Roof Decks

The roof deck is the structural foundation for the roofing system. It must be designed to provide sufficient support for all dead and live loads to which it will be exposed and must provide enough resistance to racking, flexural and torsional loads to prevent any deformation that might cause a roof failure. It must be rigid, eliminate excessive positive or negative deflection under load, and have a smooth surface with no large cracks or gaps. It must also be even and securely anchored to the building structure.

Positive attachment of the roof assembly to the deck is critical. The decking material must readily accommodate the roof system's attachment method.

An inspection of the deck's condition prior to beginning roof construction should be a key part of the installation process. Everyone involved in the design and construction of the roof should participate; the owner's representative, the designer, the roof consultant, the roofing contractor and the decking contractor. Any surface irregularities, blemishes, voids, unacceptable elevation changes, etc. in the deck must be addressed prior to the roof installation.

Expansion joints should be provided in all roof decks to accommodate movement that will result from expansion and contraction of the deck or structure. These elements should allow for both vertical and horizontal movement. The entire roof assembly (membrane, flashing systems and insulation) should be terminated at all expansion joints.

Wood Nailers

Most roof membranes and deck materials require the use of wood nailers or curbs at roof penetrations, openings and building perimeters. Nailers provide both protection for the edges of insulation and a substrate for terminating roof membranes, base flashings and metals (gravel stops and edging). Nailers must be securely fastened to the roof deck or building structure. An uplift resistance of 200 lbs per lineal foot is typically recommended for nailers. Designers should provide details and specifications addressing the nailer type, grade, attachment methods and fastener schedule.

Tapered edge-strips are often used to divert water away from roof edges. Nailers should be equal in thickness to both the total thickness of the tapered edge-strip and insulation, and be wide enough to accommodate fastening of metal edges or gutters.

Roof Drainage

One of the most critical features of any roof system is its ability to drain properly. A roof membranes performance can be impacted if it is exposed to prolonged periods of standing water or ponding. Some decks are designed and installed with little or no slope. Tapered InsulFoam is one of the most effective ways to provide drainage for a roof assembly. Drainage should move all water to the drains, scuppers and gutters. The outlets should be set below the plane of the roof membrane surface at the lowest points of the roof.

Many manufacturers' warranties limit the amount of time water is allowed to pond on their membranes, as there are numerous detrimental conditions that can result from ponding water:

Freezing and Thawing This repetitive action can scour protective surfacings (granules or coatings) off the membrane, exposing the system to the harmful ultraviolet light or physically damaging the membrane itself.

Excessive Amounts of Water This can increase deck deformation, or deflection, causing the roof to retain substantial quantities of water that might exceed design expectations and possibly compromise the deck's structural integrity and/or expose the roof membrane to severe stress.

The Accumulation of Algae and Vegetation Ponding water can promote organic growth. Some materials are susceptible to attack by algae and other organisms. Over time vegetation root growth can penetrate even the thickest membrane.

Basins or Bird Baths These areas are a point of collection for dust, debris and chemicals from various sources. Prolonged accumulation of these mixtures result in thick layers of sludge. It can contain a number of agents, many of which can harm the membrane. If a sufficient quantity accumulates, deep cracks or fissures will form and can exert stresses on the membrane, which results in leakage or premature aging of the material.

In any event, ponding water will pose a greater threat to having the roof leak.

The National Roofing Contractors Association and the Midwest Roofing Contractors Association recommend that roofing systems be designed to provide drainage throughout their service life.

Insulfoam recommends that the following guidelines be followed when designing a roof:

1. Provide adequate outlets (drains, scuppers and gutters) to completely drain all standing water from the roof surface.
2. Locate outlets at the lowest points of the roof.
3. Divert water with crickets and saddles around any building element that will impede the flow of water to outlets.
4. Provide for raised edge-metal by employing tapered edge-strip at building edges.
5. When draining to the interior of the roof area, provide sumps at all drains to ensure complete removal of standing water.

All Insulfoam locations manufacture tapered roofing systems. Insulfoam will provide shop drawings for the contractor to assist with proper installation of the Tapered InsulFoam system. These systems can provide a solution for both new construction and re-roofing applications in which standing water might be expected. Contact your local Insulfoam representative for assistance with your next roof drainage problem. Also, refer to the tapered insulation information in the Roof Insulations section of the Insulfoam Roofing Manual.

