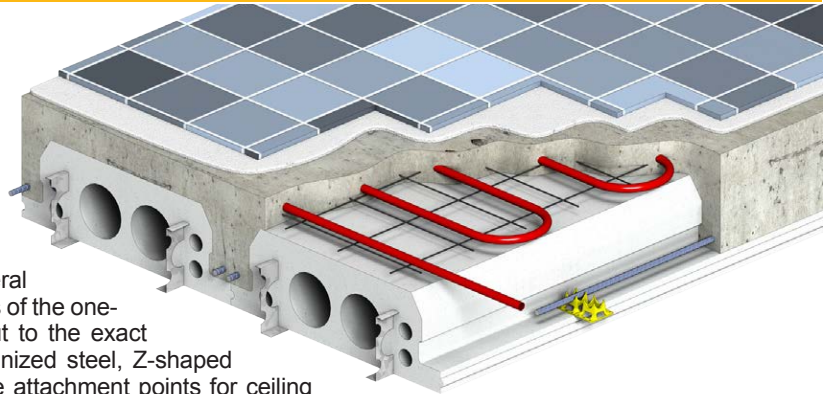


Building with Quad-Deck Floor & Roof System

What is Quad-Deck?

Quad-Deck panels are steel-reinforced, foamed plastic insulation boards used as permanent, stay-in-place concrete formwork for floor and roof construction. Reinforced concrete joists are spaced at 24" [610mm] on center and poured monolithically with the slab to form a T-Beam reinforced concrete structure.

The "pan-form" Quad-Deck panels are available in several thicknesses / beam-depths to allow varying spans and loads of the one-way concrete slabs. Each Quad-Deck panel is custom-cut to the exact length required and reinforced with two continuous, galvanized steel, Z-shaped furring strips (22 Gauge [0.8mm thickness]), which provide attachment points for ceiling finishes and serve as secondary shoring/formwork support. Primary shoring must be designed and erected as per shoring supplier, project engineer, or applicable building codes (see below).



Quad-Deck panels do not provide any permanent structural support. Structural support is provided by the reinforced concrete joists and slab topping only, which are designed by a licensed engineer in accordance with ACI 318, ACI 301, or other applicable standards.

Span and Floor Loads for Quad-Deck

Depending on live and dead loads assumed in the structural design, clear spans of up to 33 feet [10m] - measured from the center of the supporting elements - can be accomplished without modification to standard Quad-Deck profiles. Live loads exceeding 100 psf (488kg/m²) can be supported for shorter spans (see next page). Longer spans and/or higher loads may be achieved by: increasing the T-beam height profile with extra foam-blocks glued to the top of Quad-Deck panels; high-strength concrete, additional reinforcing steel, stirrups, post tensioning, and/or camber. Contact the Quad-Lock Technical Department for details. A licensed engineer has to provide the structural design for each building.

