

COURSE
 Testing techniques for structures inspection 29th and 30th May 2012



Infrared Thermography. Applications in buildings

Luís Matias (DED/NRI)

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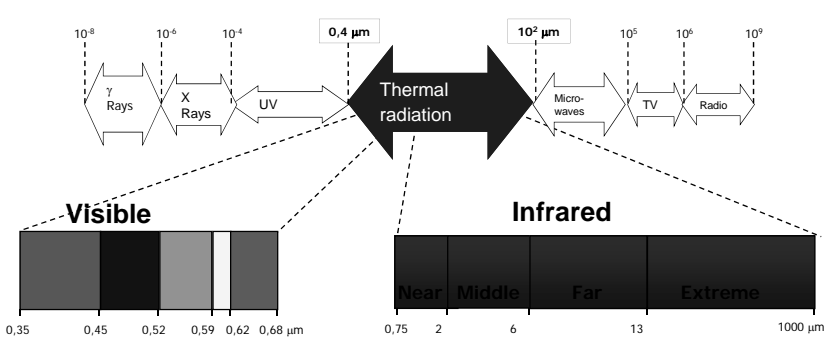
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INFRARED THERMOGRAPHY

> For temperature above absolute zero every object emits energy from its surface in the form of **thermal radiation** (T_s, ϵ).




The diagram illustrates the electromagnetic spectrum with various regions and their corresponding wavelengths:

- Gamma Rays:** 10^{-8} m
- X Rays:** 10^{-6} m
- UV:** 10^{-4} m
- Visible:** 0,35 to 0,68 μm (with sub-markers at 0,45, 0,52, 0,59, 0,62)
- Thermal radiation:** 0,4 μm to 10^2 μm
- Infrared:** 0,75 to 1000 μm (subdivided into Near, Middle, Far, and Extreme)
- Micro-waves:** 10^2 to 10^5 m
- TV:** 10^5 to 10^6 m
- Radio:** 10^6 to 10^9 m

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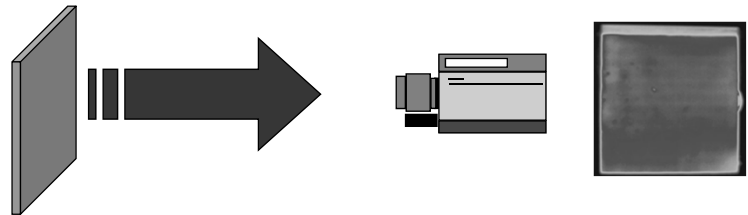
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INFRARED THERMOGRAPHY

- > The thermal imaging equipment captures the IR radiation (emitted and reflected) and converts it into an image (**thermogram**) which represents the distribution of surface temperature (**T_s**) of the object.




- > Thermal quality depends on the variation in surface temperature:
Greater contrast in T_s → **better will be thermogram**




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INFRARED THERMOGRAPHY



- > This **Non-destructive** method is used without contact with the object under inspection.
- > Allows a **qualitative evaluation** of the temperature distribution.
- > However, the interaction with several phenomena may **difficult its use and interpretation *in situ***.
- > Need, in general, **passive or active** methods (increase temp. dif.).


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Passive methods


- > Difference between indoor and outdoor temperature ($>10^{\circ}\text{C}$) to rise a **heat flux through the observed element** (ex. wall).
- > **Evaporation** of water, natural process that causes reduction of surface temperature of wet zone, can also **create a heat flux** observable by IRT.
- > Heat flux imposed by natural source **the Sun**.




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Active methods

- > Observed object is heated by an **artificial external source** (optical or mechanical excitation).





