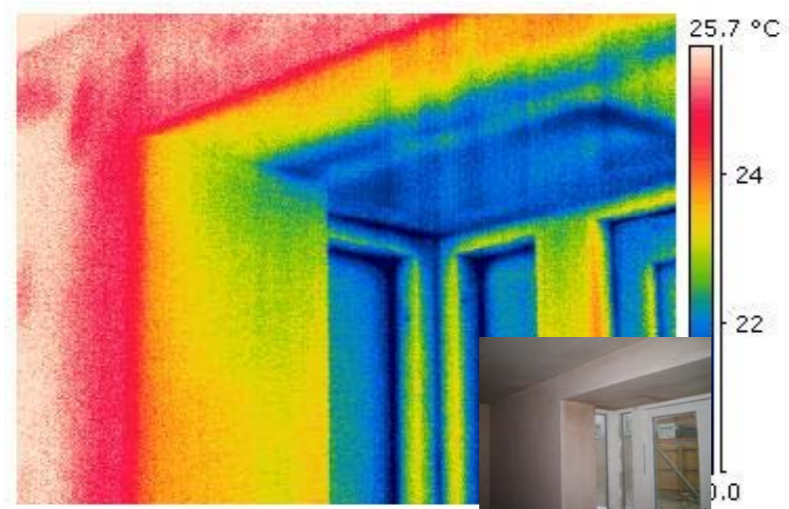
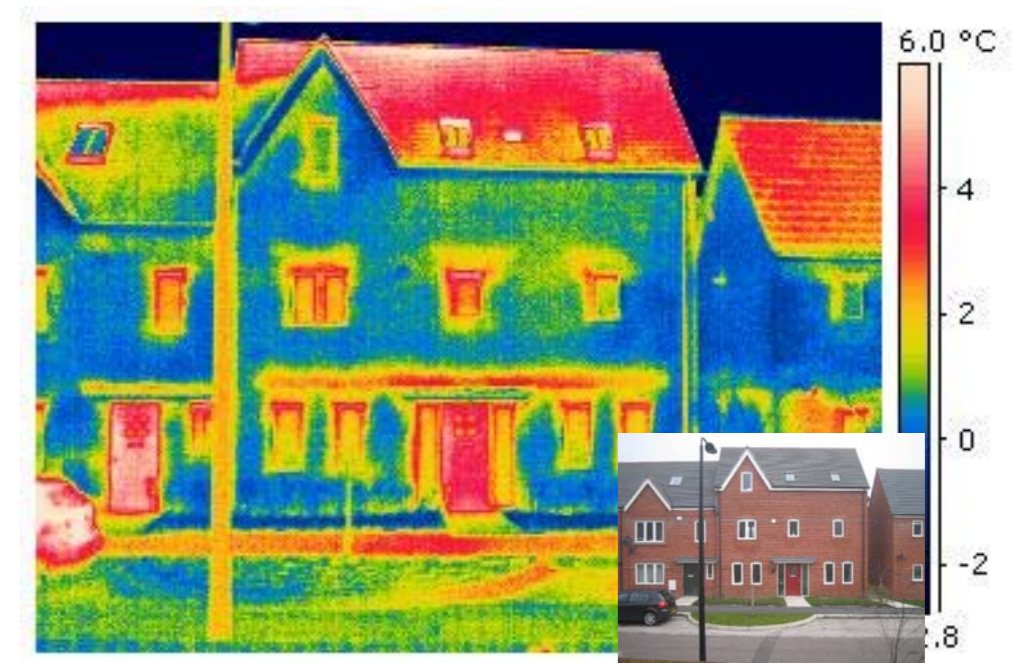


## Understand thermal performance

- Thermal Bypasses can occur where:
  - Air barrier and/or insulation layer are not continuous around the external envelope
  - Air barrier and/or insulation layer do not continue across junctions between attached buildings
  - Air barrier and insulation become separated
  - There are poorly designed cavities that penetrate the air barrier/insulation layer
- Thermal Bridging can occur where:
  - Materials of higher thermal conductivities allow greater flows of heat than the surrounding area
  - The geometric design creates disparities between internal and external heat loss areas



