

EN-EFF

New concept training for energy efficiency

Termografsko snimanje

Varaždin, 22.05.2018

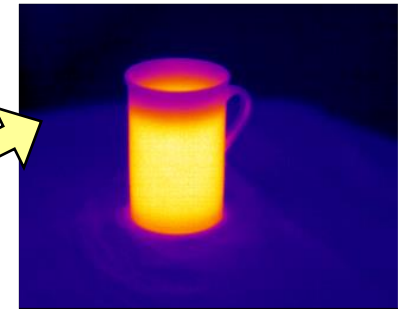
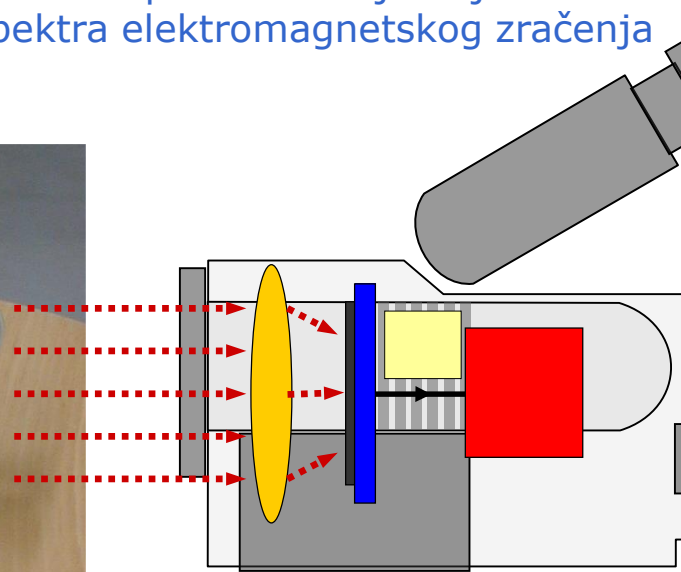
Uvod – IC termografija

Infracrvena (IC) termografija je
beskontaktna metoda mjerenja
temperature i njezine raspodjele
na površini tijela.



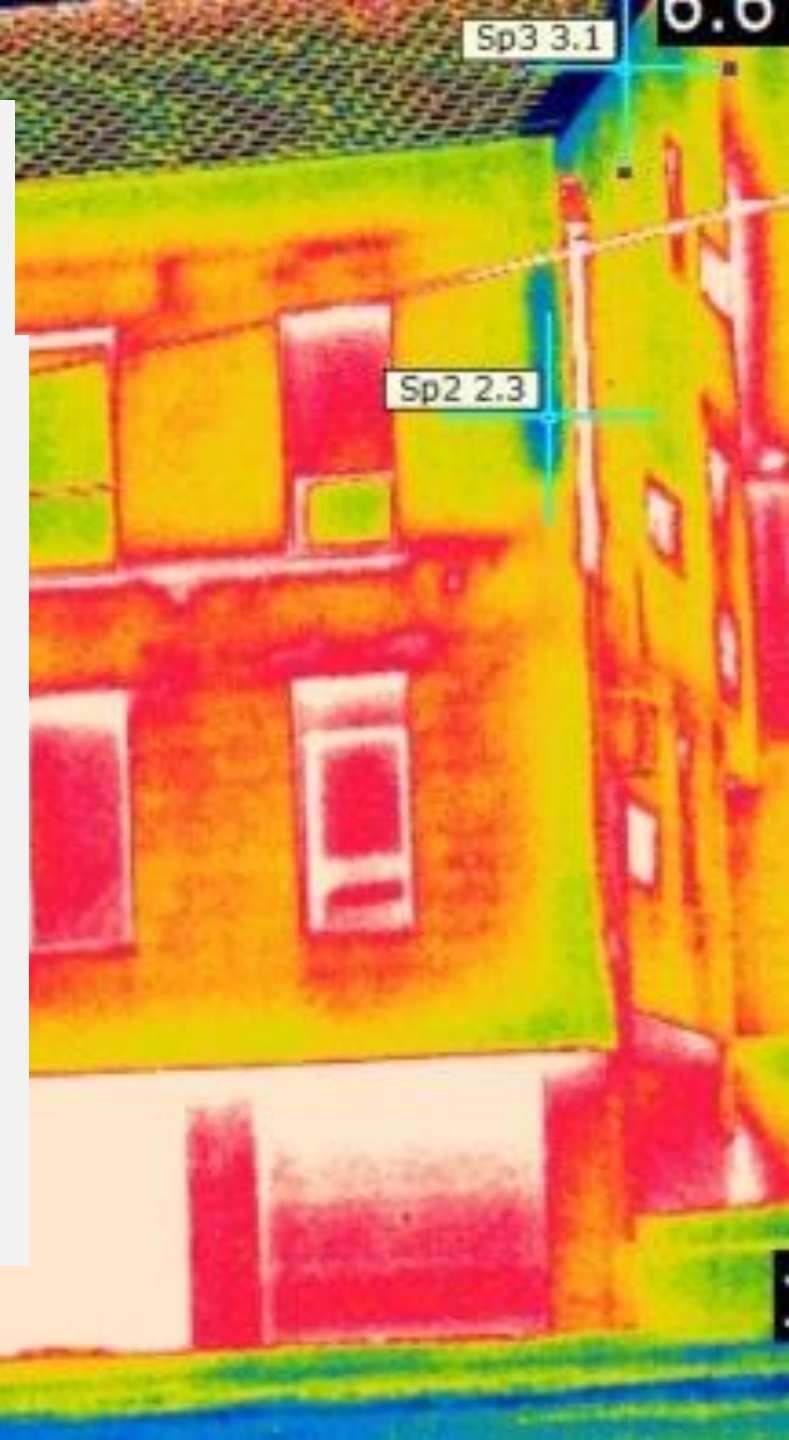
Infracrvena termografija

- energija zračenja s površine tijela s pomoću osjetnika se konvertira u ljudskom oku vidljivi dio spektra ($0,4 - 0,7 \mu\text{m}$)
- Zračenje tijela pri „sobnim“ temperaturama je u ljudskom oku nevidljivom dijelu spektra elektromagnetskog zračenja ($\lambda = 8 - 14 \mu\text{m}$)



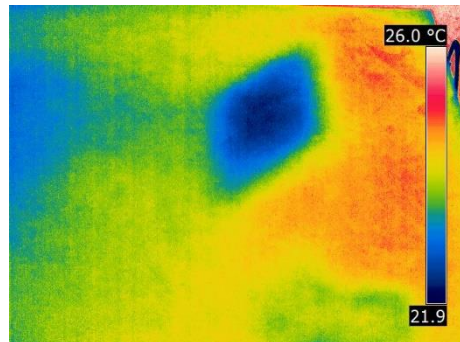
Termogram

- Uobičajeni prikaz rezultata ICT-a je termogram
 - slika koja prezentira registriranu energiju zračenja u tonovima sive boje ili nekoga drugog koda boja.
- Termogram je vizualni prikaz raspodjele temperature na površini tijela
 - TOČNO tek nakon što se provedu relevantni računski postupci s izmjerenim energijama zračenja.
 - uvjet poznavanja vrijednosti određenih fizikalnih veličina
 - temperatura i vlažnost zraka, emisivnost objekta, udaljenost mjerenja i dr.

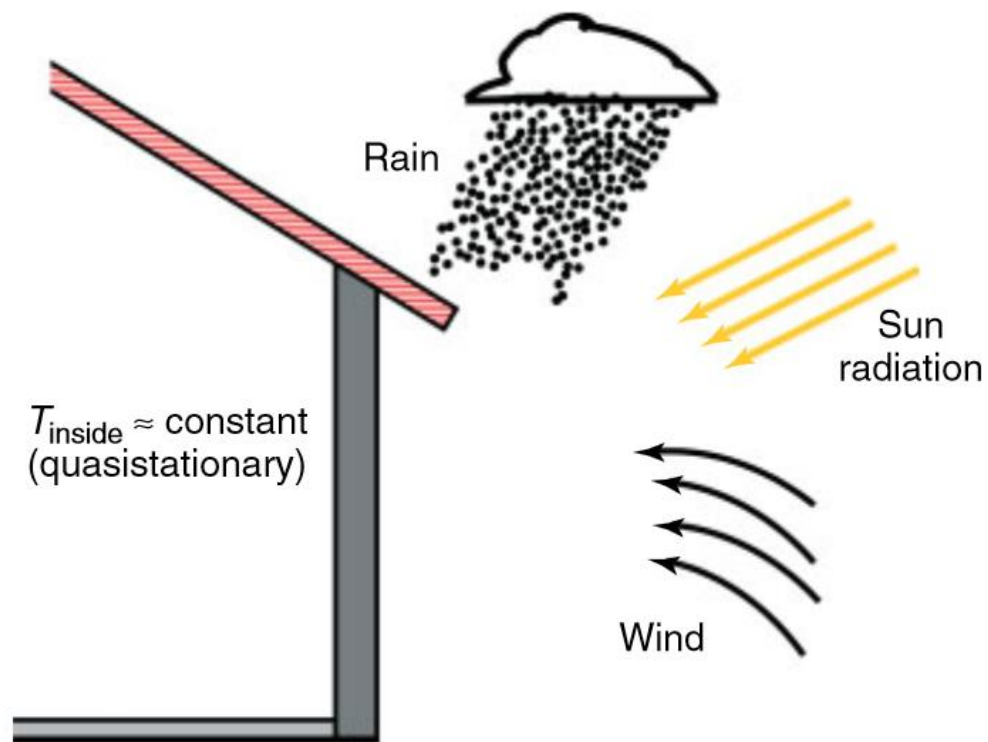


Raspodjela temperature na površini objekta mjerenja

- određena je procesima u samom objektu mjerenja.
- Znajući fiziku procesa i raspodjelu temperature površine, moguće je odrediti stanje objekta mjerenja.
 - Iznos i raspodjela temperature na površini
 - posredno daju informaciju o stanju same površine i
 - odraz su strukture i unutrašnjeg stanja promatranog objekta ispod te površine