Steel Decks

The most common decking material used for low slope roofing systems is currently cold-formed steel decking. These decks are made in several styles and gauges, and galvanized (G-60 or G-90) or painted finishes. When properly designed and installed, they provide a stable and economical substrate for virtually every type of commercial roofing system.

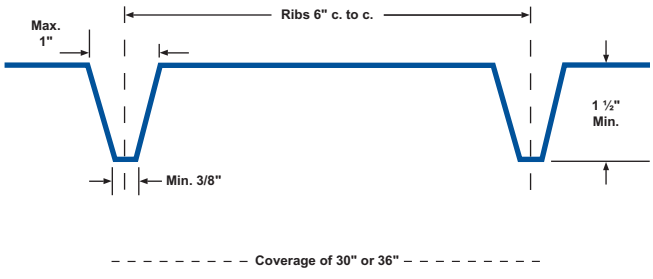
Most membrane manufacturers require that steel decks are primed and have a minimum 22-gauge thickness. Some applications require the use of galvanized steel. Steel decks are secured to the building's structural members by welding or mechanically fastening. Fastening of the side laps is often required as well; this prevents differential movement between deck panels that are exposed to roof-top traffic. If side laps are not fastened, excessive movement could damage the roofing system. The finished deck installation should result in a surface that can receive a sheathing material or insulation. These membrane substrates should be of a thickness that spans the deck flutes and provides support for any anticipated construction traffic, and in-service live and dead loads.

Steel decks are typically categorized as:

1. Narrow Rib - with a flute opening of 1" or less
2. Intermediate Rib - with a flute opening of 1" to 1 3/4"
3. Wide Rib - with a flute opening of 1 3/4" to 2 1/2"
4. Deep Rib - with a minimum flute depth of 3" and a maximum flute opening of 2 3/4"

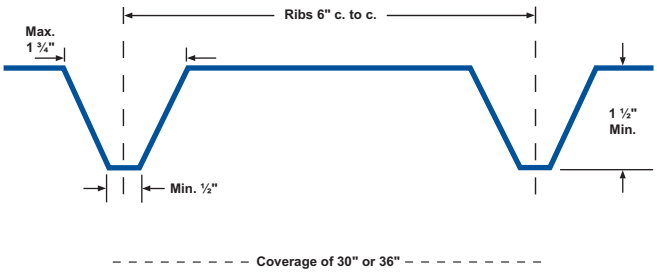
The following are typical cross-sections of types A, F, B and N decks:

Type A Roof Deck (Narrow Rib)



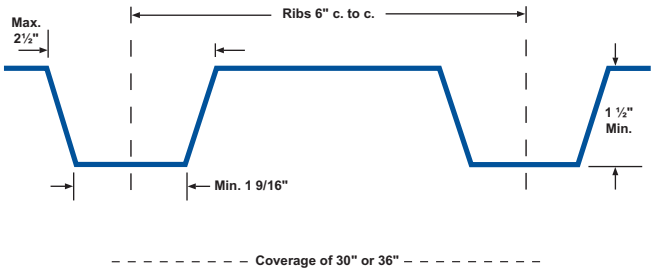
Type A roof decks are typically available in 18-, 20- and 22-gauge, with a G90 or painted finish.

Type F Roof Deck (Intermediate Rib)



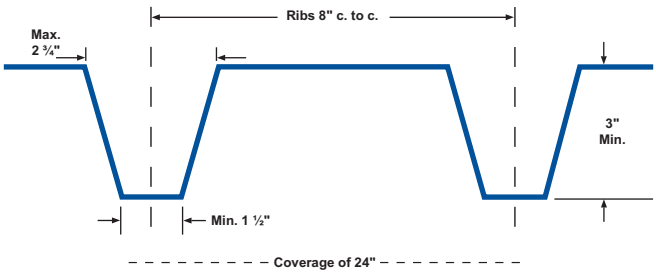
Type F roof decks are typically available in 18-, 20- and 22-gauge, with a G60 or painted finish.

Type B Roof Deck (Wide Rib)



Type B roof decks are typically available in 16-, 18-, 20- and 22-gauge, with a G60, painted or painted with white bottom finish.

Type N Roof Deck (Deep Rib)



Type N roof decks are typically available in 16-, 18-, 20- and 22-gauge, with a G60 finish.

It is recommended that roof insulation be secured to the steel deck with mechanical fasteners or adhesive systems. Some membrane manufacturers do not accept adhesive applications of insulation to steel decks. Refer to the membrane manufacturer's requirements.