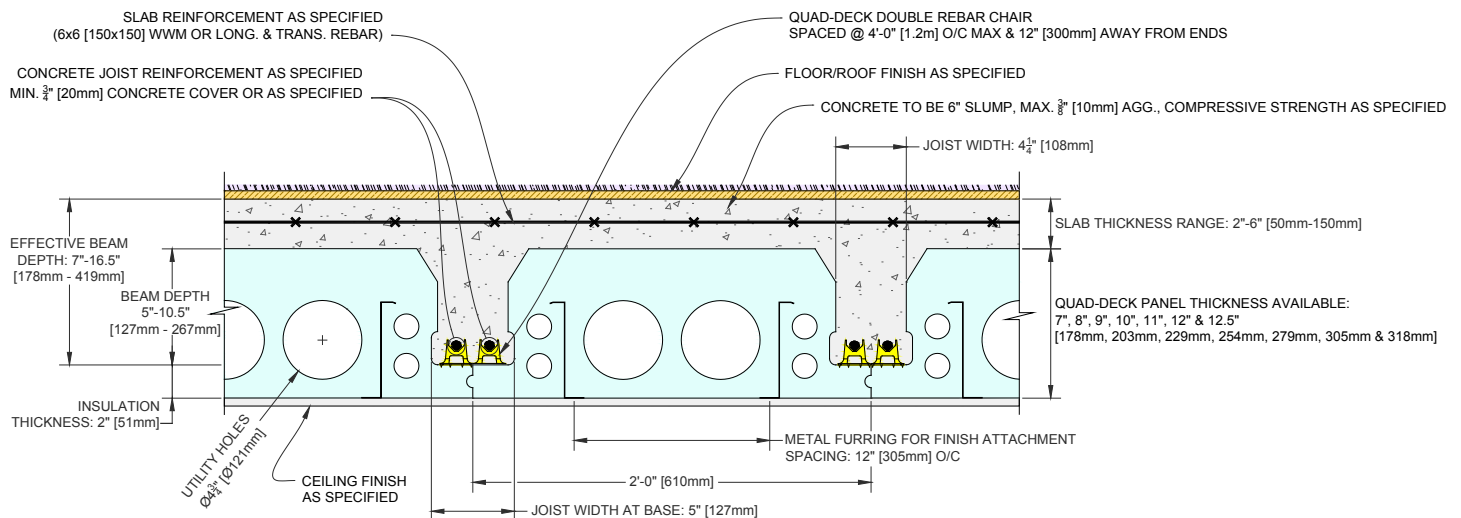
Reinforcement

Reinforcing requirements are a function of the desired span between supporting points and the live loads imposed on the structure. The size, grade, and frequency of reinforcing bar should be determined by a licensed engineer for each project. For estimating purposes, Quad-Lock provides span tables showing suggested reinforcement.

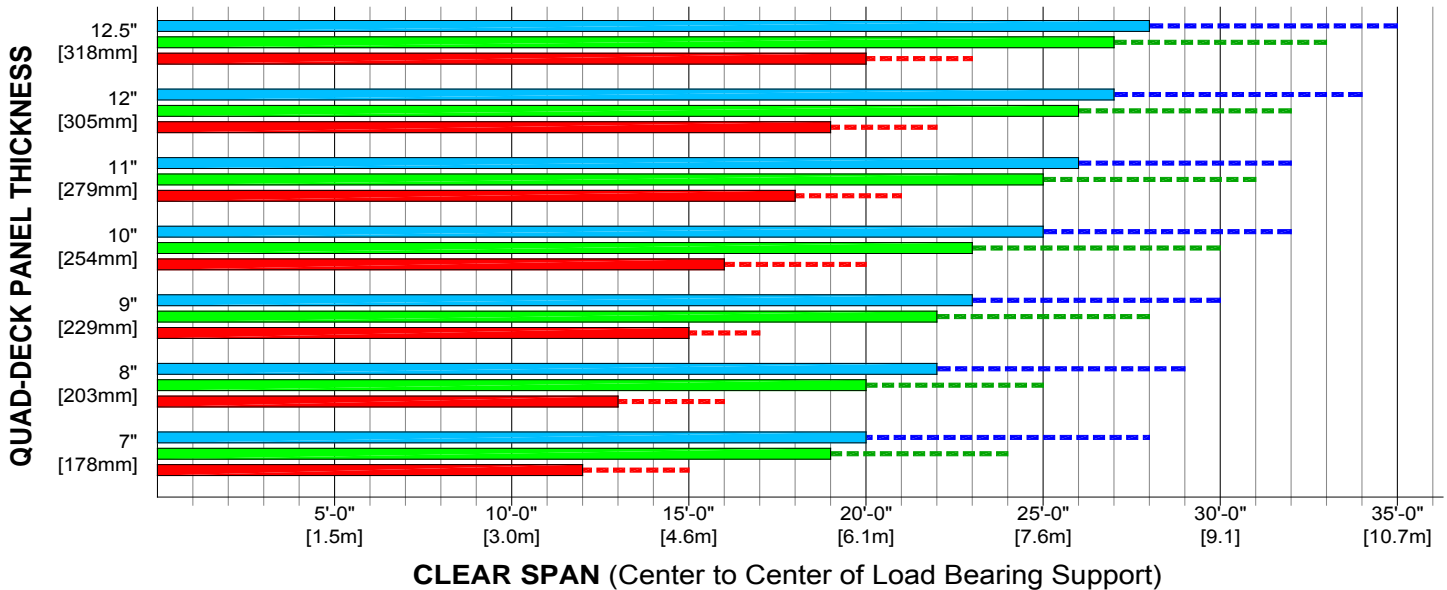
Minimum concrete cover as per ACI 318 or other applicable codes:

- Concrete for slabs, walls, joists not exposed to weather and not in contact with ground: 3/4" [20mm]
- Concrete cast against and permanently exposed to earth: 3" [75mm]
- Concrete exposed to earth or weather, #6 [20M] and higher bars: 2" [50mm]; #5 [15M] bar, W31 or D31 [Ø16mm] wire, and smaller: 1 1/2" [38mm]

The installer is responsible for placement of all reinforced concrete in accordance with ACI 318 "Building Code Requirements for Reinforced Concrete". Any variance from these standards must be provided and certified in advance by the Engineer of Record.



QUAD-DECK SPANS (FOR ESTIMATING PURPOSES ONLY!)



LEGEND:

- █ 20 psf [0.95 kN/m²] Live Load, 3" [75mm] Slab Thickness, 3000 psi [21 mPa] Concrete, 2-#6 [2-20M] Rebar Bot.
- █ 40 psf [1.92 kN/m²] Live Load; 3" [75mm] Slab Thickness, 3000 psi [21 mPa] Concrete, 2-#6 [2-20M] Rebar Bot.
- █ 100 psf [4.77 kN/m²] Live Load; 3" [75mm] Slab Thickness, 3000 psi [21 mPa] Concrete, 2-#6 [2-20M] Rebar Bot.
- - - - 4" [100mm] Slab Thickness, 4000 psi [28 mPa] Concrete, 2-#7 [2-22M] Rebar Bot. & 1-#6 [1-20M] Rebar Top

Slab Thickness

Because of the support provided by the reinforced concrete joists every 24 inches (610mm), a much thinner slab section is required. Slab sections between 2 and 5 inches (50 and 125mm), depending on live loads and other forces applied to the slab, are commonly used. This design results in 30 to 40% concrete savings in most jobs, and therefore eliminates 30 to 40% of the mass of the floor or roof. A 3" [75mm] slab thickness is common for most residential floors and 5" [125mm] slab is recommended for high point loads such as garage floors.

Construction Details

Typical construction details are available on the Quad-Lock website, www.quadlock.com, and can be downloaded at no charge in PDF or DWG file formats. Many common design features are shown, including multiple story applications, pitched roofs, cantilevers and more.

