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Strumenti di diagnostica energetica

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Termografia e altre prove non distruttive PND

PND (prove non distruttive) in edilizia

08 novembre 2010 - Facoltà di Architettura di Cesena Laboratorio integrato di Lettura della Qualità

**I ponti termici negli edifici, gli errori costruttivi
gli strumenti per identificarli
Diagnostica non distruttiva**

Marco Boscolo

Libero professionista e

Professore a contratto di Tecnologia delle costruzioni

Facoltà di Architettura - Università di Bologna - Sede di Cesena

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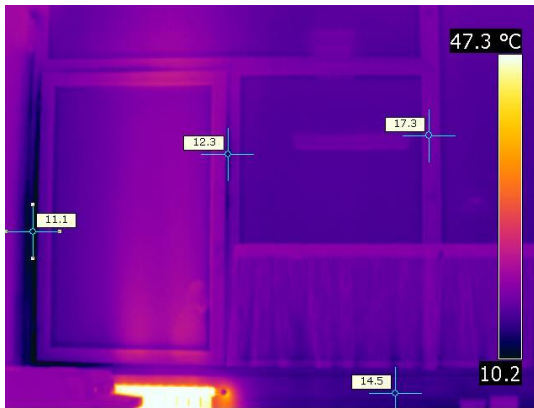
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Approccio problem - solving

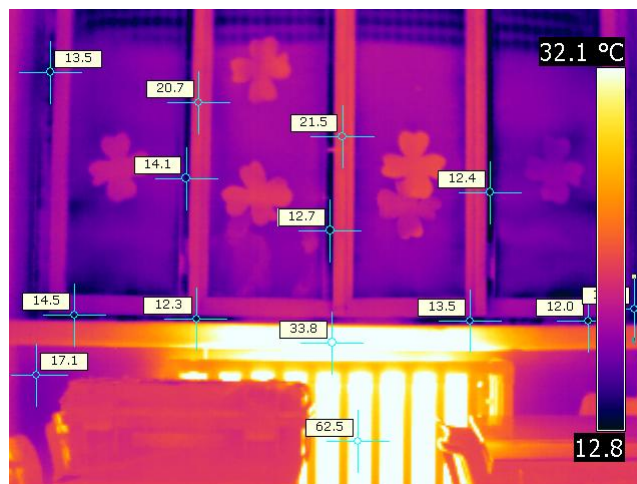
- Partiamo dal concetto di comfort
- Come formare e informare il committente (pubblico o privato)
- Fornire elementi facilmente contestualizzabili e immediatamente comprensibili

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- Situazione invernale



Quando ha troppo freddo come
risolve?
Con l'immancabile stufetta
elettrica!



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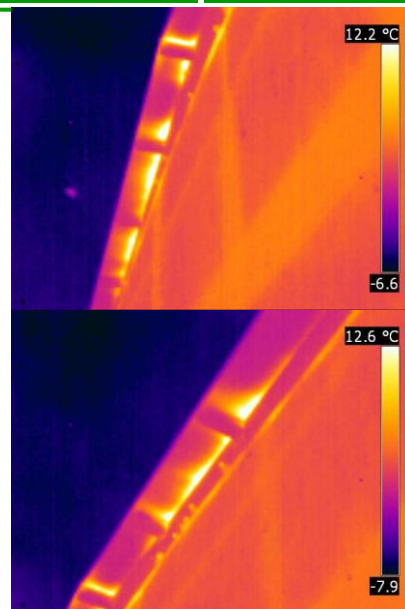
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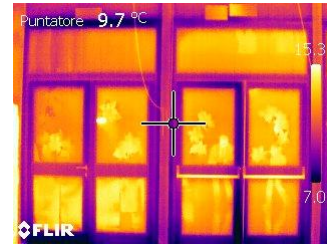
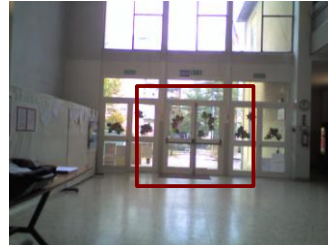
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Le porte

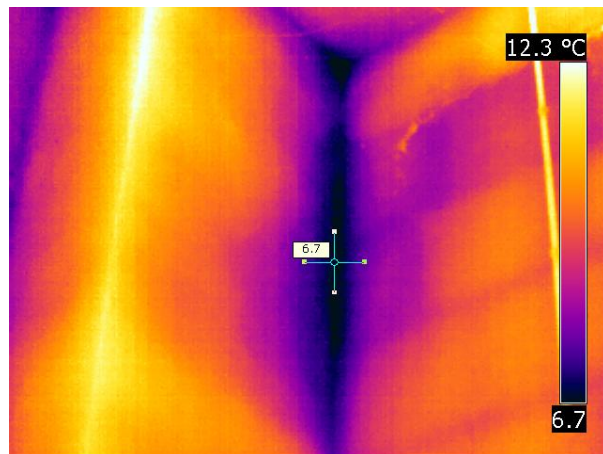
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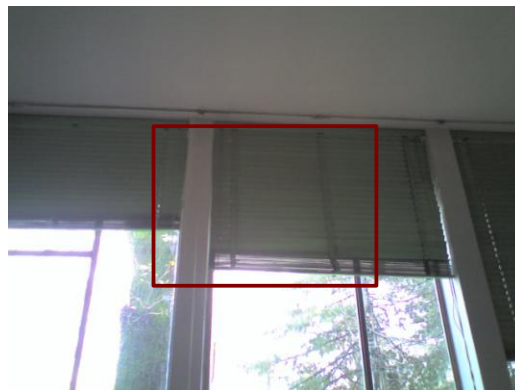
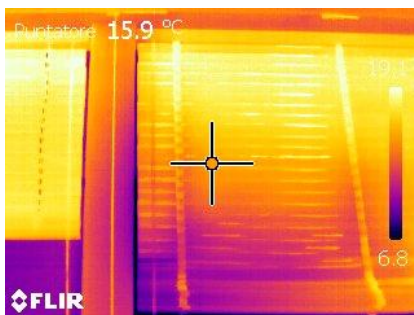
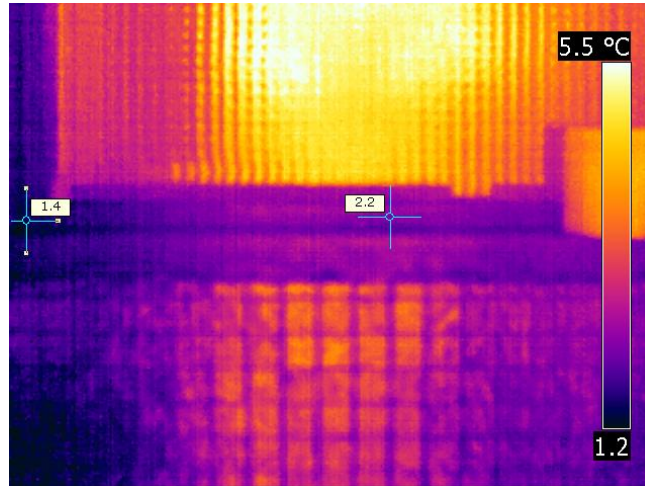
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L'antibagno del personale

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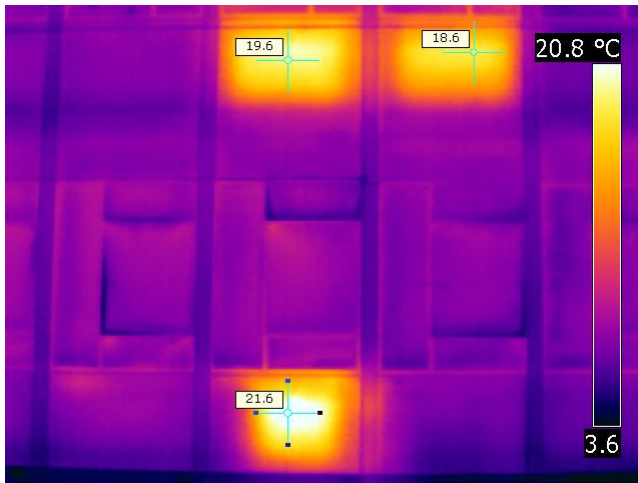

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Questo bagno non lo uso, troppo freddo!
Temperatura esterna
0,5°C



- Il serramento è rotto, ma, ahimè, è rotta anche la veneziana!, quindi Ci dobbiamo accontentare della macchia fredda
- Il lavoratore riceve uno spiffero d'aria fredda.

 $T_{est} = 1^{\circ}\text{C}$ 

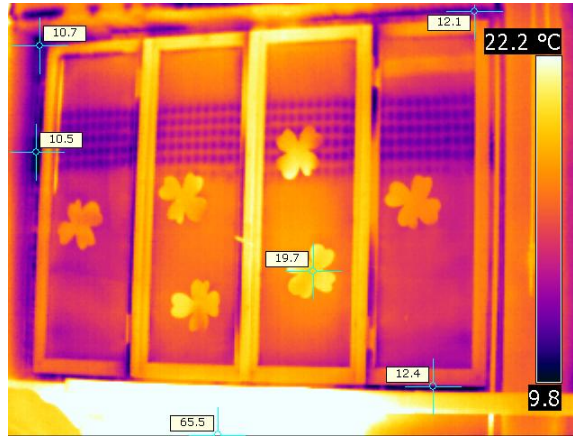
- Osservando queste immagini **NON** dobbiamo porci la domanda **PERCHE'** intervenire **MA QUANDO** intervenire



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I serramenti delle classi

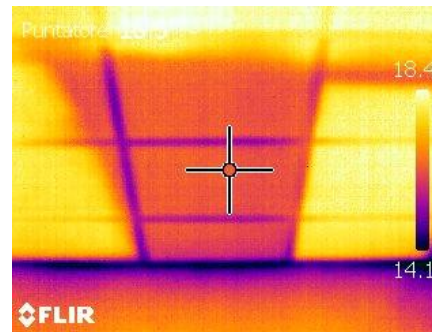
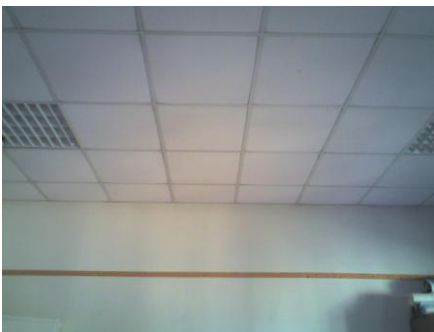
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Controsoffitto mal posato

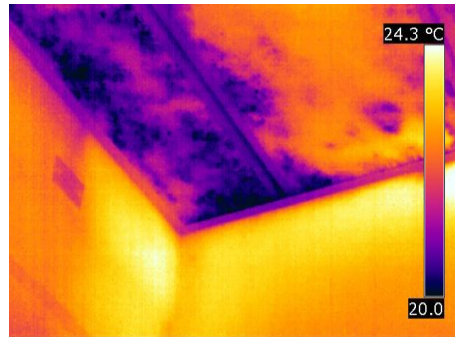
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Infiltrazioni di aria

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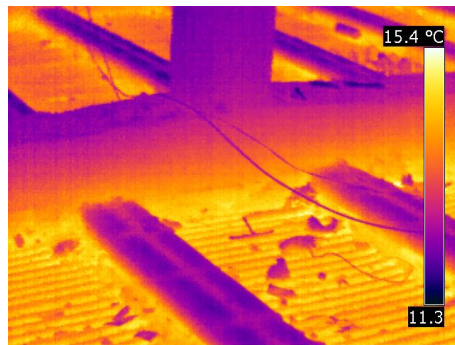
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Sottotetto freddo

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interventi

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Interventi: cappotto esterno

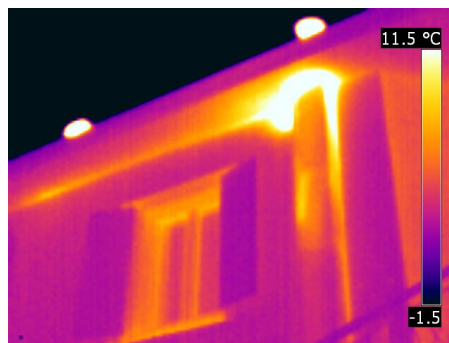
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Cappotto

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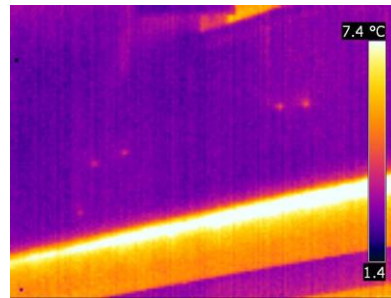
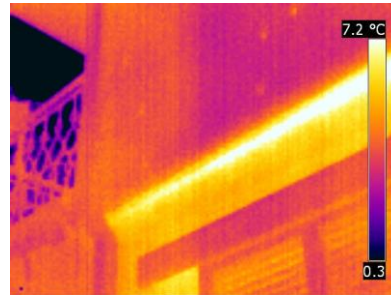
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Tasselli di fissaggio del cappotto

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Dettagli costruttivi non risolti

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Analisi di impianti fotovoltaici

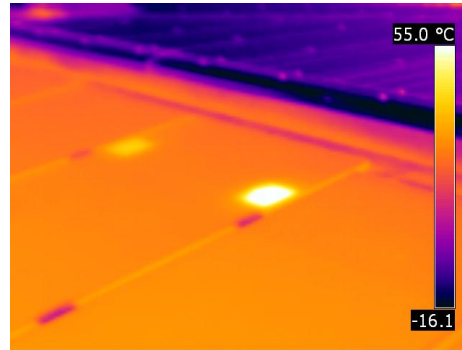
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Analisi di pannelli fotovoltaici

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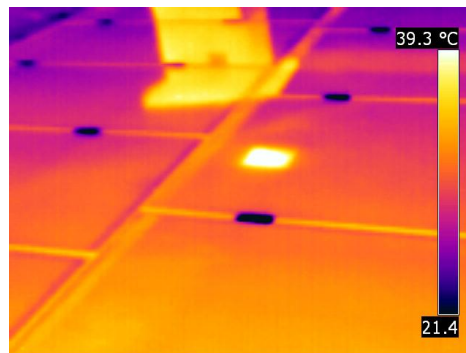
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Interventi: sostituzione di serramenti

- Esempio di intervento di sostituzione dei serramenti



Dopo aver girato diverse classi (i cassonetti presentavano diverse fessure), ci è stata proposta questa per il blower door test.

Al primo impatto una strana scelta:
Serramenti nuovi e cassonetti vecchi



- Sono stati risolti i ponti termici?
 - Davanzale passante
 - Radiatore in nicchia
 - Cassonetti
 - Ponte termico delle spalle delle finestre

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Il bancale passante**

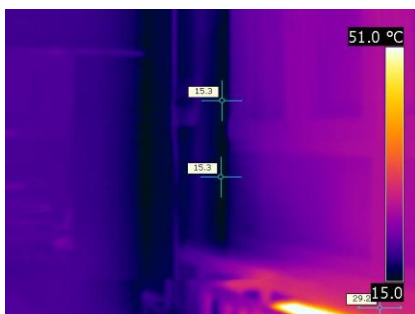
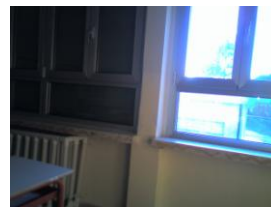
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Il ponte termico della spalla e il radiatore in nicchia**

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Il radiatore in nicchia - Esterno

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Il radiatore in nicchia - Esterno

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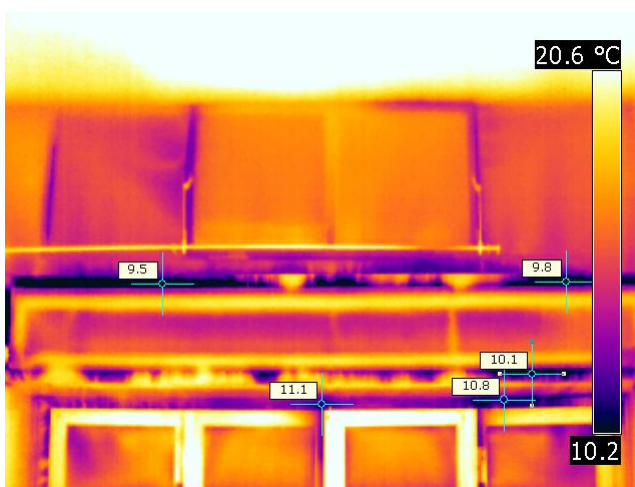
- La tapparella è rotta!!!!