InsulFoam roof insulation is used in numerous Direct-to-Deck™ applications. In these assemblies the insulation is placed directly over the steel deck. To ensure that InsulFoam performs during both the construction process and throughout the service life of the roof assembly, it is imperative that the

appropriate minimum thickness be used. The following chart lists the minimum thickness of InsulFoam required for various deck types.

METAL DECK SPANABILITY MINIMUM INSULATION THICKNESSES				
Steel Roof Deck Type	**Type A**	**Type F**	**Type B**	**Type N**
Flute Span Distance (Max)	**1.00 in.**	**1.75 in.**	**2.50 in.**	**2.75 in.**
InsulFoam I	1.25 in.	2.25 in.	3.12 in.	3.44 in.
InsulFoam VIII	1.15 in.	2.00 in.	2.88 in.	3.25 in.
InsulFoam II	1.05 in.	1.85 in.	2.63 in.	2.90 in.
InsulFoam IX	1.00 in.	1.66 in.	2.37 in.	2.60 in.
InsulFoam SP	1.00 in.	1.25 in.	1.50 in.	2.00 in.

In all applications in which a cover board, Oriented Strand Board (OSB) or a gypsum-based product, (e.g., Dens-Deck®) is used in conjunction with InsulFoam, the minimum thickness is 1.00 inch for all densities and deck types.

It is very important that the insulation be securely attached to the roof deck. Uneven or loose insulation can impact the performance of the roof membrane, and can exacerbate roof damage resulting from wind loads. When mechanical fasteners are used to attach the insulation or sheathing material, they must have a length that will permit the fastener to penetrate the steel deck by a minimum of 3/4". For multiple-layer systems, the first layer of insulation may be secured with the mechanical fasteners or a suitable adhesive and the second layer may be attached with an approved adhesive. It is also acceptable to mechanically fasten through multiple layers of insulation (InsulFoam and/or cover boards).

The required number of roof fasteners is dependant on the area of the roof being covered and the membrane being installed over the insulation.

Additional fasteners are usually required at building corners and perimeters. For more detailed design information on wind uplift resistance, refer to the Wind Loads section of ASCE/SEI Standard No. 7-05, *Minimum Design Loads for Buildings and Other Structures* provided by the American Society of Civil Engineers. For an example of a steel deck fastener and typical fastener patterns, refer to the charts at the end of this section.

Today, the use of asphalt to attach insulations directly to steel decks is rarely acceptable. This is due to historically poor wind resistance that resulted from inadequate bonding to the steel. There were numerous reasons that led to these conditions.

Two commonly cited conditions were that process oils on the steel often prevented adequate adhesion, and rapid cooling of the asphalt did not allow sufficient time for the installer to place the insulation.

Concrete Decks – Poured In Place

Poured- or cast-in-place concrete decks also provide a suitable substrate for most roof assemblies. These decks can accommodate a number of attachment methods when installed and prepared properly.

Concrete decks must be adequately cured to support roof construction traffic. Consult the designer for recommendations. The deck must be dry and have a reasonably smooth surface. Adhesive attachment of insulations may require the use of a primer to ensure an adequate bond. Consult the adhesive manufacturer's recommendations. Hot-asphalt attachment typically requires the application of a solvent-based primer prior to the application of the asphalt.

In either case, if a solvent-based primer is used, make certain it is completely dry and that all of the solvent has evaporated before applying the adhesive/asphalt and any InsulFoam insulation. The roughness of the deck will impact the quantity of adhesive or asphalt required to adequately bond the insulation.

Prior to installation of the insulation, the roofing contractor should check the dryness of the deck. If any moisture is present, the application should be delayed until the deck is dry. When hot asphalt is being used as the adhesive, the dryness of the deck can be checked by applying hot asphalt at its EVT (Equiviscous Temperature), which is printed on the package. If frothing or foaming occurs, the deck is not sufficiently dry.

There are numerous fasteners available that will permit mechanical attachment of InsulFoam insulations directly to a poured concrete deck. For an example of a concrete deck fastener and typical fastener patterns, refer to the charts at the end of this section.

