An Application of Infrared Thermography - Roofing Survey

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ABSTRACT

Infrared (IR) thermography has widespread applications, particularly in the area of roofing where the technology can be harnessed to save time and money in locating problem areas. A survey of this type can be performed to isolate a problem area, or used in a predictive measure context with roof-moisture problems. Some typical examples will be presented with case studies, illustrations and project photographs, and the results discussed.

INTRODUCTION

Infrared thermography has proven to be a successful non-destructive method of inspection in many applications, from electrical, mechanical, and medical to military and building applications. While civil and structural engineers face different kinds of problems during the construction of the RC structures, a maintenance staff would face a different set of issues. Some of the common problems are water leaks, moisture condensation from roofs due to a variety of reasons such as inadequate water proofing, or poor workmanship in the application of water sealant around roof ventilation. It makes it difficult for the maintenance engineers to identify and isolate the actual problem by visually inspecting the roof. IR thermography has been proven to be successful in identifying and isolating problem spots over a suspected area of almost any size. Application of infrared thermal imaging surveying for roofing moisture problems is considered to be the most effective method compared to other non-destructive methods available such as use of a moisture-meter and Ground Penetrating Radar (GPR). Those tests however, would complement the results obtained from an infrared survey.

PRINCIPLE

When the roof surface, and the insulation underneath, is homogeneous and free of moisture, there will not be any temperature differences on the roof surface. If there is moisture trapped in the insulation underneath the roof, it causes hot-spots or thermal anomalies which can be detected using an infrared camera as it is capable of capturing the temperature variances as small as less than one degree.

Dry insulation and wet insulation will have temperature differences due to the fact that the wet insulation conducts the heat at a higher rate than the dry. The sun heats the roof structure during the day, and the roof begins to cool after sunset. The wet insulation has a higher thermal mass than the rest of the "dry" roof structure. As a result of this difference the wet areas will maintain heat energy longer than other areas. Though the temperature difference between the wet and dry roof areas is very small (typically 2-4 degrees), this difference is captured using the infrared cameras.

TECHNICAL DESCRIPTION OF THE EQUIPMENT

The Infrared camera used in this investigation operates on the principle of object scanning. The object is scanned through a two-dimensional reflecting scanner. The vertical scanner builds up the complete image from the individual scan lines. About 200 lines can be captured at an image refresh rate of 1.25Hz. The image information delivered by the scanner is focused onto the detector through the spherical imaging optics. The focal length of the optics is 35mm, its aperture is f:1.

Figure 1: Infrared Imaging Equipment

For focusing onto different object distances, imaging optics are moved axially covering a range from 0.2m to infinity. Image 1 above shows the thermal imaging camera used for this investigation. After every scanned image, the reference source (chopper) is moved into the optical path, and its temperature measured by a thermocouple. Online temperature measurement is made possible by comparing the radiation intensity of object and chopper. Between imaging optics and the detector, a filter wheel is located. The wheel contains stops of different diameters that can be rotated into the optical path at higher temperatures. The employed object-side scanning method allows the use of an electro-optical zoom function. This is achieved by varying the oscillation amplitudes of the scanner reflectors.

AREA OF INVESTIGATION

The project was carried out on the roof of a six storey building where moisture condensation was observed on the soffit of the 6th floor, so an investigation was undertaken to locate the cause of the problem via IR survey. Prior to the survey, the client conducted a visual inspection and assumed that the cause of the moisture condensation was poor sealant used to fix the rubber lining around the roof-light-glass panel on the 6th storey. After the infrared survey was conducted, the results revealed the actual problem areas were not what were suspected through the earlier visual inspection. Figure 2 shows the layout of the roof. Area A shows the observed moisture on the roof of the 5th story (soffit of the 6th story). Area B indicates skylight with rubber lining around.

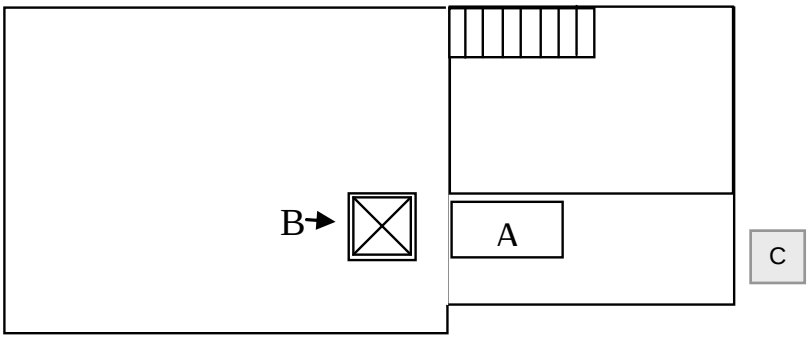

Figure 2: Roof Plan

Legend:
A – Moisture Area
B – Skylight
C – Defective area, spotted using Infrared survey

INFRARED SURVEY

The roof was washed repeatedly with water in the morning to enable the water to penetrate and get trapped under the roofing surface. During the day, the sun heated up the roof surface. The investigation was carried out in the early evening about two hours after the sunset.

Initially, the hot roof surface did not indicate any hotspots because, there was no temperature difference between the wet and dry areas. As the roof surface started to cool down, the infrared camera could detect hotspots (Figure 4). The dry area cooled at a faster rate than the wet area, which contained trapped water.

Figure 3: IR survey in progress

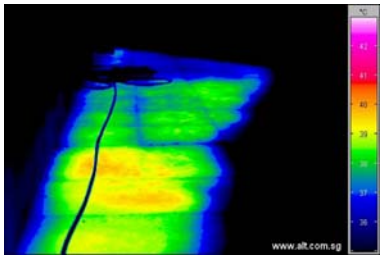

Figure 4: Hotspots on Roof

Figure 5: The Roof Surface

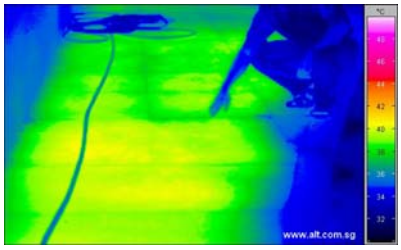

Figure 6: Thermal Image

The thermal images in figures 4 and 6 show the hotspots identified from the infrared survey and figure 5 shows the defective area. We observed from the thermal images that the temperature difference between the hotspots (yellow/red spots) and the rest of the area was about 4 degrees.

SUMMARY

The above case study presents a typical case where infrared thermography was employed to identify and isolate a problem area containing trapped moisture. In this project, the client was of the opinion that the skylight was the cause of the leak due to improper water sealing around the glass panels. When an IR survey was conducted, it revealed the actual problem area, which was not suspected in the initial visual inspections. The Infrared survey proved to be successful in identifying the source of the problem as well as a truly non-destructive inspection method to locate the roof-moisture.

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