Oops quanti spifferi

Diminuendo o Aumentando la pressione all'interno dell'edificio, Quali e quanti difetti possiamo evidenziare?
La prova è semplice (e relativamente poco onerosa)



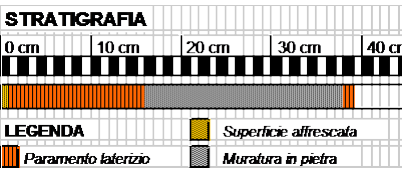
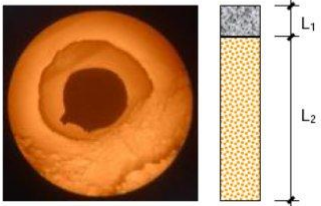
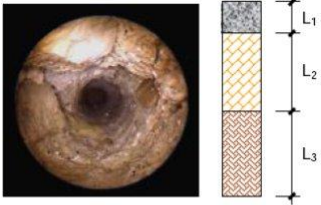
- Romanticismo del tramonto? No, semplicemente la finestra si è aperta durante la prova di depressurizzazione e poi non si chiudeva più



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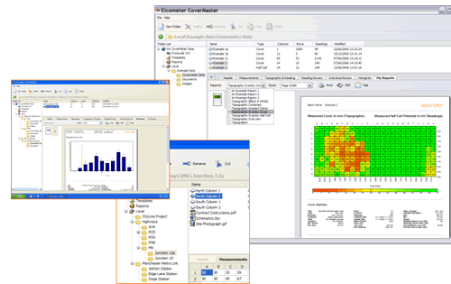
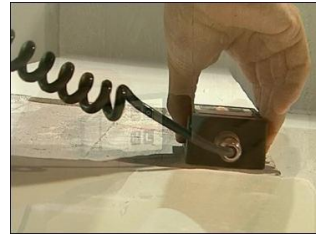
❌ Impossibile visualizzare l'immagine. La memoria del computer potrebbe essere insufficiente per aprire l'immagine oppure l'immagine potrebbe essere danneggiata. Riavviare il computer e aprire di nuovo il file. Se viene visualizzata di nuovo la x rossa, potrebbe essere necessario eliminare l'immagine e inserirne di nuovo.



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Ricerca e analisi corrosione

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Pull off – prova a strappo

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sclerometro

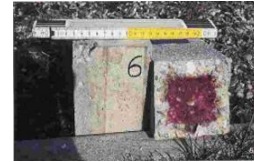
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Fenolftaleina

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Ultrasuoni

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Martinetti piatti

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Pull out – test sul calcestruzzo

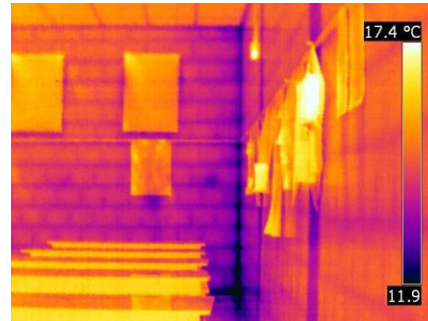
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Mensa – orditura dei mattoni

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Aula – orditura delle strutture

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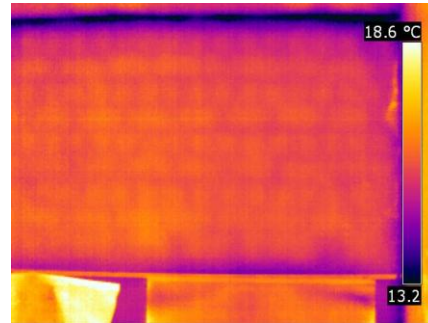
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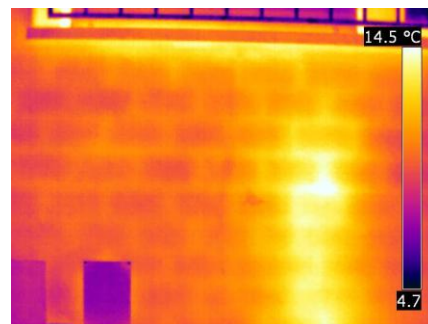
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Parete esterna - impianti


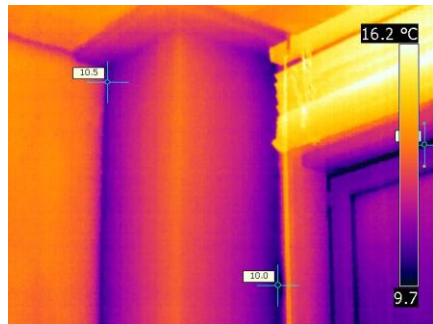
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Pilastro verso copertura

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Vano scale

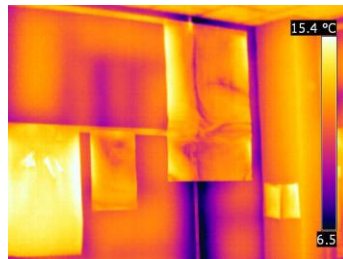
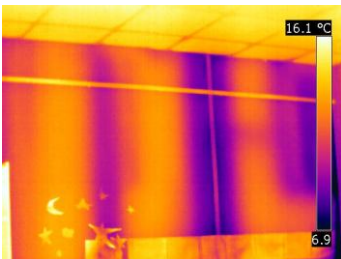
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Parete interna ed esterna: stessi componenti

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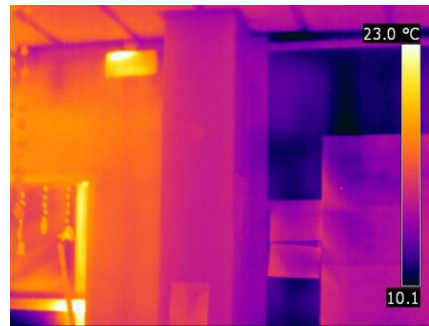
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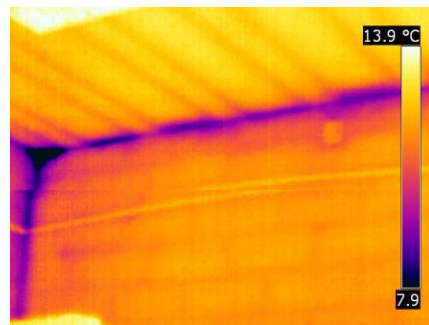
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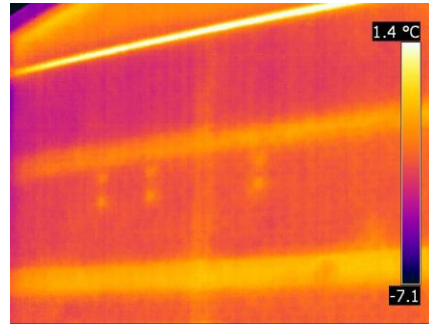
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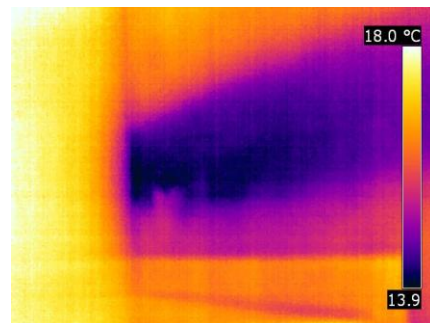
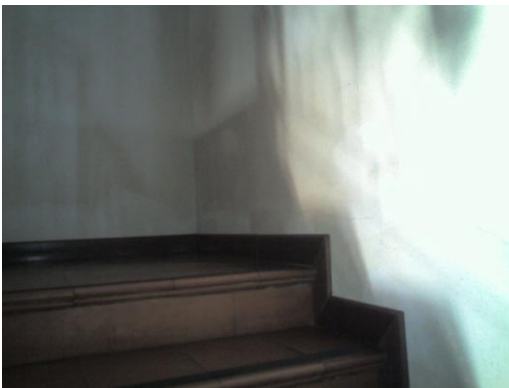
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Architrave nascosta

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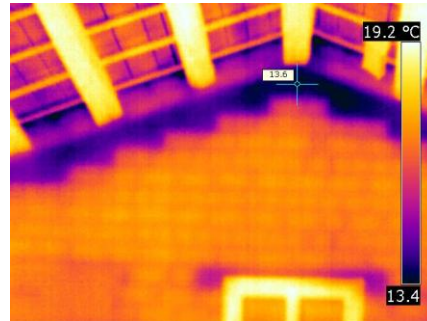
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Cordolo in c.a.

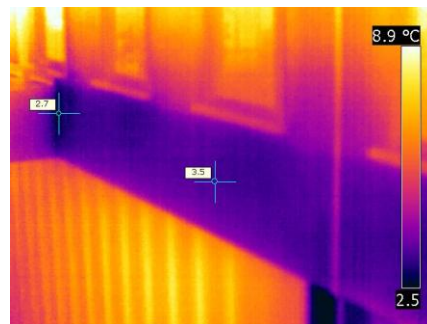
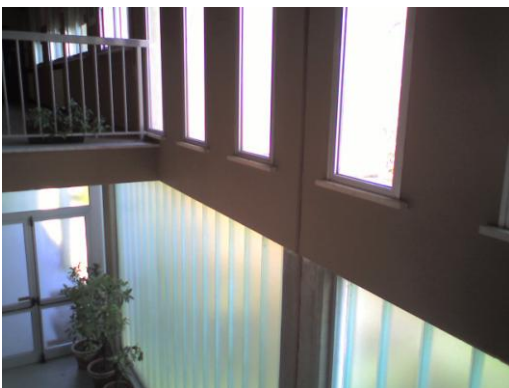
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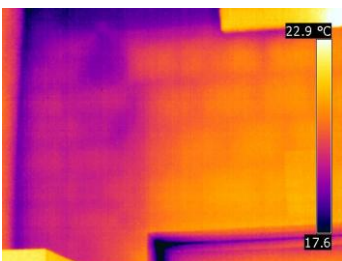
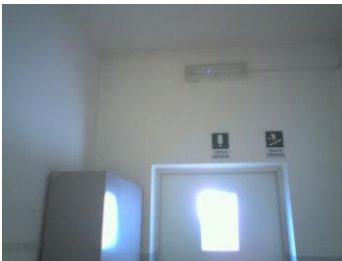
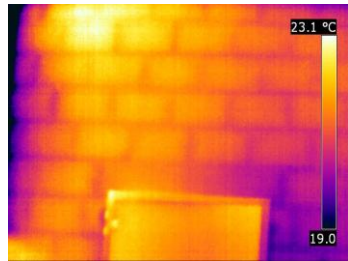
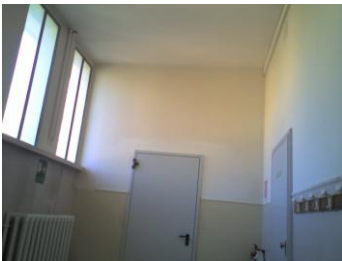
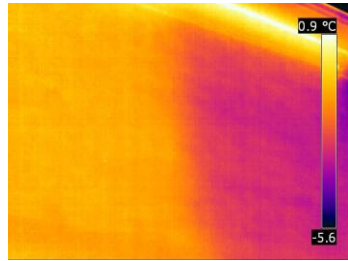
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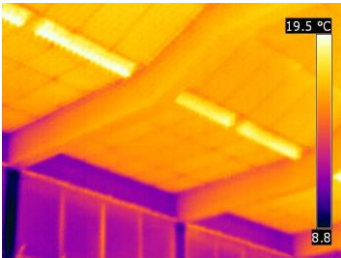
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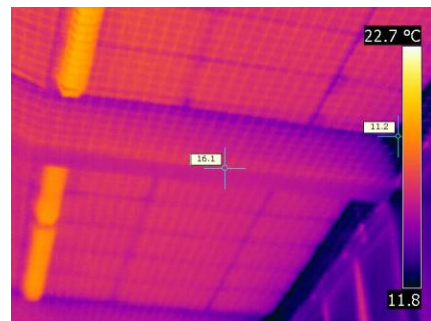
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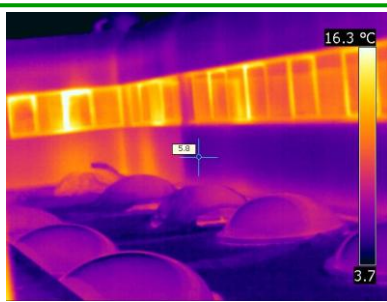

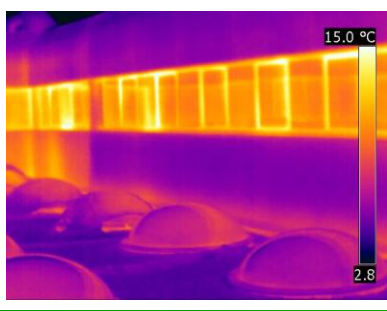

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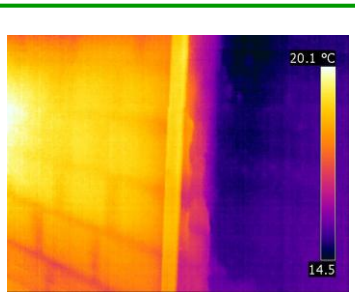

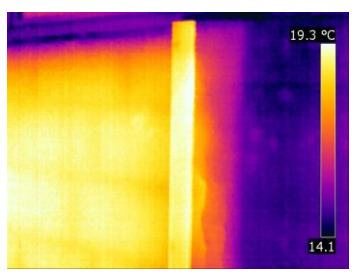

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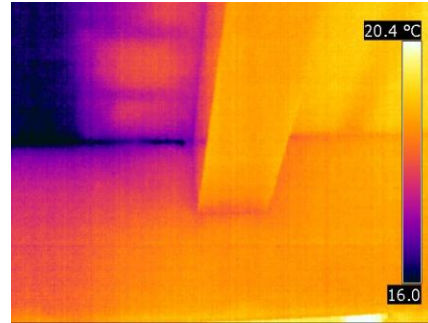
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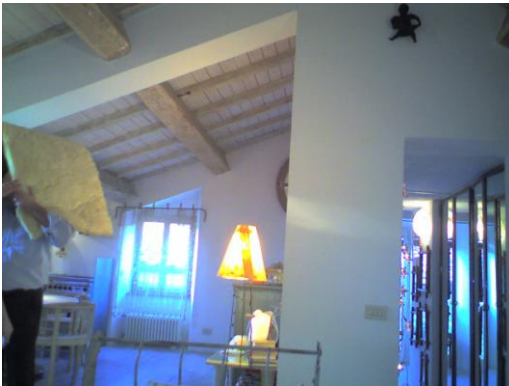
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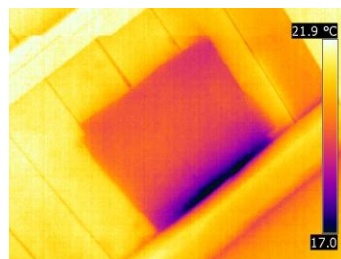
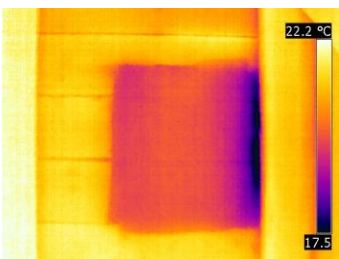
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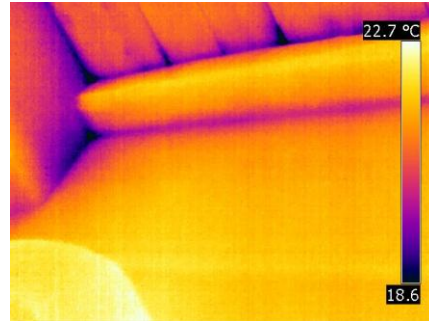


