IR Eval For A Cambridge Envelope Rehab

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ABSTRACT

A three story brick building owned by MIT in Cambridge is currently unoccupied and was previously used as office and laboratory space. A private energy group contracted use of the building and wished to perform an infrared survey to assess the buildings existing thermal condition and to see what the building offered them in terms of energy efficiency. The IR survey will also help them gauge the scope of corrective action necessary for a proper efficiency use rehab. The IR images will also be used in a separate study for a whole building computer modeling survey through another vendor.

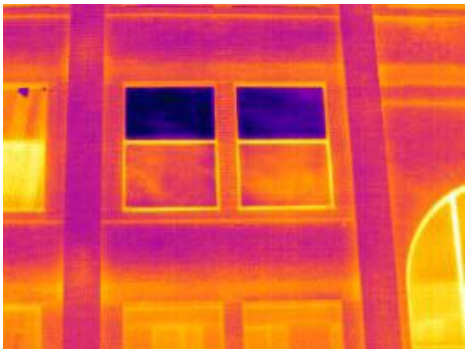
INTRODUCTION

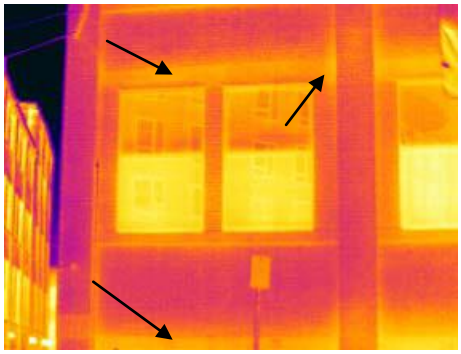
Located in Cambridge, Massachusetts the building is of wood stud brick design for approximately 36,000 square feet of office and lab space. The front of the building is street side and modern looking, having been updated within the recent past with new windows and a modern looking front glass entry way. The west side of the building is also brick and appears as nice as the front, also with newer windows. The back of the building is a mix of brick and wood studded walls covered with metal sheeting and wood paneling. The east side of the building has brick columns separated by steel panels running from the foundation to the top of the roof parapet. Through phone conversations with the client describing the building and in discussing their goals for a rehab suitable to fulfill their needs, it was decided an IR survey of the whole building would be necessary.

The IR survey took place in February and the building was heated, although unoccupied. With a New England winter IR survey of a heated building we were provided with an above adequate delta T. A FLIR® EX320 was used and Reporter 8.3 software with Image Builder, also from FLIR®, will be used to create three reports. The client requested the infrared information be broken down in sections to make dissecting data from the reports easier for them. It was decided to do a façade, roof and interior report.

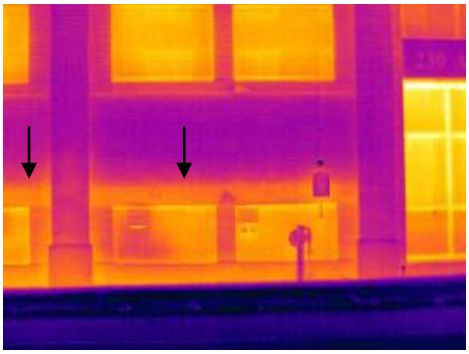
FAÇADE

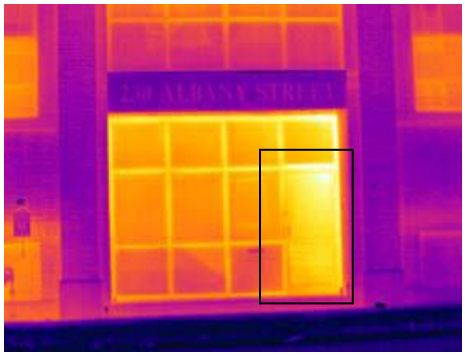
An early morning IR survey, at approximately 4:30 AM, was performed of the building's façade, the outside temperature was 38 degrees F. The indoor temp was in the high sixties. The north side of the building (front) faced the street, and being in Cambridge it was located right on the sidewalk. Visually the building's front façade looked good, with modern looking windows, and a modern glass entry way. At first glance of the front, thermal bridging is observed at the header above every window, and there were twenty of these just on the front of the building.



