

ICC-ES Evaluation Report


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<p>DIVISION: 03 00 00— CONCRETE</p> <p>Section: 03 11 00— Concrete Forming</p> <p>Section: 03 30 00—Cast- in Place Concrete</p>	<p>REPORT HOLDER:</p> <p>UNIDOME DEUTSCHLAND GMBH UNIDOME GLOBAL DWC LLC</p>	<p>EVALUATION SUBJECT:</p> <p>UNIDOME XS CONCRETE SHAPER ELEMENTS</p>	
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1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018 and 2015 [International Building Code® \(IBC\)](#)

Property evaluated:

- Structural
- Fire resistance

2.0 USES

Unidome XS Concrete Shaper Elements are used in design and construction of two-way reinforced concrete floor and roof slabs in compliance with ACI 318.

3.0 DESCRIPTION

3.1 General:

The purpose of this evaluation report is to provide a design procedure and design parameters utilizing the IBC and ACI 318-19 provisions for design of two-way reinforced concrete floor and roof slabs with Unidome XS Concrete Shaper Elements. Two-way reinforced concrete floor and roof slab thicknesses with Unidome XS Concrete Shaper Elements range from 18 to 56 cm (7 to 22 in.). Reinforced concrete floor and roof slabs are designed as flat plates or flat slabs with drop panels and column capitals.

Two-way reinforced concrete floor and roof slabs carrying flexure and shear in two directions must be designed under the IBC and comply with the requirements of ACI 318-19 Chapters 8 and 22.

The design must include basic information on the two-way reinforced concrete floor and roof slabs including deformed steel bar reinforcement limits and detailing.

3.2 Materials:

3.2.1 Concrete: Structural concrete must comply with ACI 318. Minimum concrete compressive strength must be 4,000 psi (27.6 MPa). Cast-in place concrete materials must comply with ACI 318 Chapter 19. Concrete tolerances must comply with ACI 117.

3.2.2 Deformed Steel Bar Reinforcement: Non-prestressed, deformed steel bar reinforcement must comply with ACI 318 Chapter 20.

3.2.3 Unidome XS Concrete Shaper Elements: Unidome XS Concrete Shaper Elements are proprietary hollow shapes with an integrated tunnel for stability manufactured from High Density Polyethylene (HDPE) or Polypropylene (PP) plastic conforming with the manufacturer's specifications. Unifix hooks are manufactured from HDPE or PP plastic and are used to connect the Unidome XS Concrete Shaper Elements to 6 mm diameter reinforcing steel bars conforming to B500A or B500B that are placed above and below the elements and between the top and bottom deformed steel bar reinforcement mats in the concrete roof and floor flat plate and flat slab formwork. The 6 mm diameter B500A or B500B reinforcing steel bars are for positioning and buoyancy control of the Unidome XS Concrete Shaper Elements only.

4.0 DESIGN AND INSTALLATION

Design of reinforced concrete floor and roof slabs must comply with IBC Chapters 16 and 19 requirements. Slab designs resisting gravity loads must satisfy equilibrium and geometric compatibility using the Direct Design Method or Equivalent Frame Method referenced in ACI 318 Section 6.2.4.1.

- Deflections of reinforced concrete floor and roof slabs must not exceed the more restrictive of IBC Table 1604.3 and that permitted by ACI 318 Section 8.3.2. Deflections of two-way slabs must comply with ACI 318 Section 24.2.
- Moment of inertia and cross-sectional area of slabs at the factored load level must be calculated in accordance with ACI 318 Tables 6.6.3.1.1(a) or 6.6.3.1.1(b). A more rigorous analysis may be used and must be submitted to the code official for approval.
- Modulus of Elasticity, E_c , must be calculated using ACI 318 Section 19.2.2. Minimum slab provisions must comply with IBC Section 1907. Two-way reinforced concrete floor and roof slab thicknesses must meet the requirements of ACI 318 Tables 8.3.1.1 and 8.3.1.2 and reinforcement detailing must comply with ACI 318 Section 8.7.
- Design of two-way reinforced concrete floor and roof slabs for structural integrity must comply with IBC Section 1616.2.1, including ACI 318 Section 4.10.2, Table 4.10.2.1 and Section 8.7.4.2.
- Diaphragm design of two-way reinforced concrete floor and roof slabs must be in accordance with ACI 318 Chapter 18 and ASCE/SEI 7-16 Chapter 12. Concrete slab thickness used in diaphragm design must be based on the net cross-section utilizing the concrete cover above and below the Unidome XS Concrete Shaper Elements.

4.1 Alternative Design Provisions for Two-Way Reinforced Concrete Floor and Roof Slabs Including Unidome XS Concrete Shaper Elements:

4.1.1 General: Two-way reinforced concrete floor and roof slabs must be designed using the provisions in this section addressing modifications for:

1. Stiffness modification. Unidome XS Concrete Shaper Element stiffness factors are provided in [Tables 3 and 4](#).
2. Flexural strength. Calculated in accordance with ACI 318.
3. Shear capacity. Calculated in accordance with ACI 318.
4. Punching shear. Unidome XS Concrete Shaper Elements are restricted from use in areas around columns and along the perimeter of two-way reinforced concrete slabs. In these locations, the reinforced concrete floor and roof slabs must be solid sections. Design of punching shear resistance including column capitals must comply with ACI 318-19 provisions.

