may be computed from the equation:

$\Delta = \Delta_f + \Delta_w$

where:

Δ_f = Flexural deflection of the diaphragm determined in the same manner as the deflection of beams.
Δ_w = The web deflection may be determined by the equation:

$$\Delta_w = \frac{q_{avg} L_1 F}{10^6}$$

where:

L_1 = Distance in feet between vertical resisting element (such as shear wall) and the point to which the deflection is to be determined.
$qavg$ = Average shear in diaphragm over length L_1 in pounds per square foot.
F = Flexibility factor: The average microinches a diaphragm web will deflect in a span of 1 foot under a shear of 1 pound per foot.

[4]When applying these limitations to cantilevered diaphragms, the allowable span-depth ratio will be half that shown.

[5]Diaphragm classification (flexible or rigid) and deflection limits shall comply with Section 2.6, Diaphragm Design Considerations.

TABLE 2—RESTRAINED B ($1^1/_2$-INCH) DIAPHRAGM SYSTEM DIAPHRAGM SHEAR VALUES AND FLEXIBILITY FACTORS[1,2,3,4,5,6,7]
33 ksi ≥ F_y < 40 ksi

GAGE (thickness in inches)		SEAM FASTENING											
		BP at 24″ o.c.			TSW at 24″ o.c.			TSW at 16″ o.c.			TWS at 12″ o.c.		
Maximum Span		6.0′	8.0′	10.0′	6.0′	8.0′	10.0′	6.0′	8.0′	10.0′	6.0′	8.0′	10.0′
22	*Q*	970	920	770	1,380	1,230	1,140	1,490	1,360	1,290	1,600	1,490	1,430
(0.030)	*F*	(5.6)	(7.2)	(9.0)	(4.4)	(4.8)	(5.1)	(4.0)	(4.3)	(4.5)	(3.8)	(4.0)	(4.1)
20	*Q*	1,110	1,040	910	1,450	1,300	1,210	1,590	1,460	1,390	1,720	1,610	1,540
(0.036)	*F*	(4.7)	(6.0)	(7.6)	(3.8)	(4.1)	(4.4)	(3.4)	(3.6)	(3.8)	(3.2)	(3.3)	(3.5)
18	*Q*	1,350	1,250	1,180	1,570	1,420	1,340	1,750	1,620	1,560	1,910	1,800	1,740
(0.048)	*F*	(3.5)	(4.6)	(5.9)	(3.0)	(3.3)	(3.5)	(2.7)	(2.8)	(3.0)	(2.5)	(2.6)	(2.7)
16	*Q*	1,540	1,430	1,350	1,680	1,530	1,460	1,880	1,770	1,700	2,070	1,970	1,920
(0.060)	*F*	(2.9)	(3.8)	(5.0)	(2.5)	(2.8)	(3.0)	(2.2)	(2.4)	(2.5)	(2.0)	(2.2)	(2.3)

For **SI:** 1 inch = 25.4 mm, 1 pound = 4.45 N.

[1]Decks are welded to all structural supports with minimum $^3/_4$-inch-diameter arc spot (puddle) welds at each flute. Welds require E60XX or E70XX electrodes.

[2]Construction details are presented in Figures 2 and 3.

[3]Construction Sequence:

a. Elastizell slurry is applied over decking to a depth of $^1/_8$ inch over top flute.
b. Insulation board is embedded in wet slurry with long dimension parallel to deck flutes.
c. Insulation board is covered by the specified 2-inch minimum thickness of Elastizell.

[4]Nomenclature:

BP = Button-punch seams.
TSW = Top seam welds.
Q = Diaphragm shear, in pounds per lineal foot.
F = Flexibity factor. See Table 1 for application.

[5]Diaphragm *Q* and *F* values for polystryene insulation board $^3/_4$ to 4 inches thick are noted in tables. For greater board thicknesses, *Q* and *F* values are obtained from Evaluation Report ER-2078 on restrained Type B deck systems without fill.

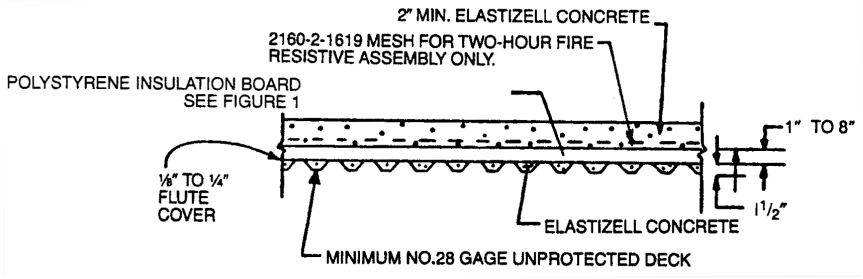
[6]The tabulated values may be used in roof systems without the insulation board, provided the Elastizell thickness is increased to $2^1/_4$ inches.