Shoring & Bracing

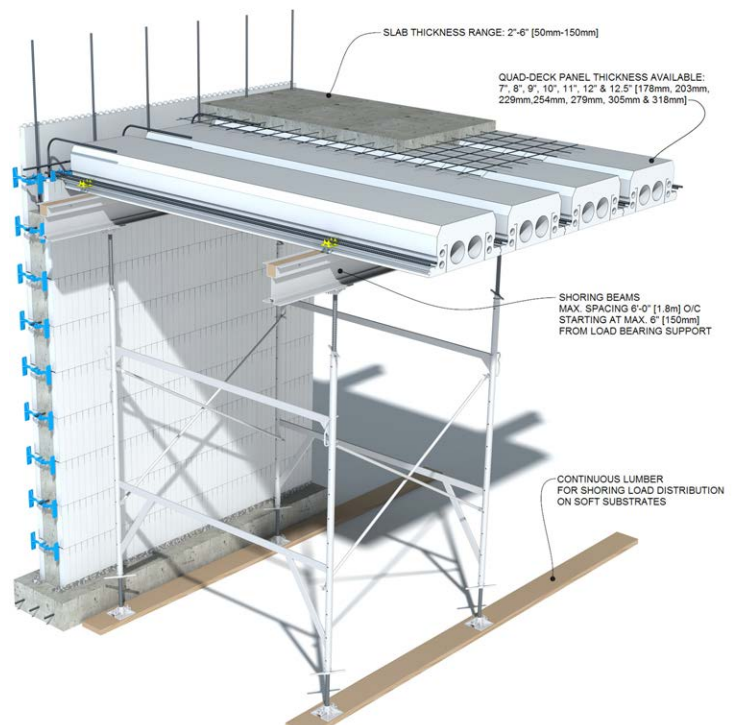
Quad-Deck requires only primary shoring for support or, if required, camber. This means that less shoring is generally required, approximately every 6'-0" [1.8m] on center and perpendicular to Quad-Deck Panels. First and last shoring beams must start at maximum 6" [150mm] from panel ends. Installer is responsible for the design and correct installation of shoring for Quad-Deck forms in accordance with ACI (American Concrete Institute) 347.2R "Guide for Shoring/Reshoring of Concrete Multistory Buildings", Chapter 2, Design.

It is recommended that an analysis of the shoring for each project be carried out by a licensed engineer (often provided by shoring suppliers), in addition to the design of the structure.

Shoring Removal

The concrete structure must be able to support its own weight (dead load) and the loads imposed during construction (construction load) without excessive deflection that will harm the structure.

Preferred Method: Determination of the length of time required before removal of shoring (or re-shoring) should be made by the Engineer of Record, based on the compressive strength of the concrete and curing conditions. A ready-mixed concrete supplier can supply high-early-strength concrete for early removal of shoring.



Building with Quad-Deck...cont'd

Alternate Method: If plans and contract documents contain no specification for minimum compressive strength of concrete at the time of formwork and shoring removal, ACI 347, Section 3.7 provides guidelines pertaining to one-way floor slabs and the removal of shoring. See standards list at the end of this bulletin.

Finishes

Ceiling finish (GWB or eq.) can be attached directly to metal Z strips integrated in Quad-Deck Panels. Dropped ceilings can be installed for projects requiring more room for HVAC or other utilities - a 15min thermal barrier (e.g. GWB) must be installed on the underside of the Quad-Deck prior to installing a suspended ceiling. In cases where a fire resistant floor is needed it is recommended that non-corrosive fasteners be placed every 8'-0" [2.5m] o/c through top of panels prior to concrete pour to connect the metal furring to the concrete slab. Contact Quad-Lock for more details.

Testing has been performed to determine the pullout strength of Quad-Deck Z Strip furring with the average result being 410 pounds [185kg] per linear foot of furring. (October 2008 - Applied Technical Services, Inc.) Contact Quad-Lock for more details.

EPS Board Type – ASTM C578

Quad-Deck is manufactured from expanded polystyrene ("EPS") at a density of 1.25 pcf [20 kg/m³]. The EPS material is **Type VIII in US** as per ASTM C578 and **Type 1 in Canada** as per CAN/ULC-S701. The EPS is treated with a flame-retardant for use in building insulation. In most design scenarios, building codes require that exposed foamed plastic insulation be covered with a minimum 15-minute rated thermal barrier, such as ½" [13mm] gypsum drywall.

The raw material vendor's evaluation and test reports, and any reports referenced below are available on request to building officials in your local jurisdiction.

Surface Burning Characteristics - ASTM E84/ UL723

Flame Spread < 25; Smoke Developed < 450 (prior to floor ignition) per Preliminary Investigation Report by Underwriters Laboratory Inc. dated August 28, 2006.