CLIMATIC CHAMBER

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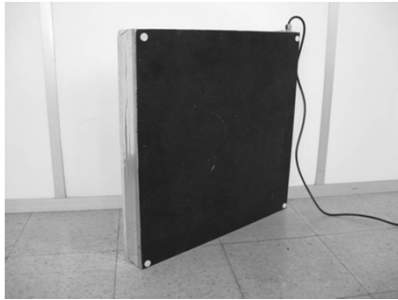
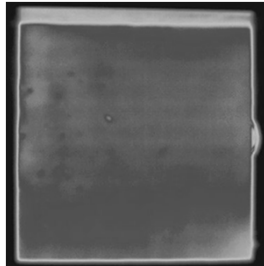
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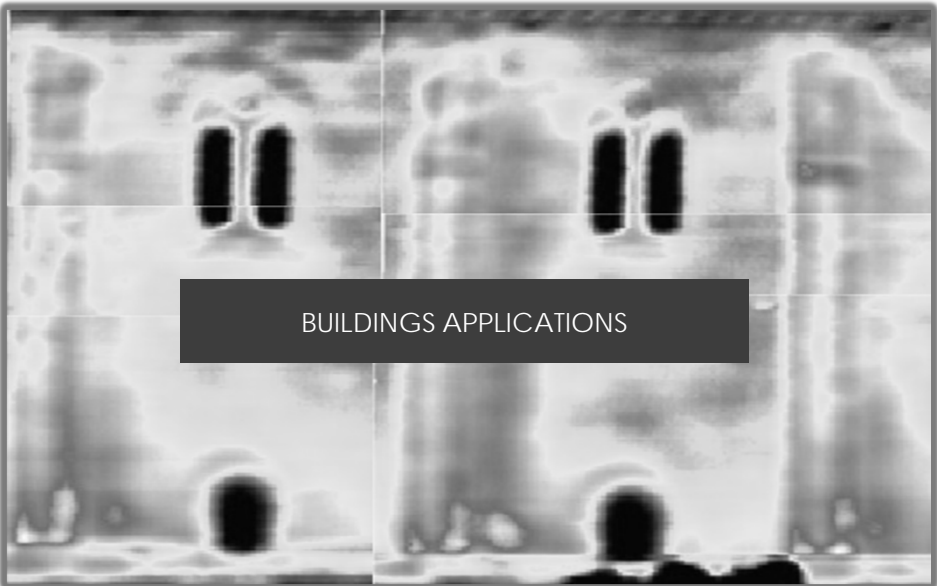
INFRARED THERMOGRAPHY
Active methods

> **HOT PLATE** for heating by **contact** or by **radiation**. It is composed by an aluminium sheet, a resistance wire and an insulation board.




 


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BUILDINGS APPLICATIONS


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BUILDINGS APPLICATIONS


> Evaluation of the **thermal quality** of the buildings' envelope (thermal bridges).

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BUILDINGS APPLICATIONS


> Evaluation of the **thermal quality** of the buildings' envelope (missing thermal isolation).

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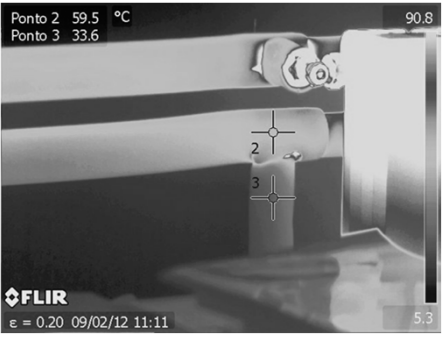
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BUILDINGS APPLICATIONS





> Evaluation of pipe's thermal insulation.



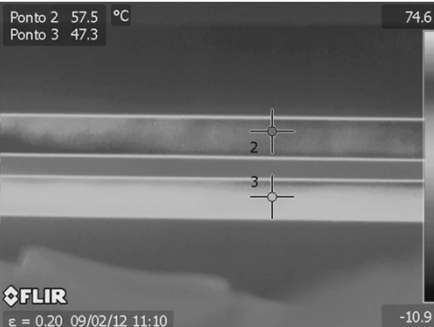
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BUILDINGS APPLICATIONS




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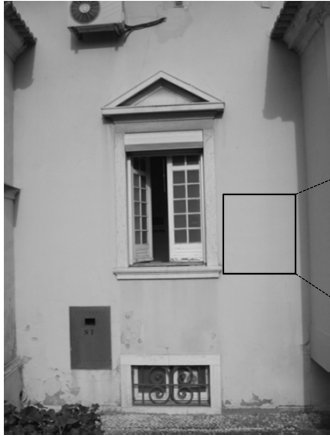
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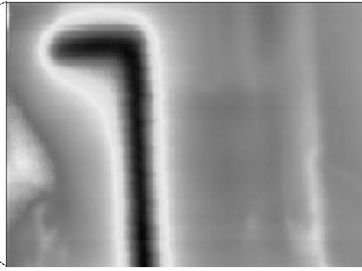
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BUILDINGS APPLICATIONS





> Detection of pipes **inside walls** after solar irradiation.




