



Exterior wall inspections using high precision thermal cameras

Since the 2011 East Japan Earthquake, people in Japan are becoming more interested in the durability and reliability of existing buildings. UDI Corporation, a government-designated private agency, was founded in April 2001 to provide more people with various building inspection services. One such service UDI offers is exterior wall diagnosis using thermal cameras. The company utilizes FLIR's thermal cameras for this purpose.

Japan's Building Standards Law requires that periodical safety inspections be made on specific types of buildings (depending on their building class usage and size) and reports of these inspections must be submitted to the relevant authorities. A recent revision of the regulations refers to specific building materials used in the construction of walls including tiles. It states that if any abnormal deterioration or damage is observed or if 10 years have passed since any external wall renovation, then a thorough hammering check of the outer tile walls must be carried out. Using either a hammer and checking the sound or using infrared thermography. This has resulted in a growing use of thermographic cameras for inspections as an alternative, less intrusive and burdensome method instead of thorough hammering checks. Thermal cameras have become very popular as a tool for building maintenance and dealing with client complaints because they can also detect water leaks and

other building problems.

The UDI Corporation has been one of the first companies to realize the potential of this innovative technology within the building industry. The company has been able



The FLIR T640 thermal camera combines excellent ergonomics with highest quality 640 x 480 pixel infrared resolution producing clear images rich in detail, making it ideal for building inspections which require many hours of hands-on labor.

Table 1. Changes of periodic report system based on Article 12 of the Building Standards Law (enacted in April 1st 2009)

Summary	(1) Defining investigation/inspection items, methods and standards (2) Enhancement of report details
Point	Regarding deterioration and damage of wall outer tiles Previous requirements: Inspect outer wall by hammering the tiles within arm's reach and perform a visual inspection of other parts. If any anything is wrong, make the building owner aware etc. by stating that "a detailed examination is required". Present law after revision: Inspect the outer wall by hammering the tiles within arm's reach and perform visual inspection of other parts. If anything is wrong, a thorough inspection by using hammer to check the sound or other specified method is required. In addition, if ten years have elapsed since the construction or wall renovation was completed, the first inspection should be a thorough inspection by using hammer sound or another specified method. The inspection should cover the parts where falling wall materials could be dangerous to pedestrians.





Figure 1 Thermal camera image

to establish thermal inspections as a viable alternative service by clearly explaining its benefits to their clients.

1. Principles of infrared wall inspection

Infrared is electromagnetic radiation with a wavelength that is longer than visible red light, but shorter than radio waves. Infrared is invisible to the naked eye. Infrared thermal imagers (thermograph or thermal cameras) are devices that capture infrared wavelengths (heat) emitted from objects to enable the visualization of the heat distribution (Figure 1).

When outer tiles or sand-sprayed finishing materials are warmed by radiation from the sun, the heat from the surface is normally conducted

away into the surrounding building frames of concrete or other materials. However, if there is flaking or peeling which creates a space between the frames and the outer materials, the temperature of the outer materials can become higher than normal due to the insulating air layer which is a poor heat conductor (i.e. has lower thermal conductivity).

An infrared outer wall inspection is a nondestructive and non-contact method which takes advantage of this phenomenon to capture an infrared image of the outer wall of the target building using advanced thermal cameras, to measure the surface temperature of the target and estimate flaking and peeling of the wall surfaces.

Figure 2 Comparison between hammering inspection and advanced infrared inspection

Items	Partial hammering inspection + visual inspection	Thorough hammering inspection	Advanced Infrared inspection
Compliance to the revised building standards law in 2009	✗ A thorough hammering inspection is required for buildings built or renovated more than 10 years ago (Note 1).	⊙	⊙
Inspection system	△	⊙	⊙ Consistent quality and high precision inspection by the central analysis center
Record	✗ Manual	✗ Manual	⊙ Record more than 300,000 thermal data as high precision thermal images
Cost	⊙	✗ Scaffolding work, hammering inspection, scaffolding removal and traffic control etc. depending on the location	⊙ Under 1/3-1/5 compared to the thorough hammering inspection.
Terms	⊙		⊙ Quick inspection is possible by human and technologically intensive work.
Safety	⊙	✗ Scaffolding work	⊙ Safe because high-precision thermal cameras capture the surface temperature of the building without the irradiation of infrared, electromagnetic wave or X-ray.
Impact to residents and building users	△	✗ Vibration, noise, blocking views from windows and invading the privacy of the residents	
Impact to the building	○ Hampering can worsen flaking or peeling.	✗ Scaffolding can damage buildings. Hammering can worsen flaking or peeling.	⊙ Because it is a non-destructive and non-contact inspection, there is no effect to the building.
Weather conditions	△ Inspection is possible but not recommended in rain or bad weather.	△ Inspection is possible but not recommended in rain or bad weather.	✗ Inspection is inappropriate because the taking of precise measurements is impossible in rain or bad weather.

⊙ excellent, ○ good, △ relatively poor, ✗ unacceptable. Comparisons were conducted based on investigations carried out by UDI corporation.
 Note1: A thorough hammering inspection is required for buildings built or renovated more than 10 years ago: The revision of the regular report system based on Article 12 of the Building Standards Law specifies that if ten years have elapsed since the completion of a construction or wall renovation, the first inspection should be a thorough inspection using hammering and noting the sound or other specified methods.

2. Benefits of infrared exterior wall inspection

Mr. Toru Suzuki, the director of UDI corporation explained that the benefits of infrared exterior wall inspection using thermal cameras can be summarized under four categories: "safety and security", "low cost", "speed" and "reportability."