## Ensure details are thermally efficient

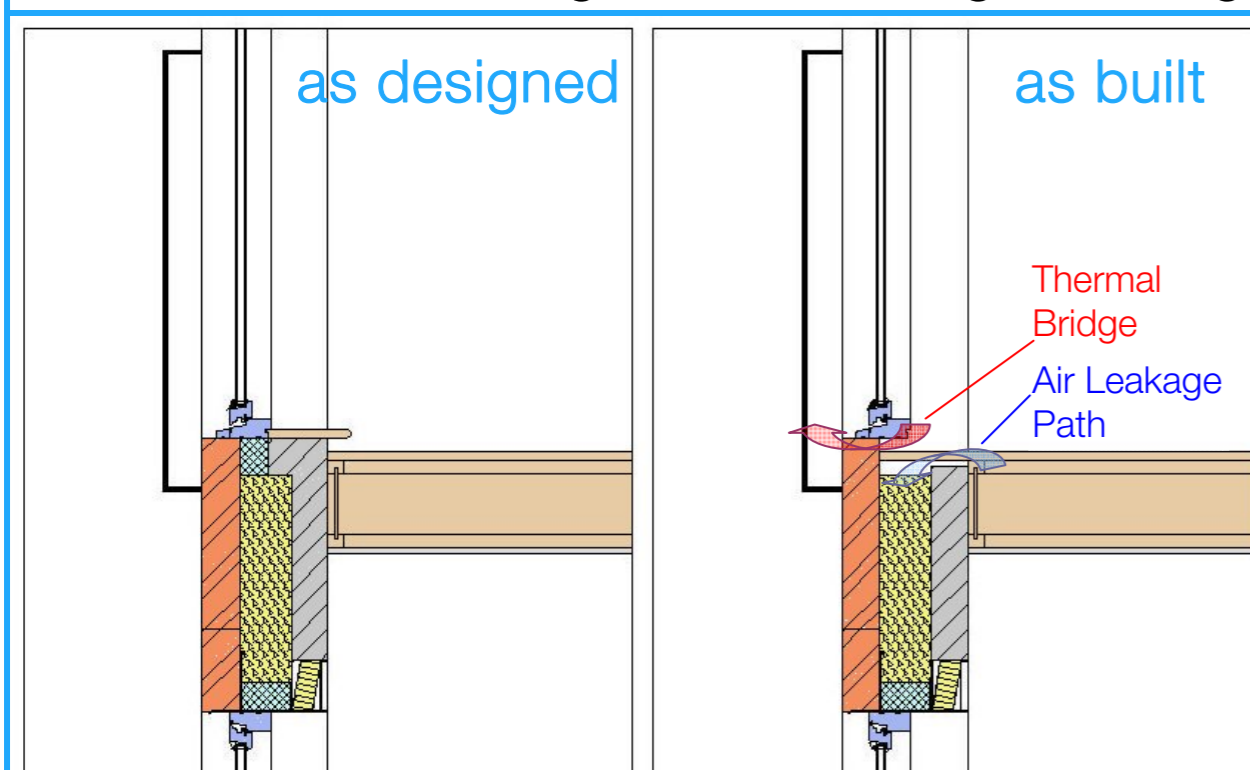
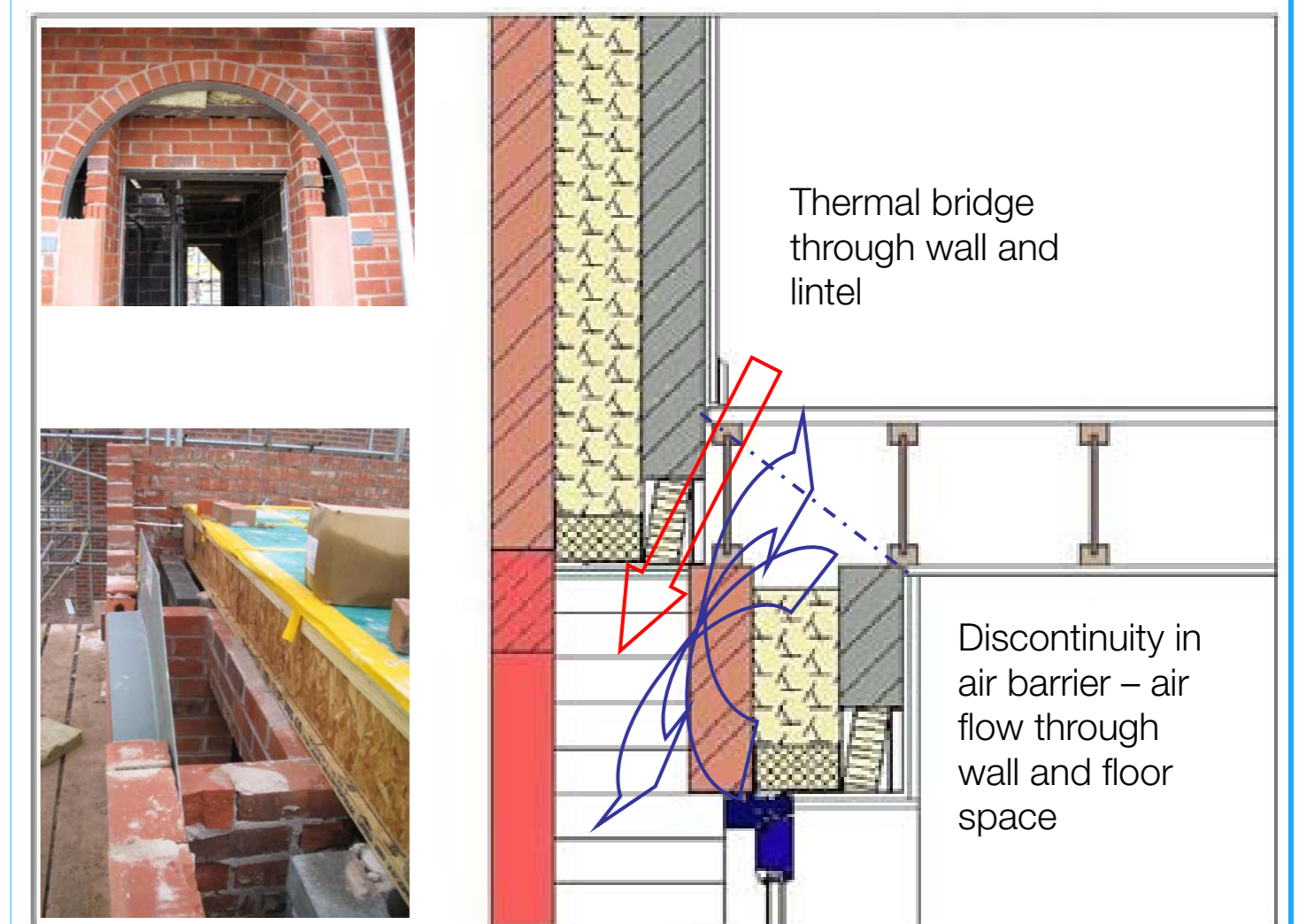
- Thermal inefficiencies can occur where:
  - There is insufficient consideration of thermal/airtightness issues in both design & construction
  - There is no clear thermal fabric performance strategy
  - The heating and/or cooling system capacities are incorrectly specified
  - Insulation is omitted, misplaced, or positioned where its benefit is compromised
  - Inappropriate products/materials are specified