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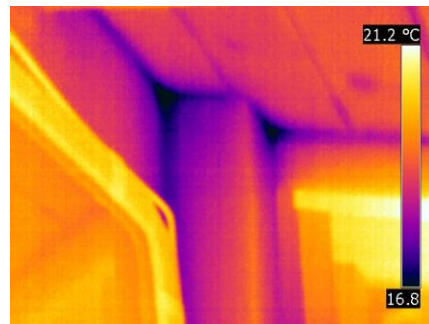
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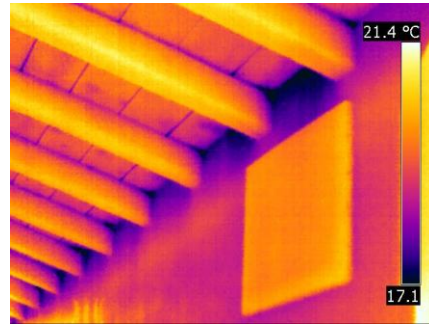
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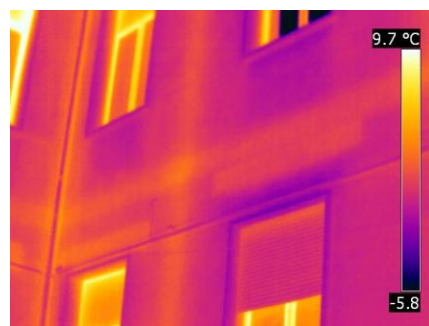
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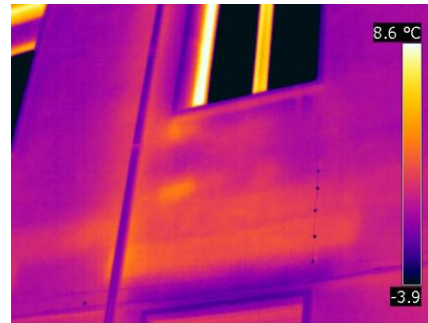
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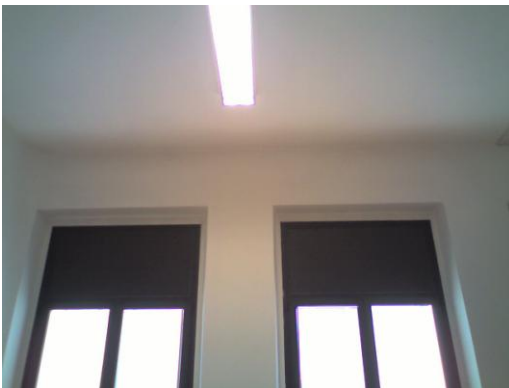
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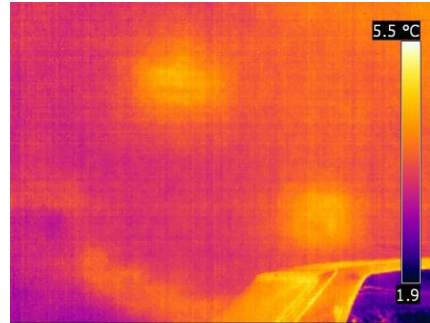
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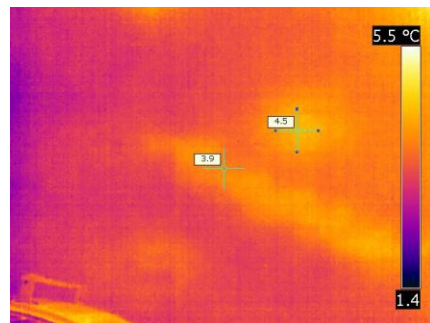
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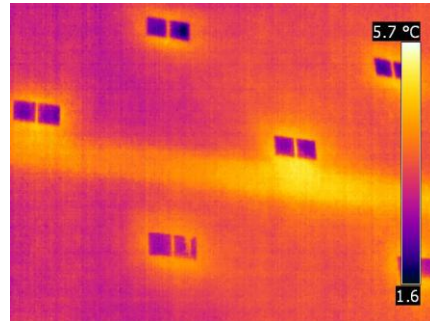
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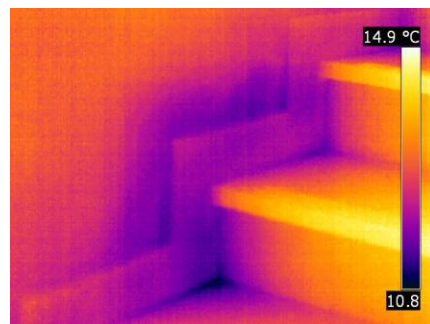
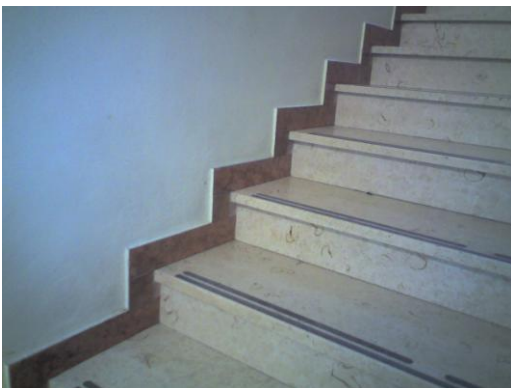
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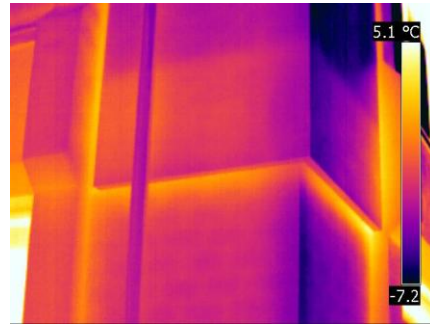
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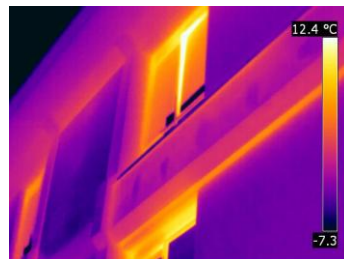
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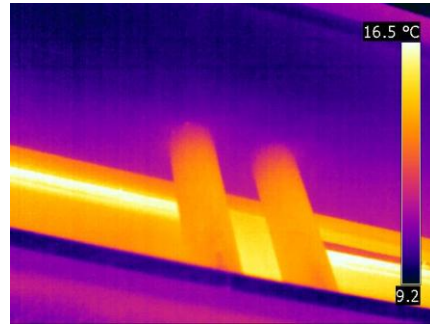
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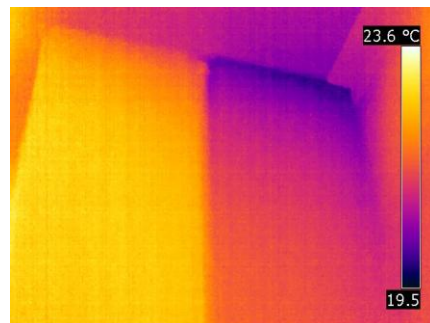
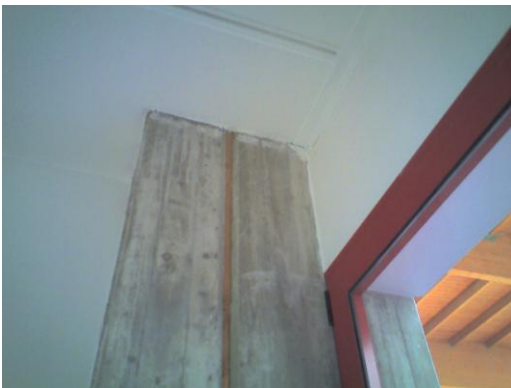
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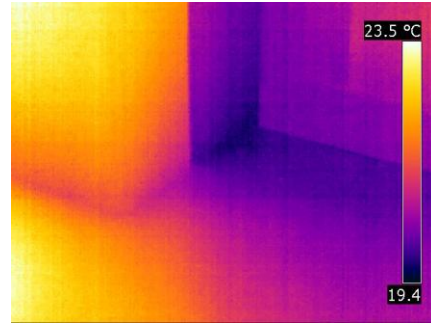
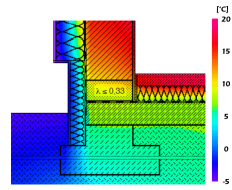
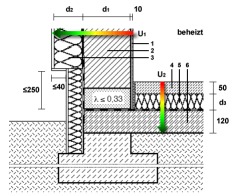
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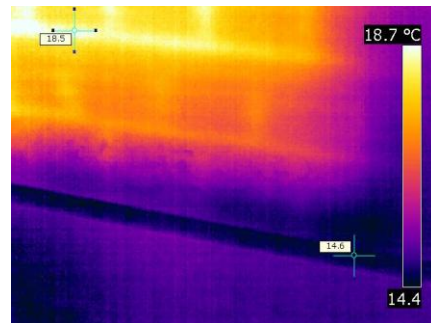
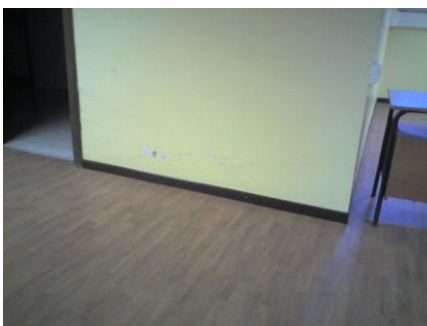
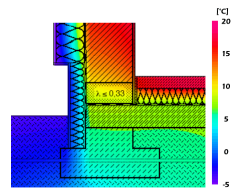
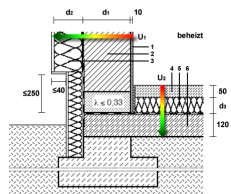


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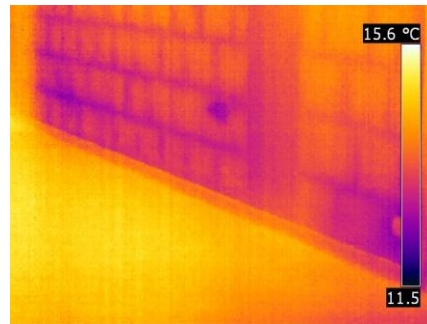
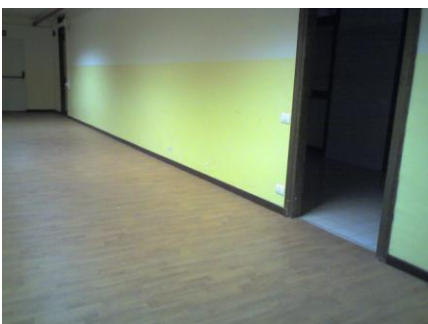
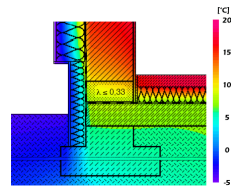
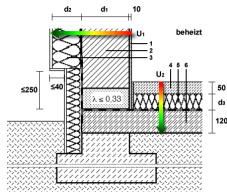
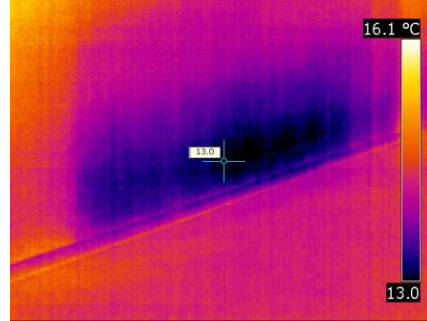
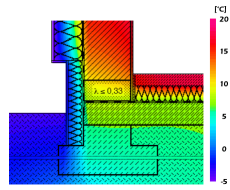
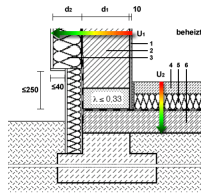


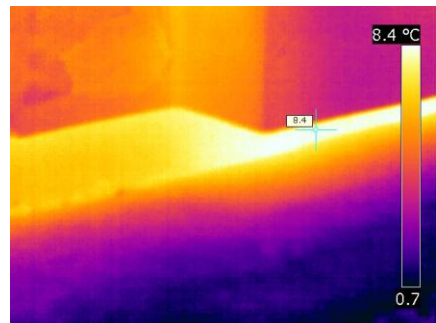
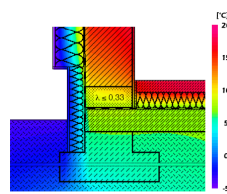
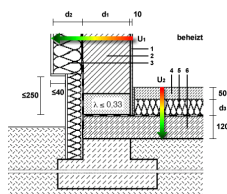
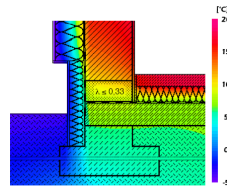
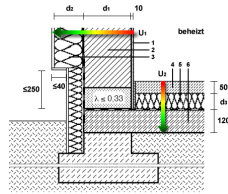
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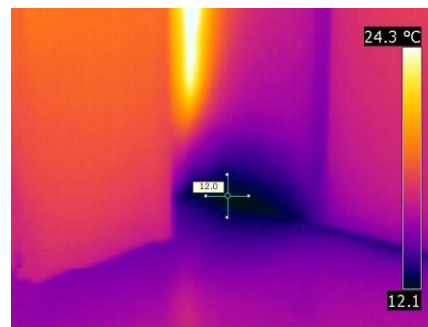
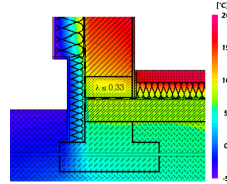
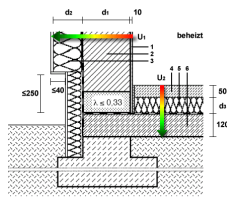
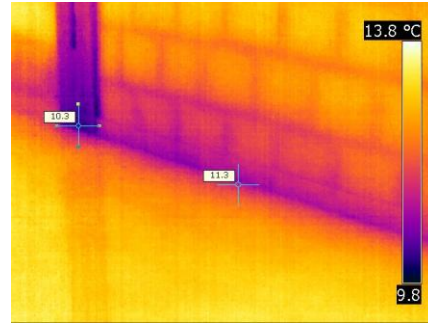
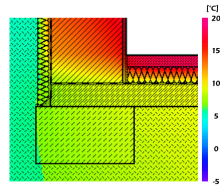
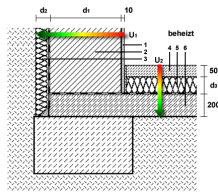


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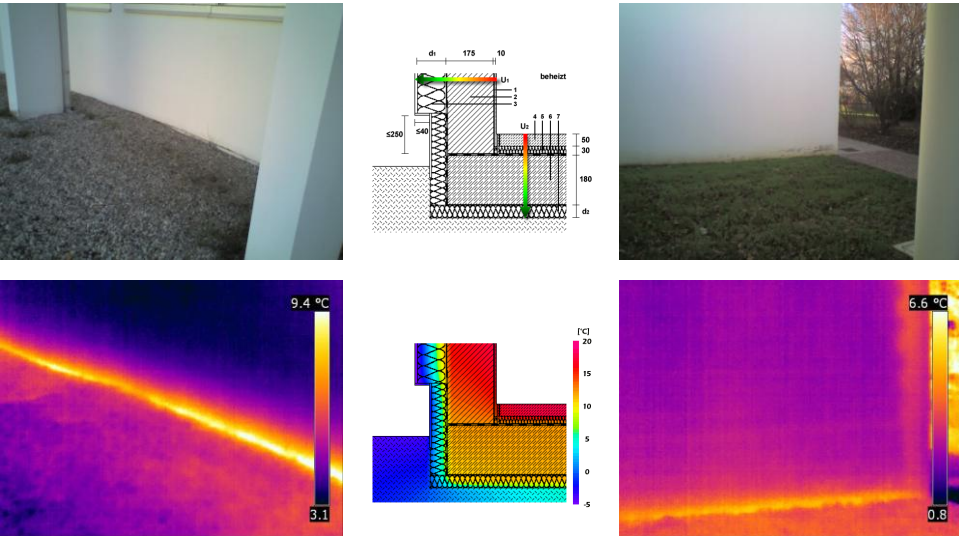






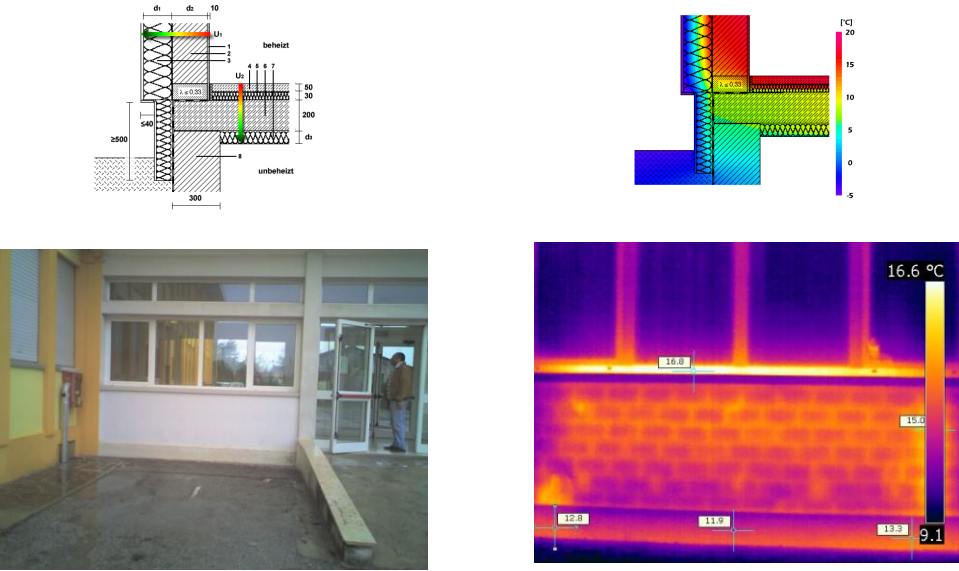


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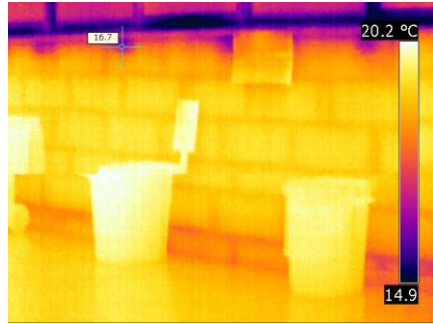