4.1.2 Alternative Design Provisions:

1. Determine the minimum slab thickness for serviceability. ACI 318-19 Table 8.3.1.1 and Table 8.1.3.2 (ACI 318-14 Table 8.3.1.1 for the 2018 IBC and ACI 318 Table 9.5c for the 2015 IBC).
2. Determine the slab thickness based on Unidome XS Concrete Shaper Element product parameters provided in [Tables 1, 2 and 3](#).
3. Determine the reduced and average dead loads taking the Unidome XS Concrete Shaper Element volume and spacing into account. The dead load reduction corresponds to an average reduction in slab weight.
4. Determine the bending moments at the critical sections for a typical interior bay. The Direct Design Method may be utilized for determination of bending moment in two-way slabs and is applicable to orthogonal frames subjected to gravity loads only in accordance with ACI 318-19 Sections 6.2.4.1, 8.2.1 and 8.4.1.2 (ACI 318-14 Sections 8.2.1, 8.4.1.2 and 8.10.2 and ACI 318-11 Sections 13.5.1.1 and 13.6.1).

- a. Determine the total factored static moment M_o in each span using load factors and combinations from ACI 318-19 Section 5.3 (ACI 318-14 Section 5.3 and Equation 8.10.3.2; ACI 318-11 Section 9.2.1 and Equation 13-4).
 - b. Distribute M_o into negative and positive bending moments in each span. (ACI 318-14 Section 8.10.4 and ACI 318-11 Section 13.6.3).
 - c. Distribute the total negative and positive bending moments in the design strip to the column strip and middle strip. (ACI 318-14 Sections 8.10.5, 8.10.5.7 and 8.10.6; ACI 318-11 Section 13.6.4, 13.6.5 and 13.6.6).
5. Determine the required flexural reinforcement at the critical sections for a typical interior bay using ACI 318-19 Chapter 22 and Sections 8.6 and 8.7 (ACI 318-14 Chapter 22 and Sections 8.6 and 8.7; ACI 318-11 Chapter 10 and Sections 10.6.2 and 13.3).
- a. Assume a tension-controlled section. Reference ACI 318-19 Section 21.2 (ACI 318-14 Section 21.2; ACI 318-11 Section 9.3.2).
 - b. Determine the nominal strength coefficient of resistance $R_n = M_u / \phi b d^2$
 - c. Determine the required reinforcement ratio ρ . (ACI 318-19 Section 21.2.2; ACI 318-14 Section 21.2.2; ACI 318-11 Section 10.3.2).
 - d. Determine the required area of tension reinforcement $A_s = \rho b d$.
 - e. Determine the minimum required area of reinforcement, $A_{s, \min}$. (ACI 318-19 Section 8.6.1.1; ACI 318-14 Section 8.6 and Table 8.6.1.1; ACI 318-11 Section 13.3.1).
 - f. Determine the depth of the equivalent rectangular stress block a . (ACI 318-19 Section 22.2.2.4; ACI 318-14 Section 22.2.2.4; ACI 318-11 Section 10.2.7).
 - g. Determine β_1 . (ACI 318-19 Table 22.2.2.4.3; ACI 318-14 Table 22.2.2.4.3; ACI 318-11 Section 10.2.7.3).
 - h. Determine the neutral axis depth c . (ACI 318-19 Section 22.2.2.4.1; ACI 318-14 Section 22.2.2.4.1; ACI 318-11 Section 10.2.7.1).
 - i. Determine ϵ_t . (ACI 318-19 Sections 8.3.3.1 (R9.3.3) and 21.2.2; ACI 318-14 Sections 8.3.3.1 and 21.2.2; ACI 318-11 Sections 10.3.4 and 10.3.5).
 - j. Choose size and spacing of reinforcing bars. (ACI 318-19 Sections 8.7.2.2, 24.4, 8.4.2.2.1, 8.4.2.2.2, Equation 8.4.2.2.2, Section 8.4.2.2.4 and Figure R8.7.3.1; ACI 318-14 Sections 8.7.2.2, 24.4, 8.4.2.3.1, 8.4.2.3.2, Equation 8.4.2.3.2, Section 8.4.2.3.4 and Figure R8.7.3.1; ACI 318-11 Sections 13.3.2, 7.12, 13.5.3, 13.5.3.2, Equation 13-1, Section 15.5.3.3a and Figure 13.3.6).
6. Check two-way shear requirements. (ACI 318-19 Sections 22.6, 22.6.5.2, 22.6.5.3 and Equation 8.4.4.2.2; ACI 318-14 Section 22.6, Tables 22.6.5.2 and 22.6.5.3, Section 8.10.7.3 and Equation 8.4.4.2.2; ACI 318-11 Section 11.11.2.1, Equation 11-33, Section 13.6.3.6 and Equation 11-37).

4.2 Fire Resistance

Fire resistance ratings must be justified to the satisfaction of the building code official in accordance with the following 2021 IBC provisions:

- Section 703.2.2 Analytical Methods,
- Section 722.2.2 Concrete floor and roof slabs,
- Section 722.2.2.1.4 Flat plate concrete slabs with uniformly spaced hollow voids.

Fire resistance and minimum concrete cover of reinforced concrete slabs with Unidome XS Concrete Shaper Elements must be determined in accordance with [Table 5](#) for one-way slabs (single spans), [Tables 6](#) and [7](#) for two-way slabs, and [Table 8](#) for flat plate slabs of uniform thickness without drop panels or column capitals. Concrete used in fire resistance design of reinforced concrete slabs with Unidome XS Concrete Shaper Elements must have a minimum concrete compressive strength of 4,000 psi (27.6 MPa) with moisture content less than 3 percent by weight.

Minimum flat plate and flat slab thickness must comply with 2021 IBC Table 722.2.2.1. Minimum concrete cover thickness for reinforced concrete floor and roof flat plates and flat slabs must comply with 2021 IBC Table 722.2.3(1).