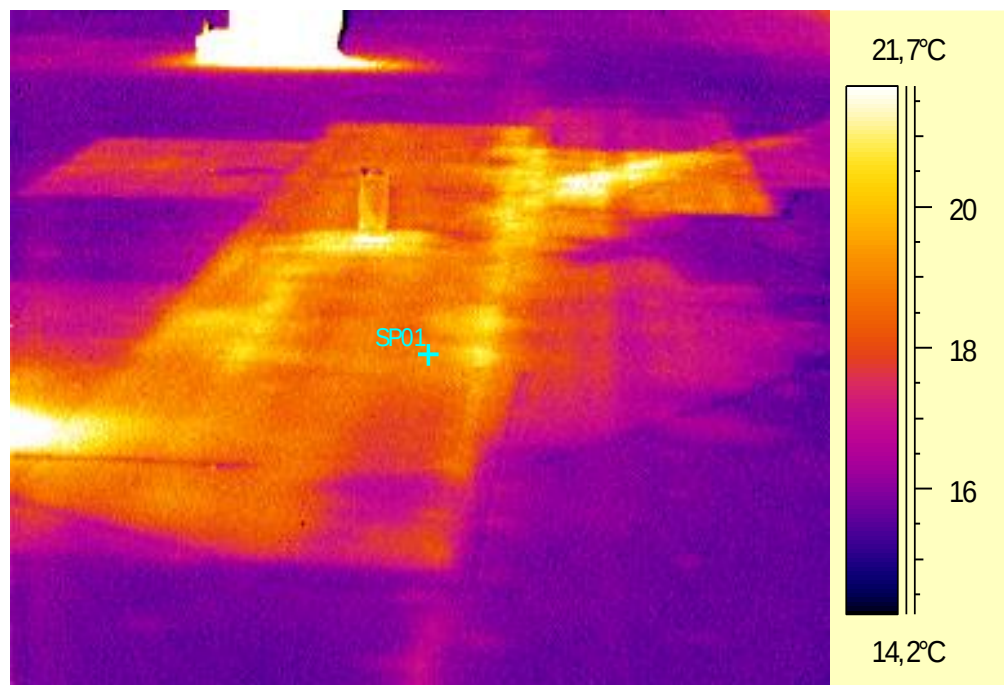


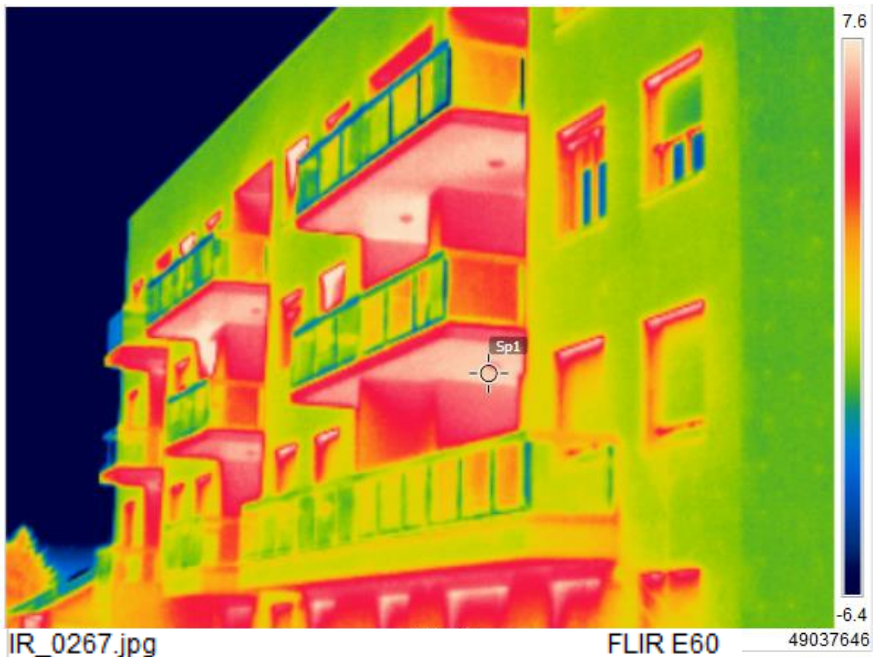
Bitan je i
„kontekst”
mjerjenja



Rezultat termografskog mjerenja

- Vлага na ravnom krovu ili samo zrak ispod hidroizolacijske membrane
 - Kada je snimanje provedeno (ujutro ili na večer)?
 - Kakva su toplinska svojstva materijala?





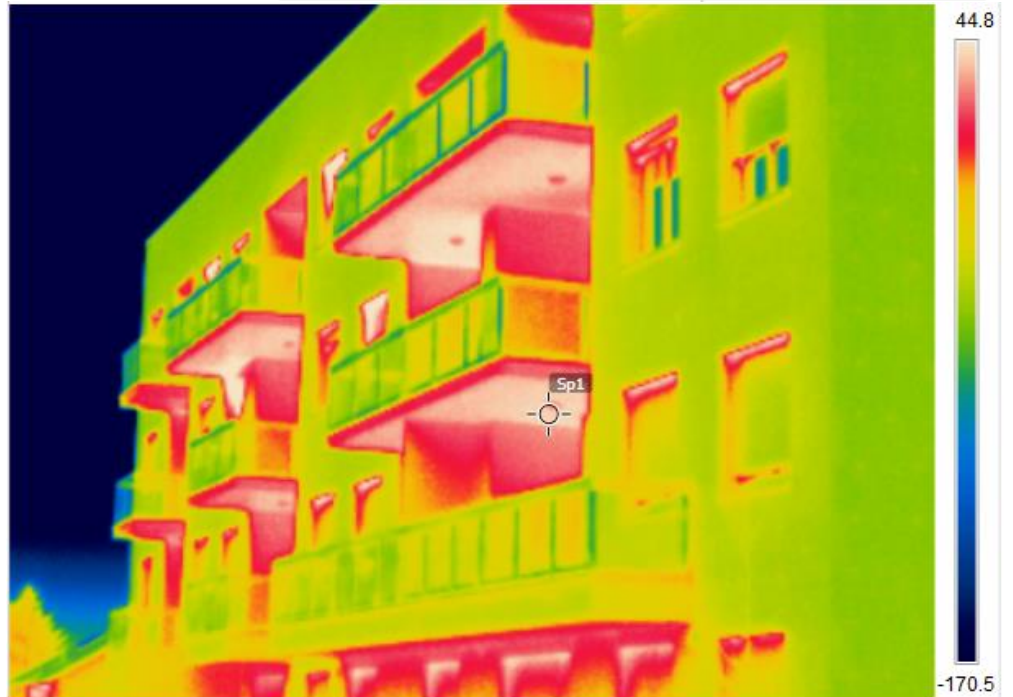
Measurements		°C
Sp1	7.1	

Parameters	
Emissivity	0.95
Refl. temp.	5 °C
Distance	20 m
Atmospheric temp.	10 °C
Ext. optics temp.	20 °C

IR_0267.jpg FLIR E60

Measurements		°C
Sp1	39.0	

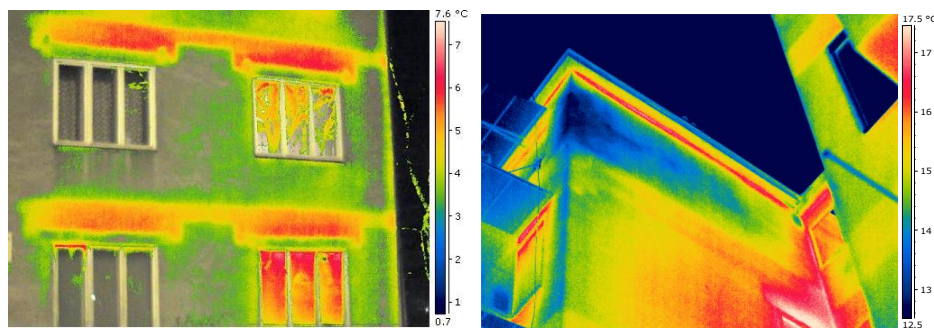
Parameters	
Emissivity	0.05
Refl. temp.	5 °C
Distance	20 m
Atmospheric temp.	10 °C
Ext. optics temp.	20 °C



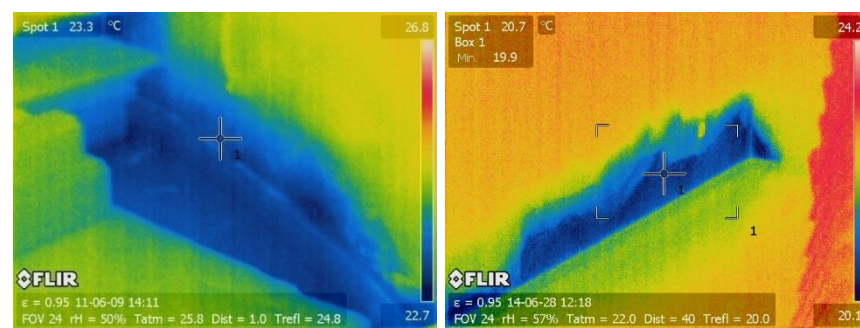
IC termografija u zgradarstvu

- najčešće se u području građevinarstva koristi za:

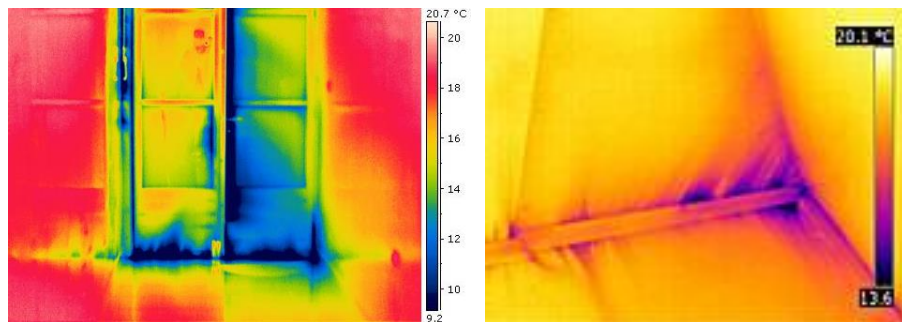
Otkrivanje mjesta gubitaka topline



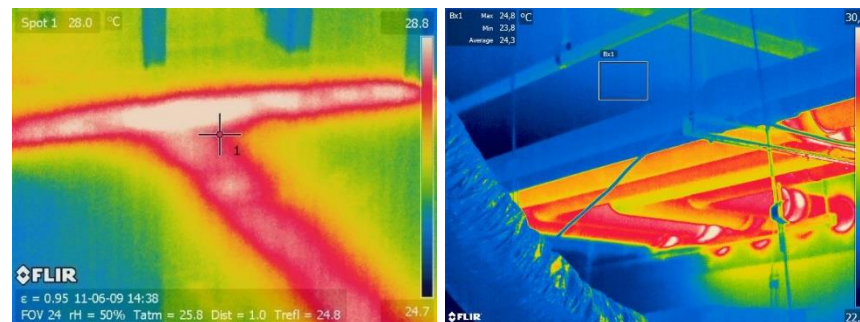
Otkrivanje mjesta povećane vlažnosti



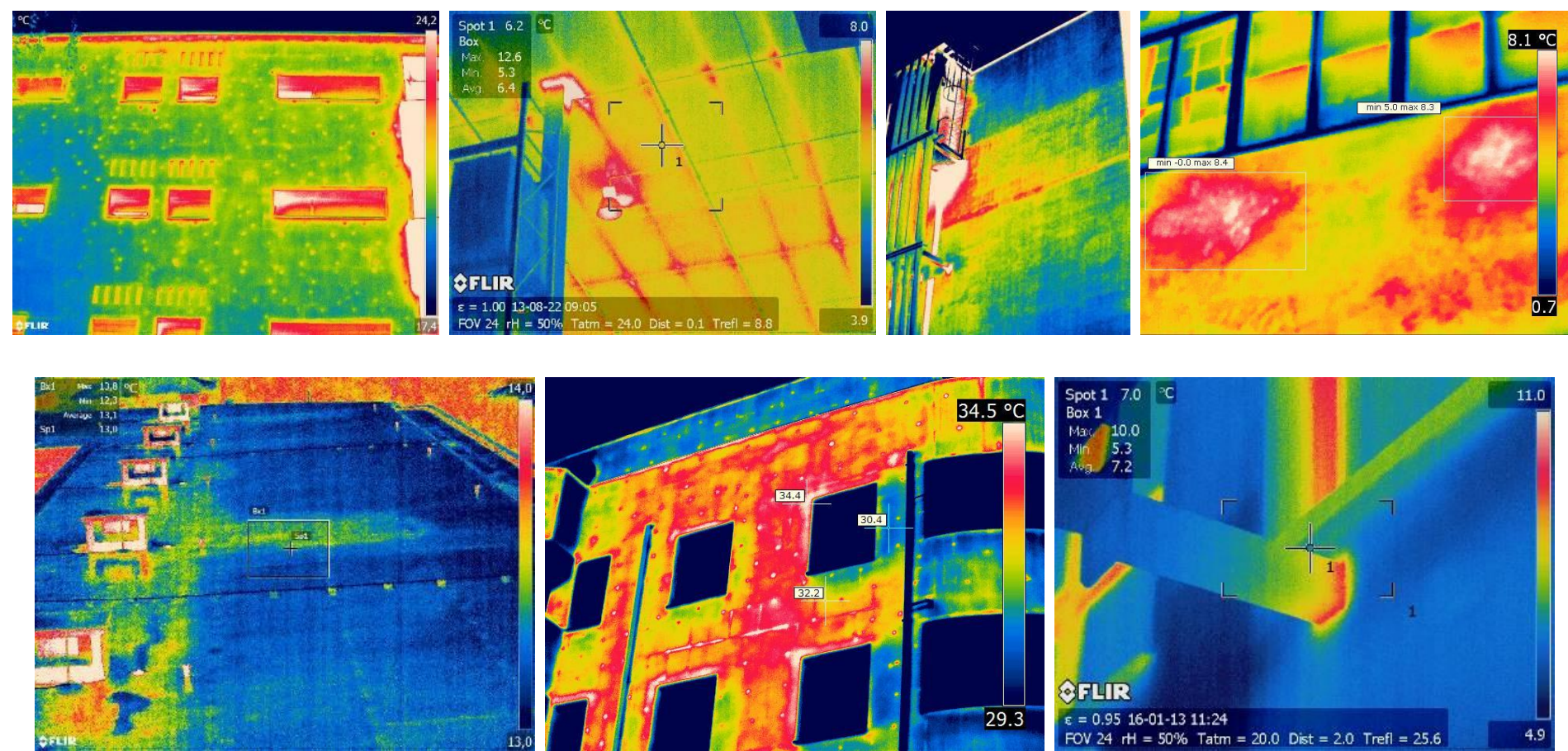
Otkrivanje mjesta infiltracije hladnog zraka



Kontrola sustava HVAC

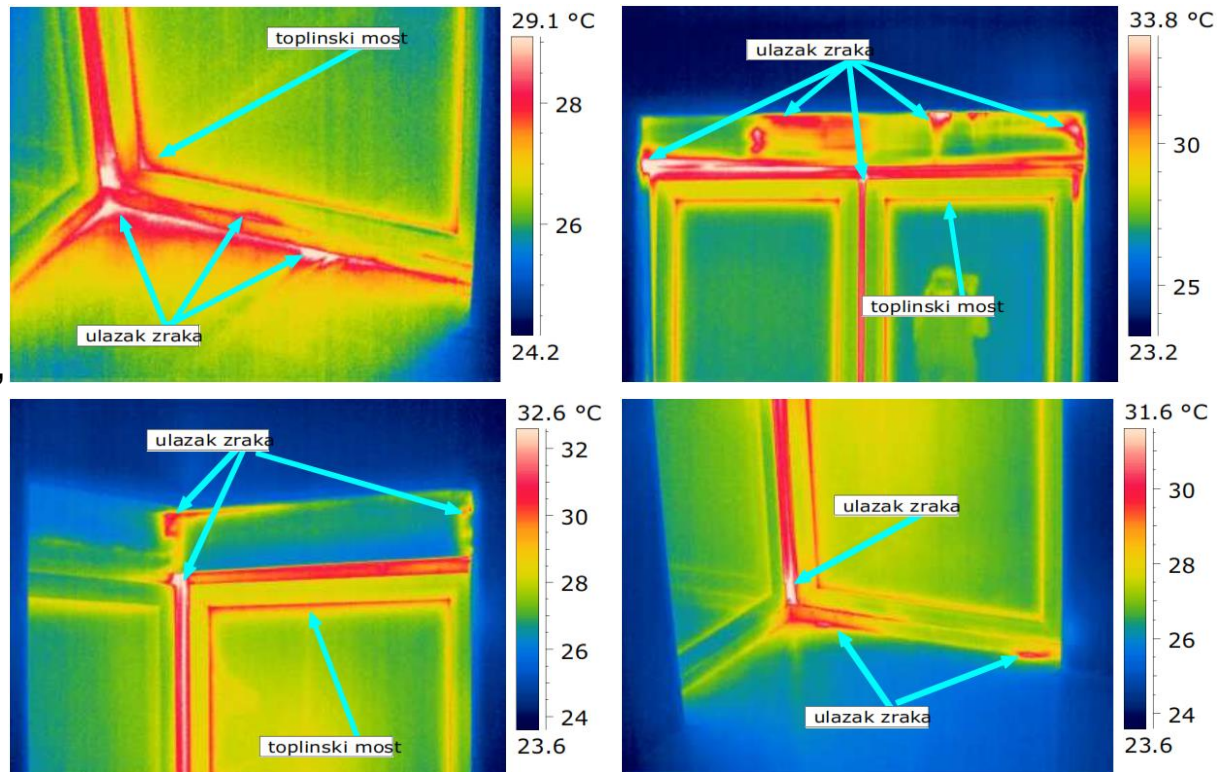


Toplinski mostovi



Propuštanje vanjske ovojnice zgrade

- Tijekom ispitivanja zrakopropusnosti
- Loša ugradnja prozora
 - Nema „RAL montaže”



