PIMA Technical Bulletin #108

Tapered Insulation Systems

About Polyiso Insulation

Polyiso is a rigid foam insulation used in more than 70% of commercial roof construction and offers a continuous insulation solution for commercial and residential wall assemblies. As one of North America's most widely used and readily available building products, Polyiso is a cost-effective insulation option for reducing building energy use and improving the overall service-life of roofs and walls.

The benefits of using Polyiso include:

- High R-value per inch of thickness
- Excellent fire test performance
- Extensive building code approvals
- Cost-effective continuous insulation (ci) solution
- Compatible with most roof and wall systems
- Dimensional stability
- Compressive strength
- Moisture resistance
- Thinner walls and roofs with shorter fasteners
- Long service life
- Preferred insurance ratings
- Virtually no global warming potential
- Zero ozone depletion potential
- Recyclable through reuse
- Recycled content (amount varies by product)
- Regional materials (nationwide production network)
- QualityMark^{CM} certified LTTR-values

POLYISO

Surround yourself with the best.

Why Choose Tapered Roof Insulation?

The goal of tapered roof insulation systems is to reduce or eliminate the amount of ponding/standing water on the membrane when the roof deck does not provide adequate slope. Draining water in a timely and efficient manner minimizes the adverse effects that ponding/standing water can have on completed roof membranes. A properly designed tapered roof insulation system not only provides the positive drainage needed but also helps extend the life of the roof membrane. As more designers and roofing professionals understand the importance of positive drainage in good roofing practice for both new construction and re-roofing, the popularity of tapered insulation has increased dramatically.

Ponding water can be the greatest threat to a roofing membrane. It not only shortens the expected life of the membrane, potentially voiding the membrane warranty, but can also lead to more serious problems such as structural deflections of the roof deck and bacterial or unwanted vegetative growth on the roof.

Many professional agencies and code groups recommend or require a minimum roof slope in both new construction and re-roofing projects. When reviewing the choices available, designers can satisfy slope requirements by using either tapered roof insulation or by sloping the structural deck. Often tapered roof insulation is used in conjunction with structural slope and in many cases tapered roof insulation replaces structural slopes altogether. Designers, architects and building owners should consider the options available that best ensure the long-term performance of the entire roof assembly.

Tapered Polyiso Insulation - The Product of Choice

After the decision has been made to use a tapered roof insulation system, designers, architects and specifiers must determine which tapered roof insulation system is best. Tapered polyiso is frequently the tapered system of choice.

The advantages provided by tapered polyiso make the decision a simple one. Tapered polyiso is the only foam plastic roof insulation product to have passed both UL 1256 (US) (CAN/ULC-S126 for Canada) and the FM 4450 Calorimeter test in direct to steel deck applications. Tapered polyiso products also provide:

- Outstanding physical properties (see chart on next page);
- High R-values;
- Compatibility with virtually every roof membrane;
- Wide variety of tapered products; and
- A variety of composite products (perlite, woodfiber, or Dens-Deck®) for applications when a separation layer is specified.

Physical Property Chart

Property	Method	Value (typical)
Compressive Strength	ASTM D1621	16 to 25 psi
Dimensional Stability	ASTM D 2126	<2% linear change (length & width), 7 days
Moisture Vapor Transmission	ASTM E96	<1 perm
Water Absorption	ASTM C209	<1% volume
Flame Spread (Foam core only)	ASTM E84	25
Service Temperature		-100° to 250° F (-73°C to 122°C) (ASTM C1289) -76° to 200° F(-60°C to 93°C) (CAN/ULC-S704)

It is easy to specify polyiso insulation by referring to product standard ASTM C1289 (US) or CAN/ULC-S704 (Canada). Many polyiso manufacturers provide experienced personnel to consult and educate the contractor, architect, and the design and specifying communities on the design of a tapered system and the importance of positive drainage. With all these benefits and tools available it is easy to see why specifiers consider tapered polyiso the product of choice.

Design Considerations

While tapered insulation systems have an important role in the successful performance of the roof assembly, proper design and installation are even more important.

PANEL SIZES:

Polyiso insulation panels are manufactured in standard 4'x4' sizes. 4'x8' sizes can be manufactured as a special product for large areas free of valleys or ridgelines. The minimum manufactured thickness of tapered polyiso board at its low edge is 1/2" and the maximum thickness of a single layer of board is 4". A flat polyiso underlayment board (flat fill) is used beneath continuing, repeating tapered panels.