4.3 Installation

Complete installation instructions for the Unidome XS Concrete Shaper Elements must be provided and available at the project site during construction. Installation instructions must include requirements and limitations regarding Unidome XS Concrete Shaper Elements and description of the methods of field preparation and installation in the formwork. Deformed steel bar reinforcement placement and tying procedures must be defined by Unidome. See [Figure 4](#).

4.3.1 Special Inspection: Concrete floor and roof slab construction utilizing Unidome XS Concrete Shaper Elements is subject to special inspection and test requirements in IBC Section 1705.3 and Table 1705.3. Documentation providing evidence of conformance to the quality standards for materials in ACI 318 Chapters 19 and 20 shall be submitted to the building official. Inspections shall be performed by qualified inspectors under the supervision of a registered design professional. Special inspection must also comply with Chapter 17 of the IBC.

5.0 CONDITIONS OF USE:

The alternative design of two-way reinforced concrete floor and roof slabs described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 Design of two-way reinforced concrete floor and roof slabs with Unidome XS Concrete Shaper Elements must be in accordance with ACI 318 provisions and this report.
- 5.2 Design of two-way reinforced concrete floor and roof slabs must be performed by a registered design professional and submitted to the building official for approval.
- 5.3 Corrosion resistance of the Unidome XS Concrete Shaper Elements and Unifix Hooks is outside the scope of this evaluation report. A registered design professional must be responsible for addressing corrosion resistance.
- 5.4 Embedments and anchorage to two-way reinforced concrete floor and roof slabs with Unidome XS Concrete Shaper Elements are outside the scope of this evaluation report.
- 5.5 Penetrations and openings in two-way reinforced concrete floor and roof slabs with Unidome XS Concrete Shaper Elements are outside the scope of this evaluation report.
- 5.6 Unidome XS Concrete Shaper Elements are manufactured in Dubai, UAE under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

- 6.1 Unidome XS Concrete Shaper Elements product data and test reports.
- 6.2 Finite Element Analysis of concrete slabs with Unidome XS Concrete Shaper Elements.
- 6.3 Calculations in accordance with ACI 318-19 and the Concrete Reinforcing Steel Institute (CRSI) Design Guide for Voided Concrete Slabs, First Edition, 2014.

7.0 IDENTIFICATION

- 7.1 The Unidome XS Concrete Shaper Elements must be identified with a label including the company name (Unidome), XS Concrete Shaper Element nomenclature and size, and the evaluation report number ESR-4762.
- 7.2 The report holder's contact information is the following:

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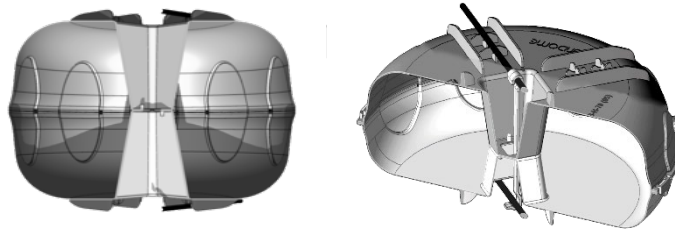


FIGURE 1—UNIDOME XS CONCRETE SHAPER ELEMENT AND CROSS-SECTION

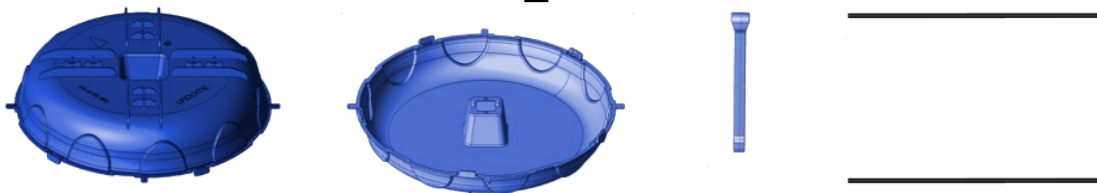


FIGURE 2—UNIDOME XS CONCRETE SHAPER ELEMENT HALVES, UNIFIX HOOK AND 6 MM DIAMETER STEEL REINFORCING BARS FOR INSTALLATION IN REINFORCED CONCRETE FLOOR AND ROOF SLABS

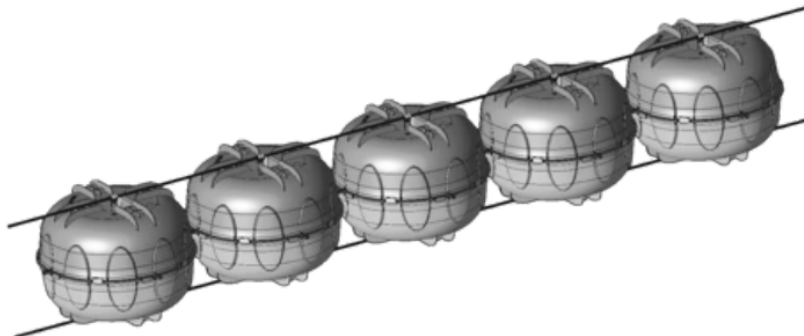


FIGURE 3—UNIDOME XS CONCRETE SHAPER ELEMENTS ATTACHED TO 6 MM DIAMETER STEEL REINFORCING BARS WITH UNIFIX HOOKS

TABLE 1—UNIDOME XS CONCRETE SHAPER ELEMENT DIMENSIONS AND MINIMUM SLAB THICKNESS

XS-SIZE	XS 60 (90)	XS 80 (110)	XS 100 (130)	XS 120 (150)	XS 140 (170)	XS 160 (190)	XS 180 (210)	XS 200 (230)	XS 220 (250)	XS 240 (270)	XS 260 (290)
XS-H top	30 (45)	50 (65)	50 (65)	70 (85)	70 (85)	110 (125)	110 (125)	130 (145)	110 (125)	130 (145)	130 (145)
XS-H bottom	30 (45)	30 (45)	50 (65)	50 (65)	70 (85)	50 (65)	70 (85)	70 (85)	110 (125)	110 (125)	130 (145)
min slab thickness [cm]	18	20	22	24	26	28	30	32	35	38	40

For SI: 1 cm = 0.394 in.

