Modern roof maintenance depends on up-to-date techniques

Contour maps may reveal hidden problems

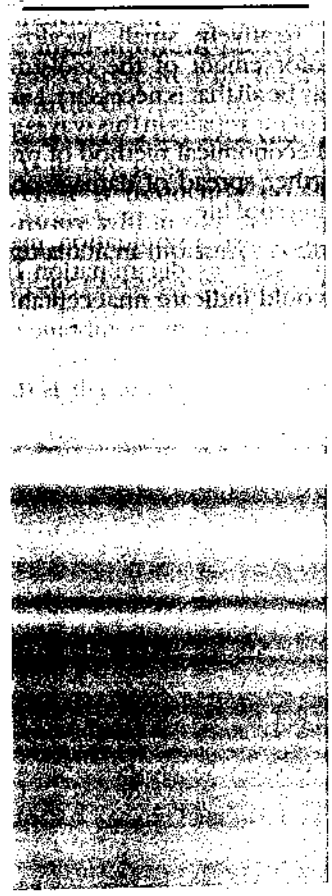
by Richard G. Anderson, P.E.

The use of contour maps is not at all complicated. The moisture contours graphically displayed on a contour map indicate the location and the degree of roof deterioration. Because roof deterioration and moisture penetration are closely related, it is possible to determine the amount of moisture present in a roof using the maps. When consultants, roofing contractors and building supervisors have this kind of information available, they are better equipped to make maintenance decisions.

Understanding the internal moisture penetration of roof structures is the key to understanding the use of contour maps. To illustrate the moisture penetration of a roof, the contoured areas are shaded progressively darker. The shading indicates the relative severity of moisture penetration and roof damage; the darker the shading, the greater the penetration and more severe the roof damage.

Visual inspection not enough

Before 1974, the presence or absence of internal roof moisture was generally determined by sight or touch. The eyes and hands are quite insensitive devices for determining moisture penetration, however. Moisture in roofing materials is generally not apparent to sight or touch until the moisture content exceeds 45 percent to 65 percent by weight. Small amounts of moisture, which would indicate a roof problem in its early stages, cannot be detected by visual inspection.



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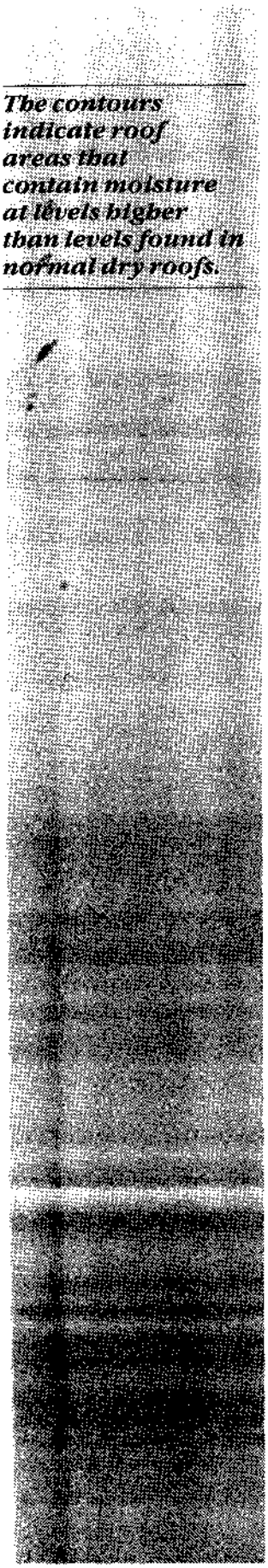
A moisture detection system such a A-Tech's can distinguish minute changes i moisture content. This improves both th quality and the amount of roof moistur information available. Problem areas ca now be located long before they would b suspected using visual inspection tech niques. Using these modern methods, it i possible to locate areas where moistur problems are just beginning. Many of thes areas, because they do not look or feel wet would remain undetected if the old sight and-touch method were used.

