Identifying Moisture Problems with IR Thermography

In moisture remediation, the first step is to find the source and correct the problem. Infrared thermography can detect the source of moisture even when it's hidden from view.

By Rafael Royo and Carla Montagud

Infrared thermography gives building inspectors and remediation specialists an advantage when investigating moisture problems. For example, it makes it possible to immediately detect moisture from a variety of sources and identify problems relating to insulation failures.

Thermography is an important tool for quickly finding and repairing moisture problems, as well as helping to resolve associated litigation issues.

There are many situations where thermography is helpful, including:

- Detection of air and water infiltration
- Locating moisture due to leaking pipes
- Detecting moisture due to condensation
- Easy visualization of 'thermal bridges' located in pillars, beams, windows, etc.
- Finding water pipes and electric lines inside walls
- Detection of different construction materials inside the walls or on their surface
- Determination of external surface temperatures in the building, which will allow for the analysis of heat losses
- Discovery of materials no longer firmly attached to the external surface of the building, such as ceramic or marble tiles

Thermography Speeds Up Inspections

The examples highlighted here come from a cluster of buildings in a tourist destination in the south of Spain. The mild climate there may have led builders to believe there was no need for insulation. Despite 10 years of attempted repairs, moisture problems persisted and their source was unclear.

Although a moisture meter can be used to help find the source of a problem, it can be a time-consuming process. Physically moving the meter over a large surface area is tedious, and may require a ladder or scaffolding.

IR thermography is a non-contact method that can be used from ground level. It quickly narrows your search for moisture sources, and is a timesaving first step before using a moisture meter.

To locate the moisture sources in this particular case, the authors used an IR camera to detect temperature differences that usually occur in the presence of water. The IR camera used here has a sensor and electronics that converts temperature profiles to visible images with an associated temperature scale. Measurement accuracy is about ±2°C, but it is the temperature differentials in the camera's field of view that are important.

The thermal images collected in this case were taken with a FLIR ThermaCAM S65 IR camera. It also has a built-in digital photo camera that is used to produce visible light images of the same areas where thermal images are collected. Before inspecting the housing units with the IR camera, a powerful heating system was turned on to improve thermal contrast.

Thermal Bridges

Walls and roofs often incorporate elements with higher thermal conductivity, which lowers the overall thermal insula-

About the Author

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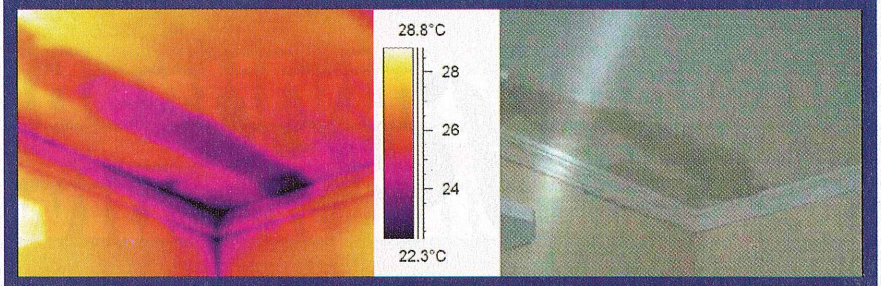
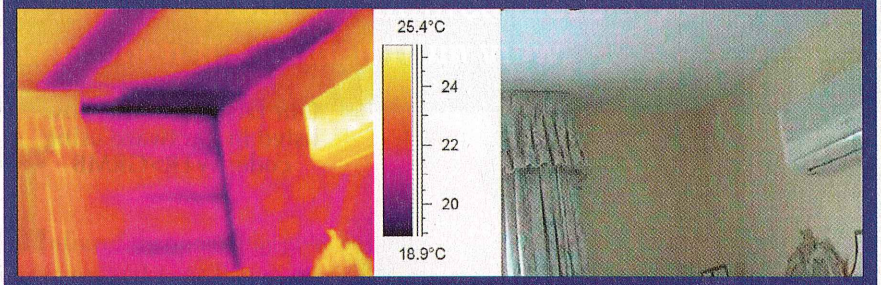
Figure 1



Thermogram and photo of a cold bridge causing condensation.

Figure 2



Thermogram reveals lack of insulation as evidenced by cooler pillars, beams and building blocks behind the walls, which causes condensation.

tion of the structure, increases its U-value (heat transfer coefficient), and can result in increased condensation risk. Persistent condensation often leads to mold growth on the internal surrounding surfaces.

Examples of thermal bridges include the lintel above a window; aluminum framing around a window; concrete or steel beams linking the building insides to outside temperatures; and corners and junctions of walls and floors.

Figure 1 illustrates the effect of a huge "cold" bridge caused by both the metallic structure of the building and a complete lack of insulation.

The thermogram shows the position of the steel structure causing the condensation staining that appears in the digital photo. In this case, a partial repair is not possible, because condensation will appear again in the next closest cold area.

Sometimes the visual effects of condensation are not so dramatic, as shown in **Figure 2**. However, the thermogram reveals that this is probably a condensation problem. The shape

of the blocks in the wall can be seen due to a global insulation failure, along with very cold beams and vertical pillars.

It is also important to point out that the building owner uses a gas heating appliance during cool weather, which increases both temperature and absolute humidity. This makes condensation more likely.