Poured Gypsum Decks

Today, poured gypsum decks are not usually used for new construction. However, they can be encountered in re-roofs of existing buildings. It was not uncommon for poured gypsum decks to experience cracking over structural support members during curing. Once completely cured, they are relatively stable. Most roof membrane systems have performed well over poured gypsum decks when designed and installed correctly and allowed to completely cure (dry). There are specially designed insulation fasteners available for use with these decks. Contact a specialty fastener supplier to determine fastener frequency, patterns and acceptable deck conditions. Prior to installing any insulation over these systems, the roof designer and contractor should make certain the deck is capable of supporting and receiving the new roof assembly and related construction loads. In order to accommodate mechanical fasteners, a minimum gypsum deck thickness of 2" is typically recommended. Pull tests are recommended to determine the holding capability of the fastener. This data is used to determine the fastener frequency needed for the designed wind conditions. For an example of a gypsum deck fastener and typical fastener patterns, refer to the charts at the end of this section.

These decks were considered by many membrane manufacturers to be nailable only – meaning they were suitable to receive a nailed asphalt-coated fiber glass base sheet. These base sheets are frequently referred to as G2 base sheets, referring to their Underwriters Laboratories, Inc classification. The decks are not considered suitable for direct adhesive or hot-asphalt attachment due to their surface condition and residual moisture. Therefore, roof assemblies including insulation frequently require it to be hot-mopped or adhered to a fiber glass base sheet.

Pre-Cast Concrete Decks

Many of the recommendations for cast-in-place concrete decks also apply to pre-cast concrete decks. However, one common condition encountered with pre-cast decks is the difference in height between adjacent panels, which results from placement or variation in curvature. Any height difference must be addressed by grouting the lower panel to provide a transition capable of accommodating the roof insulation. It is strongly recommended that fill boards be used to provide an even substrate for the roof membrane in areas of differential panel height. If not addressed properly water can accumulate in low and uneven areas. Mechanical attachment to these decks is not recommended.

Pre-Cast Gypsum

Again, these types of decks are not typically used in new construction today, but can be encountered on re-roofing projects. It is very important that the original deck manufacturer's roof installation procedures and recommendations be followed closely. These decks can accommodate nailed base sheets and mechanical insulation fasteners; however, they must be of a design approved by the deck manufacturer.

Tongue and Grooved (T&G) Wood Decks

For many years, these were the decks of choice, particularly in the western part of the country. Proper design and installation, as with any decking material, is critical to the performance of the deck and subsequently the attached roof assembly. Wood is hydroscopic – it tends to absorb moisture from its environment. As wood's moisture content changes, it will expand or contract, causing movement of the deck. It is desirable to separate any deck movement from the roof membrane. Mechanically fastened insulations can provide adequate separation from these changes.

Wood decks should not be warped, cupped or have an excessive number of knots or cracks. Cover small cracks and knots with a layer of 20-gauge sheet metal or an adequate thickness of insulation. Many built-up and modified bitumen roofing membrane manufacturers recommend minimum board widths and thicknesses in order to prevent excessive deflection or other movement of the wood deck. If the wood deck has been treated with any oil or creosote, InsulFoam products must not be applied without an approved separator sheet, either red-rosin paper, fiber glass base sheet or SecurePly. This separator sheet will prevent any undesired bonding of the insulation to the wood as a result of seeping wood resins.

Plywood and Oriented Strand Board (OSB)

In most cases, engineered wood products have replaced solid wood as the standard material in building construction.

Plywood Decks Plywood is a panel that consists of multiple layers of rotary cut veneers, laminated together with alternating plies with their grain running perpendicularly to the adjacent ones. Panels used as roof-deck sheathing should meet the standard properties prescribed in U.S. Product Standard PS-1 81 (ANSI A199.1). Fire-treated plywood must be certified by the manufacturer for use in low-slope roof applications.

Oriented Strand Board Oriented Strand Board (OSB) is made by bonding relatively small wafers or chips of wood into panels consisting of multiple layers, laid perpendicularly to each other. These products should carry the American Plywood Associations (APA) label indicating that the product is CD, Exposure 1, Struc 1, with the minimum thickness recommended by the membrane manufacturer.

It is recommended that these panels NOT be abutted directly against each other. A gap, typically 1/8", is left to accommodate any movement resulting from moisture gain. If installed too tightly the roof deck can buckle at the panel joints. For this reason, the deck material should be kept dry, requiring that exposed decking be roofed as quickly as possible. In order to prevent condensation on the interior surface of the deck adequate InsulFoam insulation should be installed.