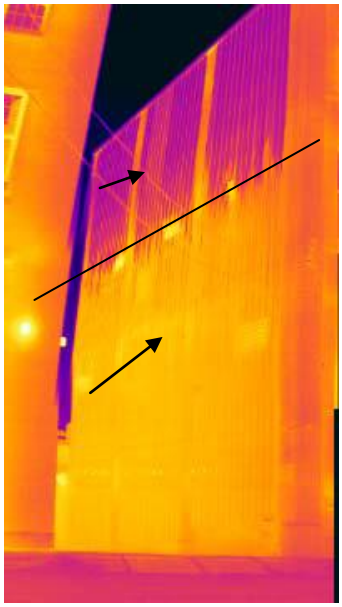


Also the heat loss from the foundation (left), which is a common occurrence in all commercial and residential buildings I observe. And for this building, the front door (right) showed an excessive heat loss signature.



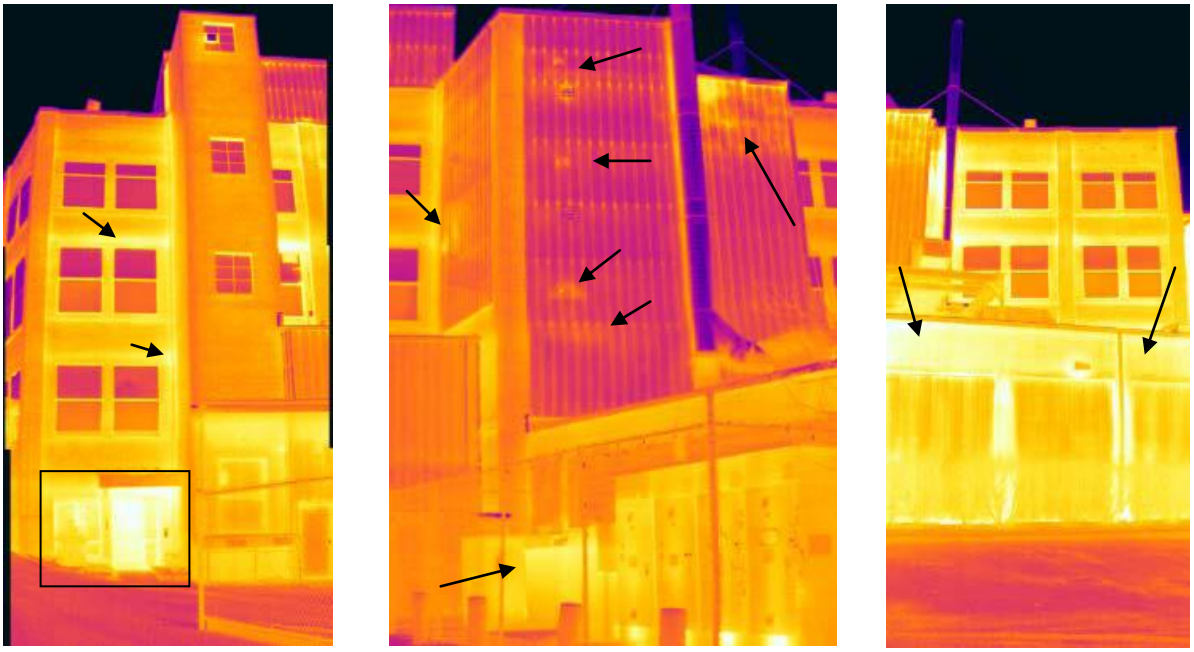


The more subtle issues were the heat issues behind the façade and the parapet which we will look at in the roof and interior survey scans.
From the initial survey of the front of the building we can assume we may see similar comparisons around the other exterior wall surface areas of the building, and we do with the west side of the building façade. This is also the smallest area wall section of the building. Window header thermal bridging and minimal foundation heat loss is seen here on the west side, as this foundation inside wall is insulated, are the only issues here. This was the side the client had least to worry about, and correct.
The east side of the building is wider than the west and it has no windows, it's brick columns with steel sheets between them running from the foundation to the top of the parapet.



First glance lets us assume heavy heat loss from the first and second floor with a band of heat loss at the third floor (center, top arrow). But is this interpretation a correct one? Then we have to realize the building to the left of our subject building is close enough to influence our subject building, and we have to also consider the building material here, steel and brick. It looks so bad on the exterior because of the outside influences of the other building. This same wall was found to be bad thermally on the interior portion of this wall section scan, but we did not know exactly how bad or good this wall section would be until we got inside for the interior survey.