Fire Resistance Ratings

Actual Fire Resistance Ratings shall be determined by the licensed professional engineer. The below Fire Resistance Ratings were estimated based on Table 2.1 "Fire resistance of singular layer concrete walls, floors and roofs" of ACI 216.1 and only consider the concrete slab thickness:

Aggregate Type	Quad-Deck Slab Thickness for Fire Resistance Rating (in)				
	1 hr	1.5 hr	2 hr	3 hr	4 hr
Siliceous	3.5" [89mm]	4.3" [109mm]	5.0" [127mm]	6.2" [157mm]	7.0" [178mm]
Carbonate	3.2" [81mm]	4.0" [102mm]	4.6" [117mm]	5.7" [145mm]	6.6" [168mm]
Semi-lightweight	2.7" [69mm]	3.3" [84mm]	3.8" [97mm]	4.6" [117mm]	5.4" [137mm]
Lightweight	2.5" [64mm]	3.1" [79mm]	3.6" [91mm]	4.4" [112mm]	5.1" [130mm]

Insulation Values - ASTM C578

Calculated as per ASTM C578, R-Value for Type VIII EPS is 3.8 per inch thickness @ 75°F. The ASHRAE Handbook allows using higher and more accurate R-Values for EPS, especially in cold conditions, in contrast to many other insulation materials that perform worse than advertised when heating or cooling is actually required. To determine the R-value of the concrete slab, concrete is about R-0.09 per inch thickness.

Quad-Deck Panel Thickness	7" [178mm]	8" [203mm]	9" [228mm]	10" [154mm]	11" [279mm]	12" [305mm]	12.5" [318mm]
Thermal Resistance R-Value (h-ft ² •°F/BTU)	16	19	22	25	28	32	33
Heat Transfer Co-efficient U-Value (W/m ² •K)	0.35	0.3	0.26	0.23	0.20	0.18	0.17

STC Sound Tests (Sound Transmission Loss - Airborne Noise) - ASTM E90

Per reports by Architectural Testing dated January 23, 2007, four tests were performed on different floor types as follows:

Floor Type	STC
12" [305mm] Floor Assembly (9" [228mm] Quad-Deck & 3" [75mm] Concrete)	46
12" [305mm] Floor Assembly (9" [228mm] Quad-Deck & 3" [75mm] Concrete) + 1 layer 5/8" [16mm] gypsum board	49
12" [305mm] Floor Assembly (9" [228mm] Quad-Deck & 3" [75mm] Concrete) + 1 layer 5/8" [16mm] gypsum board over resilient channel	50
12" [305mm] Floor Assembly (9" [228mm] Quad-Deck & 3" [75mm] Concrete) + 2 layers 5/8" [16mm] gypsum board	53

IIC Sound Tests (Impact Insulation Class - Field Test) - ASTM E1007-04

Per report by Southwest Research Institute dated October 06, 2008, four tests were performed on different floor types as follows:

Floor Type	IIC
15" [381mm] Floor Assembly (12" [305mm] Quad-Deck & 3" [75mm] Concrete) - no finish on ceiling or floor	17
15" [381mm] Floor Assembly (12" [305mm] Quad-Deck & 3" [75mm] Concrete) - 2 Layers of 5/8" [16mm] Type X GWB ceiling finish	26
15" [381mm] Floor Assembly (12" [305mm] Quad-Deck & 3" [75mm] Concrete) - 1/2" [13mm] tile on floor and 1/2" [13mm] GWB ceiling finish	26
15" [381mm] Floor Assembly (12" [305mm] Quad-Deck & 3" [75mm] Concrete) - 5/8" [16mm] Jute Carpet on floor and 1/2" [13mm] GWB ceiling finish	70

