Novel Infiltration Diagnostics based on Laser-line Scanning and Infrared Temperature Field Imaging

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Iowa State University
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Team

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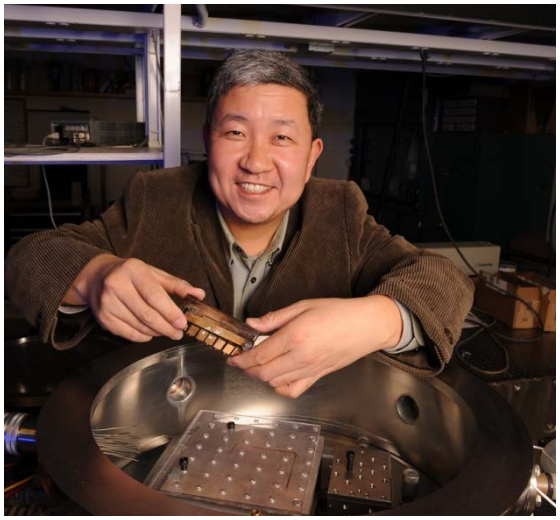
- Collaborator: SystemWorks LLC, Iowa (Garry Caldbeck)

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Blower door test for infiltration/leak diagnostics of building envelopes

- The uniform pressure it produces makes it difficult to see the localized pressurization in a house/building.
- The testing itself cannot provide information on the leakage location and extent.
- The testing itself requires a stable environment pressure condition, like still outdoor conditions. Otherwise, it becomes more difficult to find a reference pressure for testing. This problem becomes more severe for high-rise buildings.
- During testing, all other exterior openings of the building have to be closed tight. This will give a lot of disruption to building occupants.

Tracer gas testing

- Subjected to strong weather effect.
- Duck leakage can significantly affect the air handler pump test.

Visual inspection and infrared camera-based inspection for infiltration diagnostics

- When the air inside and outside the building has little temperature difference, the infrared camera-based inspection will give very limited information on infiltration.

Summary

- Each infiltration technique has its own unique advantage and limitations.
- The current infiltration inspection techniques often require extensive visual inspection and/or whole building pressure test. They could not meet more than three of the five criteria of ideal infiltration diagnostics.
- They are either too expensive or time consuming, and often lack sound accuracy and repeatability.
- They are hardly applicable to facades/facades section.

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Laser line-scanning and simultaneous Infrared Temperature field imaging (LIT)

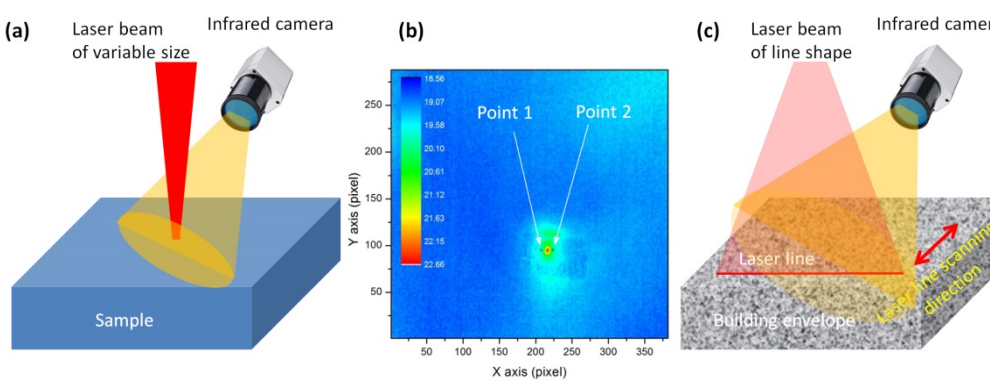

Fig. 1: Schematic of the physical principle.