Lightweight Insulating Concrete

Lightweight insulating concrete (lightweight concrete) is a poured-in-place slurry composed of Portland cement, water, sand and aggregate or a foaming agent (cellular). These decks, when designed and installed correctly, provide a suitable foundation for most roof assemblies. In addition, they provide excellent wind and fire resistance.

One of the key features of these decks is their ability to build-in slope for the roof with multiple layers of InsulFoam. The InsulFoam in these applications is often referred to generically as holey board because of the integral voids formed into the panels. During application, the slurry migrates through these large perforations and bonds to underlying layers, forming a composite matrix of InsulFoam and lightweight concrete. Most membranes systems can be mechanically attached to these decks.

The aggregate-based lightweight concrete contains either vermiculite or perlite fillers that are employed to keep the density low and provide some insulation value. Minimum thicknesses recommended depend on numerous factors, including the membrane to be installed, the type of fasteners and the desired thermal performance. Vented decks accommodate evaporation of excess moisture from the slurry. The manufacturers of these materials permit placement over vented, or slotted, galvanized steel decking, pre-cast or poured-in-place concrete, or existing roofing systems.

The cellular lightweight concrete systems employ a foaming agent that creates small uniform bubbles in the cement mixture. These systems typically consume all free water during

the curing process, making them ideal for most roof assemblies. The manufacturer's mixing and installation procedures must be followed precisely to ensure that the system does not dry too quickly and cause severe surface cracking, or contain an amount of moisture that could impact the performance of the roof membrane.

These systems have been approved for use by Factory Mutual, and the FM Approval Guide should be consulted for approved types and fastening rates.
The use of InsulFoam HB (Holey Board) roof insulation in these systems can provide desired thermal values as an integral part of the deck assembly.

These can be highly competitive alternatives for both new construction and re-roof applications. In addition, re-roof applications over these decks can be performed without disturbing the deck material and InsulFoam insulation, eliminating expensive insulation replacement costs.

Cementitious Wood Fiber Panels

Cementitious wood fiber deck panels (e.g. Tectum®), are made from long strands of wood (historically aspen), coated with a portland cement binder. These panels exhibit excellent acoustical properties and provide an attractive surface for the interior of the building. Tectum is a registered trademark of Tectum, Inc.

Products used in roof deck applications may be made with a moisture-resistant cement binder, and have a sufficient density to support the desired live and dead loads to which the roof will be exposed. The designer should consult the deck manufacturer or the Structural Cement Fiber Products Association for design assistance.

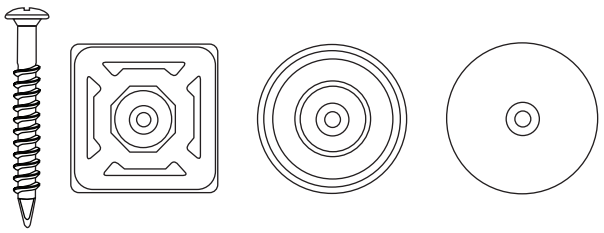
As with any building material, there are limitations that should be considered with these decks. In the past these materials were used extensively over indoor pools and gymnasiums. This often resulted in the accumulation of moisture in the deck, which adversely affected the performance of the roof membrane. Other issues can be encountered as a result of the gaps between the panels, differential heights of adjacent panels (which must be leveled) and excessive deformation over time.

Differential heights can easily be addressed with a leveling layer of InsulFoam insulation or R-Tech Fanfold Roof Underlayment, which may be mechanically fastened to the deck using specialty fasteners shown at the end of this section of the manual.

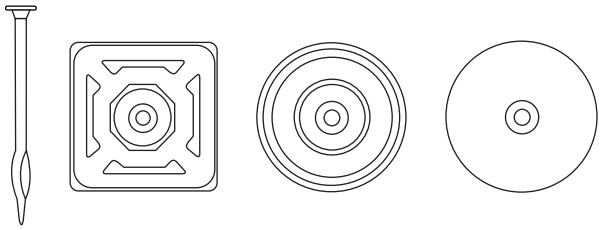
The deck manufacturer's installation recommendations must be followed closely. All leveling, mechanical attachment and protection procedures must be followed. For an example of a cementitious wood fiber deck fastener and typical fastener patterns, refer to the charts at the end of this section.

Mechanical Fasteners

Typical Steel & Wood Deck Fastener & Plates



Typical Concrete Deck Fastener & Plates



Typical Tectum®, Gypsum & Lightweight Concrete Deck Fastener & Plate