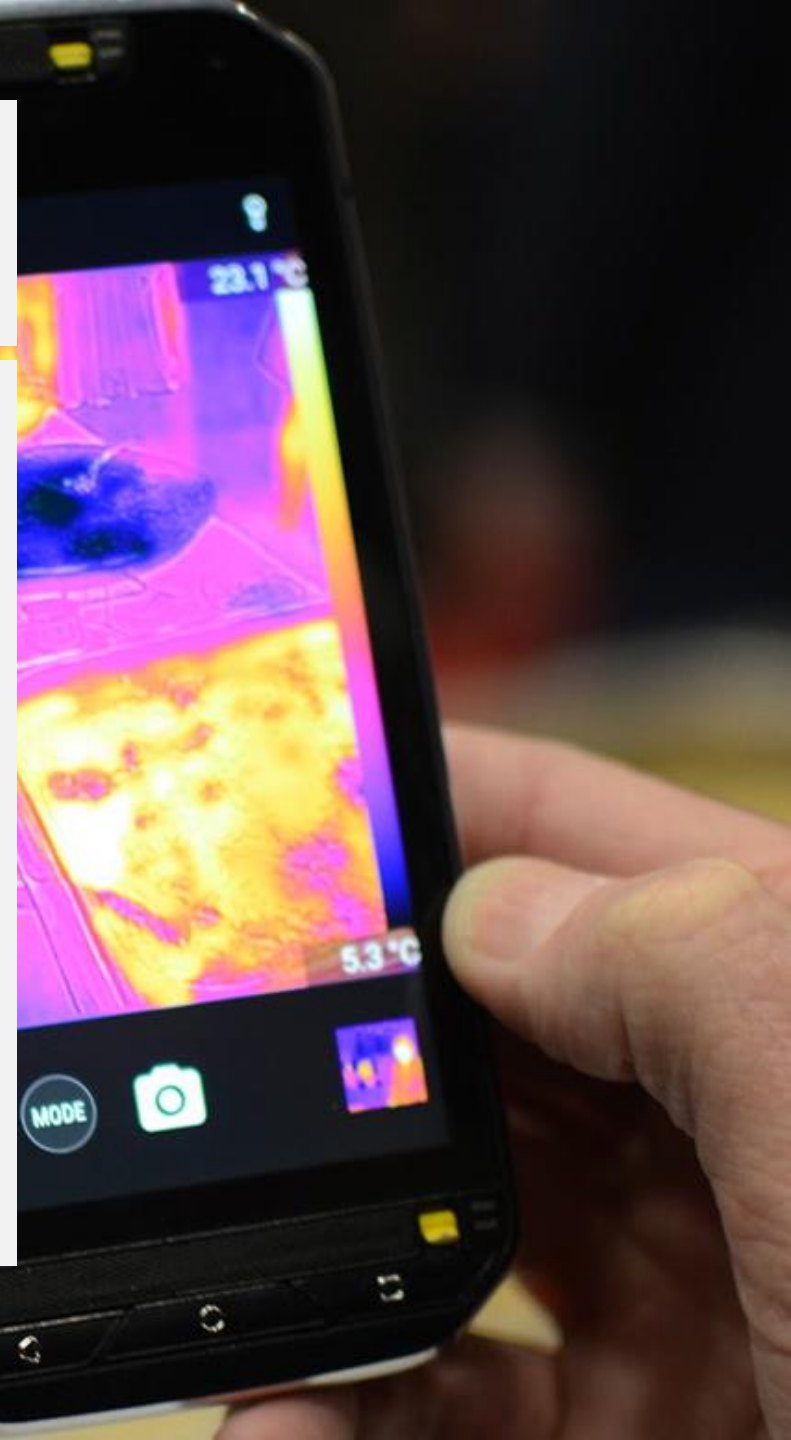
Oprema

- MW ili LW kamera
- Mogućnost podešavanje ključnih parametara
 - Emisivnost
 - Reflektirana temperatura
 - Relativna vlažnost zraka
- Geometrijska rezolucija barem 320×240
- Temperaturna rezolucija (NETD) <0,10 °C



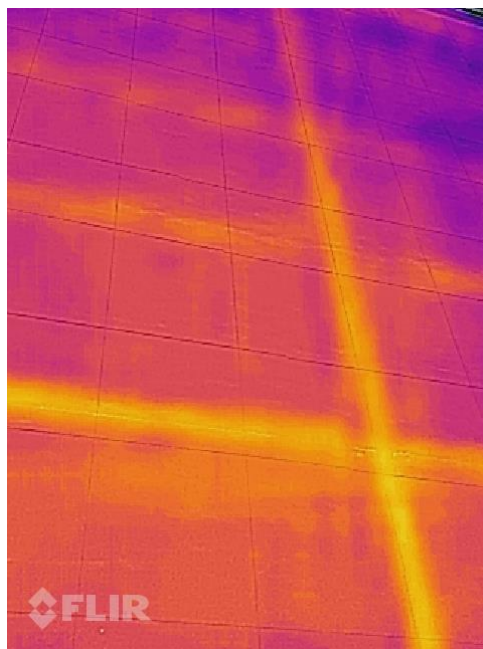
PROBLEM!

- Cijena termografskih mjernih uređaja sve je prihvatljivija,
 - zbog novih tehnoloških rješenja i povećane primjene,
- POSLJEDICA:
 - termografskim uređajima često koriste i nedovoljno educirane osobe.
 - Rezultati navedenog često su nezadovoljavajuća obrada i netočna interpretacija rezultata termografskih mjerenja.

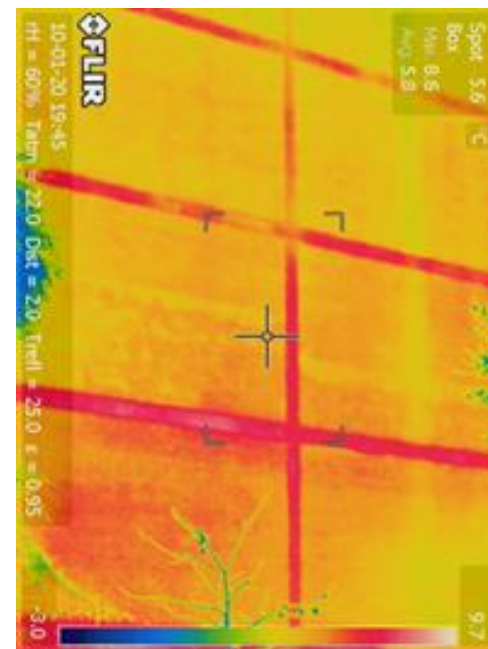


Usporedba

- Kamera loše temperaturne i geometrijske rezolucije
- Needucirana osoba provodi ispitivanje

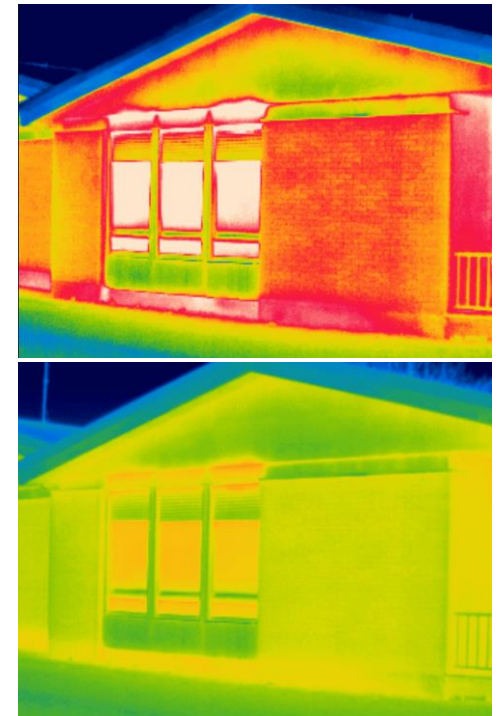
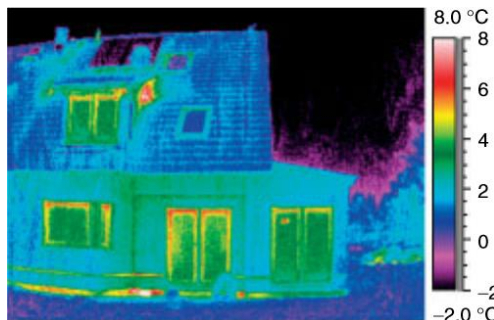
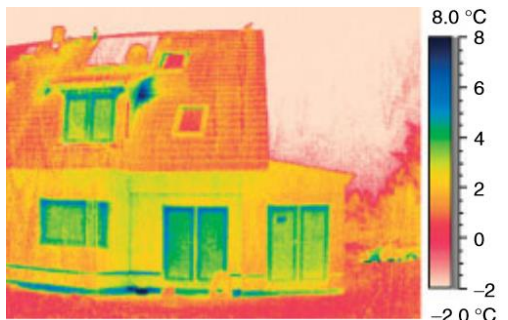
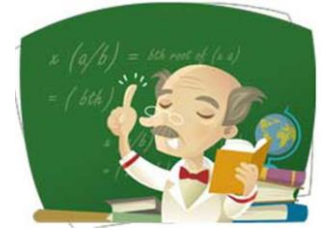


ili



OPREZ!

- Termogram **nije jednostavno** interpretirati...
 - Crvena boja nije nužno loše područje
- ... ali je na žalost moguće **vrlo jednostavno** manipulirati termogramima





Objavljaju se i fotomontaže...