TABLE 2—UNIDOME XS CONCRETE SHAPER ELEMENT PROPERTIES

Unidome XS	XS-60 (90)	XS-80 (110)	XS-100 (130)	XS-120 (150)	XS-140 (170)	XS-160 (190)	XS-180 (210)	XS-200 (230)	XS-220 (250)	XS-240 (270)	XS-260 (290)
diameter of concrete shaper without flange [cm]	31.50										
diameter of concrete shaper with flange [cm]	32.84										
cavity height [cm]	6	8	10	12	14	16	18	20	22	24	26
total height of element [cm]	9	11	13	15	17	19	21	23	25	27	29
thickness of wall [mm]	>1.0										
weight [g/concrete shaper]	between 350 and 600										
concrete shapers per element [pc]	1 up to 6										
diameter of fixing reinforcement bar [mm]	6										
minimum center distance of concrete shapers (length- and crosswise) [cm]	35										
height of integrated spacers top and bottom each [mm]	15										

For SI: 1 cm = 0.394 in.; 1 mm = 0.0394 in.; 1 g = 0.0022 lbs.

TABLE 3—UNIDOME XS CONCRETE SHAPER ELEMENT DESIGN PARAMETERS

		XS-60 (90)	XS-80 (110)	XS-100 (130)	XS-120 (150)	XS-140 (170)	XS-160 (190)	XS-180 (210)	XS-200 (230)	XS-220 (250)	XS-240 (270)	XS-260 (290)	
General													
min. slab thickness	$h_{d,min}$	cm	18	20	22	24	26	28	30	32	35	38	40
max. slab thickness	$h_{d,max}$	cm	36	38	40	42	44	46	48	50	52	54	56
height of concrete shaper (cavity only)	D_{XS}	cm	6	8	10	12	14	16	18	20	22	24	26
height of concrete shaper (including spacers)		cm	9	11	13	15	17	19	21	23	25	27	29
shear factor	f_v	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
stiffness factor	f_{EI}	-	0.98	0.97	0.96	0.94	0.93	0.92	0.92	0.91	0.91	0.91	0.91
cavity diameter (horizontal)		cm	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
min. center distance of concrete shapers	e_{xy}	cm	35	35	35	35	35	35	35	35	35	35	35
void formers per m ²		pcs/m ²	8.16	8.16	8.16	8.16	8.16	8.16	8.16	8.16	8.16	8.16	8.16
concrete strength and type		-	$f_c > 4000$ psi; normal weight concrete										
maximum aggregate size		mm	16	16	16	16	16	16	16	16	16	16	16
volume displacement	v_{ys}	m ³ /m ²	0.0335	0.0443	0.0551	0.0652	0.0753	0.0837	0.0938	0.1010	0.1123	0.1195	0.1265
weight reduction (concrete 25 kN/m ³)		kN/m ²	0.84	1.11	1.38	1.63	1.88	2.09	2.35	2.53	2.81	2.99	3.16

For SI: 1 cm = 0.394 in.; 1 mm = 0.0394 in.; 1 kN/m² = 20.89 psf; 1 m³/m² = 3.28 ft³/ft²; 1 MPa = 145 psi.

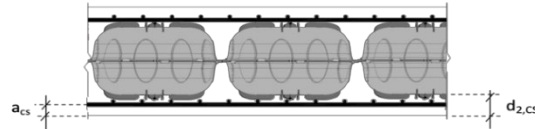
TABLE 4—STIFFNESS FACTORS FOR CONCRETE SLABS WITH UNIDOME XS CONCRETE SHAPER ELEMENTS COMPARED TO SOLID CONCRETE SLABS