With early moisture detection and mor precise information, it is now possible t greatly improve decisions concerning th type of maintenance needed for each situ tion. In the past, the standard recommer dation of roofing consultants was t remove all wet roofing material an replace it with new, dry material. It is tru that large areas of insulation and men brane that are very wet certainly should b removed and replaced. But it may not b necessary to take such drastic measure with every roof where moisture has bee detected. In many cases, it is both sensibl and economical to allow smaller, less we areas of roofing, where the moisture pen tration is just beginning, to remain aft the moisture entrance points have bee repaired. Minor repairs to prevent th spread of internal damage may be all th are needed.

A moisture detection and mapping tec nique such as A-Tech's provides inform tion that has not been available in the pa concerning the degree of moisture penetr tion in a roof. As a result, consultants, co tractors and maintenance personnel ca better judge if roofing materials that co tain moisture should be removed. It is al possible to determine with more accurac the extent of repairs or maintenanc required.



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What the moisture contours reveal

The contour lines drawn on a roof moisture survey map call attention to areas containing moisture that are hidden from sight and touch. The contours indicate roof areas that contain moisture at levels higher than levels found in normal dry roofs. (The level of moisture that may be found in a dry roof is called its ambient moisture.)

The moisture contoured areas should be examined closely to determine the cause of moisture entry. Once the source of moisture is located, repairs can be made to prevent further entry and damage. Levels of moisture higher than ambient moisture may be caused by:

- general deterioration of the protective membrane;
- physical damage to the membrane;
- flashing imperfections;
- dew point condensation; or
- wet materials built in during construction.

Flashing problems and membrane damage are by far the major sources of internal moisture found in built-up roofing systems.

During the follow-up visual examination of the roof areas that contain moisture, the extent of repair or replacement necessary may be determined. If the visual examination finds the membrane's condition generally sound and the area of moisture-containing insulation relatively small, localized repair and reinforcement of the moisture entry points may be all that is necessary. Limiting the extent of the repairs in this way is an acceptable and economical method of preventing the further spread of damage and greatly extending roof life.

However, the visual examination may reveal problems such as delamination or rotting. This would indicate unacceptable physical deterioration of the membrane or insulation. In this case, tearing off and replacing the deteriorated materials is the preferred method of repair.

Good roof maintenance is the best way to avoid situations where extensive roof replacement is necessary. The key to good maintenance is the early detection and repair of moisture entry points. Small moisture entry problems in their early stages are the easiest to repair. When these problems are corrected promptly, a premature roof replacement costing thousands of dollars may be avoided.

"Dry" and "wet" defined

A-Tech has conducted extensive studies to establish when roofing materials should be considered dry or wet. For each individual roofing material A-Tech has determined a range of values for the product in its dry and wet states. When a moisture content is detected in a product that is above its normal ambient range, it indicates a roof problem. The amount of roof moisture detected above the ambient range indicates the degree of the problem.

If a roof is said to be entirely dry, it means that the total roof is within its normal ambient range. The amount of moisture in a wet roof may range from slightly above the roof's ambient level to saturation.

Some moisture present in all roofs

All roof assemblies and the materials used in their construction contain moisture. The normal moisture content of the insulation, membrane and deck is governed by the moisture content of the surrounding air. As the relative humidity of the ambient air increases, the moisture content of the roof's components increases. Lower relative humidity will decrease the moisture content of the roofing materials.

This range of normal moisture levels varies with the roofing materials used. A dry range that is normal for one roofing material may not be normal for another.

Roofing materials that contain moisture above normal ambient levels are defined as wet. When it is determined that a roof contains wet materials, it does not necessarily indicate the need for replacement of those materials. It does, however, indicate roof problems.