Sustavno obrazovanje termografista



Na Građevinskom fakultetu, Sveučilišta u Zagrebu se održava

**program izobrazbe termografista za
LEVEL 1 s međunarodnim certifikatom**

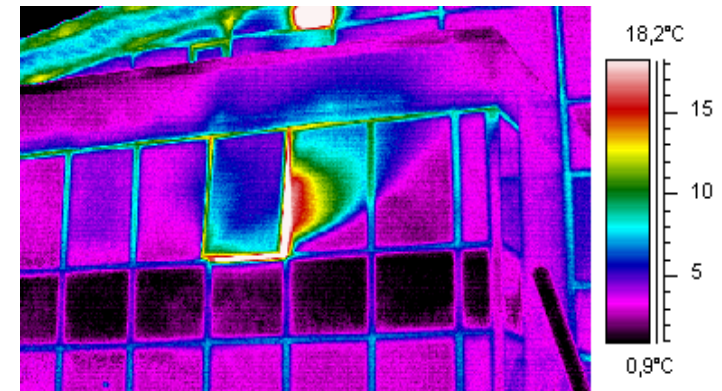


www.grad.hr/gfitc

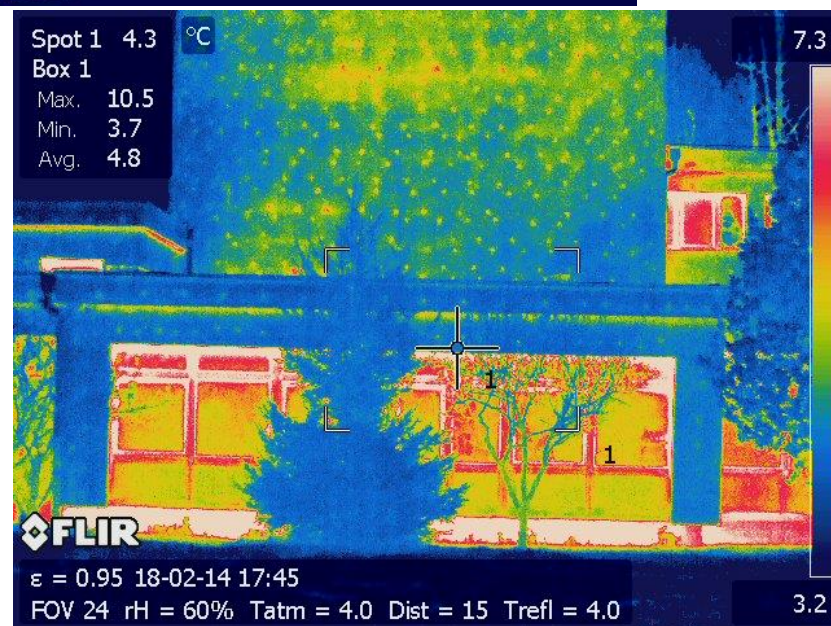
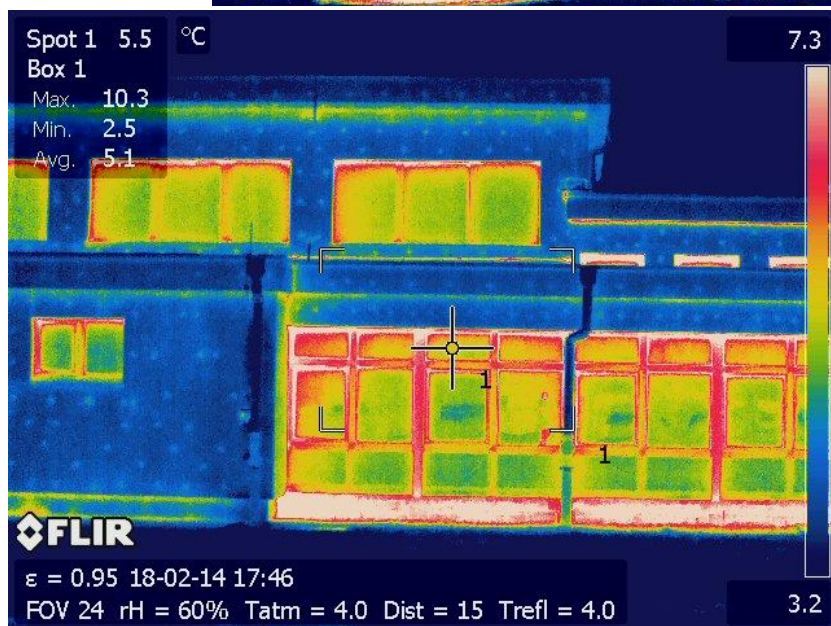
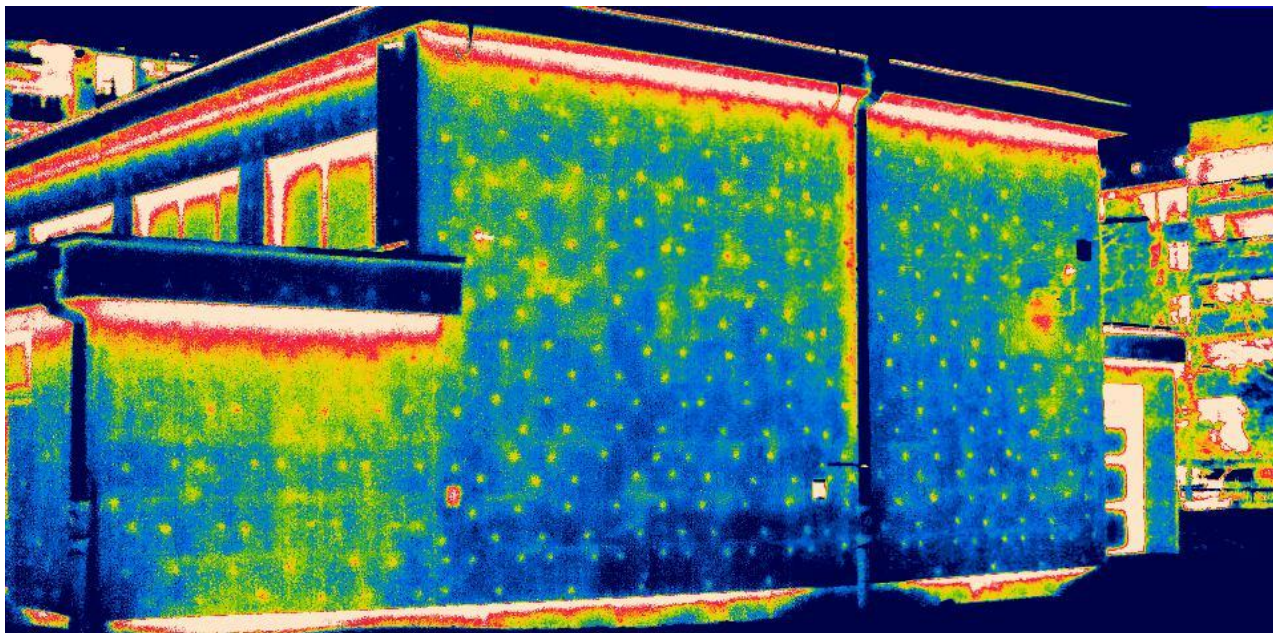


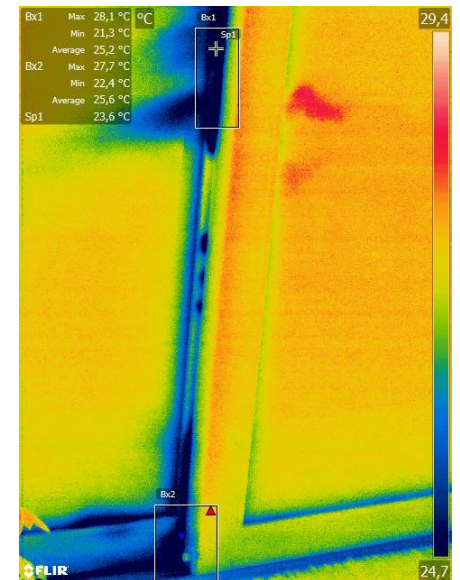
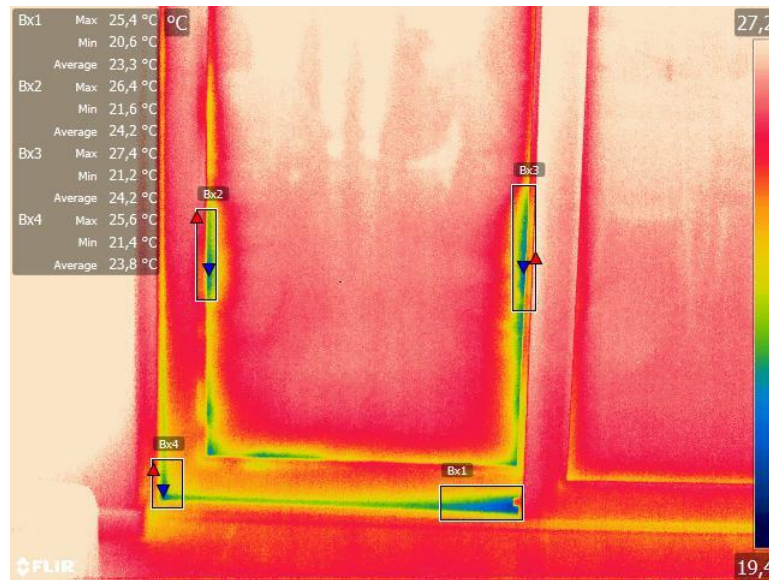
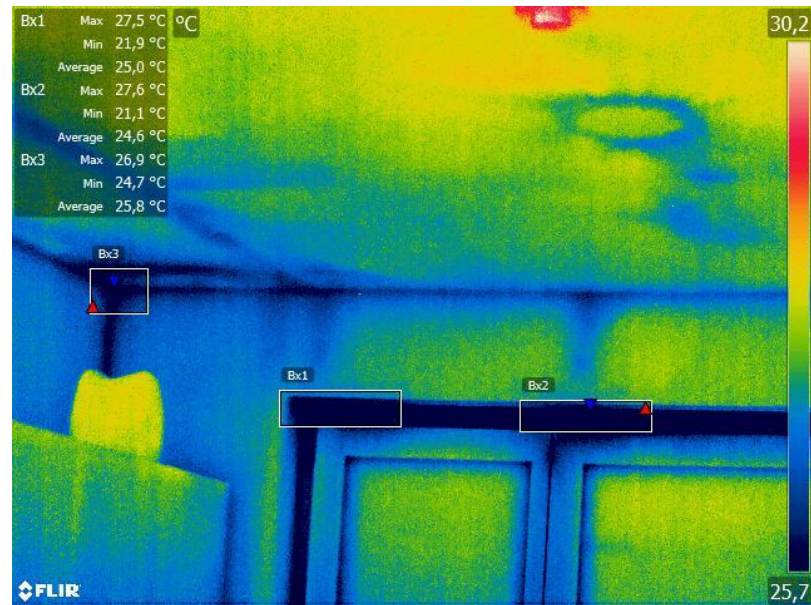
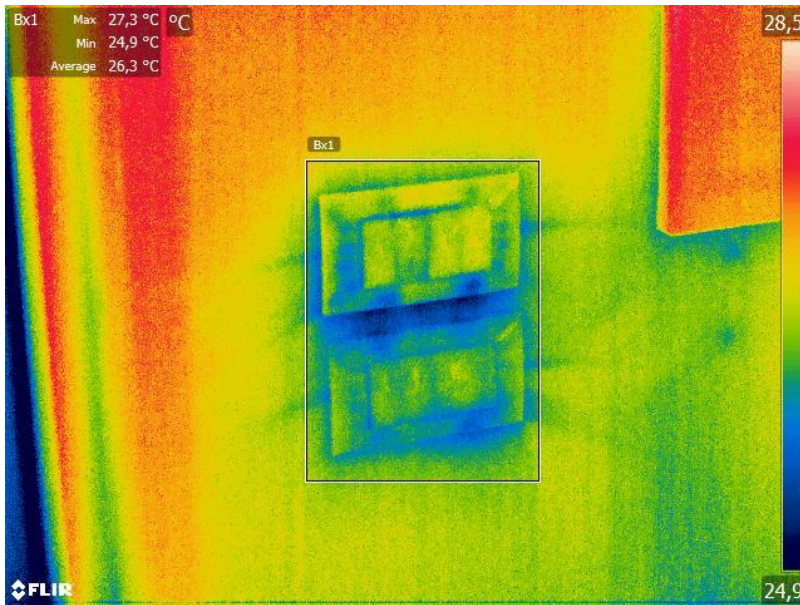
Zaključak