## Allow for buildability

- Sequencing issues can occur where:
  - The build sequence is inflexible and not included in the designs
  - Build sequence is dictated by operatives presence on site rather than planned timings
- Design complexity issues arise where:
  - There are insufficient skilled or appropriately trained operatives
  - "Simple" designs are replaced for aesthetic purposes

## Compel site teams to look at design information

- Failure of design communication systems can occur where:
  - Different trades work from different sets or versions of drawings
  - Operatives work from "experience" rather than from designs
  - Third party drawings lack details not directly related to their specific trade
  - Staff are incorrectly trained or inducted, or miss staff briefings
  - There is a shortage of detail design drawings available on site

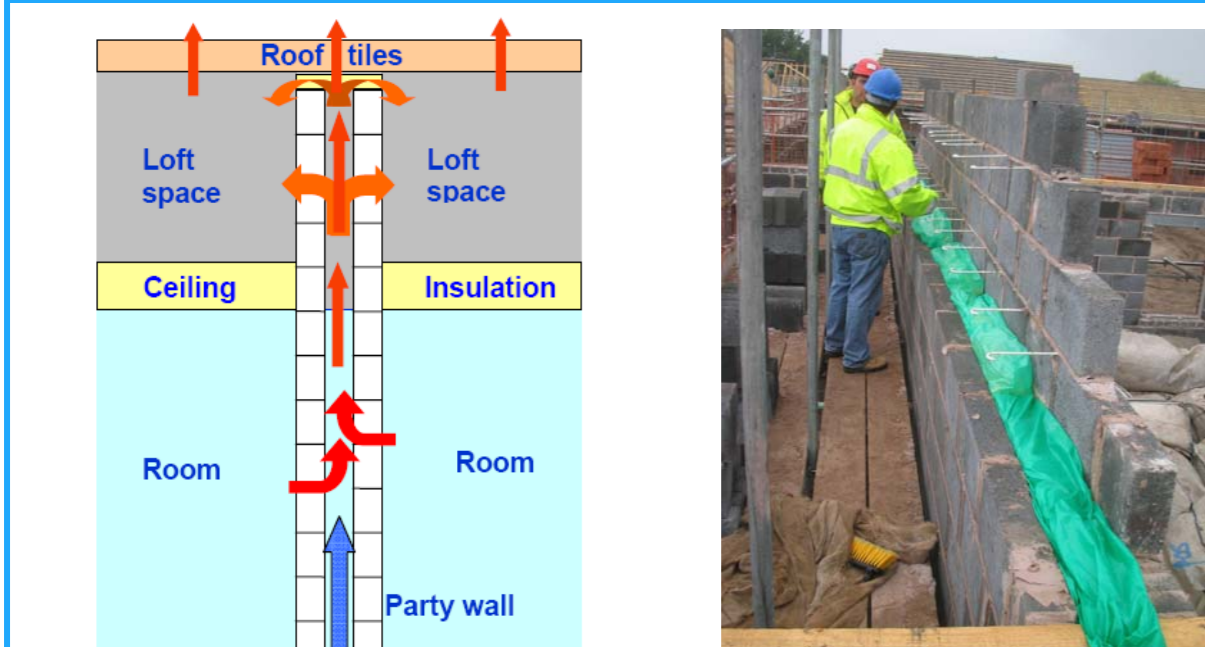


## Minimise design modifications and material substitutions

- Check changes are thought through and approved:
  - Avoid on site *ad hoc* designs
  - Design modification approvals process needs to be robust
  - Specification changes need recording and new documents issued immediately
  - Alterations to designs and product substitutions require the same rigorous vetting procedures as original designs and material choices
- Where details rely on the work of more than one trade:
  - If one trade makes an alteration to a design, ensure this is disseminated to all other trades
  - Introduce procedural instructions into the design and construction notes

## Is thermal performance measured routinely?

- Persevere with a rigid testing regime:
  - Physical testing or quality control checks on all materials and components
  - Air permeability tests, test on completion of the air barrier (when problems can easily be rectified) as well as on completion
  - Thermal imaging and physical measurement of heat movement when conditions permit
  - Coheating tests, if practicable
  - Post-occupancy monitoring



Identify problems & propose solutions

## Use measurement to provide feedback on performance

- Analyse data from testing and monitoring, then act on it:
  - Identify areas of under-performance and notice trends developing
  - Establish where maximum benefit can be obtained with future investment
  - Amend designs accordingly

## Learn from mistakes

- Repeating the same mistakes costs time, effort and money:
  - If operatives have to work around problems, ensure this filters back to design staff.
  - Eliminate the wasteful practise of "design, build, break-into, install, repair"
  - Amend designs accordingly

## Are regulation standards being achieved on the ground?

- How do you know how your dwelling performs?
  - Ensure inspections occur when the element being checked is visible or accessible
  - Don't assume, measure
  - If monitoring, be as comprehensive as practicable to isolate occupier effects as much as possible
- How do others know how your dwelling performs?
  - Can you guarantee your dwellings' performance? If not, why not?
  - How do you get to the next level if you don't know where you are at right now?
  - If you are building to a higher standard than the UK norm, let people know and show them that you can prove it