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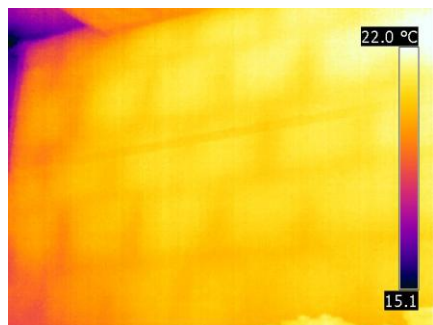
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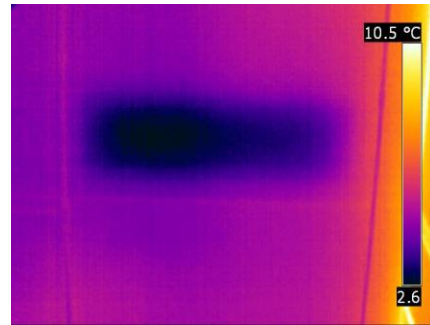
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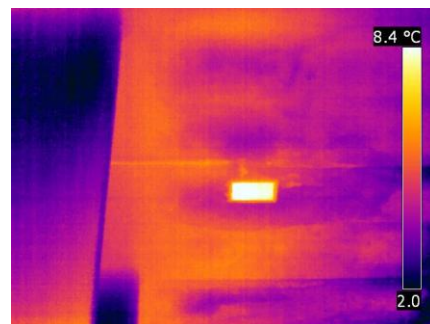
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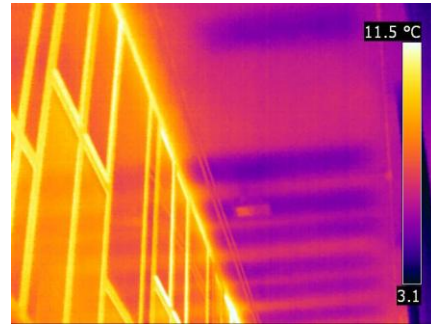
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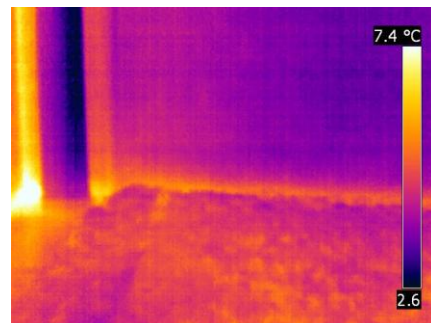
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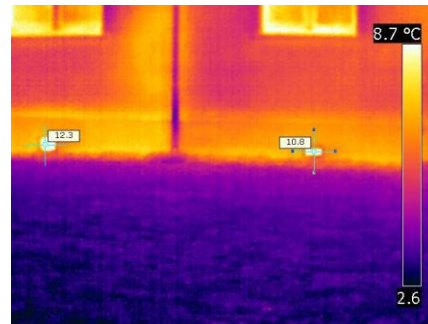
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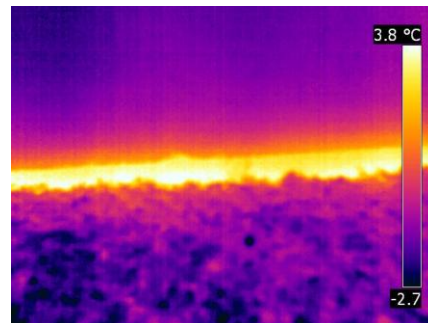
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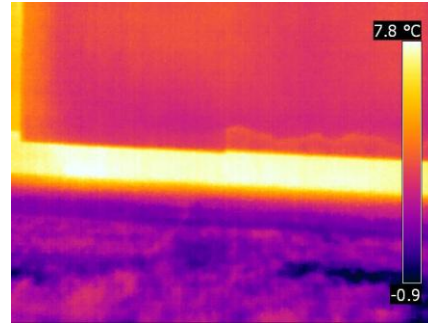
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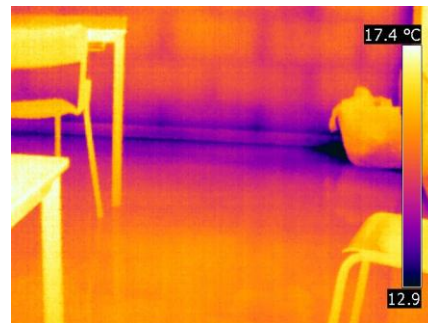
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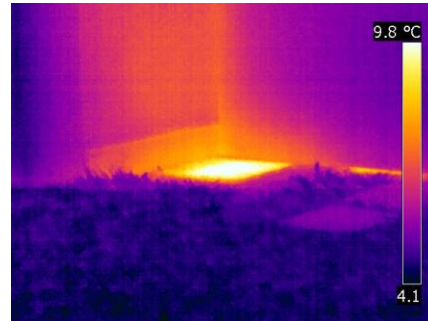
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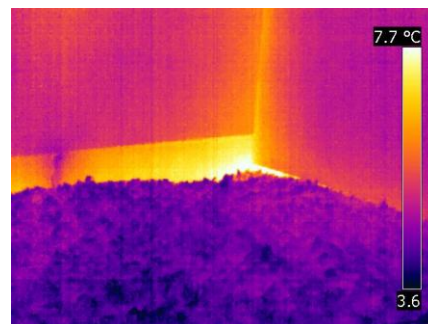
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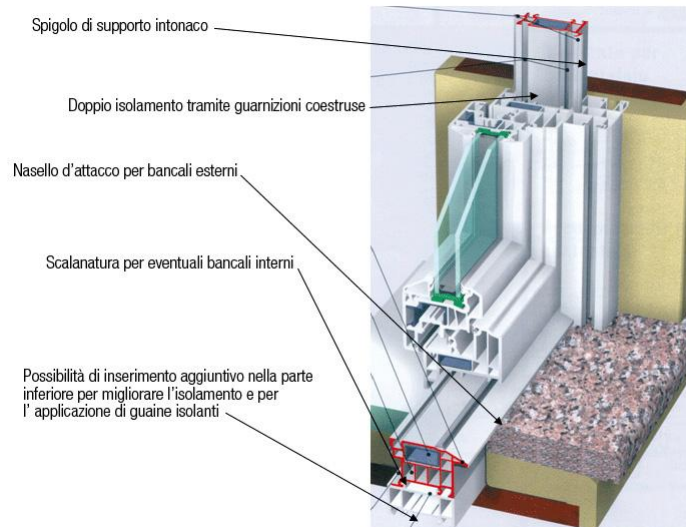
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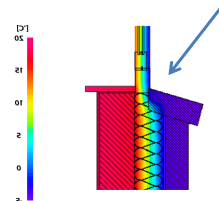
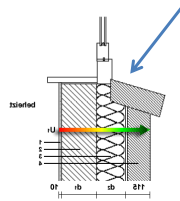
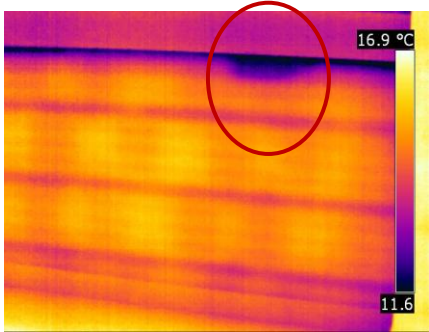
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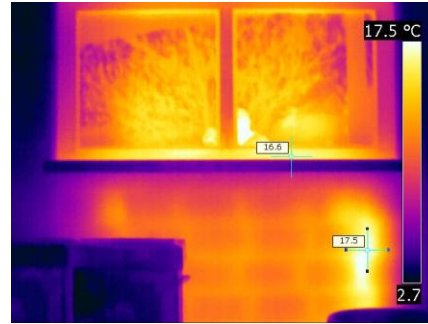
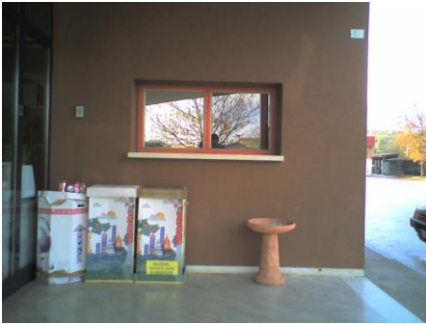
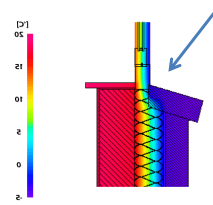
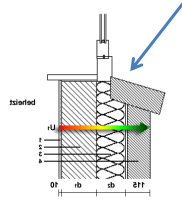




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Davanzale continuo o passante

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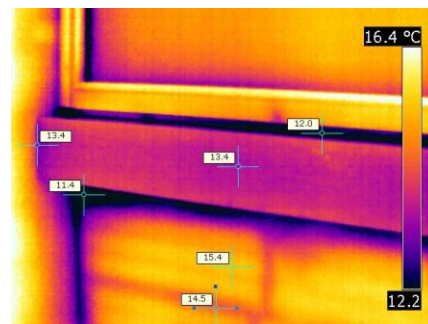
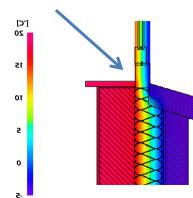
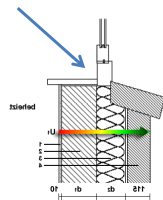
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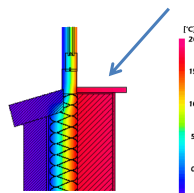
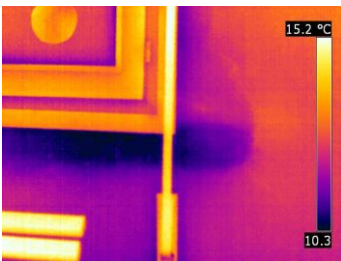
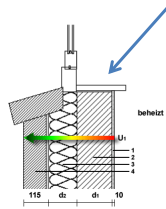
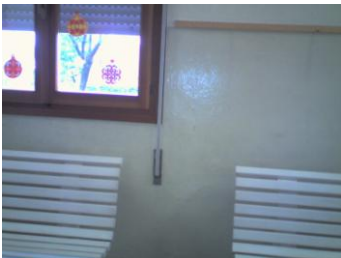
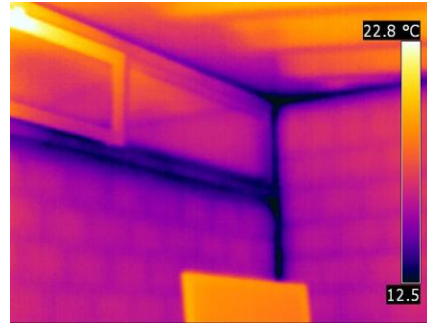
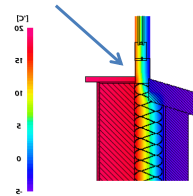
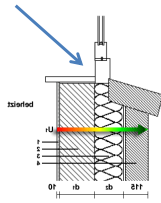
Strumenti di diagnostica energetica
Davanzale passante

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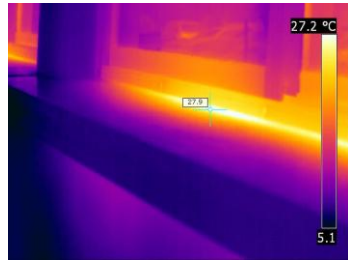
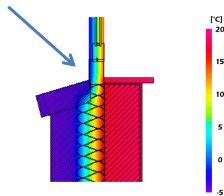
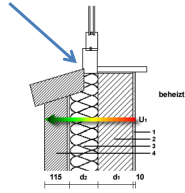


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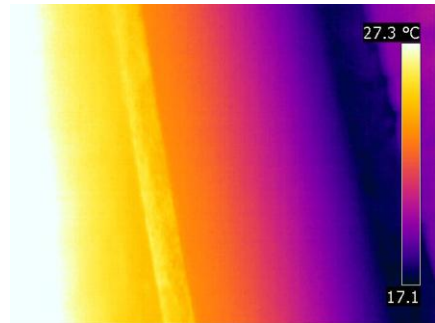
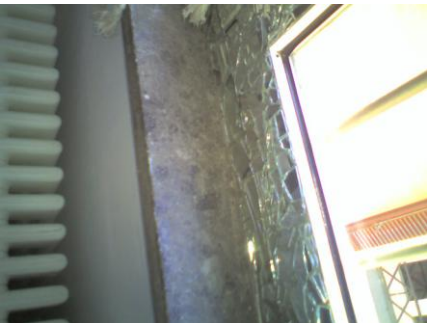
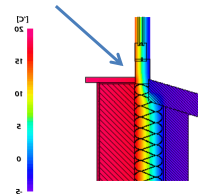
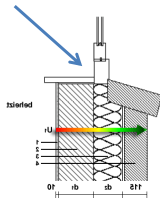


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Davanzali Roma 06/11/2010



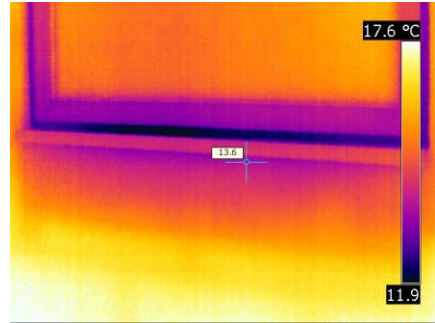
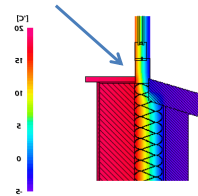
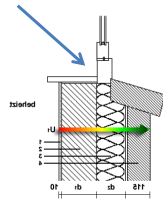
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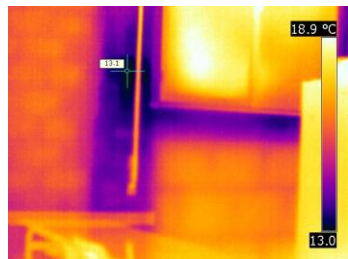
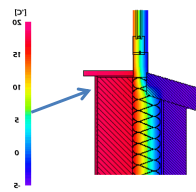
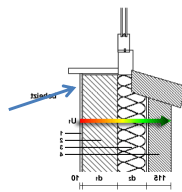
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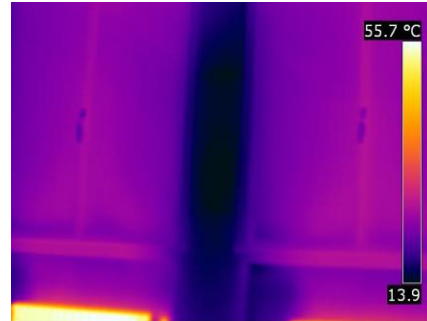
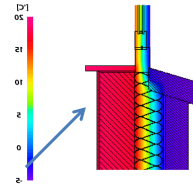
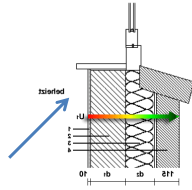
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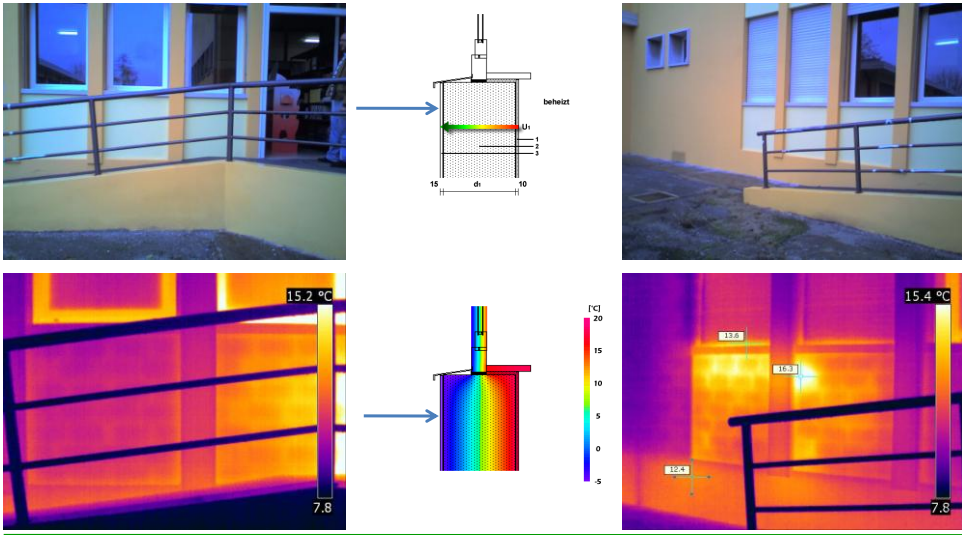
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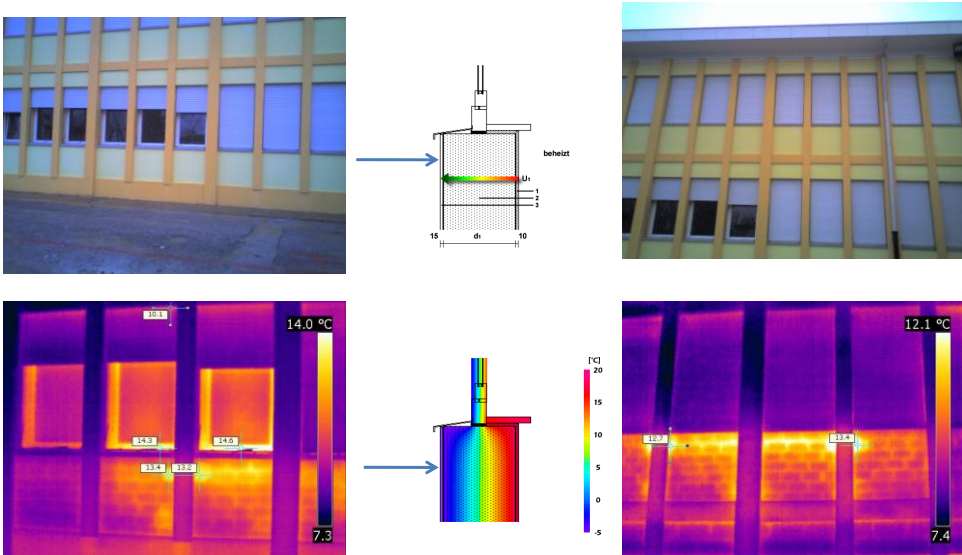