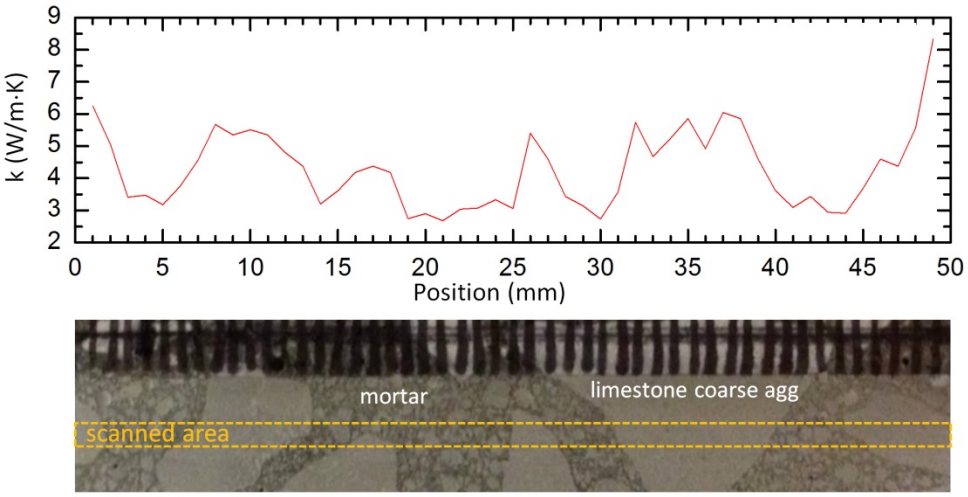

Fig. 2: Preliminary results for k measurement of high strength concrete.

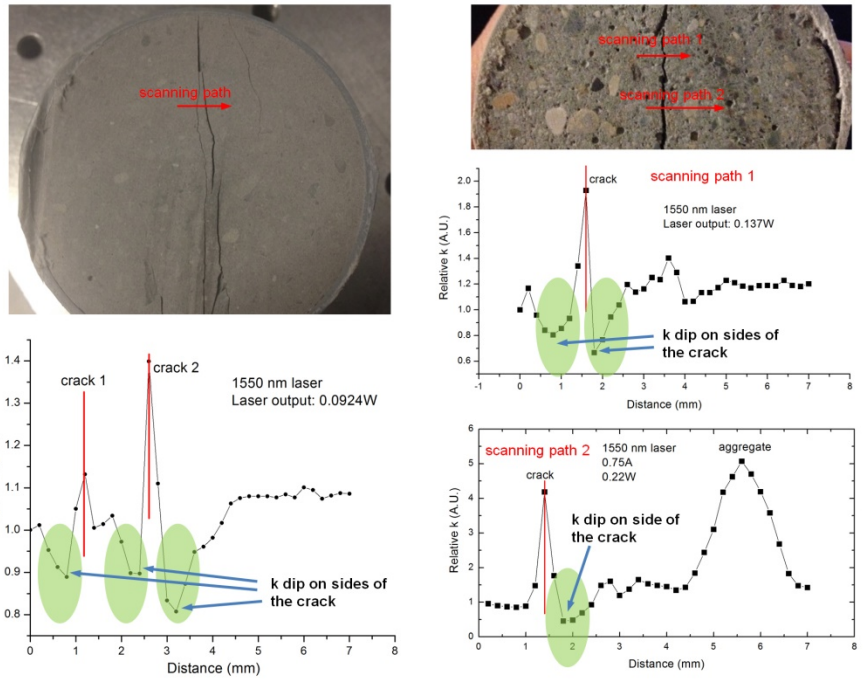

Fig. 3: Preliminary results for crack diagnostics in concrete with (a) fine and uniform structure, and (b) rough surface and large aggregates.

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- It will provide **quantitative location and extent of infiltration.** Our laser beam width can be down to 0.1 mm, meaning very fine infiltration location can be identified. The relative k reduction level can be used as an indicator of infiltration extent with pre-calibrated relation.
- Our technology is applicable to the **whole building or sections of the envelopes, even building floors, facades or facade section**.
- Our LIT technology is **non-contact and non-destructive, requires no need for tear-down**. We will develop a multi-wavelength scanning capability to target different building envelopes with efficient but moderate laser heating.
- In our diagnostics, the points for temperature measurement to calculate the relative k are very close to the laser-line. Therefore, **environment radiation and convection have negligible effect** on the relative k calculation and infiltration diagnostics.
- Since the infiltration diagnostics can be done outside the building without surface preparation, it has **least (almost zero) disturbance to building occupants**.
- The LIT technology provides a critical tool for identifying infiltration locations and leads to the best solutions for energy saving. As projected, in 2030 the annual primary energy use due to infiltration for residential and commercial buildings will be 2780 TBTU for heating, secondary heating and cooling. Assuming conservatively 20% of infiltration problem-fix using the LIT technology, the annual primary energy saving will be 566 TBTU in 2030.

Thank You

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