[7]Maximum span used shall also be limited by the vertical load design based on the section properties and yield strength of the steel deck alone.

TABLE 3—RESTRAINED B ($1^1/_2$-INCH) DIAPHRAGM SYSTEM DIAPHRAGM SHEAR VALUES AND FLEXIBILITY FACTORS[1,2,3,4,5,6,7]
F_y = 40 ksi

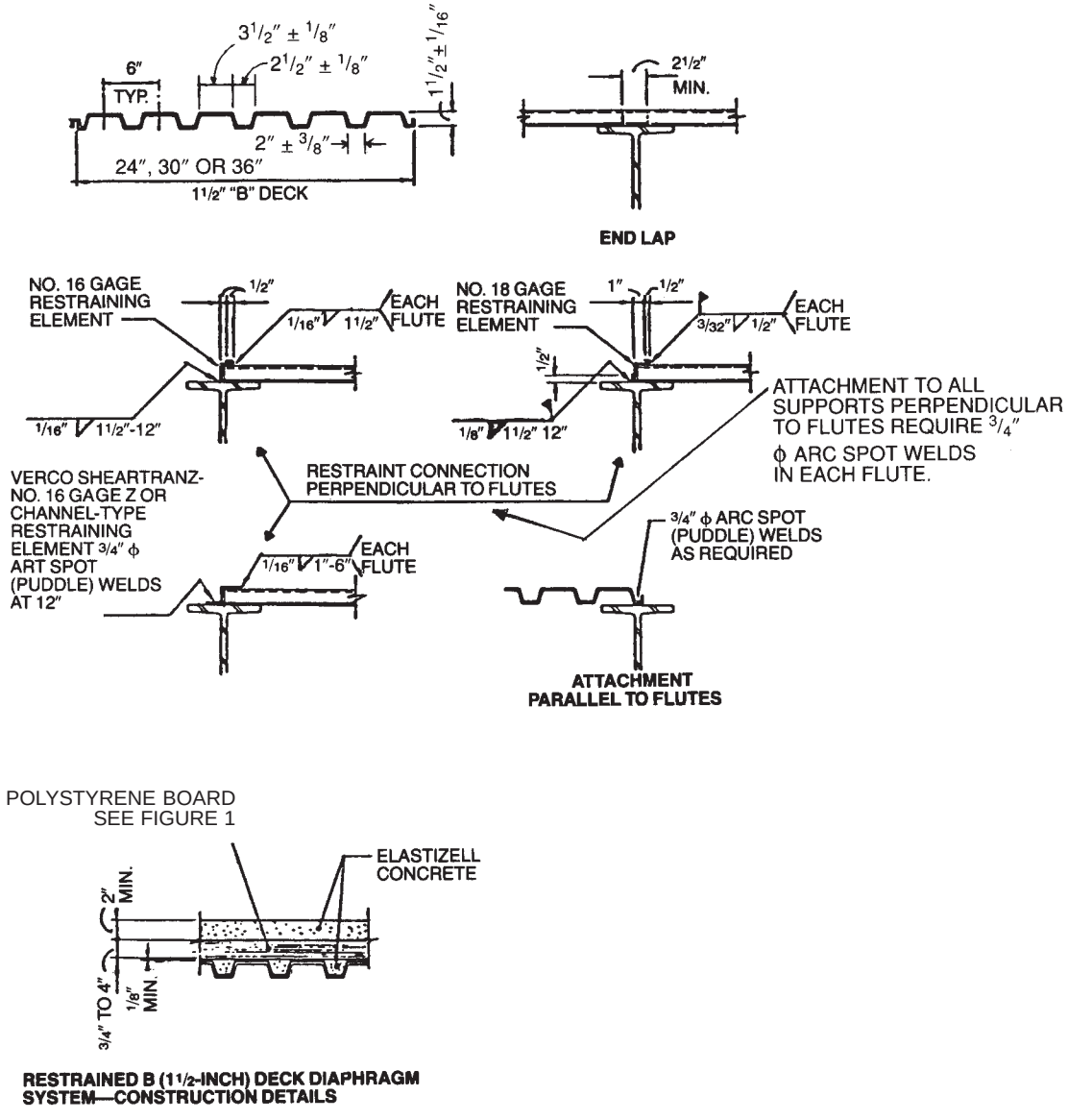
GAGE (thickness in inches)		SEAM FASTENING											
		BP at 24″ o.c.			TSW at 24″ o.c.			TSW at 16″ o.c.			TWS at 12″ o.c.		
Maximum Span		6.0′	8.0′	10.0′	6.0′	8.0′	10.0′	6.0′	8.0′	10.0′	6.0′	8.0′	10.0′
22	*Q*	1,020	970	880	1,420	1,260	1,160	1,530	1,390	1,310	1,640	1,510	1,450
(0.030)	*F*	(5.7)	(7.3)	(9.2)	(4.5)	(4.9)	(5.3)	(4.1)	(4.4)	(4.6)	(3.8)	(4.0)	(4.2)
20	*Q*	1,170	1,100	1,040	1,500	1,330	1,230	1,620	1,480	1,400	1,750	1,630	1,560
(0.036)	*F*	(4.7)	(6.1)	(7.8)	(3.9)	(4.2)	(4.6)	(3.5)	(3.7)	(3.9)	(3.2)	(3.4)	(3.6)
18	*Q*	1,420	1,320	1,240	1,610	1,450	1,360	1,780	1,640	1,570	1,930	1,820	1,760
(0.048)	*F*	(3.6)	(4.7)	(6.1)	(3.1)	(3.4)	(3.7)	(2.7)	(2.9)	(3.1)	(2.5)	(2.7)	(2.8)
16	*Q*	1,630	1,500	1,410	1,710	1,560	1,470	1,910	1,790	1,720	2,100	1,990	1,930
(0.060)	*F*	(2.9)	(3.9)	(5.1)	(2.6)	(2.9)	(3.1)	(2.3)	(2.4)	(2.6)	(2.1)	(2.2)	(2.3)