TABLE 1

Roofing Material	Approximate Maximum Equilibrium Moisture Content	Approximate Maximum Moisture Content (Saturation)
Organic Felt Membrane	1.0 %	20%
Glass Felt Membrane	NK	NK
#15 Organic Felt	4.0 %	75%
#15 Asbestos Felt	2.0 %	25%
Glass Felt	1.0 %	19%
Insulation		
Fiberboard	12.0 %	430%
Perlite Board	3.5 %	460%
Fiberglass	2.0 %	690%
Lightweight Concrete	6.0 %	60–110%
Cellular Glass	0.01%	30%
Urethane	6.0 %	1000%
Expanded Polystyrene	3.0 %	2000%
Extruded Polystyrene	0.5 %	10–15%
Dry Asphaltic Fills	0.1 %	60%
Deck		
Concrete	2.0 %	
Gypsum	2.5 %	105%
Wood	16.0 %	60–100%
Tectum	10.0 %	97%

Approximate Percent Moisture By Weight

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The moisture level in wet materials may range from slightly above the maximum ambient level to saturation. Each roofing material has its own wet moisture content range. A-Tech studies have established the limits of these ranges for each individual roofing material.

The ambient dry range and wet range of various roofing materials is shown in Table 1. The table indicates, for example, that the moisture level of dry fiberboard may range from 0 percent to 12 percent by weight. Wet fiberboard may contain 12 percent to 430 percent moisture by weight, according to the table. By comparison, the table lists the normal dry range of fiber glass as being 0 percent to 2 percent, while the wet range varies from 2 percent to 690 percent.

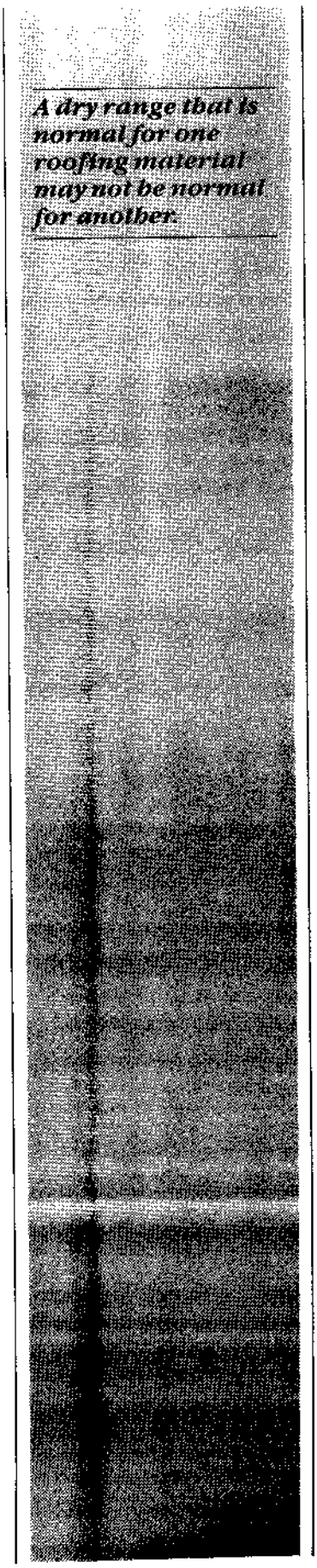
Five levels of moisture indicated

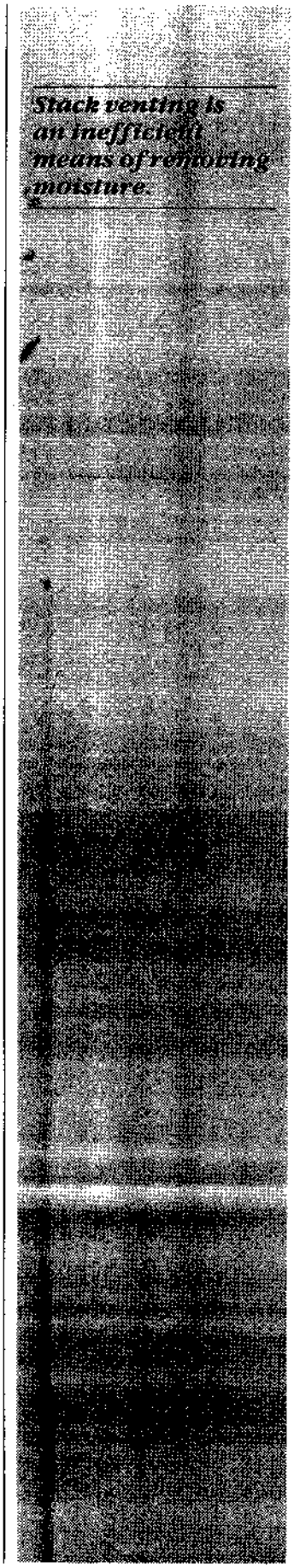
A built-up roof is a structure composed of a membrane, insulation, and a deck. When one part of the structure is wet and contains moisture above the ambient level, it does not necessarily follow that the remaining layers are wet or equally as wet.