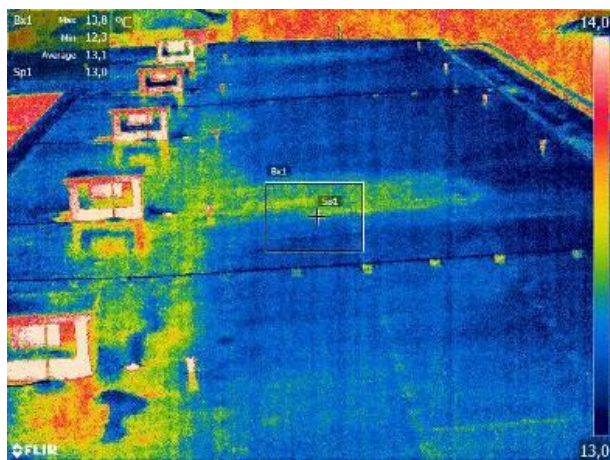
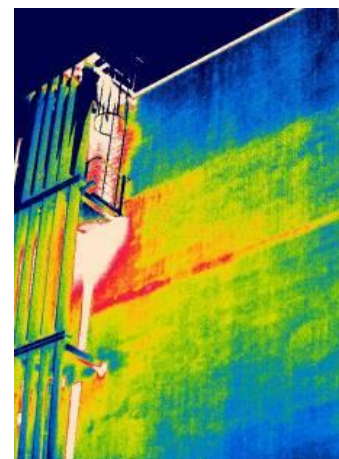
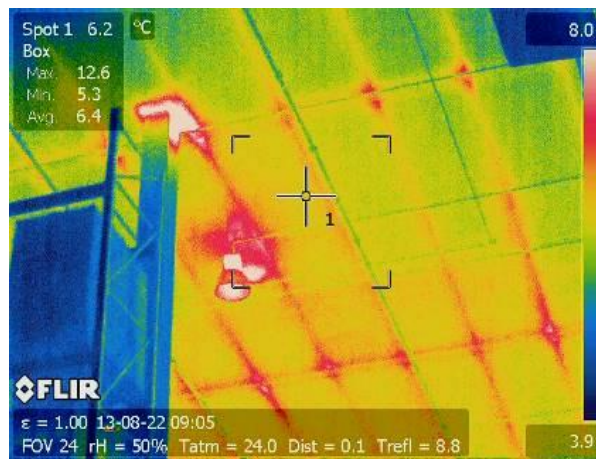
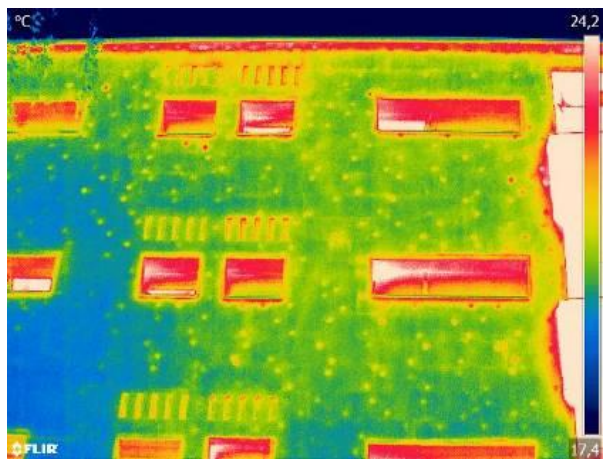
- termografija u zgradarstvu omogućava
 - kvantitativne (???) ocjene gubitaka energije
 - nalaženje mjesta s povećanom vlagom,
 - ocjenu učinkovitosti sustava grijanja, hlađenja i ventilacije,
 - određivanje toplinskih značajki građevinskih materijala
- Uspješna se primjena termografije u navedenim primjerima postiže samo ako su ostvareni određeni uvjeti koji se odnose na:
 - mjernu opremu,
 - klimatske uvjete,
 - način provedbe termografskog mjerenja te
 - obradu i analizu rezultata mjerenja.
- **ISKUSTVO!!!**

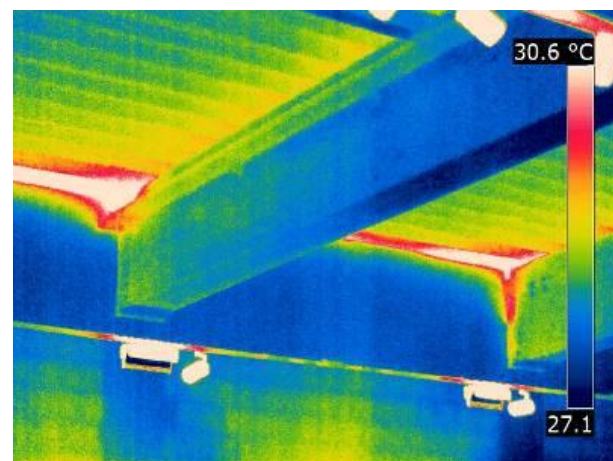
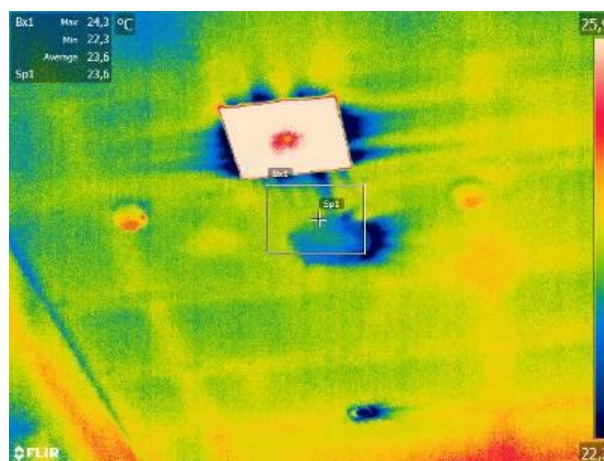
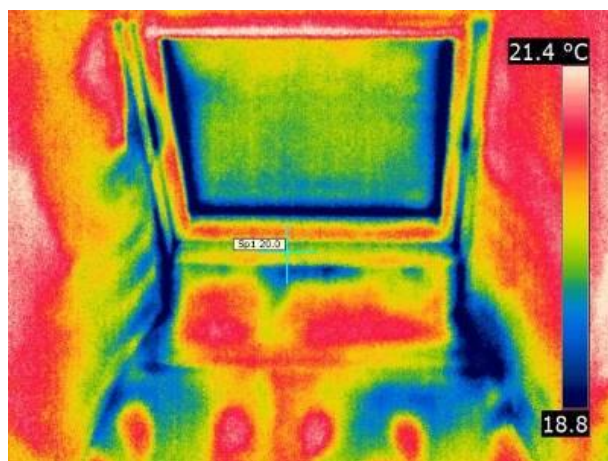
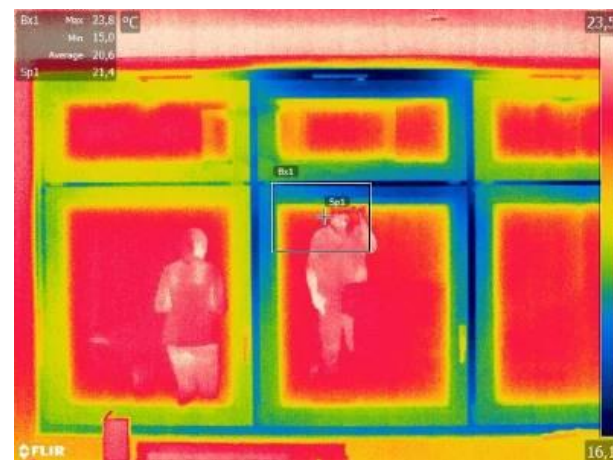
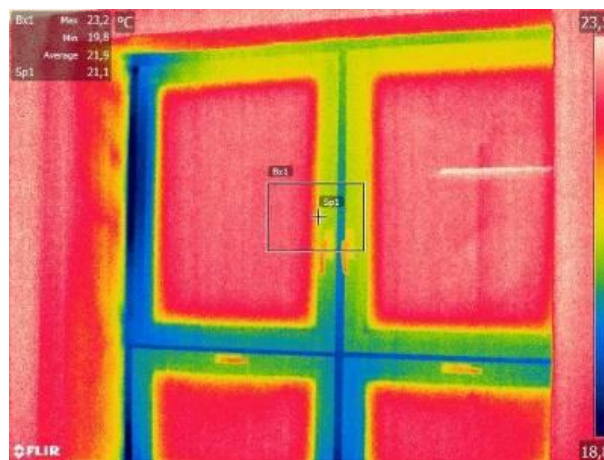
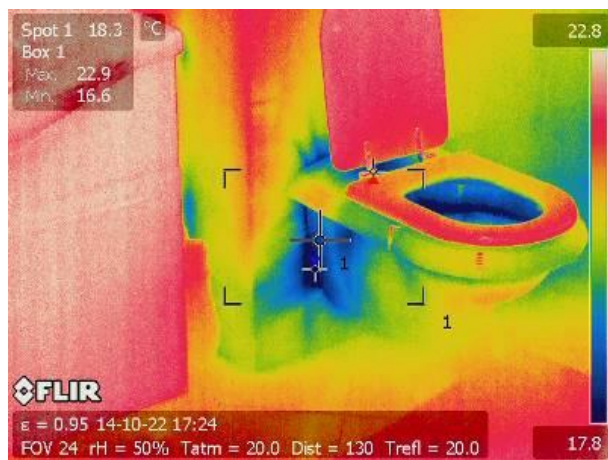


izgradimo li ono što
projektiramo?



