KEEPING OUT THE WATER

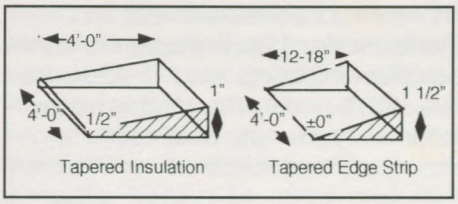
John J. Serke AIA RRC

Specifying Tapered Insulation

What is the similarity between Atlantic City and a set of construction documents? Could it be that architects and contractors are taking a chance, playing craps, or dropping out of a poker hand? The first two are quite often acknowledged to be true. However, during bidding, only a contractor can drop out; an architect can't. Information on drawings leaves an architect exposed to second guessing. Having correct information can be a warm and friendly feeling. This is especially true with tapered insulation. Correct documentation (plans and specifications) can save an architect valuable time and administration costs later on.

Tapered Insulation - The Choices

When you cannot slope the structural deck of a building roof structure, you must consider the use of tapered insulation. Some codes require a positive slope to drain, and most manufacturers will not issue a guarantee without good drainage. There are two types of tapered systems that can be used to provide a positive slope for drainage. 1. Field fabricated and poured in place insulating lightweight fill can be installed in a variety of slopes and on irregular geometric shapes. 2. Factory fabricated tapered rigid insulation must follow a regular geometric pattern, drains must be aligned, and the perimeter should be able to accommodate uneven elevations. (For internal drains). Design of the two systems should reflect their installation differences, and the designer should know the requirements for each. Once the minimum or average R-value is determined, the roof plan can be prepared. Insulating lightweight fill should be specified by indicating the low and high points in inches. Tapered rigid insulation should be specified by establishing the low point thickness and giving the rate of slope (ie 1/4 or 1/8") per foot.



Layout Examples of Tapered Systems

The geometry of the roof plan is an important consideration when choosing a factory fabricated or field fabricated insulating system. If the plan is unusual in shape and will not allow the placement of valleys at 45 degrees, drains are not lined up, or there is considerable deflection, a field fabricated system can be cost effective and provide positive slope. A roof plan that is rectangular with drains lined up is more cost effective using a factory tapered system.

What's the R-Value?

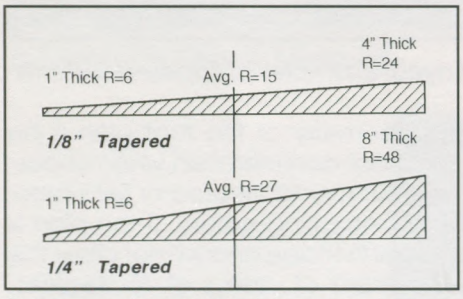
The R-value of a tapered system is specified in terms of either a minimum or an average insulation value. If you choose to specify a minimum value, you must make sure that the thickness is not less than allowed by the insulation or membrane manufacturer. Minimum thickness is usually 1 to 1 1/2 inches for lightweight insulating fill and 1" for rigid insulation. If you choose an average value as the basis for your specification, the manufacturer will supply the most economical design. This may be a slope less than you desire. Therefore it is good practice to specify the minimum slope you will allow.

By using the formula: (MIN T + MAX T) ÷ 2 x R/in. = AVG R, you can see how the average R-value dramatically increases for the 1/4 inch system as opposed to the 1/8 inch system. This increase will also be reflected in the cost of the material.

1/8 inch taper (min. 1" thickness):
(1" + 4") ÷ 2 x 6 = AVG R = 15

1/4 inch taper (Min. 1" thickness):

(1" + 8") ÷ 2 x 6 = AVG R = 27
The illustration below shows the comparative thickness and R-value between 1/8 and 1/4 inch tapered insulation over a length of 32 feet.



Comparative Thickness / Average R-Value Based on Avg. R = 6 per inch

Rigid Insulation Types
Tapered insulation and tapered edge strips are different products used for different purposes. Tapered insulation, which makes the tapered roofing system, made from foam products is usually manufactured in 4 x 4 foot panels and limited to a minimum thickness of 1/2 inch. Tapered fiberglass, fiberboard, or perlite panels are usually 3 x 4 or 2 x 4 feet and are tapered down to ±0 inches. Tapered edge strips, which are used around projections and roof perimeters, are factory fabricated down to ±0 inches and are smaller in size and easier to handle than the larger tapered roof panels. The thinner panels or edge strips are easily damaged during shipment or installation and must be handled carefully.