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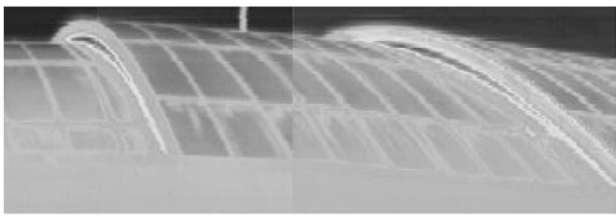
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BUILDINGS APPLICATIONS





> Detecting points of **exfiltration** or **air infiltration** through the envelope.



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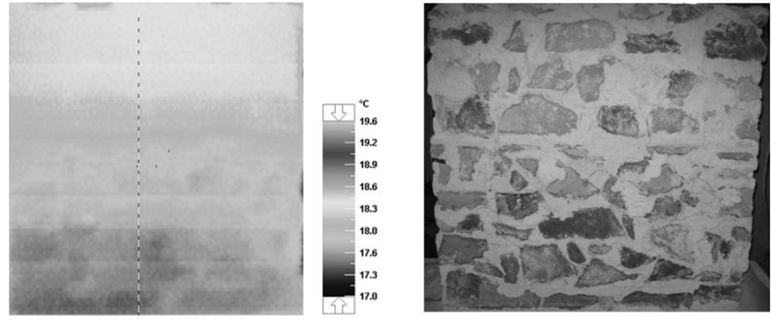
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BUILDINGS APPLICATIONS


> Detecting the **presence of moisture** in elements of buildings' envelope due to evaporation process



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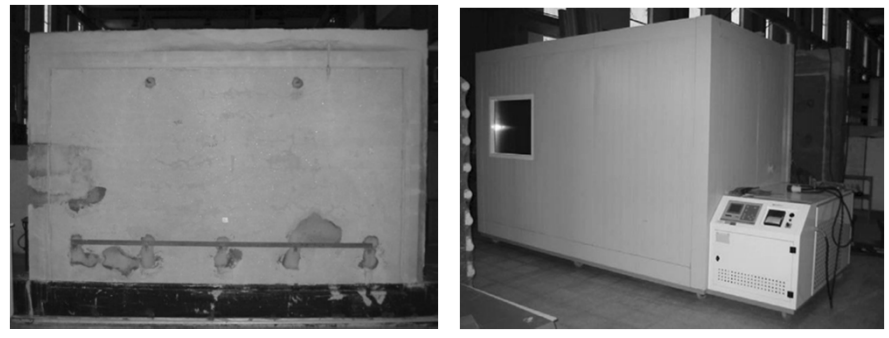
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BUILDINGS APPLICATIONS


> Detection of **detachments of renders** on external walls (laboratory results).



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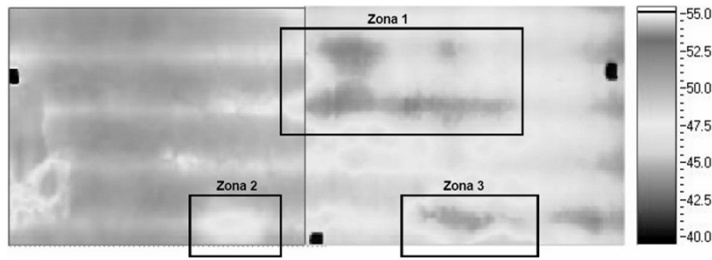
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BUILDINGS APPLICATIONS

> Detection of **detachments of renders** on external walls (laboratory results).



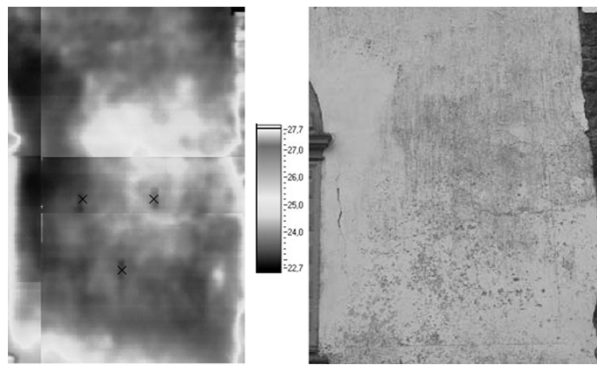
The image shows a thermal scan of a wall. Three rectangular areas are marked: 'Zona 1' at the top, 'Zona 2' at the bottom left, and 'Zona 3' at the bottom right. A vertical color scale on the right indicates temperature values from -40.0 to -55.0 in increments of 2.5.