Slab Thickness h [cm]	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Cavity Height D_{UD} [mm]	60 Type XS-60 (90)																						
$I_{UD}/I_{solid} [-]$ centrally	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm	0.98	0.98	0.98	0.97	0.97	0.96	0.96	0.95	0.94	0.94	0.94	0.94	0.93	0.92	0.92	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.91
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.98	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.94
Slab Thickness h [cm]	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Cavity Height D_{UD} [mm]	80 Type XS-80 (110)																						
$I_{UD}/I_{solid} [-]$ centrally	0.97	0.97	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm	0.97	0.97	0.97	0.97	0.96	0.95	0.95	0.94	0.94	0.94	0.93	0.92	0.92	0.92	0.91	0.91	0.9	0.9	0.9	0.9	0.9	0.9	0.90
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.96	0.96	0.95	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.93	0.93
Slab Thickness h [cm]	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Cavity Height D_{UD} [mm]	100 Type XS-100 (130)																						
$I_{UD}/I_{solid} [-]$ centrally	0.96	0.96	0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm	0.96	0.96	0.96	0.95	0.95	0.95	0.94	0.94	0.93	0.92	0.92	0.92	0.91	0.91	0.90	0.90	0.9	0.89	0.89	0.89	0.88	0.88	0.88
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.95	0.95	0.95	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.92
Slab Thickness h [cm]	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Cavity Height D_{UD} [mm]	120 Type XS-120 (150)																						
$I_{UD}/I_{solid} [-]$ centrally	0.94	0.95	0.96	0.96	0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm	0.94	0.95	0.95	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.87
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.95	0.96	0.96	0.97	0.97	0.97	0.96	0.96	0.96	0.95	0.95	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.91	0.91
Slab Thickness h [cm]	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Cavity Height D_{UD} [mm]	140 Type XS-140 (170)																						
$I_{UD}/I_{solid} [-]$ centrally	0.93	0.94	0.95	0.95	0.95	0.96	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm	0.93	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.91	0.91	0.90	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.87	0.87	0.87
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.92	0.92	0.92	0.91	0.91	0.91
Slab Thickness h [cm]	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Cavity Height D_{UD} [mm]	160 Type XS-160 (190)																						
$I_{UD}/I_{solid} [-]$ centrally	0.92	0.93	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm	0.92	0.93	0.93	0.93	0.93	0.93	0.92	0.92	0.91	0.91	0.91	0.90	0.90	0.9	0.89	0.88	0.88	0.88	0.87	0.87	0.87	0.87	0.87
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.93	0.94	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.91	0.91	0.91
Slab Thickness h [cm]	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Cavity Height D_{UD} [mm]	180 Type XS-180 (210)																						
$I_{UD}/I_{solid} [-]$ centrally	0.92	0.93	0.93	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm	0.92	0.92	0.93	0.93	0.93	0.93	0.93	0.92	0.91	0.91	0.9	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.87	0.87	0.87	0.86	0.86
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.93	0.94	0.94	0.92	0.92	0.95	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.91	0.91	0.91	0.91	0.90
Slab Thickness h [cm]	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Cavity Height D_{UD} [mm]	200 Type XS-200 (230)																						
$I_{UD}/I_{solid} [-]$ centrally	0.91	0.92	0.93	0.93	0.94	0.94	0.95	0.95	0.95	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm	0.91	0.92	0.92	0.92	0.92	0.92	0.92	0.91	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.88	0.88	0.88	0.87	0.87	0.87	0.87	0.86
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.92	0.92	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.91	0.91	0.90	0.90
Slab Thickness h [cm]	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Cavity Height D_{UD} [mm]	220 Type XS-220 (250)																						
$I_{UD}/I_{solid} [-]$ centrally		0.92	0.92	0.93	0.93	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm		0.91	0.92	0.92	0.92	0.92	0.92	0.91	0.91	0.91	0.9	0.9	0.9	0.89	0.89	0.89	0.88	0.88	0.87	0.87	0.87	0.87	0.87
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm			0.92	0.93	0.93	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.90
Slab Thickness h [cm]	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Cavity Height D_{UD} [mm]	240 Type XS-240 (270)																						
$I_{UD}/I_{solid} [-]$ centrally					0.92	0.92	0.93	0.94	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.97
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm					0.92	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.89	0.88	0.88	0.88	0.87	0.87
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm					0.92	0.92	0.93	0.94	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.92	0.92	0.92	0.91	0.91	0.91
Slab Thickness h [cm]	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Cavity Height D_{UD} [mm]	260 Type XS-260 (290)																						
$I_{UD}/I_{solid} [-]$ centrally							0.93	0.94	0.94	0.94	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97
$I_{UD}/I_{solid} [-]$ $u_{UD} = 6$ cm							0.92	0.92	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.88
$I_{UD}/I_{solid} [-]$ $u_{UD} = 8$ cm							0.93	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.92	0.92	0.91

For SI: 1 cm = 0.394 in.

- u_{UD} is the distance from the Unidome XS Concrete Shaper Element to the bottom edge of the slab.

TABLE 5—FIRE RESISTANCE AND MINIMUM CONCRETE COVER OF SINGLE SPAN REINFORCED CONCRETE SLABS WITH UNIDOME XS CONCRETE SHAPER ELEMENTS



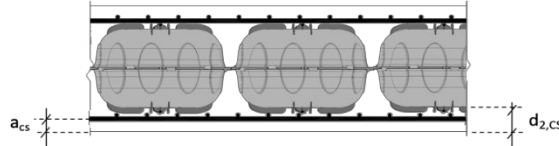
Fire Resistance Rating (minutes)		30	60	90	120	180	240
Concrete cover to center axis of reinforcement solid slab (mm)		10	20	30	40	55	65
Unidome size	$d_{2,CS}$	a_{CS}	a_{CS}	a_{CS}	a_{CS}	a_{CS}	a_{CS}
XS 60	60 mm	11	27				
	70 mm	11	23	45			
	80 mm	11	22	38			
	90 mm	11	21	34	53		
	100 mm	11	21	32	47		
XS 80	60 mm	11	27				
	70 mm	11	23	45			
	80 mm	11	22	38			
	90 mm	11	21	34	53		
	100 mm	11	21	32	47		
XS 100	60 mm	11	27				
	70 mm	11	23	45			
	80 mm	11	22	37			
	90 mm	11	21	34	53		
	100 mm	11	21	32	47		
XS 120	60 mm	11	27				
	70 mm	11	23	45			
	80 mm	11	22	37			
	90 mm	11	21	34	53		
	100 mm	11	21	32	47		
XS 140	60 mm	11	27				
	70 mm	11	23	45			
	80 mm	11	22	37			
	90 mm	11	21	34	53		
	100 mm	11	21	32	47		
XS 160	60 mm	11	27				
	70 mm	11	23	45			
	80 mm	11	22	37			
	90 mm	11	21	34	53		
	100 mm	11	21	32	47		
XS 180	60 mm	11	27				
	70 mm	11	23	45			
	80 mm	11	22	37			
	90 mm	11	21	34	53		
	100 mm	11	21	32	47		
XS 200	60 mm	11	27				
	70 mm	11	23	45			
	80 mm	11	22	37			
	90 mm	11	21	34	53		
	100 mm	11	21	32	47		
XS 220	60 mm	11	27				
	70 mm	11	23	44			
	80 mm	11	22	37			
	90 mm	11	21	34	52		
	100 mm	11	21	32	47		
XS 240	60 mm	11	27				
	70 mm	11	23	44			
	80 mm	11	22	37			
	90 mm	11	21	34	52		
	100 mm	11	21	32	47		
XS 260	60 mm	11	27				
	70 mm	11	23	43			
	80 mm	11	22	37			
	90 mm	11	21	34	51		
	100 mm	11	21	32	46		

For

SI: 1 mm = 0.0394 inch.