Building with Quad-Deck...cont'd

Quad-Deck Floor Weights

Quad-Deck Floor Weights (lb/sqft)							
Quad-Deck Panel Thickness	Slab Thickness						
	2"	2.5"	3"	3.5"	4"	4.5"	5"
7"	45.1	51.4	57.6	63.9	70.1	76.4	82.6
8"	47.3	53.6	59.8	66.1	72.3	78.6	84.8
9"	49.5	55.8	62.0	68.3	74.5	80.8	87.0
10"	51.7	58.0	64.2	70.5	76.7	83.0	89.2
11"	53.9	60.2	66.4	72.7	78.9	85.2	91.4
12"	56.2	62.5	68.7	75.0	81.2	87.5	93.7
12.5"	57.3	63.5	69.8	76.0	82.3	88.5	94.8

Notes: The above are unfactored estimated weights which include concrete (150pcf), reinforcement (3lb/sqft), Quad-Deck Panel (2lb/sqft) & misc. (2lb/sqft).

Quad-Deck Floor Weights (Kg/m ²)							
Quad-Deck Panel Thickness	Slab Thickness						
	50mm	75mm	90mm	100mm	110mm	120mm	130mm
178mm	218.8	278.8	314.8	338.8	362.8	386.8	410.8
203mm	229.6	289.6	325.6	349.6	373.6	397.6	421.6
228mm	240.4	300.4	336.4	360.4	384.4	408.4	432.4
254mm	251.2	311.2	347.2	371.2	395.2	419.2	443.2
279mm	262.0	322.0	358.0	382.0	406.0	430.0	454.0
305mm	272.8	332.8	368.8	392.8	416.8	440.8	464.8
318mm	278.2	338.2	374.2	398.2	422.2	446.2	470.2

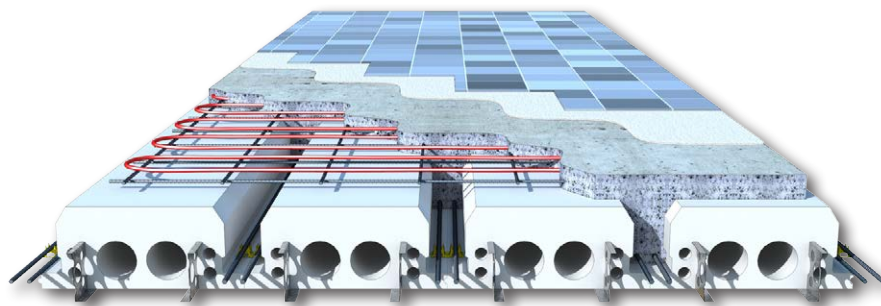
Notes: These are unfactored estimated weights which include concrete (2400Kg/m³), reinforcement (15Kg/m²), Quad-Deck Panel (10Kg/m²) & misc. (10Kg/m²).

Publications

More information, code requirements, and guidelines can be found in these publications:

Document	Title
ACI 216	Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies
ACI 301	Specifications for Structural Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 332	Guide to Residential Cast-in-Place Concrete Construction
ACI 347	Guide to Formwork of Concrete
ACI 347.2R	Guide for Shoring/Reshoring of Concrete Multistory Buildings
ANSI A10.9	American National Standard for Construction and Demolition Operations
ASCE 24	Flood Resistant Design and Construction
CSA A23.1	Concrete Materials & Methods of Construction
CSA A23.2	Methods of Test and Standard Practices for Concrete
CSA A23.3	Designing Concrete Structures
CSA S269.1	Falsework for Construction (Reaffirmed 1998)
CSA S269.3-M92	Concrete Formwork
FEMA 320	Taking Shelter From The Storm: Building a Storm Room for your House or Small Business
FEMA 361	Design and Construction Guidance for Community Safe Rooms
NBC 2010	National Building Code of Canada 2010
OSHA 29 CFR	Construction Safety and Health Regulations for Construction
SEI/ASCE 37	Design Loads on Structures During Construction
UL 723	Surface Burning Characteristics of Building Materials (ASTM E84)

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