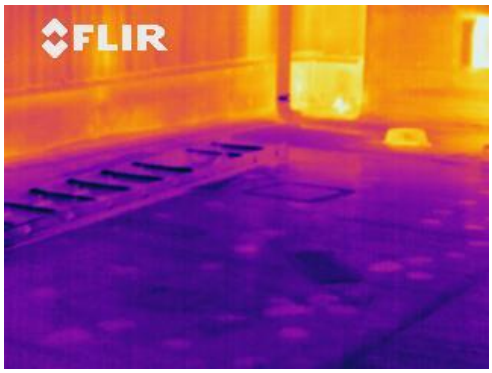
The back of the building was a compilation of brick wall sections joined by wood and steel wall sections covering stairways and rear storage and docking areas.

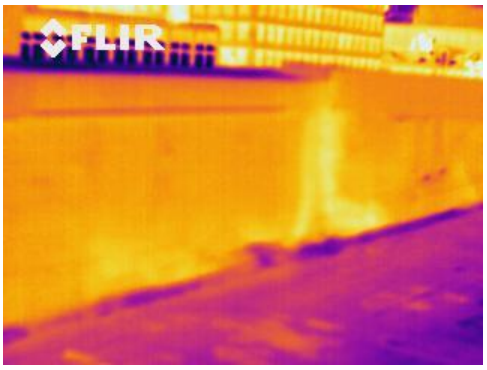


This is the south side, back of building, west (L) to east. The left image is similar to the front and west wall side with more heat loss from the door area (area box). The middle image shows the wall area heat loss sections, as does the image on the right of the storage and docking areas of the building.
Now this building's building façade survey was more involved than this paper obviously portrays. How the IR survey procedure is approached with its thermal findings are this paper's focus. The original façade report is fifty-five pages with seventy-two images which are each highlighted with comments and an overall report summary. One hundred and twenty-nine exterior images were taken, all in an hour and a half time line, for just the façade. You need to work thoroughly, quickly and accurately as it's a lot of work for the façade scan and you need to formulate and plan how you will put all of the images together for your report as you survey it. Taking the images seems easy compared to the time necessary to do a thorough well done report and you need to think ahead as to how you want the report to look as you do the field work.
So, what I had after completing one section of the job (façade scan) was that the west wall section looked fine with no real problems externally, other than the thermal bridging of the window headers. I always mention the best aspects of the survey in the report summary first. The building's front had the window header thermal bridging, the foundation heat loss, and wall areas that may have heat loss issues, a front door and a third floor window wall area with excessive heat loss issues. There appeared to be a hint of a parapet issue with heat loss as well and I kept that information in mind for the roof scan. I did not detect any moisture issues which I always look for while scanning the walls as well. The east wall was deceptive because of an adjacent buildings close proximity influence on our subject building. So I will compare it to the interior IR scan with the east side façade images later for the final determination on the wall's thermal condition. The back of the building showed many heat loss sections needing correction. This is a lot of useful information for an owner, builder, or contractor conscientious enough to correct these found energy and building performance issues. It is interesting to note these thermal issues are often overlooked for correction because when the developer or builder cannot see a problem it is often thought that there is no problem. The infrared camera gives them the visual evidence they need to make the connection when there is an issue they can't see. The façade survey was the largest report, and it always is in these types of surveys, providing a very thorough thermal view of the building's exterior all while giving an insight to the thermographer as to what may be seen in the interior survey, and how best to approach it when performing that survey.