1. Minimum cover requirements must comply with 2021 IBC Table 722.2.3(1).
2. a_{CS} is the minimum center axis to bottom reinforcing bars.

TABLE 6—FIRE RESISTANCE AND MINIMUM CONCRETE COVER OF TWO-WAY SPAN REINFORCED CONCRETE SLABS ($l_y / l_x \leq 1.5$) WITH UNIDOME XS CONCRETE SHAPER ELEMENTS

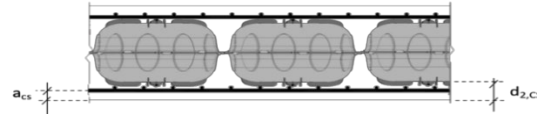


Fire Resistance Rating (minutes)		30	60	90	120	180	240
Cover to center axis reinforcement solid slab (mm)		10	10	15	20	30	40
Unidome size	$d_{2,cs}$	a_{cs}	a_{cs}	a_{cs}	a_{cs}	a_{cs}	a_{cs}
XS 60	60 mm	11	17	29			
	70 mm	11	13	22	31		
	80 mm	11	12	19	27	56	
	90 mm	11	11	17	24	45	
	100 mm	11	11	16	23	39	65
XS 80	60 mm	11	17	29			
	70 mm	11	13	22	31		
	80 mm	11	12	19	27	56	
	90 mm	11	11	17	24	45	
	100 mm	11	11	16	23	39	65
XS 100	60 mm	11	17	29			
	70 mm	11	13	22	31		
	80 mm	11	12	19	27	55	
	90 mm	11	11	17	24	44	
	100 mm	11	11	16	23	39	64
XS 120	60 mm	11	17	29			
	70 mm	11	13	22	31		
	80 mm	11	12	19	27	55	
	90 mm	11	11	17	24	44	
	100 mm	11	11	16	23	39	64
XS 140	60 mm	11	17	29			
	70 mm	11	13	22	31		
	80 mm	11	12	19	27	55	
	90 mm	11	11	17	24	44	
	100 mm	11	11	16	23	39	64
XS 160	60 mm	11	17	29			
	70 mm	11	13	22	31		
	80 mm	11	12	19	27	55	
	90 mm	11	11	17	24	44	
	100 mm	11	11	16	23	39	64
XS 180	60 mm	11	17	29			
	70 mm	11	13	22	31		
	80 mm	11	12	19	27	54	
	90 mm	11	11	17	24	44	
	100 mm	11	11	16	23	39	63
XS 200	60 mm	11	17	29			
	70 mm	11	13	22	31		
	80 mm	11	12	19	27	53	
	90 mm	11	11	17	24	44	
	100 mm	11	11	16	23	39	62
XS 220	60 mm	11	16	29			
	70 mm	11	13	22	30		
	80 mm	11	12	19	26	52	
	90 mm	11	11	17	24	43	
	100 mm	11	11	16	22	38	60
XS 240	60 mm	11	16	28			
	70 mm	11	13	22	30		
	80 mm	11	12	19	26	51	
	90 mm	11	11	17	24	42	
	100 mm	11	11	11	22	38	59
XS 260	60 mm	11	16	28			
	70 mm	11	13	22	30		
	80 mm	11	12	19	26	50	
	90 mm	11	11	17	24	41	
	100 mm	11	11	11	22	38	58

For SI: 1 mm = 0.0394 inch.

1. Minimum cover requirements must comply with 2021 IBC Table 722.2.3(1).
2. a_{cs} is the minimum center axis to bottom reinforcing bars.

TABLE 7—FIRE RESISTANCE AND MINIMUM CONCRETE COVER OF TWO-WAY SPAN REINFORCED CONCRETE SLABS ($1.5 \leq l_y / l_x \leq 2$) WITH UNIDOME XS CONCRETE SHAPER ELEMENTS