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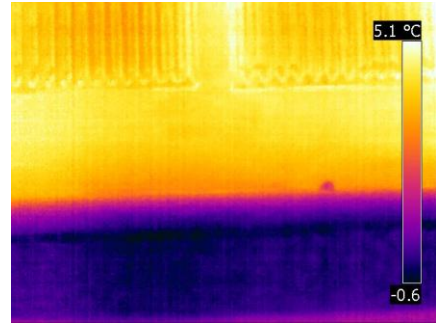
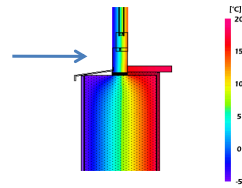
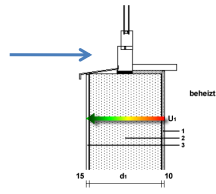


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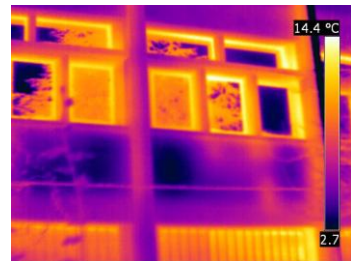
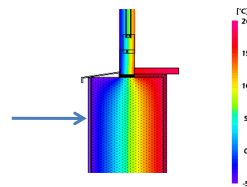
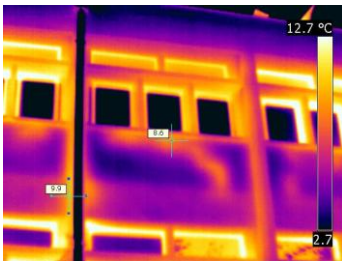
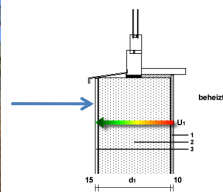


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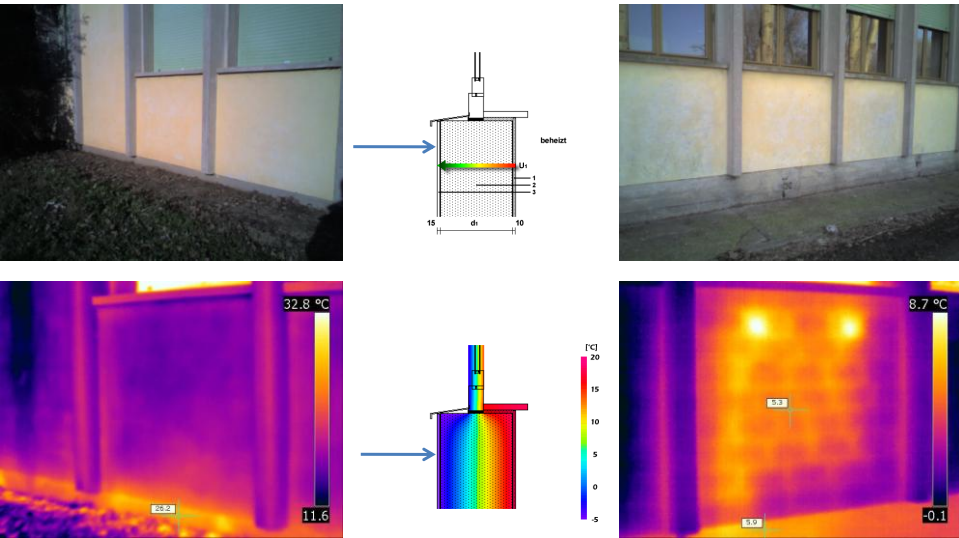
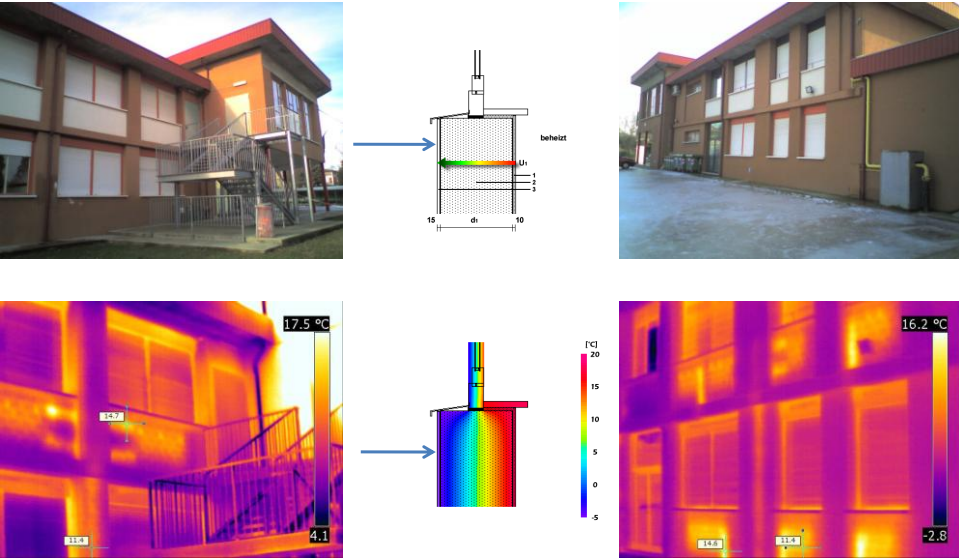


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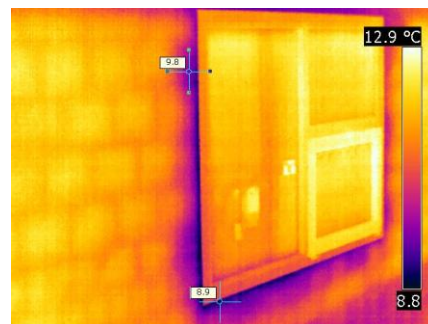
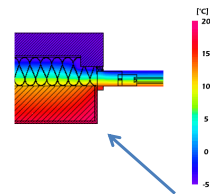
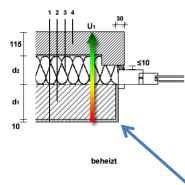
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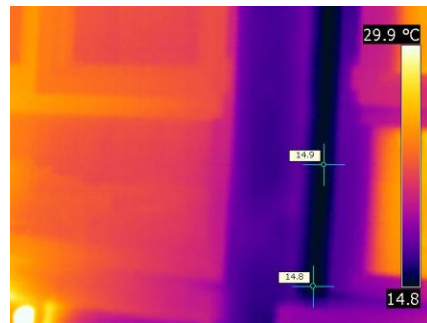
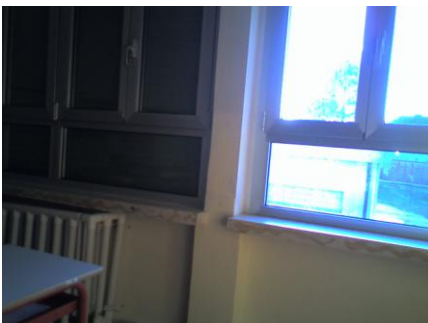
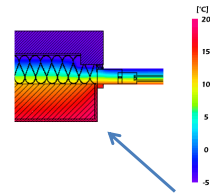
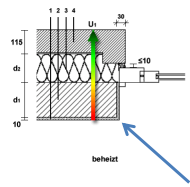
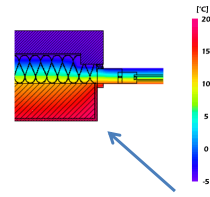
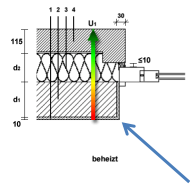
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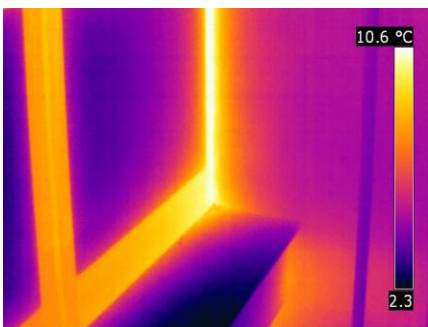
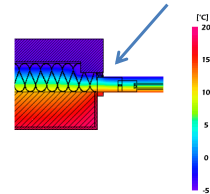
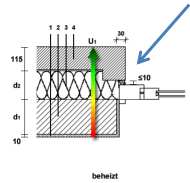
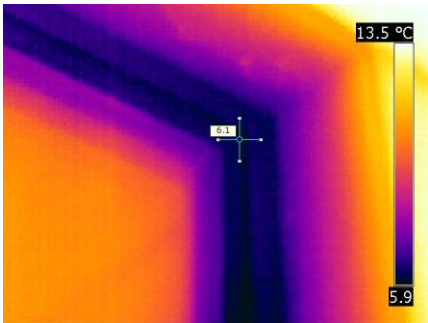
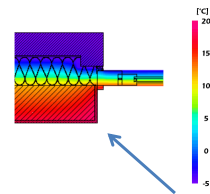
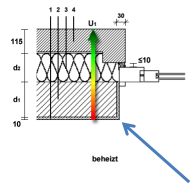
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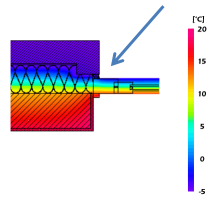
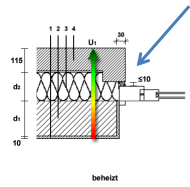


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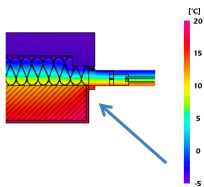
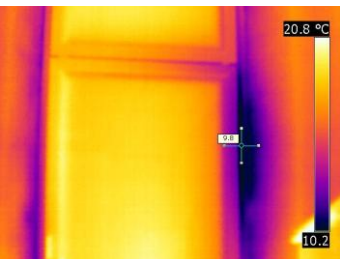
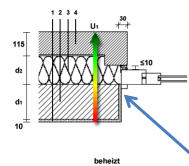
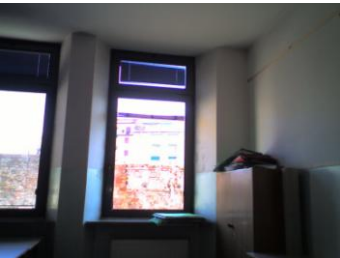








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Corridoio con serramenti senza taglio termico

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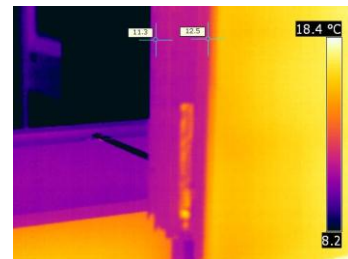
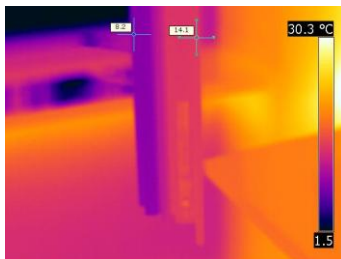
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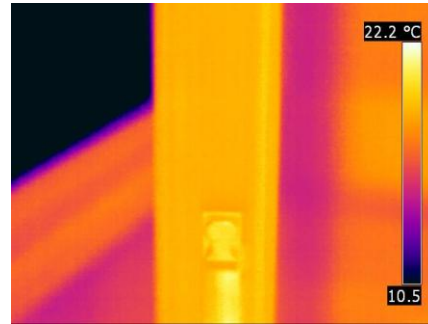
Strumenti di diagnostica energetica
Serramenti all'apparenza simili, ma solo all'apparenza

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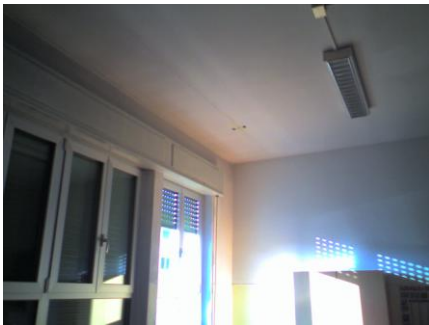
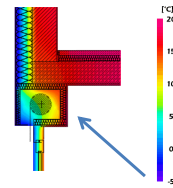
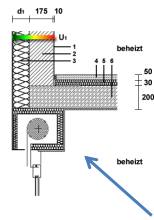


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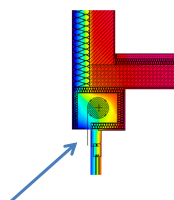
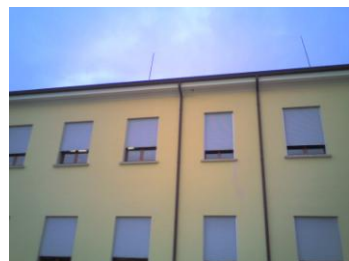
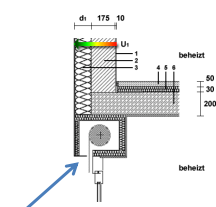
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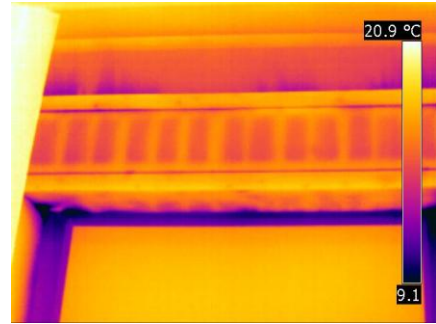
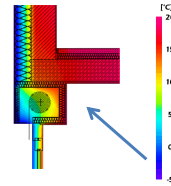
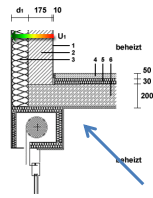


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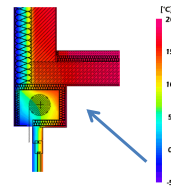
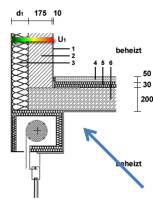


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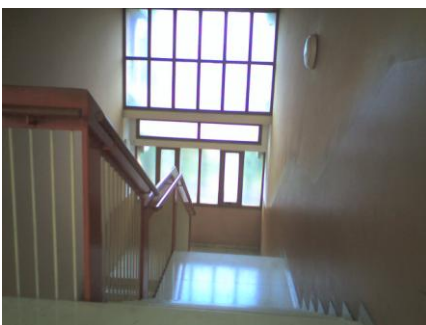
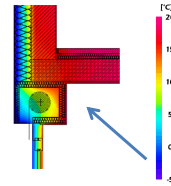
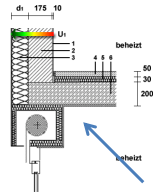