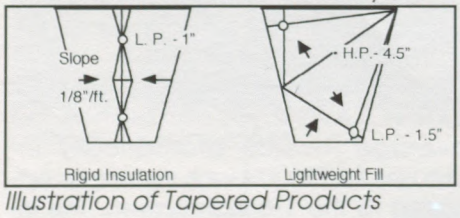
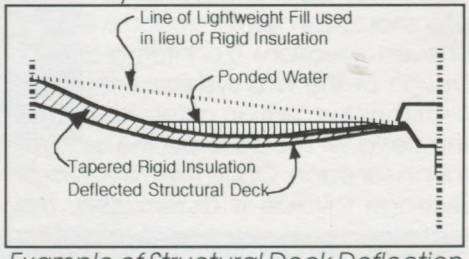


Illustration of Tapered Products

Insulation Attachment
With the exception of ballasted single ply systems, all tapered systems are attached to the structural deck. Otherwise, shifting of loose insulation can occur during construction and wind uplift. Displaced insulation can cause serious thermal and drainage problems, and I recommend that all insulation be adhered to the deck. Saddles and crickets that are placed over the base system should always be adhered to the base to eliminate movement.
When mechanical fasteners are used to attach rigid insulation, it is good practice to specify that the fasteners be sized according to the insulation thickness. Maximum penetration should not exceed 1 to 1 1/2 inches for metal decks. Fasteners should not penetrate through concrete decks, and should engage the top of a metal deck - not the flutes. If conduit or other accessories are placed on, below, or in a structural deck, the specifications should acknowledge that special care is necessary.

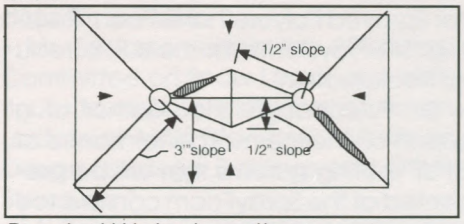
Watch for Ponded Water
When the structural substrate is uneven or has pronounced deflection, tapered rigid insulation will follow those deflections and a low point may still exist in the tapered system. It is virtually impossible to "engineer out" these deflections and the use of field fabricated insulating fill easily overcomes this problem. Contractors installing insulating fill should lay out the slope with a string line so the top surface follows a true slope and not the slope of the deck. The illustration below shows how the two systems work in this case.



Example of Structural Deck Deflection

Slope is measured by its rate of change along the line that is normal to the plane of slope. The valley created by two sloping planes will have a rate of slope less than either plane, and this is

where water will often pond. When crickets or saddles are used to divert water towards a drain, the water will run along the leading edge of the saddle. Since this slope is less than the roof slope, water can also pond in this area.



Ponded Water Locations

When crickets or saddles are used between drains, the tapered saddle is laid over the tapered roof system. An additional tapered edge strip will be necessary to make a smooth transition between the roof and saddle. The illustration below shows one side with a tapered edge strip and the other with a 1/2 inch ledge created between the two insulations. The latter is standard roofing practice. To assure that the installation will be correct, a detail or reference in the specification will be necessary.

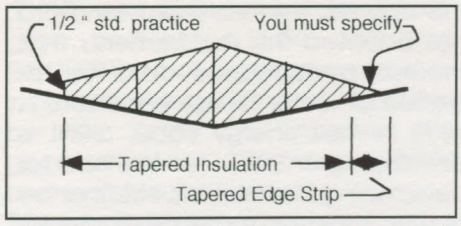
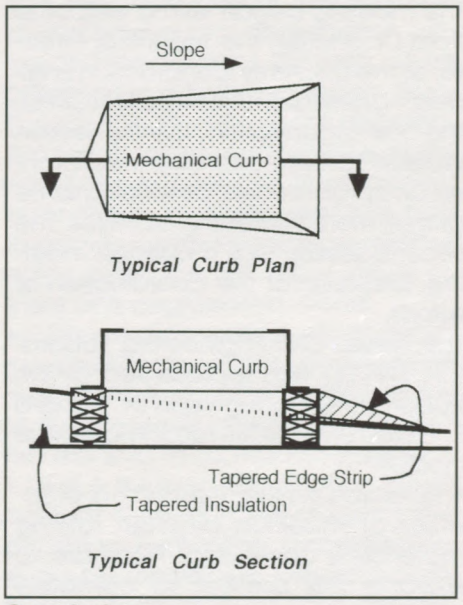


Illustration at Saddle Between Drains

Details Need Special Attention

Some lightweight insulating systems need to be vented so the moisture in the installation process can vent out. Special metal decking should be specified for this purpose. If the deck is homogeneous, such as concrete, a system that does not require venting is necessary. Both rigid insulation and lightweight fill need to be covered with a membrane as soon as possible. Rigid insulation should be covered on the same day it is installed. Lightweight should be covered within several days as soon as the curing process allows.

When specifying a tapered system, it is important to alert your structural and mechanical consultants and coordinate the heights of curbs and roof penetrations. A standard 9 inch curb set directly on the structural deck may only have 4 inches of flashing height after the tapered system is installed. When the curb is installed on wood blocking, additional tapered insulation is necessary to "flush out" the insulation with the blocking.



Conclusion

A properly designed tapered insulation system presents no more installation problems than a non-tapered system and the cost factor between the two is minimal. Proper specification assures you that the shop drawings will be clear and easy to check, installation will proceed without interruption, and the final product will perform as intended. On the other hand, a poorly specified system can lead to confusion for the manufacturer and result in hours and days of unanticipated architectural time to resolve problems as they are presented to you.