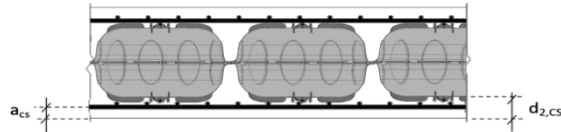


Fire Resistance Rating (minutes)		30	60	90	120	180	240
Cover to center axis reinforcement solid slab (mm)		10	15	20	25	40	50
Unidome size	$d_{2,cs}$	a_{cs}	a_{cs}	a_{cs}	a_{cs}	a_{cs}	a_{cs}
XS 60	60 mm	11	22	34			
	70 mm	11	18	27			
	80 mm	11	17	24	35		
	90 mm	11	16	22	31		
	100 mm	11	16	21	29	56	
XS 80	60 mm	11	22	34			
	70 mm	11	18	27			
	80 mm	11	17	24	35		
	90 mm	11	16	22	31		
	100 mm	11	16	21	29	56	
XS 100	60 mm	11	22	34			
	70 mm	11	18	27			
	80 mm	11	17	24	35		
	90 mm	11	16	22	31		
	100 mm	11	16	21	29	55	
XS 120	60 mm	11	22	34			
	70 mm	11	18	27			
	80 mm	11	17	24	35		
	90 mm	11	16	22	31		
	100 mm	11	16	21	29	55	
XS 140	60 mm	11	22	34			
	70 mm	11	18	27			
	80 mm	11	17	24	35		
	90 mm	11	16	22	31		
	100 mm	11	16	21	29	55	
XS 160	60 mm	11	22	34			
	70 mm	11	18	27			
	80 mm	11	17	24	35		
	90 mm	11	16	22	31		
	100 mm	11	16	21	29	55	
XS 180	60 mm	11	22	33			
	70 mm	11	18	27			
	80 mm	11	17	24	35		
	90 mm	11	16	22	31		
	100 mm	11	16	21	29	55	
XS 200	60 mm	11	22	33			
	70 mm	11	18	27			
	80 mm	11	17	24	35		
	90 mm	11	16	22	31	64	
	100 mm	11	16	21	29	55	
XS 220	60 mm	11	21	33			
	70 mm	11	18	27			
	80 mm	11	17	24	34		
	90 mm	11	16	22	31	64	
	100 mm	11	16	21	28	54	
XS 240	60 mm	11	21	33			
	70 mm	11	18	27			
	80 mm	11	17	24	34		
	90 mm	11	16	22	31	63	
	100 mm	11	16	21	28	53	
XS 260	60 mm	11	21	32			
	70 mm	11	18	27			
	80 mm	11	17	24	34		
	90 mm	11	16	22	31	61	
	100 mm	11	16	21	28	52	

For SI: 1 mm = 0.0394 inch.

1. Minimum cover requirements must comply with 2021 IBC Table 722.2.3(1).
2. a_{cs} is the minimum center axis to bottom reinforcing bars.

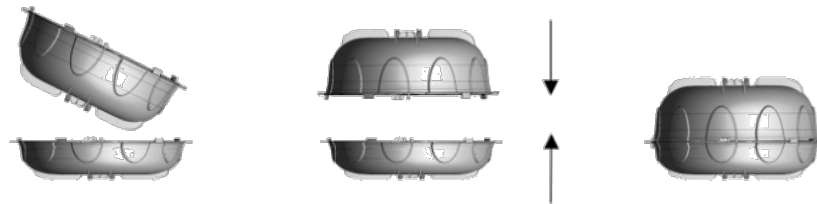
TABLE 8—FIRE RESISTANCE AND MINIMUM CONCRETE COVER OF REINFORCED CONCRETE FLAT SLABS WITH UNIDOME XS CONCRETE SHAPER ELEMENTS



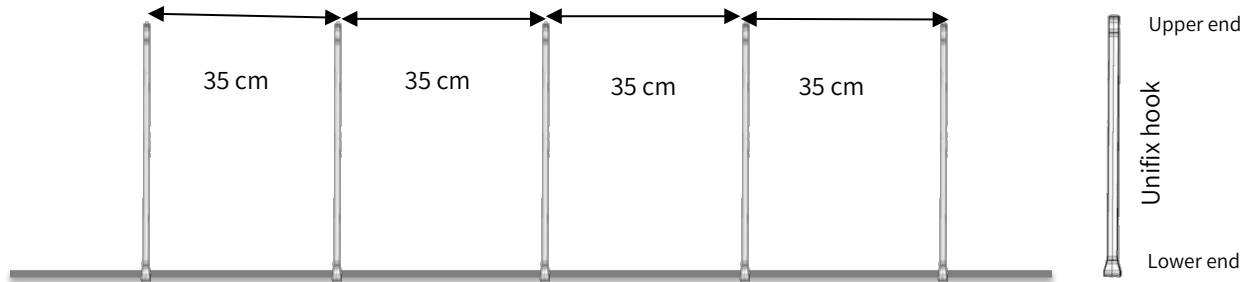
Fire Resistance Rating (minutes)		30	60	90	120	180	240
Cover to center axis reinforcement solid slab (mm)		10	15	25	35	45	50
Unidome size	$d_{2,CS}$	a_{CS}	a_{CS}	a_{CS}	a_{CS}	a_{CS}	a_{CS}
XS 60	60 mm	11	22				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41		
XS 80	60 mm	11	22				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41		
XS 100	60 mm	11	22				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41		
XS 120	60 mm	11	22				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41		
XS 140	60 mm	11	22				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41		
XS 160	60 mm	11	22				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41		
XS 180	60 mm	11	22				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41		
XS 200	60 mm	11	22				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41		
XS 220	60 mm	11	21				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41	65	
XS 240	60 mm	11	21				
	70 mm	11	18	36			
	80 mm	11	17	31			
	90 mm	11	16	28	45		
	100 mm	11	16	27	41	63	
XS 260	60 mm	11	21				
	70 mm	11	18	35			
	80 mm	11	17	31			
	90 mm	11	16	28	44		
	100 mm	11	16	27	40	62	

For SI: 1 mm = 0.0394 inch.

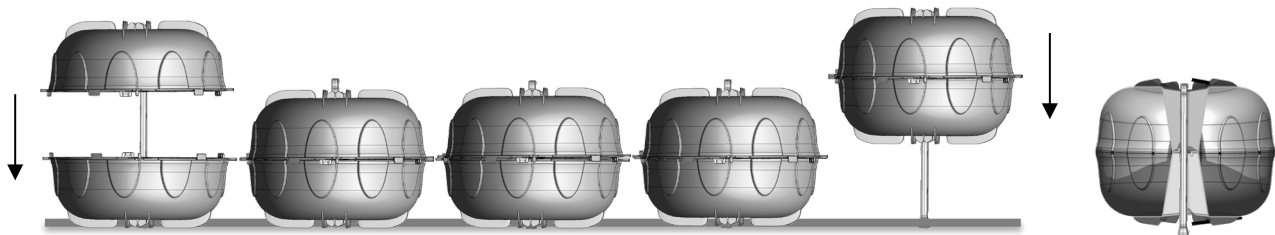
1. Minimum cover requirements must comply with 2021 IBC Table 722.2.3(1).
2. a_{CS} is the minimum center axis to bottom reinforcing bars.