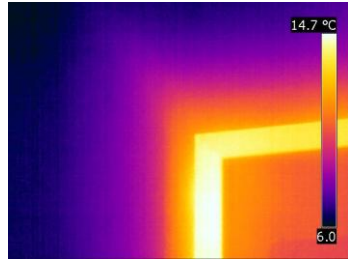
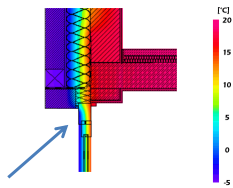
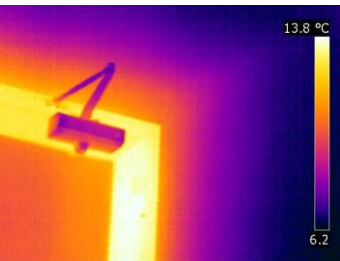
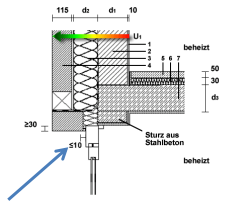
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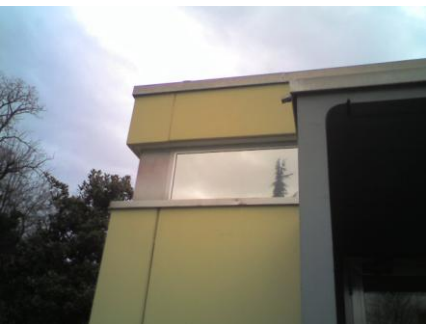
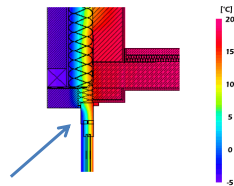
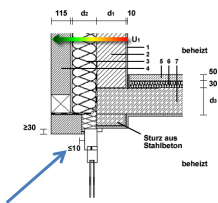
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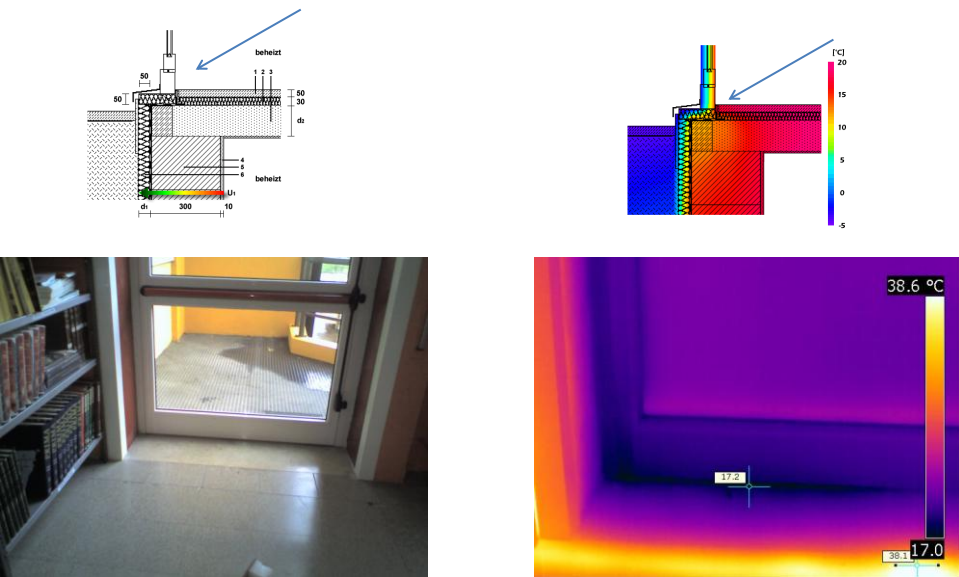
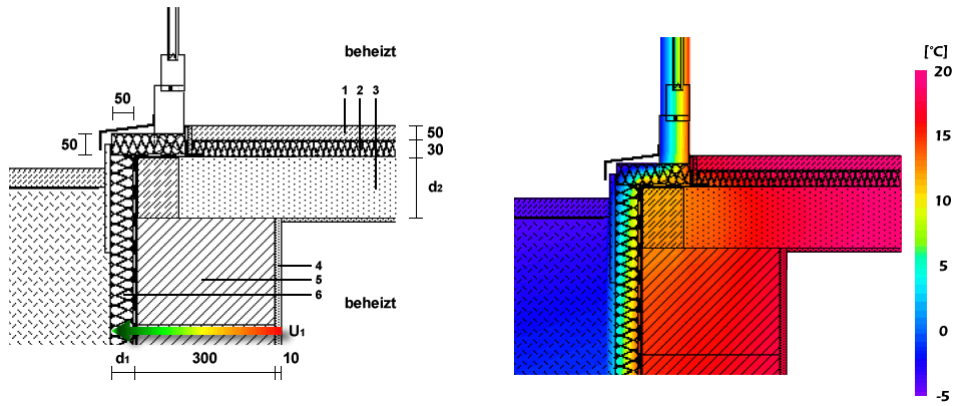
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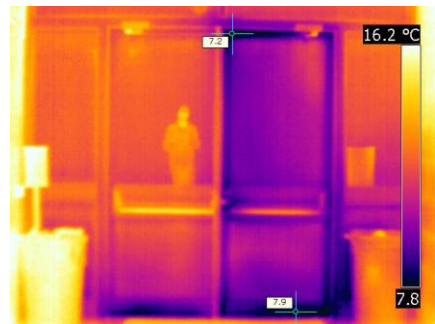
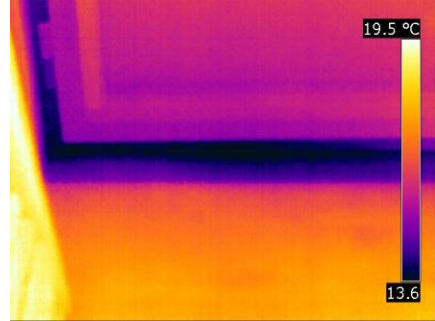
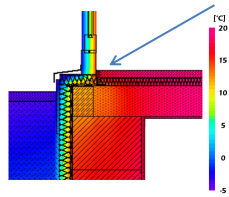
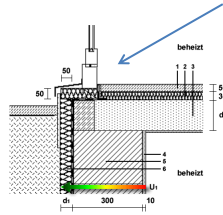
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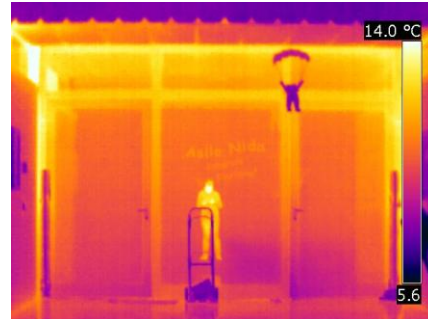




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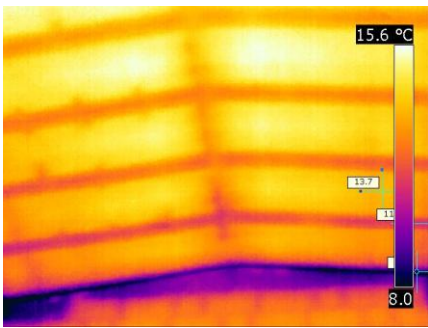
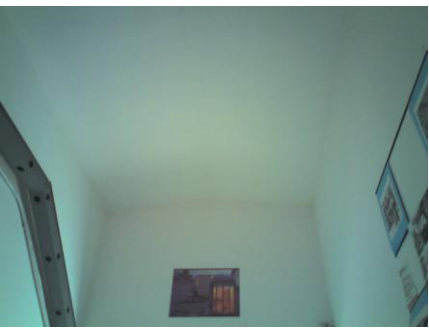
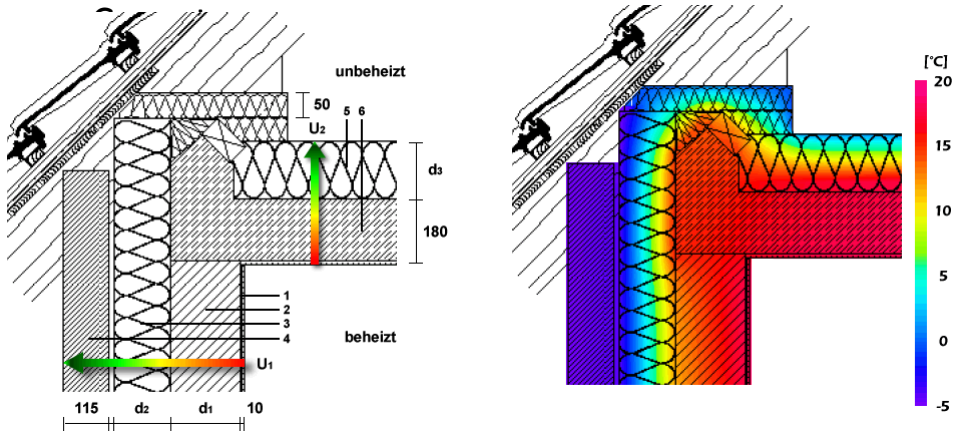
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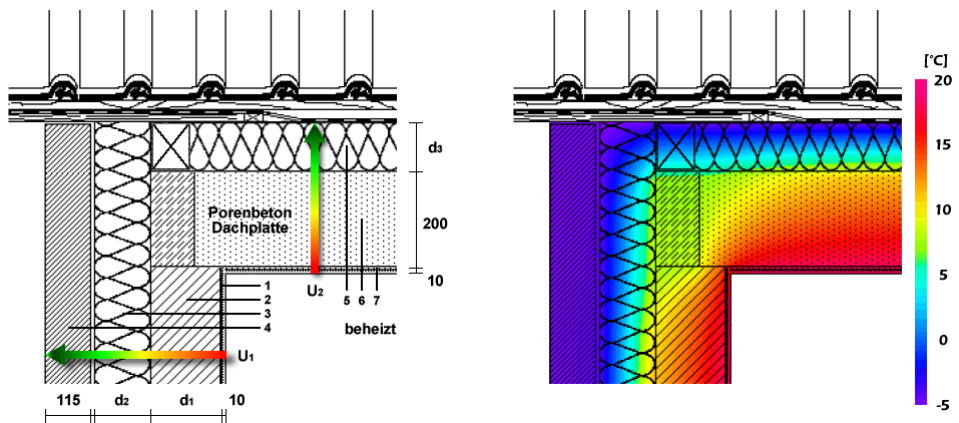
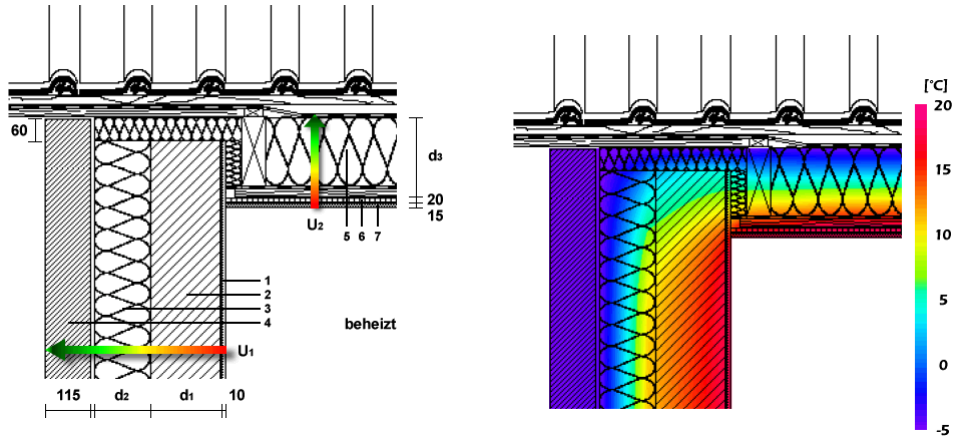
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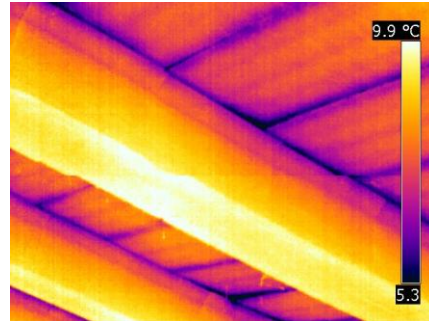




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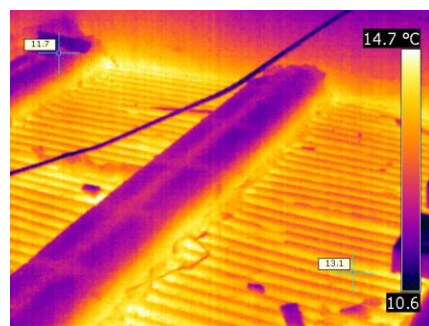
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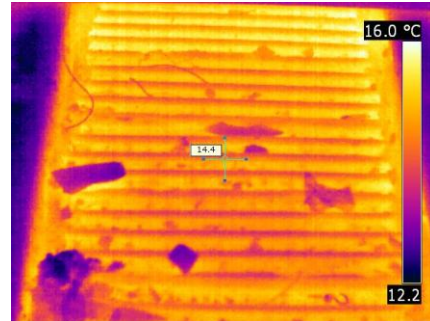
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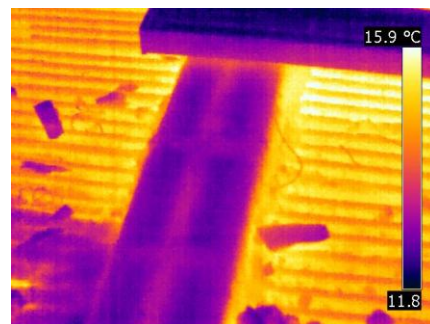
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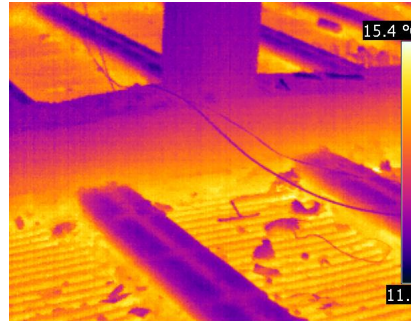
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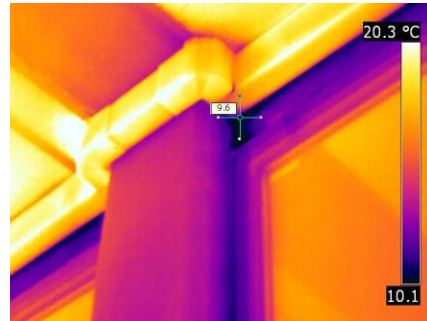
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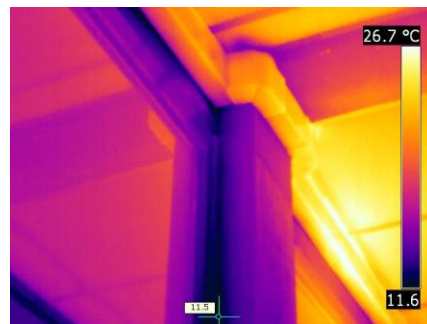
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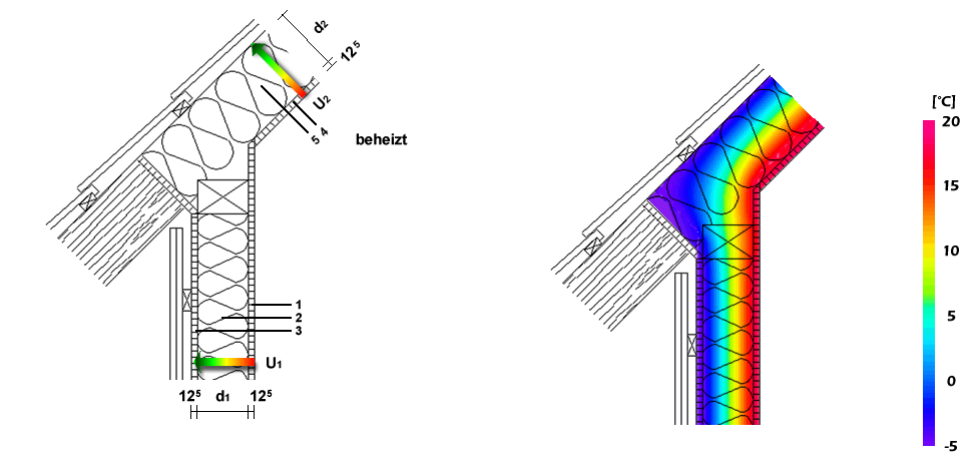
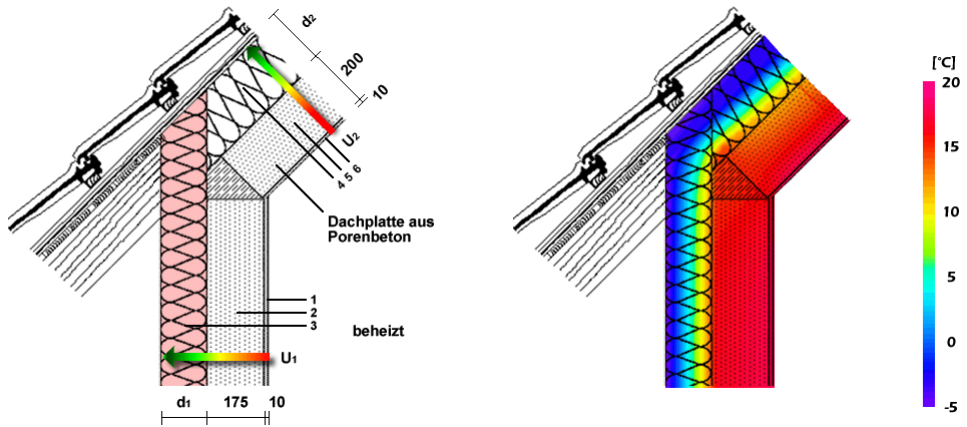
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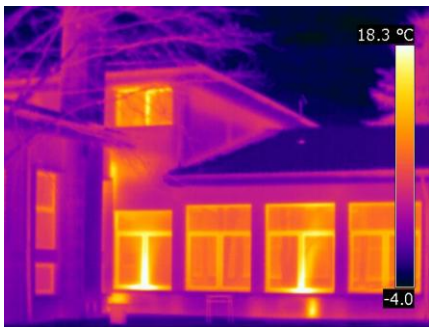
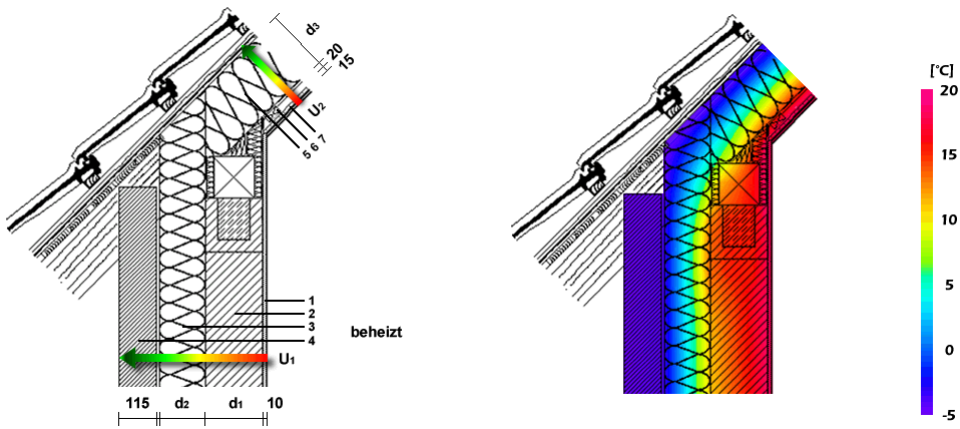
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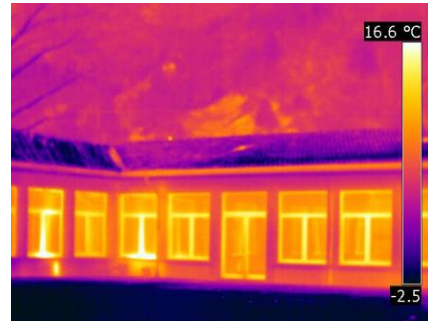