Safety and security

- As there is no vibration or noise during inspection, discomfort to residents or people in the building is eliminated.
- Because no scaffolding is needed, there is no requirement for measures that ensure the safety of children and the elderly around the doorway.
- There is no risk of infringing the building occupant's privacy, especially in apartments, hospitals, hotels and offices.

Low cost

- Infrared inspection eliminates the cost of scaffolding and gondola installation and removal, because inspectors capture images using thermal cameras from around the building.
- Personnel costs can be reduced because it is not necessary to take additional measures to ensure the safety of building users or to control neighborhood traffic.

Speedy

Time of work can be shortened because no installation or removal of scaffolding is needed.

Compliance to the periodic report

- Infrared inspection allows for quick reports from speedy inspections and is approved as an alternative inspection method to thorough hammering inspections for the periodic reports required by Article 12 of the Building Standards Law.
- The data can be stored electronically, allowing for paperless operations.
- Periodic infrared inspections help monitor the aging and degradation of buildings.

3. FLIR SC620, a high precision thermal camera to improve inspection efficiency

In order to perform the comparison survey and provide services to their clients, UDI corporation chose FLIR Systems' high precision and high resolution thermal camera FLIR SC620 out of various infrared cameras. Mr. Toru Suzuki explained the reason why the company selected the FLIR SC620, "High precision and high resolution is necessary for the diagnosis of buildings, especially for outer wall inspection. Before choosing a thermal camera, we actually tested the camera and chose the FLIR SC620, because it features a built-in high definition digital camera (3,200,000

pixels) and high resolution (640 x 480 pixel) thermal camera capable of detecting temperature differences as small as 0.04 °C. The model can be equipped with an extender lens for long distance observations, which is an important feature because we have to compile a report of inspection results."

"We need to scan tall or wide targets working in tight spaces. A 5.6 inch wide LCD and tiltable lens unit of FLIR SC620 is perfect for building

inspection. It has easy access to a video connection, which is convenient when we want to share findings with customers."

4. Case examples of infrared inspection

Figures 3 and 4 show examples of inspections using infrared thermal cameras.

5. Buildings which will benefit from infrared thermography inspection

According to Mr. Suzuki, the following build-

Figure 3 Examples of outer wall inspections using infrared thermal cameras



Visual image



Thermal image



Visual image



Thermal image

Figure 4 Examples of infrared inspection (water leakage inspection)



Visual image



Thermal image



Visual image



Thermal image

ings will benefit from advanced infrared wall inspection.

1. Buildings with exterior walls of tiles, stones (except for dry wall), or mortar.
2. Buildings combining low-rise and high-rise aspects
3. Buildings with an unusual shape, e.g. circular
4. Buildings with a high usage by children and the elderly
5. Buildings covered by scaffolding, with a higher risk of criminal activities or infringement of privacy.

6. ITC infrared training center

Mr. Suzuki said that choosing the right camera is critical, but training is also important.

"Infrared wall inspection needs advanced analysis expertise backed up with experience. We initially purchased the high-accuracy infrared thermal camera FLIR SC620 and then added the FLIR T640 and FLIR Researcher software to cope with growth in demand. Using these tools, a team of trained full-time engineers has been engaged in on-site building diagnostic inspection and data analysis."

"We believe that you do not only need to know how to operate your cameras and software but also understand thermography expertise in order to perform accurate thermal image analysis. That is why we required all eight members of our full-time thermal engineering team to complete the ITC infrared training level 1. Taking ITC training allows them to scan buildings under the same test conditions 24/7, day and night, in all seasons, as well as to make an accurate diagnosis and report based on their knowledge of thermography and building architecture. We will require our staff to take ITC level 2 training in order to make maximum use of thermal imaging technology and provide a reliable inspection service."

"UDI corporation performs inspection servic-



The full-time engineering team members of UDI who perform analysis and compile a report at the central analysis center.

es based on the building standards law as an inspection body, designated by the Land, Infrastructure and Transportation Ministry, and has a top share of Kanto area of Japan. As a true third party inspection agency, UDI has extensive experience in providing reliable and high quality services including thermal exterior wall inspection mainly for government and other public offices. I also act as the chairperson of the infrared technology committee in the "Search for alternative applications for community and humanity" approved by the Land, Infrastructure and Transportation Ministry.

We are looking for a strong partnerships with FLIR Systems regarding its thermal cameras and technologies in order to increase public awareness on thermal inspection and diagnosis, including nondestructive and noncontact exterior wall and water leakage inspections.

We need Infrared technology to be properly understood so that its versatility and capability is neither overestimated nor underestimated by customers. In other words, we need to be careful not to lose credibility due to the extravagant expectations of clients saying things like "I thought it was versatile but there were things it was incapable of doing." On the contrary, lack of understanding on what the technology can offer may often cause some potential markets to remain untapped. Therefore, UDI provides seminars as required from clients in order to help enhance their understanding on exterior wall infrared inspection. We are planning to hold regular seminars in collaboration with "Search for alternative applications for community and humanity" and FLIR Systems Japan.



Mr. Toru Suzuki, the director of UDI who speaks about the perspective of infrared inspection at the central analysis center.



Contact us for further information on thermal imaging cameras and this application.

FLIR Commercial Systems

Luxemburgstraat 2
2321 Meer
Belgium
Tel. : +32 (0) 3665 5100
Fax : +32 (0) 3303 5624
e-mail: flir@flir.com

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