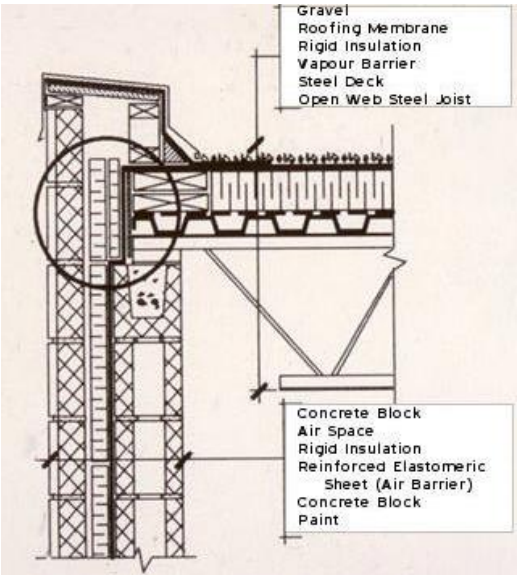
ROOF

I like to do the roof survey much earlier in the morning than I did this one and my preference is to do the roof scan first, in all survey situations. The building super was late letting me in, which is why the façade was scanned first. This roof consisted of two small sections, a west and east section. Each section was under a thousand square feet and both were EPDM rubber roof membranes. There was a client concern with the roof since they wanted to add solar instruments and other related equipment to it and their thoughts were of a weak roof structure. My thoughts were of a wet roof surface and the imaging required to document it if the condition existed, and I still had it in my mind to scan the parapet well, as I had formed this thought from seeing earlier images taken during the façade survey that showed the parapet may have some heat loss issues. The roof surface scan was fine (left image), the parapet showed heat loss (right image), as suspected.





The parapet heat loss is most likely the result of an ineffective or non-existent air barrier. This is a tough correction on a building where the air barrier was not a consideration, and this is probably an issue in a very large number of buildings without them. In the roof surveys I do with a parapet there is always a high heat loss issue from the parapet as observed with the IR camera. The heat loss here comes from the heat escape from the building into the air space behind the brick façade and it rises to the parapet where it is trapped or escapes through the cap flashing or other roof area egresses. The building practice that separates the inside air from the outside air is an effective air barrier, or combination air/vapour barrier that is continuous from the wall to the roof connection. Refer to the below diagram, Fig.13.[1]

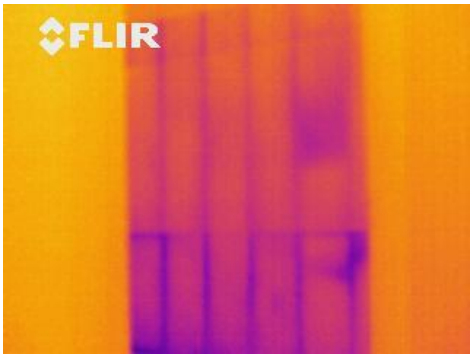


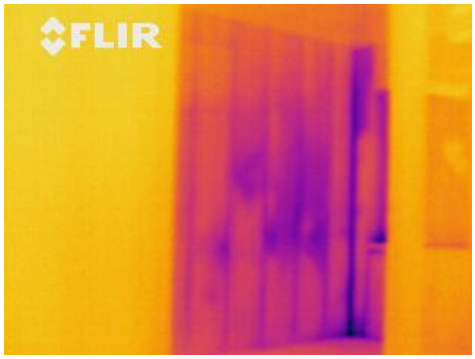
The roof report consisted of a fourteen page report using twenty-two infrared images. It showed the client that there were no moisture issues with the roof, which is a good thing for them. But, it highlighted an often overlooked issue that there are heat escape issues at the roof parapet.

1. Quirouette, Rick; Marshall, Sandra and Rousseau, Jacques; “Design Considerations for an Air BarrierSystem”; CMHC-SCHL; QBS 00c20a1-7; Nov 11, 2000;p.16;Fig.13.

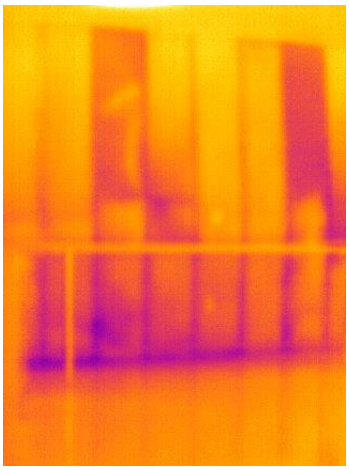
INTERIOR

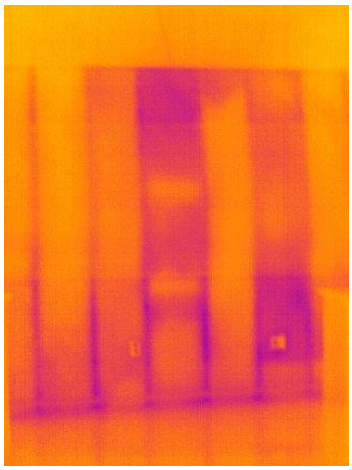
I started the interior scan with a lot of previously compiled thermal information from the facade and roof surveys. So, I had a good idea of what I may find from scanning certain wall sections within the building already. I had correctly assumed that I would probably find minimal issues with the west side of the building, and that was the case there. The front of the building revealed a few more cold intrusion issues to the inside, which turn into heat loss issues when scanning the outside, and some of that is dependent upon the air path taken through the wall as well. The east side and the back (south) side had more cold air intrusion issues, and it was only a matter of thoroughly documenting the interior wall section anomalies and concentrating on the east wall section to finish the field portion of this infrared envelope survey.
The interior survey was started on the third floor since we had just finished performing the roof scan. The third floor east wall looked bad, as suspected and the below two images show missing wall insulation.