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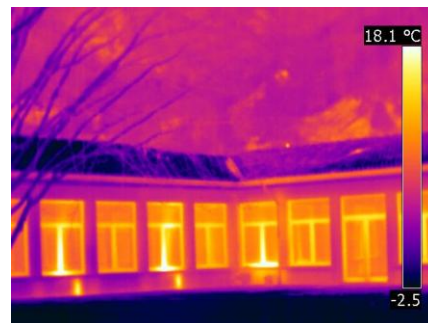
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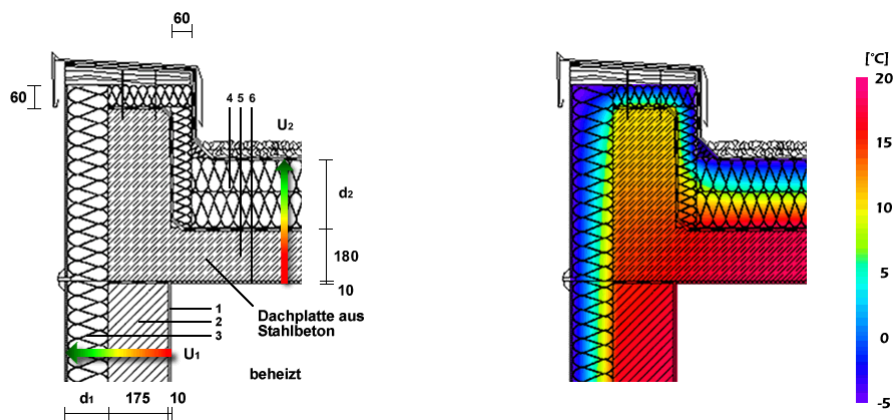
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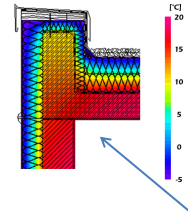
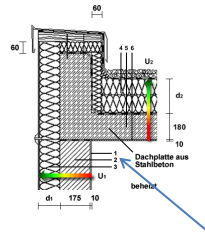


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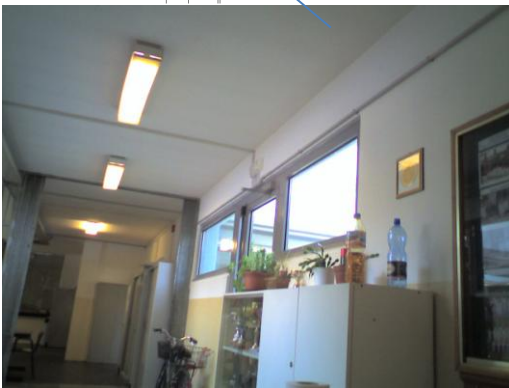
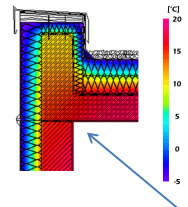
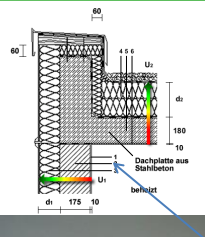


- TETTO PIANO



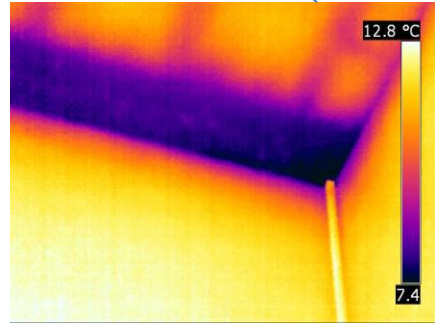
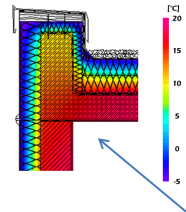
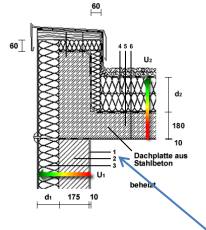


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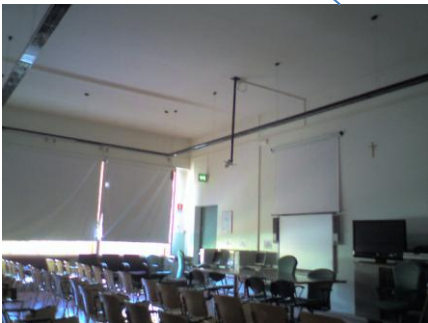
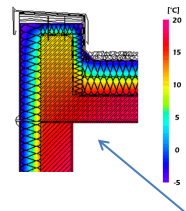
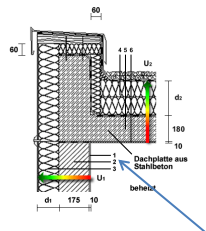


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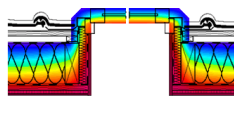
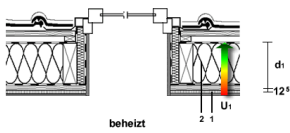
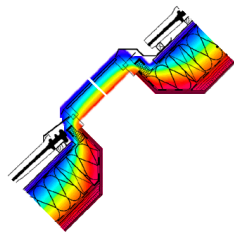
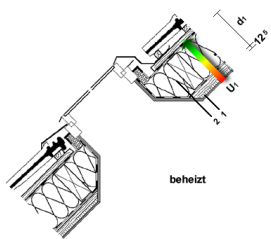
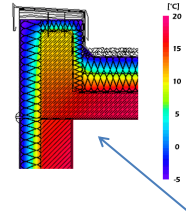
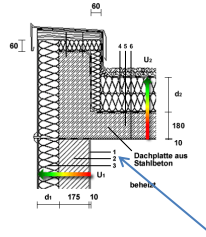


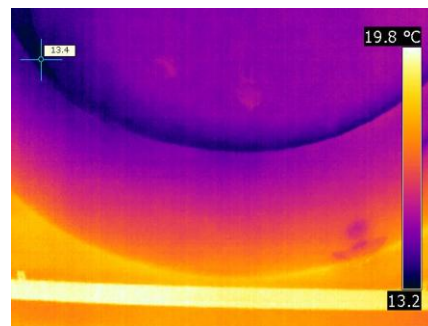
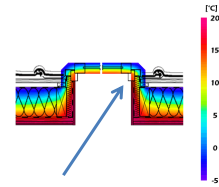
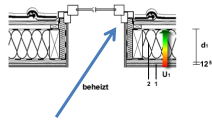
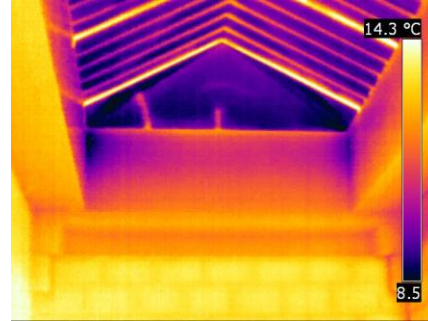
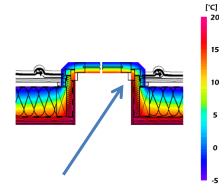
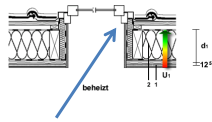
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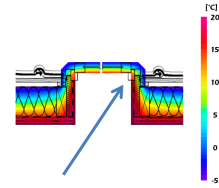
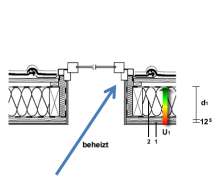