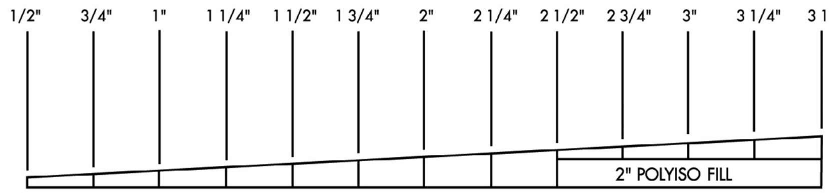
SLOPES:

A 1/4" per ft. minimum field slope is recommended by the National Roofing Contractors Association (NRCA Roofing and Waterproofing Manual) and Canadian Roofing Contractor Association (CRCA), and required by various model building codes. However, a variety of standard and special order slopes are available and acceptable based on field conditions and building parameters. Always consult local code authorities for specific code requirements.

PROFILES:

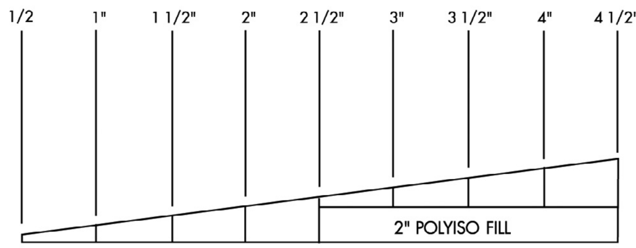
While polyiso manufacturers' designations for each panel may vary, the available profiles are consistent. One design variation is the issue of abbreviated panel system (Fig. P2, P4) using 2" fill boards vs. extended panel system, which uses 3" fill boards (Fig. P3, P5). Both profiles have their advantages and disadvantages. The abbreviated systems materials generally cost less; however, they require additional labor and handling. Moreover, in hot applications, additional asphalt is required for adhering multiple layers. The extended panel systems, although less labor-intensive, will have a higher material cost and do not provide for staggered joints until further up the run.

Any variation from this design will also affect the efficiency of the system in draining water. Therefore, every tapered system should start with a 4-way direct to the drain design. The next

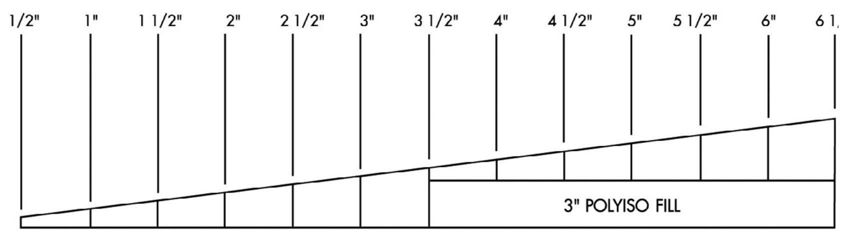


TYPICAL CROSS-SECTION OF 1/16"/FT. SLOPE
P1

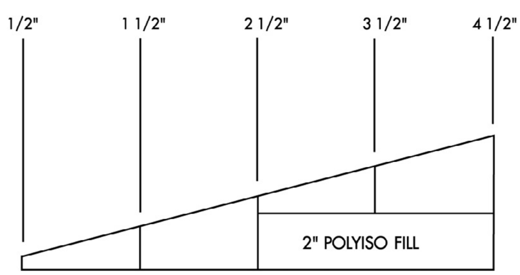
- 1/16” per ft. (special order) - Primarily used to increase insufficient structural slope or where runs are so long the high points exceed the maximum conditions. (Fig. P1)



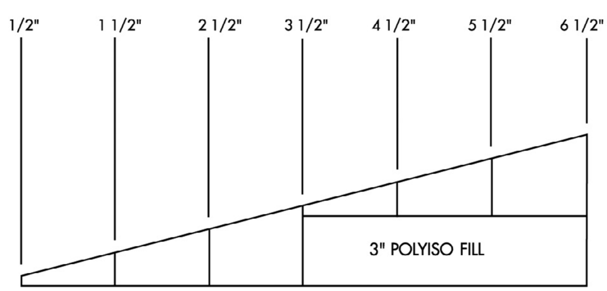
ABBREVIATED PANEL: TYPICAL CROSS-SECTION OF 1/8" SLOPE
P2