Water Infiltration

Moisture due to water infiltration can become a significant source of microbial contamination in building environments, leading to health problems for occupants. Rain is probably the most common source of infiltration, but even dew can be a problem.

After water infiltrates, it evaporates. During evaporation, a large amount of energy is absorbed by the water and taken from the wet surface. This typically causes a cold zone that can be detected with an IR camera.

Figure 3 shows one of these cold zones on a roof terrace. Since the zone is near the rainwater drain, it's reasonable to assume cooling due to accumulated water from previous infiltrations. This may be the reason for so many damp spots on the underside of this building's roof.

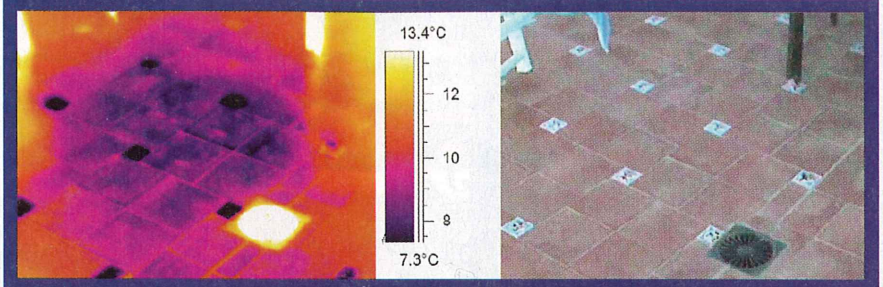
Different tiling materials in the terrace cause different heat radiation patterns, causing apparent temperature difference to the IR camera. The camera operator needs to be aware of this when interpreting thermographic images.

Pipe Leakage

Thermography can also detect leakage from pipes and the pipes themselves. In one of the houses we inspected, the owner complained about moisture and mold growth in the walls. This appears as a raised pattern between the door frame and upper wood molding in the digital photo of **Figure 4**. The thermogram in that figure shows a yellow and blue vertical thermal pattern on the wall in the same area.

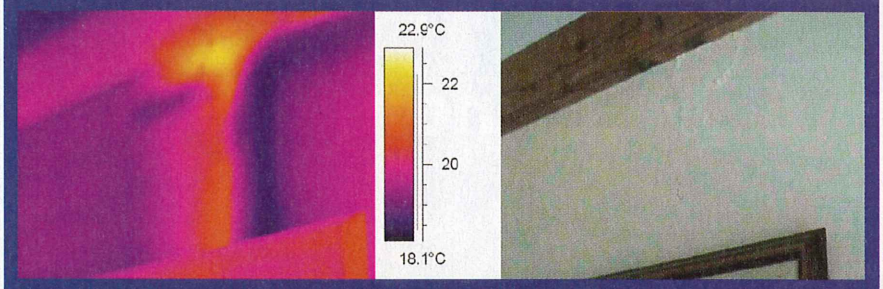
Next, we entered the room behind the wall shown in Figure 5, which turned out to be a bathroom. The reason for the moisture problem was evident when we focused the camera on this side of the wall. In **Figure 5** you can see the locations of the hot and cold water lines. Notice that the cold zone around the cold water line is more pronounced near the tap handle, i.e., there is a strong temperature gradient in that area. This tends to indicate leakage.

Figure 3



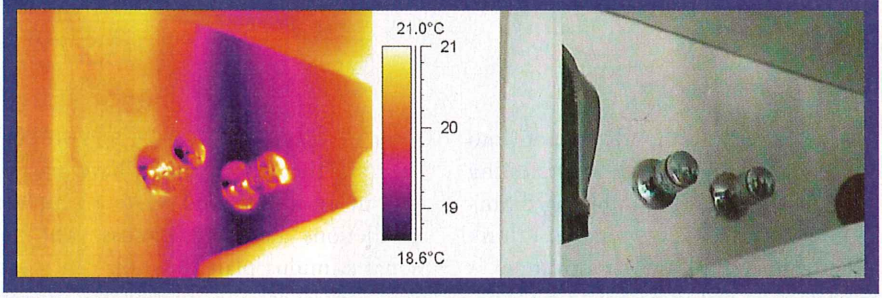
Cold zone on a roof terrace, likely caused by water infiltration below the drain opening.

Figure 4



Thermogram and photo of an apparent moisture problem.

Figure 5



It is important to point out that even if pipes are not leaking, moisture due to condensation could occur on the pipes and fixtures as a result of temperature differentials between them and the surrounding air. However, such differential temperatures probably would not be as great as those caused by leakage.

Conclusions

More often than not, observed moisture problems come from condensation associated with internal surfaces having temperatures below the dew point. Frequently, these effects are caused by strong thermal bridges in the internal structure of the building, such as pillars and beams with high thermal conductivity.

In other cases the cause may be poor or no insulation. In addition to remediation and repair, the implied solution is to add insulation at the external or internal side of the surface with the problem. Where practical, the latter is cheaper, but requires a vapor barrier to prevent condensation in the insulation layer.

In other cases, moisture problems may be caused by water infiltration or pipe leakage. Sometimes these problems can be distinguished from condensation by the concentration and intensity of the thermal gradients. Condensation may also accompany infiltration and pipe leakage problems. **R&R**