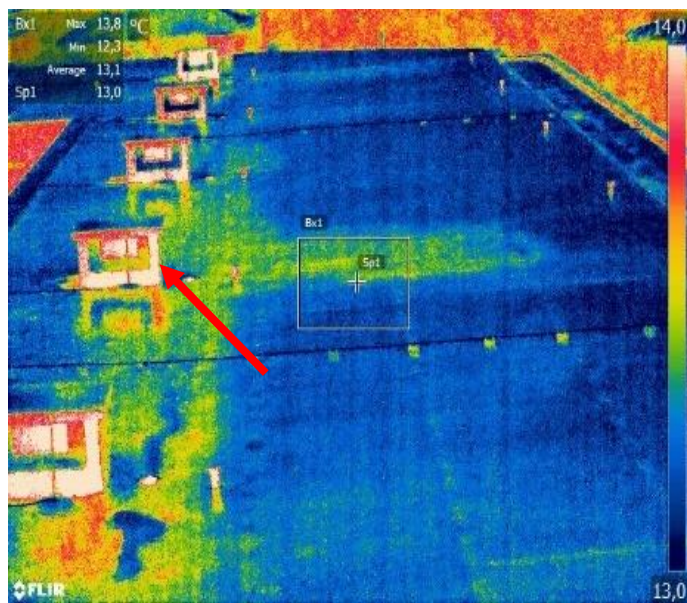
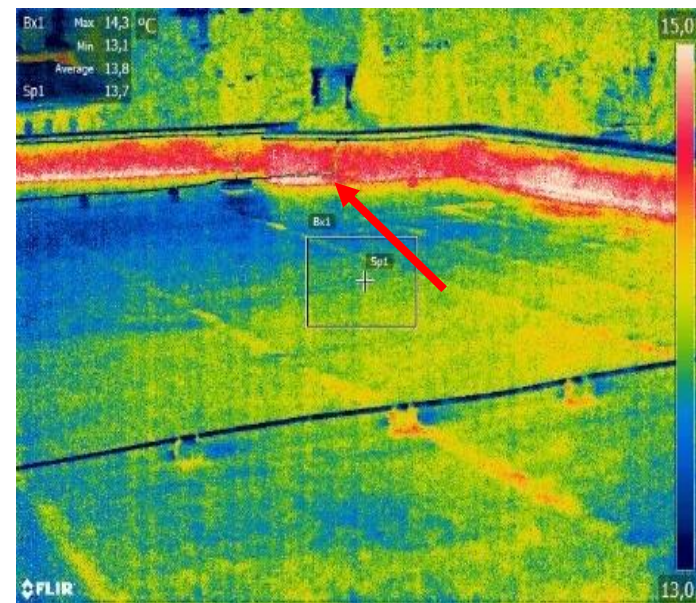
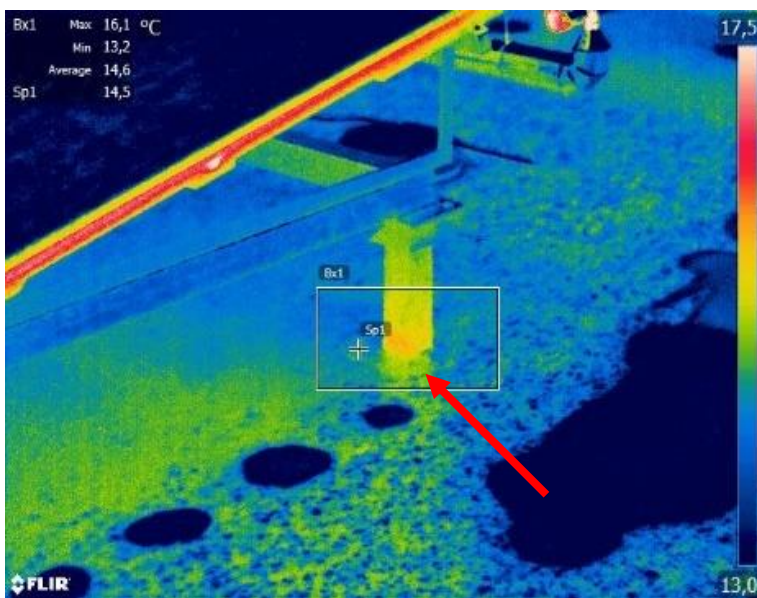




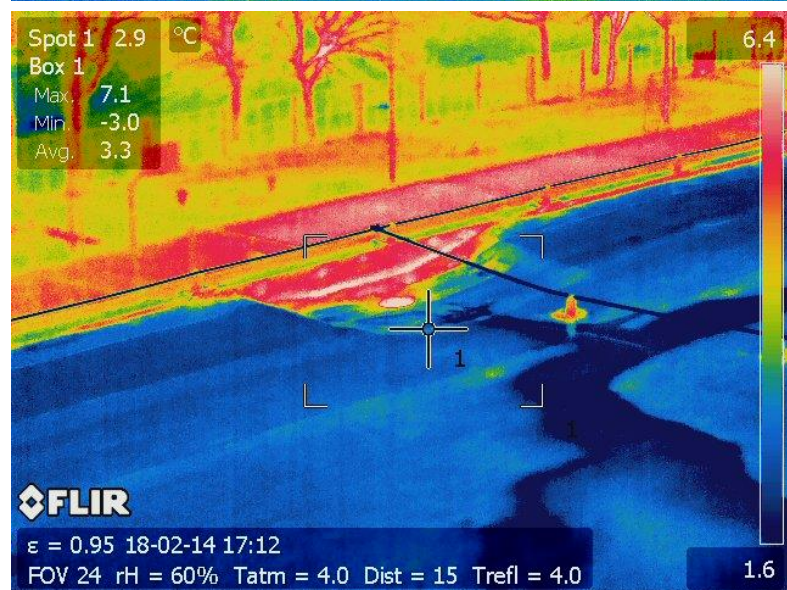
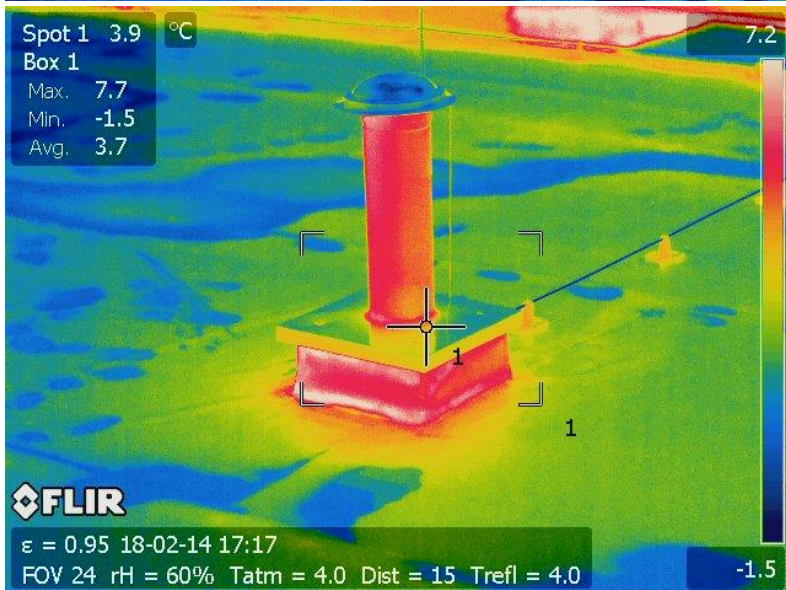
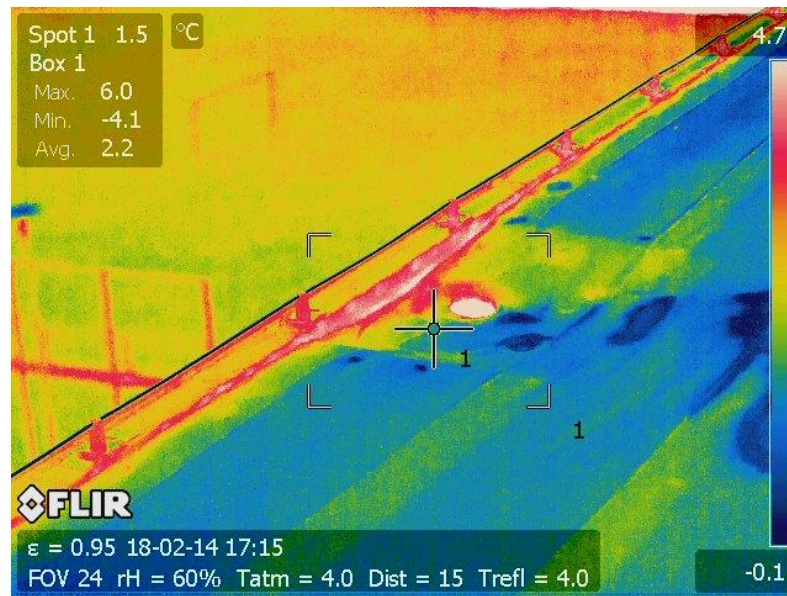
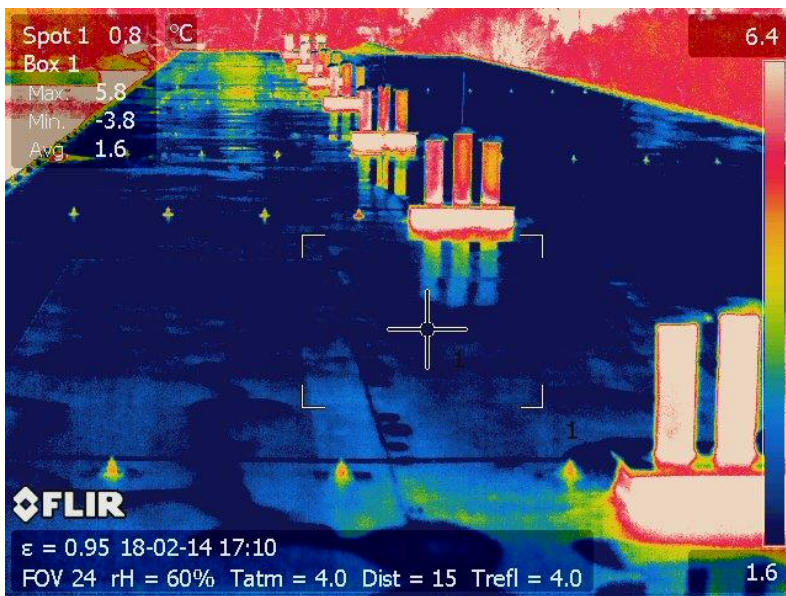