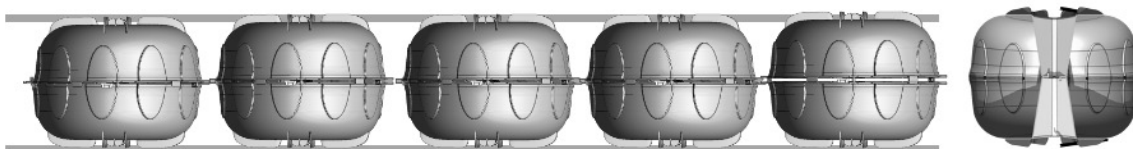
Unidome XS Concrete Shaper Elements are assembled. Using the supplied single 6 mm diameter bars and mounting aid, the Unifix hooks are attached to the lower bar at a minimum spacing of 35 cm.



Unifix hooks attached to lower 6 mm diameter bar at a minimum spacing of 35 cm

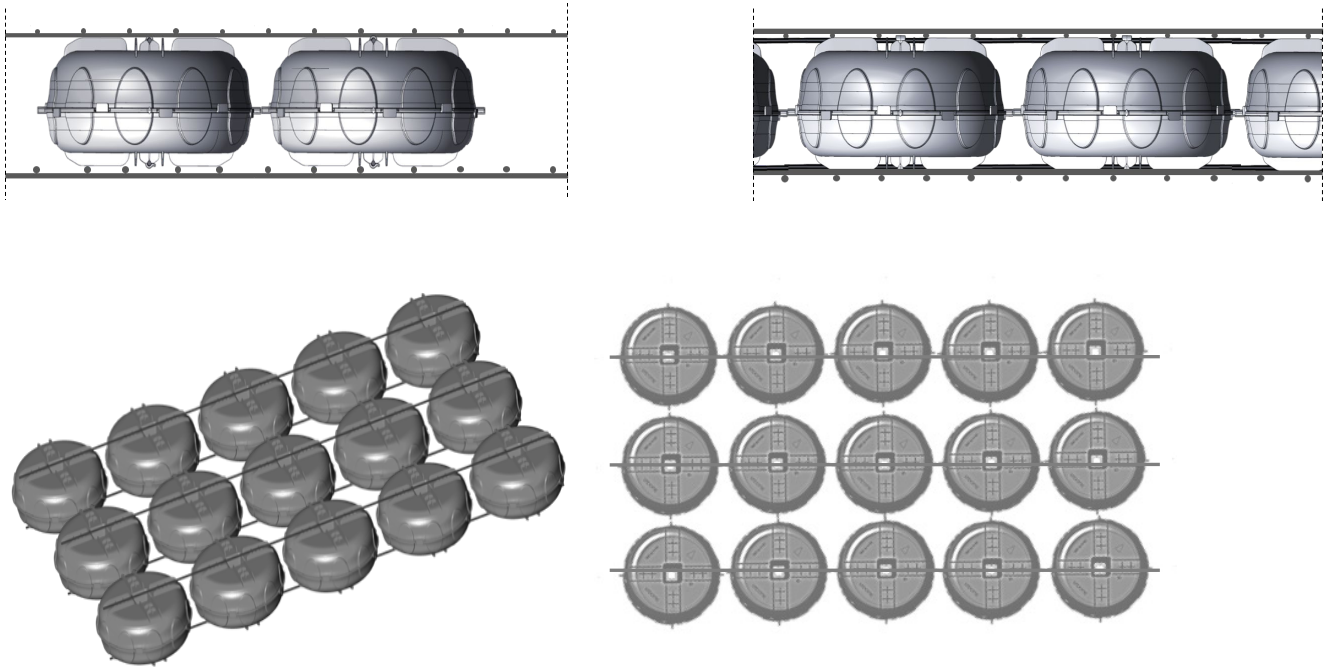


Unidome XS Concrete Shaper Elements are then placed onto the Unifix hooks with the Unifix hooks positioned into the middle integrated tunnel of the Unidome XS Concrete Shaper Elements. After attaching the Unidome XS Concrete Shaper Elements to the 6 mm lower bar with Unifix hooks, a 6 mm diameter top bar is connected to the Unifix hooks. The supplied Unifix hooks ensure accurate placement and create rigid void elements.



After installing the lower steel reinforcement mat in the concrete floor or roof slab, the Unidome XS Concrete Shaper Elements are installed. The Unidome XS Concrete Shaper Elements run parallel to the directly adjacent steel reinforcement and are tied to the lower steel reinforcement mat with tie wire. The steel reinforcement mat is laid orthogonally to the void elements. An example arrangement of the void elements with respect to the reinforcement mats is shown below. Further information on the reinforced concrete floor or roof slab cross-section must be found in the project installation plans. During installation, it is important to ensure a minimum spacing of 35 cm. Spacer pins on the Unidome XS Concrete Shaper four sides help ensure correct layout without misalignment.

FIGURE 4—UNIDOME XS CONCRETE SHAPER ELEMENT ASSEMBLY AND INSTALLATION INSTRUCTIONS



Cross-section and arrangement of the Unidome XS Concrete Shaper Elements in the reinforced concrete floor or roof plans.

FIGURE 4—UNIDOME XS CONCRETE SHAPER ELEMENT ASSEMBLY AND INSTALLATION INSTRUCTIONS
(Continued)