On a moisture contour map these varying levels of moisture content are indicated. The levels are divided into five distinct ranges to show the extent and seriousness of the moisture penetration.

The lowest level of moisture penetration is indicated on a moisture survey map by the **high-ambient-moisture contours.** Areas represented by these contours are still in the dry range. But, because the moisture level of a dry area can vary from near zero to the product's maximum ambient level, it is frequently possible to detect moisture within this dry range. While the high-ambient-moisture contours do not indicate excessive wetness, they frequently indicate a problem area in its early stages.

A dry range that is normal for one roofing material may not be normal for another.





Stack venting is an inefficient means of removing moisture.

The lowest moisture level within a membrane's wet range is indicated by the **first-stage moisture contours.** These contours designate minor moisture penetration into the membrane. Areas represented by first stage contours may contain weakened spots that are susceptible to further physical damage.

More severe moisture penetration of the membrane is indicated by the **second-stage moisture contours.** Second stage contours point to problems that are similar to the problems encountered with first-stage moisture penetration. The only difference is that there is a greater amount of moisture present in the membrane. At times, the damage caused by this level of moisture penetration may be quite severe. Delamination, ridging, blistering and extensive loss of tensile strength may occur when the membrane is this wet.

Where the moisture has penetrated the insulation, the area is marked on the contour map by **third-stage moisture contours.** When moisture penetration is this severe, extensive horizontal migration of the moisture can weaken the insulation and lower its thermal resistance. Eventually, the moisture reaches the surface of the deck, allowing moisture to leak into the building wherever a crack penetrates the deck.

The last stage indicates the **area of greatest moisture content.** This is an area where moisture penetration is most severe. These contours can indicate one of two conditions:

- flashing and membrane problem areas where moisture entry occurs from damage such as tears, splits, punctures and flashing imperfections; or
- low areas of the roof, such as around drains, where internal moisture collects.

Contours indicate repair needs

There are two courses of corrective action that can be taken when moisture damage has been discovered in a built-up roof. Either the damaged area can be replaced and rebuilt with new, dry materials, or the area may be reinforced with high-quality materials to restore as much of the strength as possible and prevent further moisture entry.

A-Tech's studies indicate that when first-stage wet membrane areas are properly repaired and sealed, the areas will dry within approximately one year. Second-stage wet membrane areas will become considerably dry in a year or two.

Third-stage wet insulation areas in roof structures dry much too slowly. Leaving the wet insulation in place provides little practical benefit because the material's insulating properties do not improve. The area also remains a weak spot and the continuing expansion and contraction of the trapped moisture causes further damage.

Stack venting is frequently suggested as a method of drying out moisture trapped in roofing insulation. But this is an inefficient means of removing moisture and is not of practical benefit. Recommendations for venting usually stipulate the use of one vent per 1,000 square feet of roof area. Studies under controlled conditions indicate that 25 to 70 years would be required to successfully dry wet insulation with this method. Single-ply membranes applied over wet roof structures also do not effectively vent trapped moisture. Effective drying of the insulation depends upon exposing large segments of surface area to a flow of dry air.

Repairing moisture penetration areas in their early stages is a key component of a planned predictive maintenance program. A program that can detect and repair problems before further damage occurs reduces the possibility of building leaks, expensive repairs, premature roof replacement and heat loss due to wet insulation.