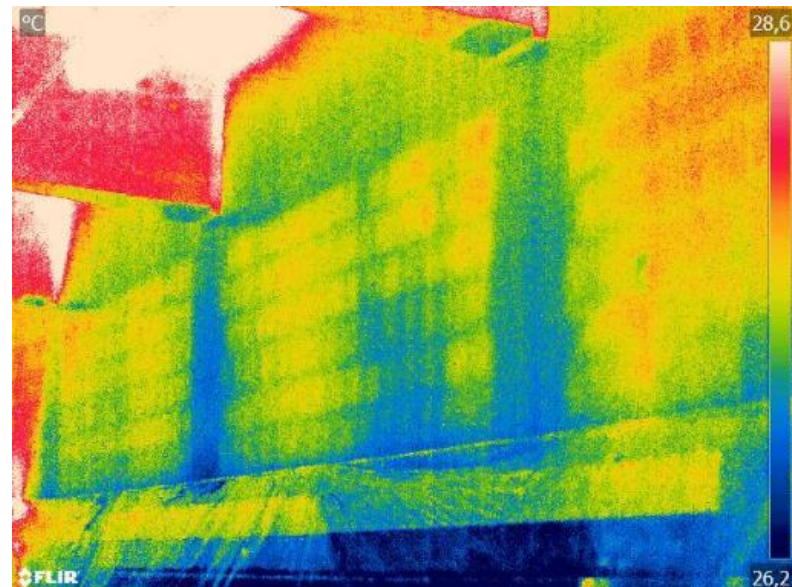
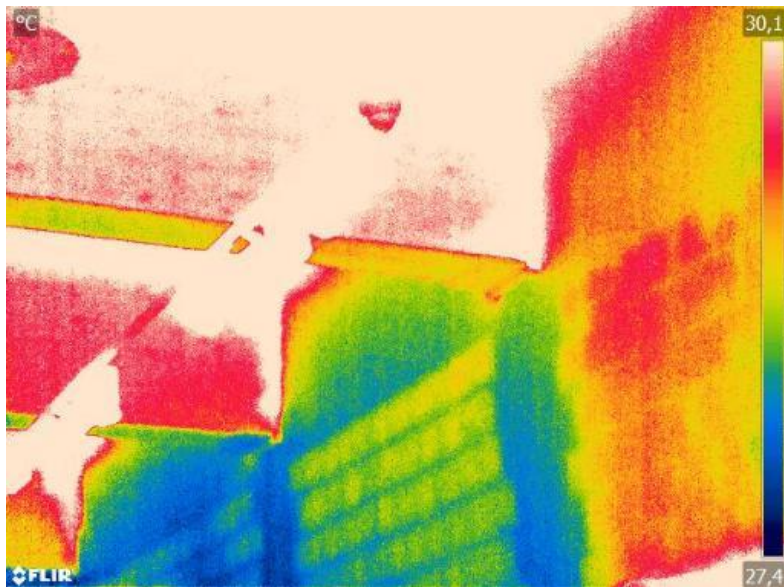
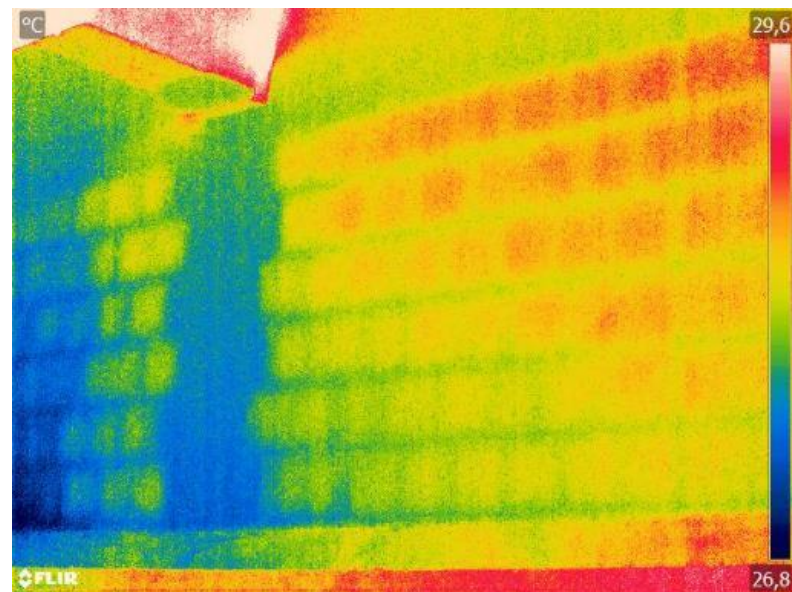
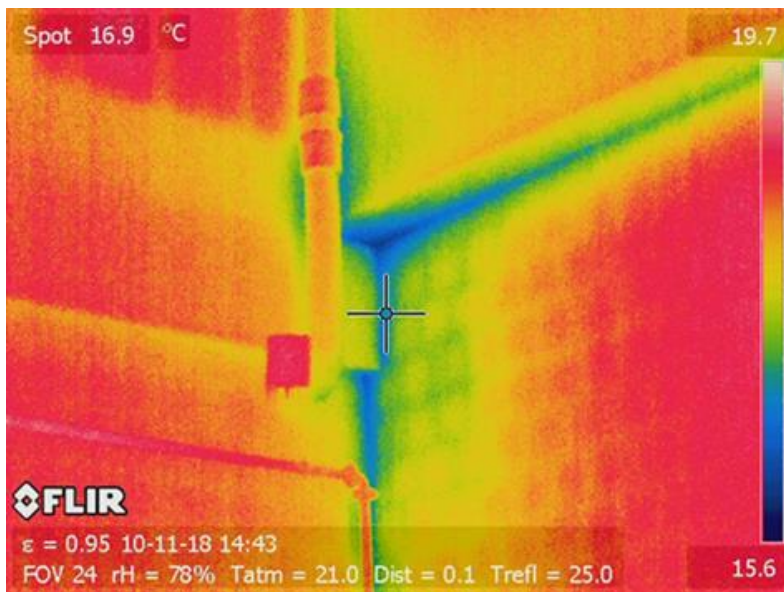
Potencijalna mjesta toplinskih mostova na neprohodnom ravnom krovu



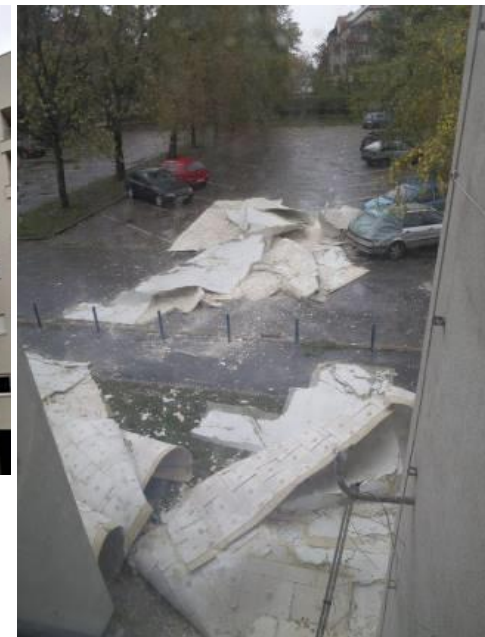
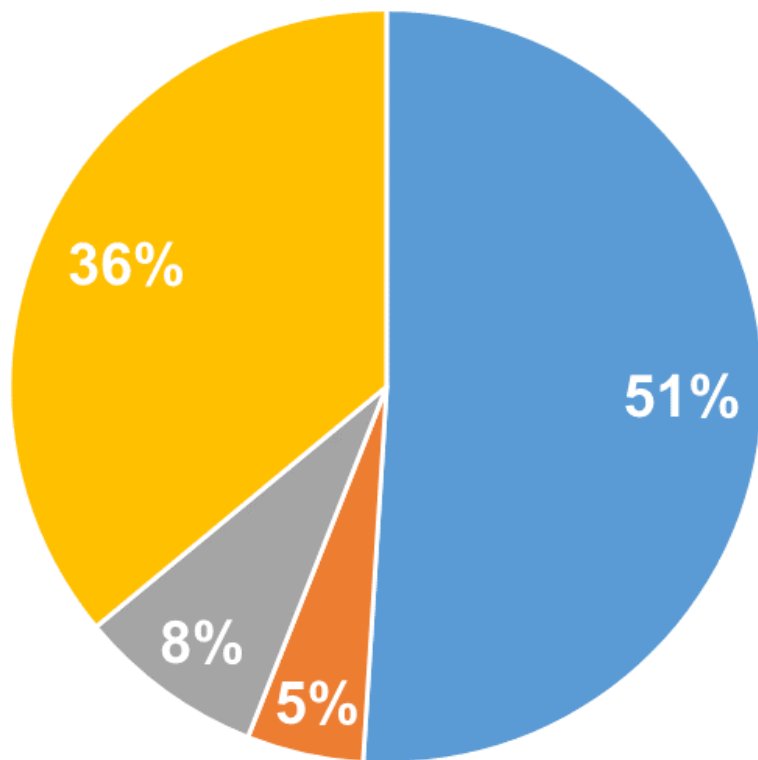


Termogramami toplinskih mostova





Uzroci preranog dotrajanja



- Nedovoljna pozornost posvećena pitanju trajnosti tijekom izvođenja
- Neredovito održavanje ili neodržavanje tijekom uporabe
- Nepravilan izbor materijala
- Nedovoljna pozornost posvećena pitanju trajnosti u projektu



Hvala na pažnji!

Bojan Milovanović

bmilovanovic@grad.hr