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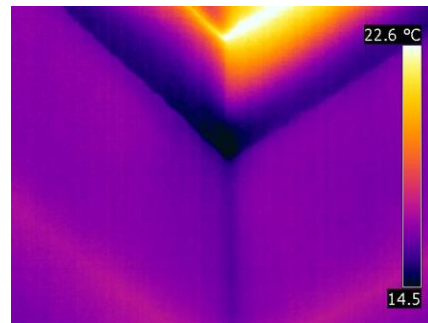
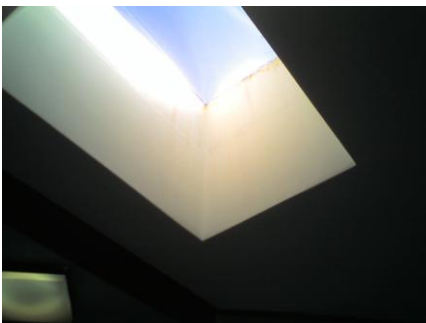
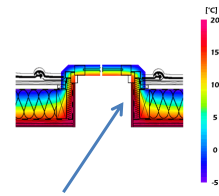
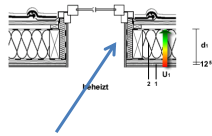
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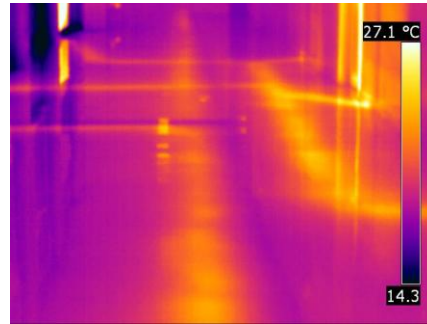
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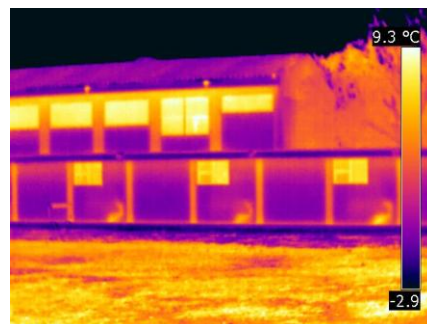
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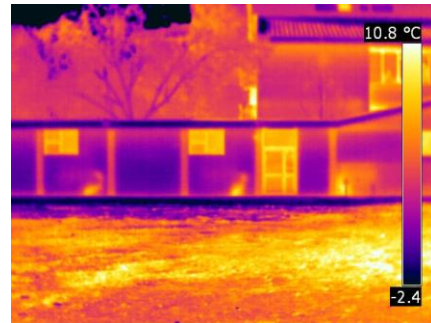
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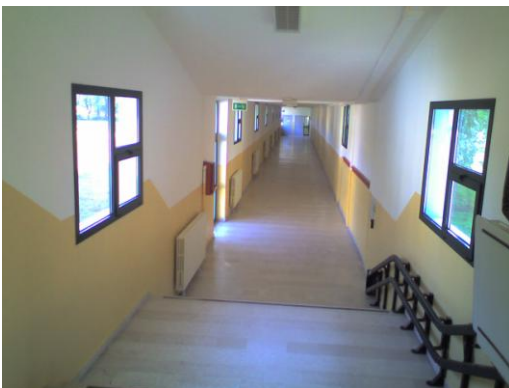
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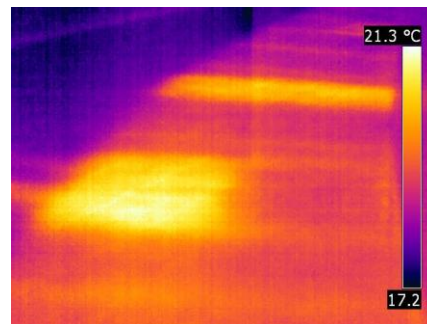
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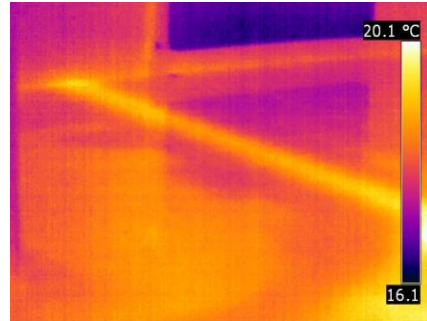
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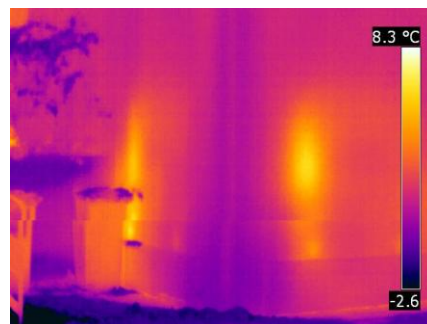
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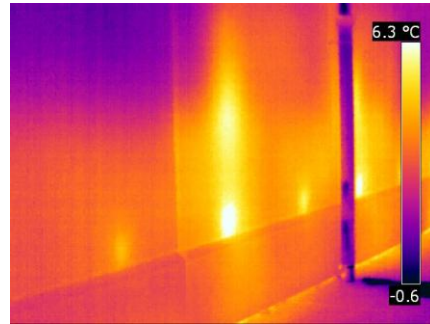
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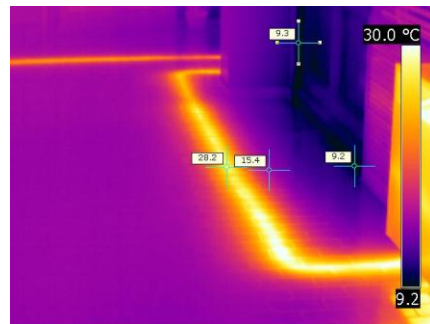
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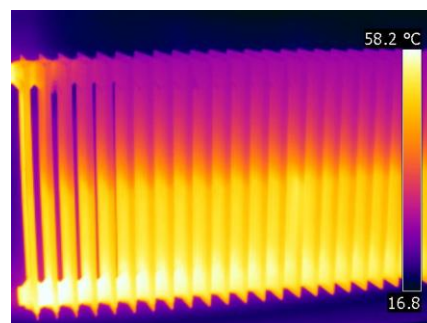
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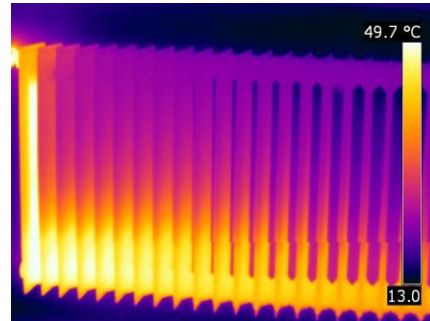
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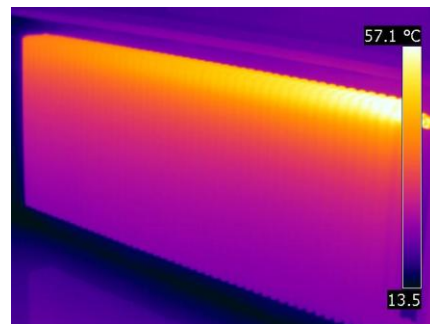
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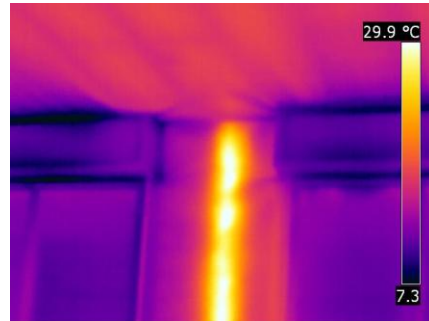
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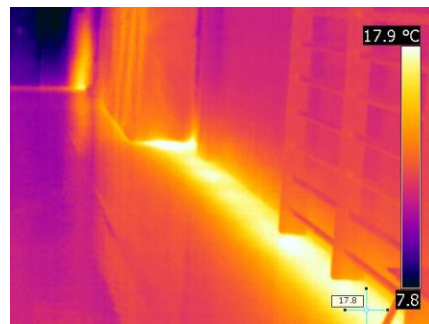
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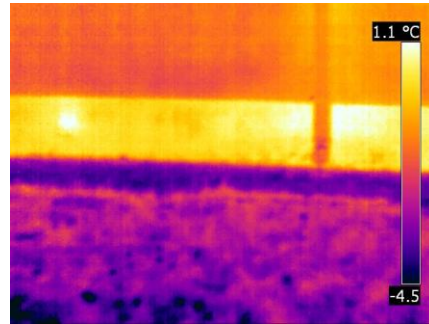
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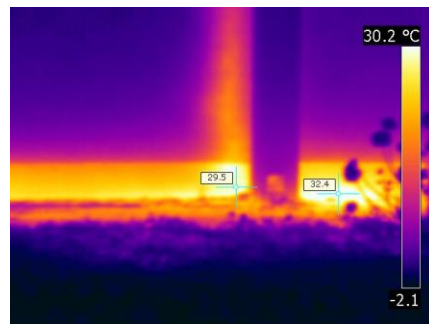
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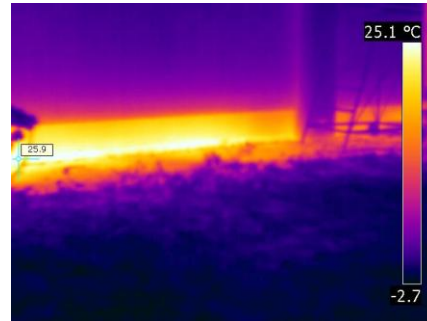
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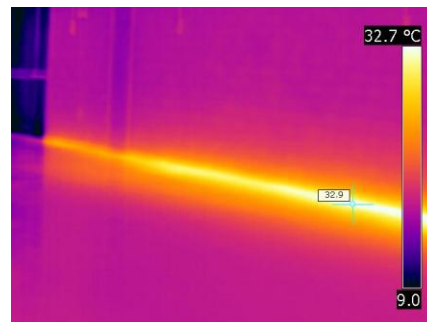
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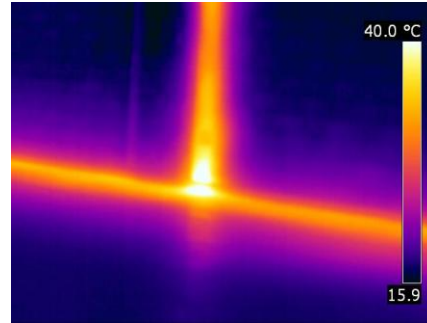
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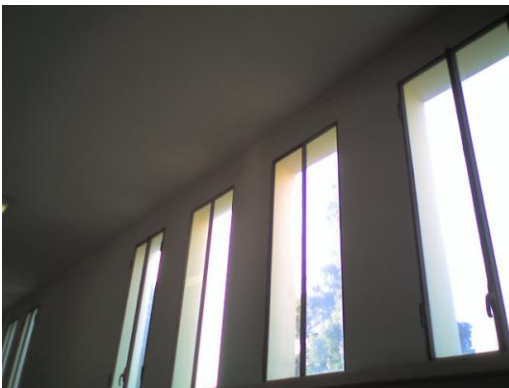
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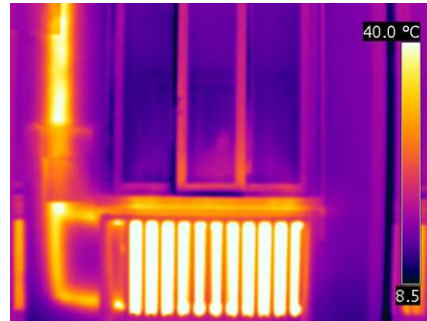
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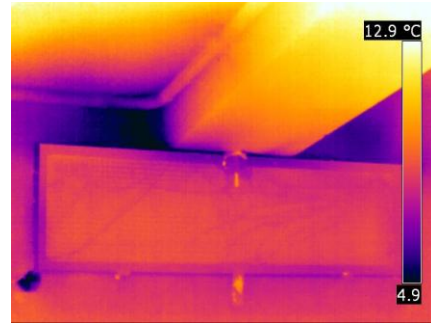
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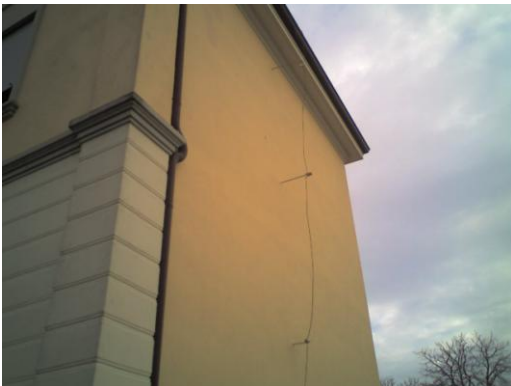
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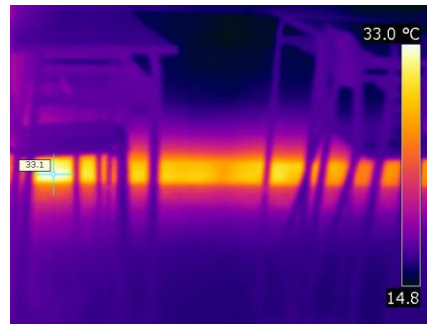
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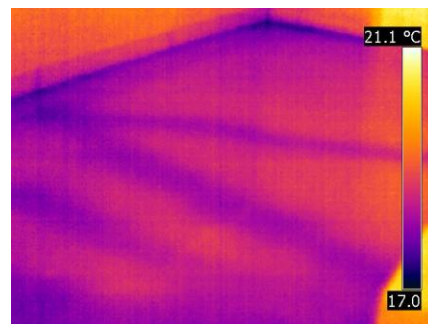
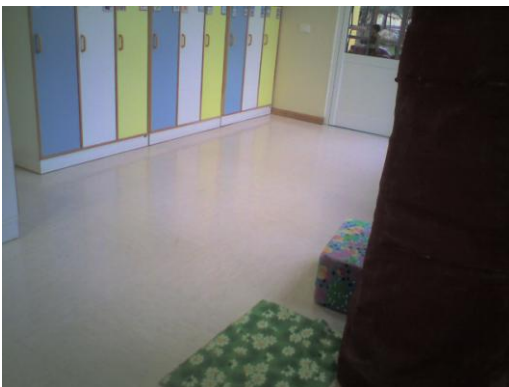
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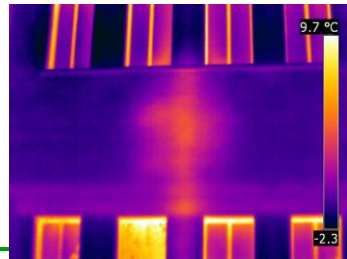
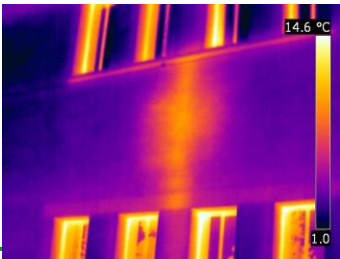
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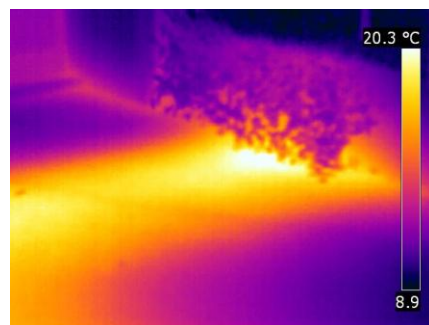
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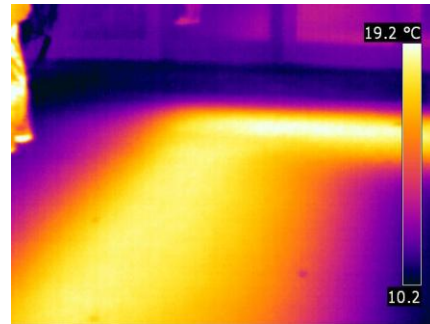
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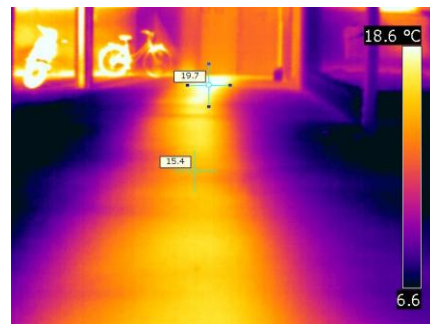
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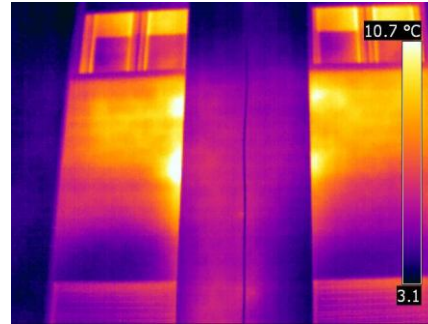
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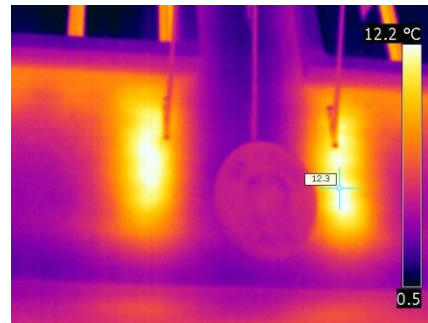
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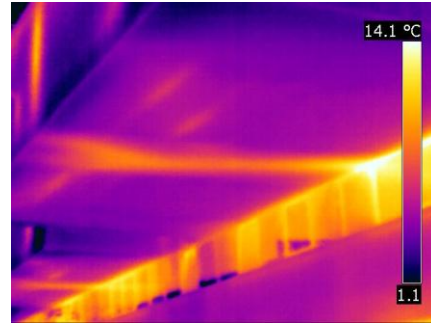
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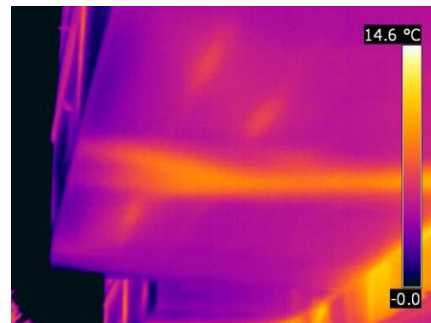
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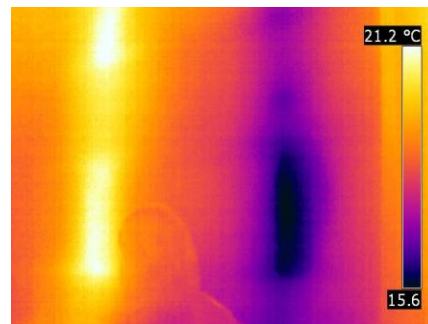
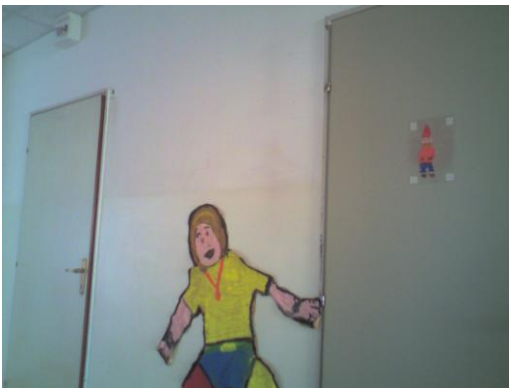
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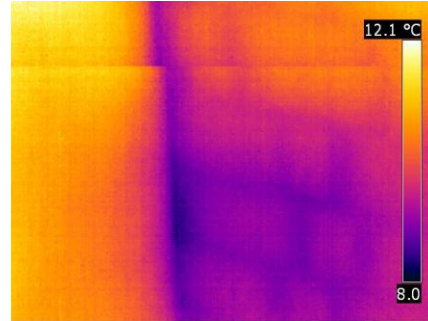
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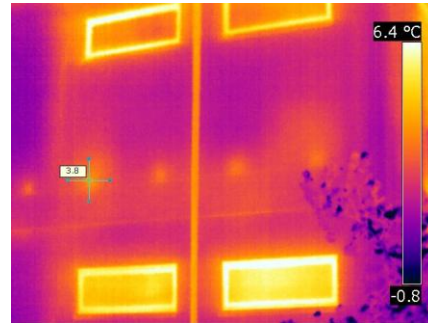


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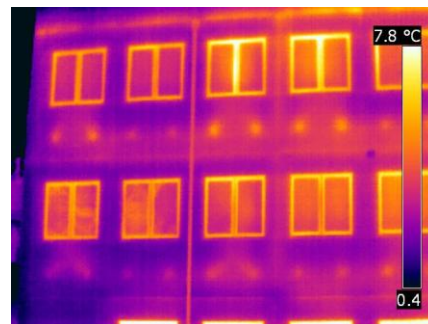
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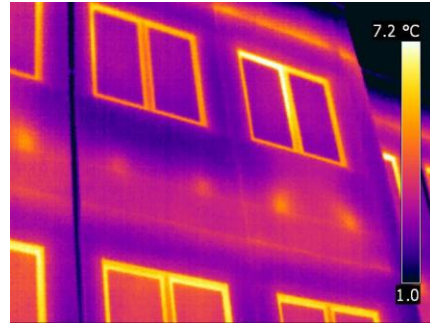
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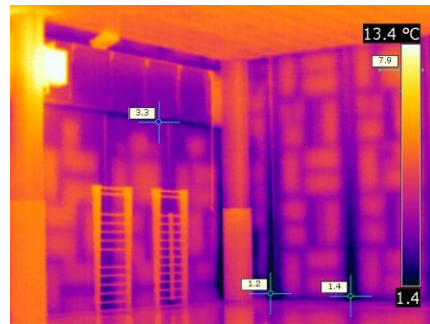
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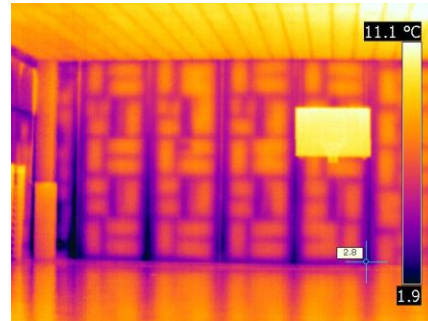
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