For **SI:** 1 inch = 25.4 mm, 1 pound = 4.45 N.
For footnotes, see Table 2.



For **SI:** 1 inch = 25.4 mm.

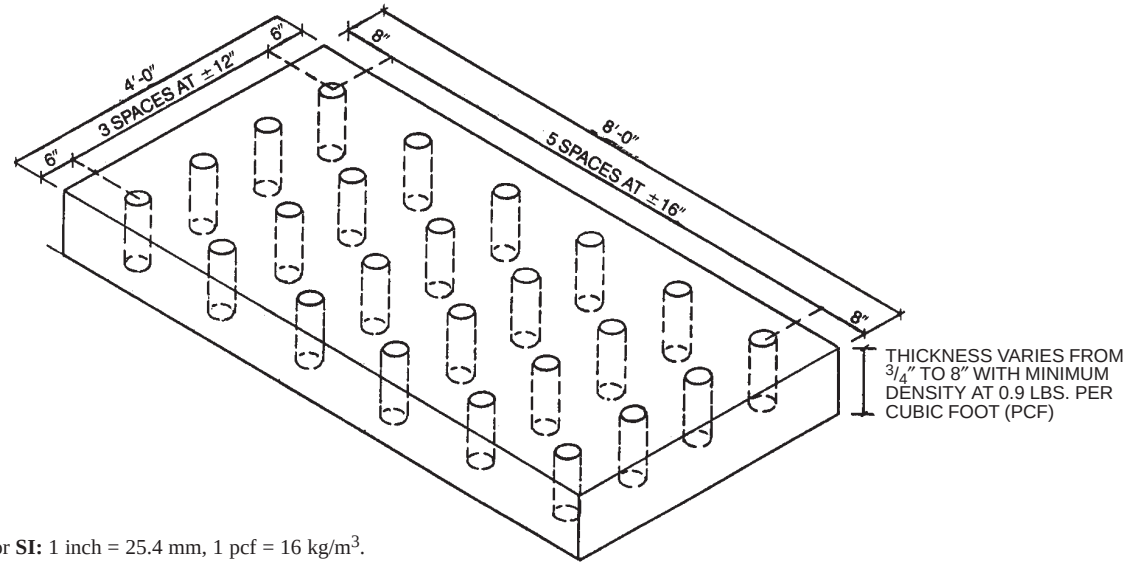
FIGURE 1—UNRESTRAINED ASSEMBLIES



RESTRAINED B (1 1/2-INCH) DECK DIAPHRAGM SYSTEM—CONSTRUCTION DETAILS

For **SI:** 1 inch = 25.4 mm.

FIGURE 2—RESTRAINED B (1 1/2-INCH) DECK DIAPHRAGM SYSTEM—CONSTRUCTION DETAILS



For **SI:** 1 inch = 25.4 mm, 1 pcf = 16 kg/m^3.

FIGURE 3—POLYSTYRENE INSULATING BOARD