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BUILDINGS APPLICATIONS

> Detection of **detachments of renders** on external walls (*in situ* results) after solar irradiation.



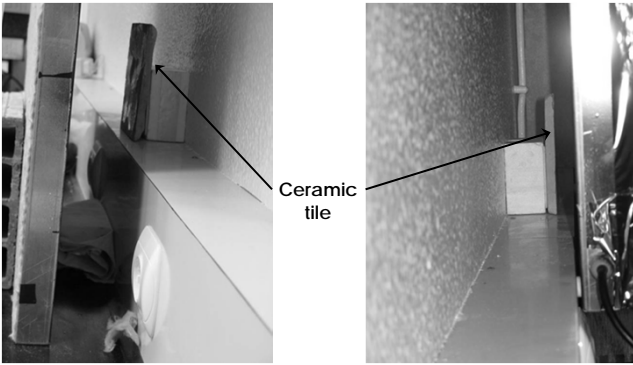
The image shows two views of a wall. On the left is a thermal scan with three 'x' marks indicating detachment points. On the right is a photograph of the same wall. A vertical color scale between them indicates temperature values from -22.7 to -27.7 in increments of 0.7.

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SUPPORTING THE CONSERVATION OF TILES
Laboratory results

> Hot plate application **by radiation** ($T_{\max} = 50\text{ }^{\circ}\text{C}$) to heating a tile.



Ceramic tile

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FRANCO DE ALBUQUERQUE
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FRANCO DE ALBUQUERQUE


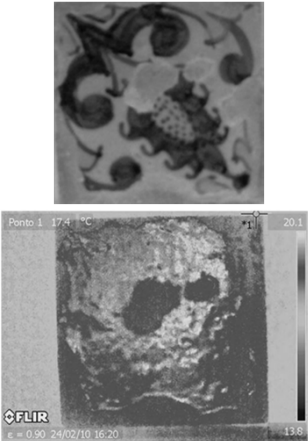
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Laboratory results

> High external radiation **reflection** on the glazed tile.




FLIR
Ponto: 1 17,4 °C
e = 0,90 24/02/10 16:20

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SUPPORTING THE CONSERVATION OF TILES
Laboratory results


> Visualization of the glaze tile's **delamination**.




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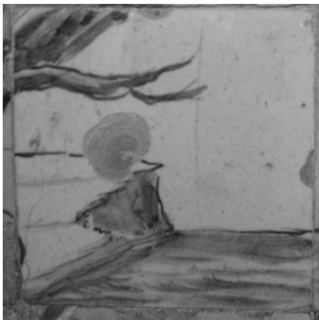
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SUPPORTING THE CONSERVATION OF TILES
Results *in situ* (MNaZ)


> Glaze **delamination** of a ceramic tile.




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SUPPORTING THE CONSERVATION OF TILES


Results *in situ* (LNEC)


> Visualization of tile's **detachments** from an external wall.

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STRUCTURAL SURVEY


> Assessment of **building structures** IRT has been also very successful.


- **High temperature difference** between inside and outside temperature
- A good **orientation of buildings** to use Solar radiation but **without presence of nearby obstacles** (shading).
- The **adoption of active methods** (hot plate, lamps).

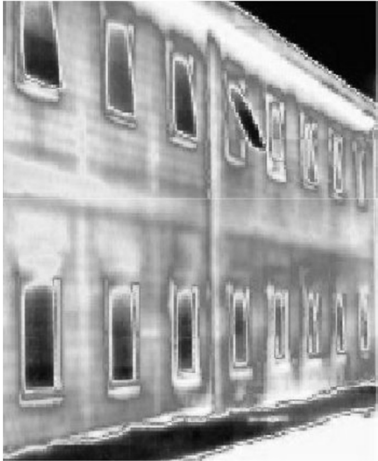
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**Infrared Thermography.
Applications in buildings**


Thank you!

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