EXTENDED PANEL: TYPICAL CROSS-SECTION OF 1/8" SLOPE
P3

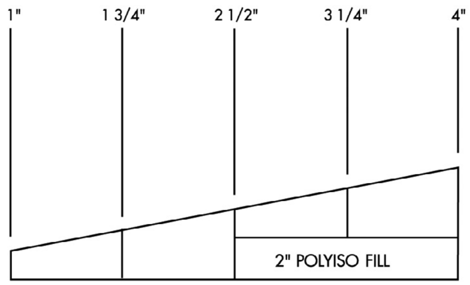


ABBREVIATED PANEL: TYPICAL CROSS-SECTION OF 1/4" SLOPE
P4

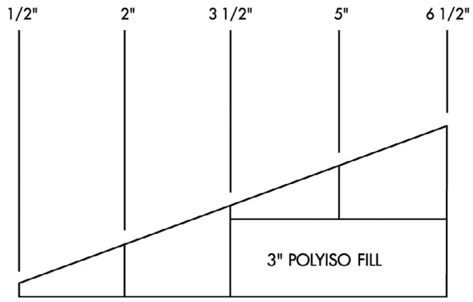


EXTENDED PANEL: TYPICAL CROSS-SECTION OF 1/4" SLOPE
P5

- 1/8” (Fig. P2, P3) and 1/4” per ft. (Fig. P4, P5) - These are the most commonly used slopes.

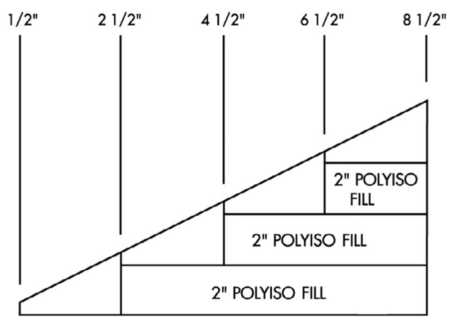


TYPICAL CROSS-SECTION OF 3/16" SLOPE
P6



TYPICAL CROSS-SECTION OF 3/8" SLOPE
P7

- 3/16″ (Fig. P6) and 3/8″ per ft. (Fig. P7) (special order) - Used to achieve the best gradient for restrictive thickness conditions.

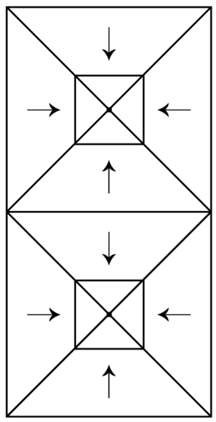


TYPICAL CROSS-SECTION OF 1/2" SLOPE
P8

- 1/2″ per ft. (Fig. P8) - Commonly used for crickets and saddles - can also be used for very efficient drainage of small roof areas.

DESIGN:

There are numerous ways to design a tapered insulation system for even the simplest of roof plans; however, moving the water most effectively to the specified drainage point is the primary goal. **A 4-way direct to the drain design is the most effective way of moving water off the roof (Fig. D1).**



D1

step is to identify justifiable reasons to alter the layout. Also note that precise field information and accurate drawings, which not only outline the roof areas and drain locations, but also identify mechanical units, skylights, height restrictions and expansion and control joints, are necessary information in the design process.

Valid reasons for compromising 4-way slope may be:

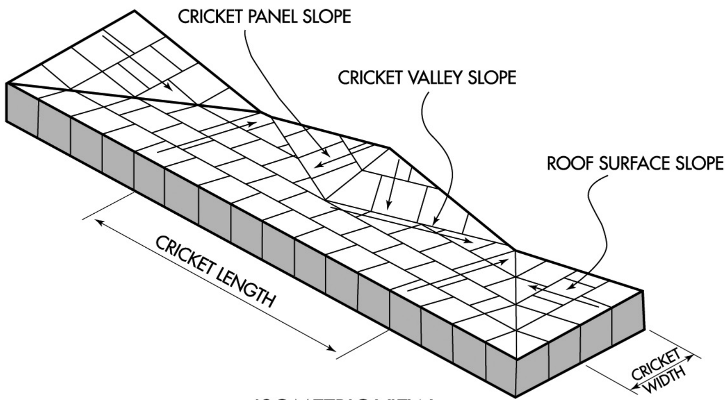
- COMPLEXITY OF EXISTING DRAIN LOCATIONS - Extended sumps or valleys can be used to simplify design while eliminating complex cutbacks.
- CONSTANT PERIMETER - Edge conditions may dictate a constant thickness of insulation at the roof perimeter.
- MULTIPLE DRAINS AT A LOW POINT - With the absence of an overflow drain, valleys between drains provide a helpful water path to drain, should one of the drains fail.
- COST - Tapered insulation is an expensive material element of the roofing system and therefore is often the primary target for value engineering (changing the design to lower the cost)—it should be noted that value engineering while reducing the cost also compromises the drainage effectiveness of the tapered system.
- HIGH POINT RESTRICTIONS - When a perimeter condition limits the thickness of a material.
- ROOFTOP PENETRATION LOCATIONS - Extended low points and/or sumps may be needed to move valleys past or around rooftop units or skylight penetrations. In order to provide the most efficient tapered insulation drainage system, one should prioritize design intent, budget allowances and field parameters for each project.

Crickets

Crickets are a secondary application of insulation used to divert water from rooftop curbs, valleys, and low points to drains or scuppers. There are two factors that contribute to the working effectiveness of a cricket. (1) The slope of the field (either structurally sloped or with tapered insulation) (2) The angle of the cricket up that slope, i.e., the wider the cricket, the more the slope of the deck is utilized.

HOW TO CALCULATE CRICKET VALLEY SLOPE:

Cricket Valley Slope =



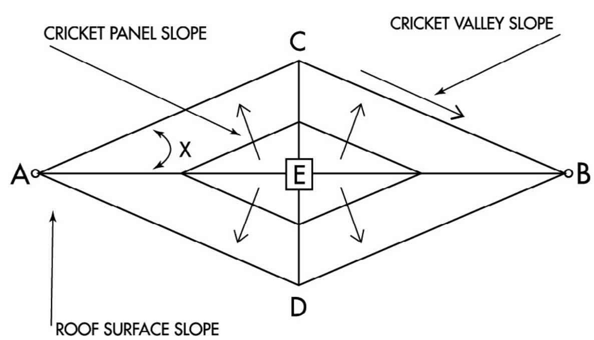
ISOMETRIC VIEW

Rise is the roof surface slope x 1/2 the cricket width (C to E)
Run is the length of cricket valley (C to A)

or Tan (x) x Roof Surface Slope

Tan (x) = (C to E)
(A to E)

The general rule used to figure cricket size is that the total width of a full diamond cricket should be between 1/3 and 1/4 of its total length.



Roof Surface Slope	The slope that is created by the structural deck, tapered insulation or a combination of the two.
Cricket Width	(Points C to D) Generally the shorter of the 2 cross-sections.
Cricket Length	(Points A to B) Generally the longer of the 2 cross-sections.
Cricket Panel Slope	The slope of the cricket panel.
Cricket Valley Slope	(Points C to B) The net slope created along the edge of the cricket.
Cricket Angle (x)	The angle between corresponding lines AB (Cricket Length) and AC (Cricket Valley).

AVERAGE R-VALUES:

In order to determine the average system R-values for a tapered insulation project, the average thickness for the insulation system must first be determined. This is calculated by dividing the total volume of insulation (the board footage) by the area of insulation coverage (the square foot area). The average R-value is then referenced by associating the average thickness for the project with the R-value for the corresponding thickness of a flat insulation product.

Finally

Although design theory, job conditions and budget constraints may vary, one factor remains constant, a properly designed and installed tapered polyiso insulation system can add years of satisfactory performance to any roof.

PIMA

For more than 30 years, PIMA (Polyisocyanurate Insulation Manufacturers Association) has served as the unified voice of the rigid polyiso industry proactively advocating for safe, cost-effective, sustainable and energy-efficient construction. PIMA's membership includes manufacturers of polyiso insulation and suppliers to the industry. The products of PIMA's members comprise the majority of the polyiso produced in North America.

PIMA produces technical bulletins to address frequently asked questions about polyiso insulation. These publications update and inform architects, specifiers, and contractors about and build consensus on the performance characteristics of polyiso insulation. Individual companies can provide specific information about their respective polyiso products.

For more information on polyisocyanurate insulation, visit www.polyiso.org

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