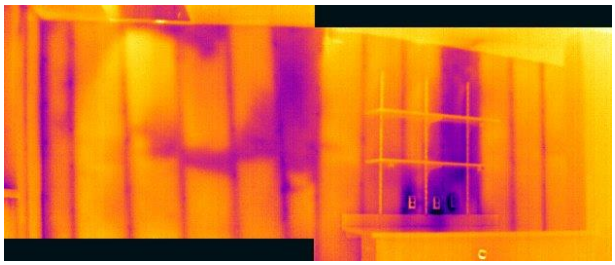


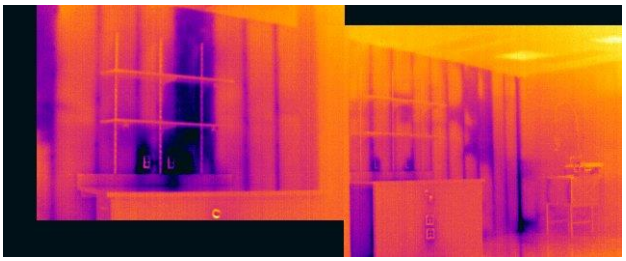
The second floor of the east side looked worse than the third floor regarding missing insulation. Image Builder was used to show the top to bottom sections of the wall using two ‘stitched’ images in these wall views.





The first floor east wall was as bad as the second floor but it still did not reflect the outside whole view image as seen on page two, as to give you the sense the second and first floors were devoid of any insulation whatsoever.





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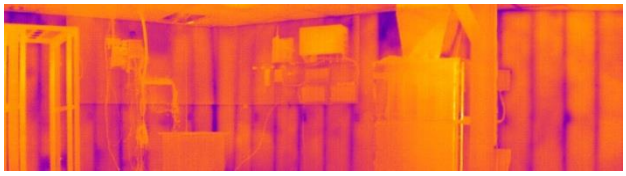
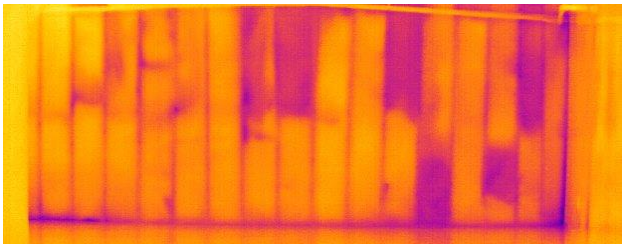
It is nice to even the margins on the stitched images but in certain situations I don't think it reflects the whole image view. So by showing the images offset you can see more of the wall section, and also that two or more images were used to give you the visual thermal image. And below, the finished basement was used for laboratory space and it is lacking insulation as well on this east side, just like the first and second floor is.





Now the left image above is three stitched wall images and the right wall image are two images, but I cut the margins and you can see the differences in their presentation to the client. The interior IR survey had forty-one pages and seventy-one images.

SUMMARY

This particular infrared survey is a good one on a number of levels. For one this is an involved whole building envelope inspection and by that I mean inside, and outside. It was done in the winter, and it created three reports totaling one hundred and ten pages. Every infrared situation has had its differences, testing your IR experience and knowledge of building science principles. The IR survey of this building is typical for an older brick building in New England where most of the building's heat goes out the roof, in this case by way of the building parapet. Correction for this can be made by means of an effective air barrier as mentioned in the roof section of the paper, on page four and five, and it's a situation that often goes uncorrected because of the difficulty of the repair between the wall and roof connection once the buildings construction is completed. Earlier I said you should tell the client the best aspects of the survey and work towards the worse aspects of their building since it's easier for the client to digest the news and for you to do the report. It seems to work.

So for this client their interests were the roof and how the buildings thermal envelope performed.

The infrared surveys thermal findings showed the largest issue was the thermal bridging taking place over all of the building's windows. Practically, they will probably live with this issue since economically it would be a big job to fix unless they have a major façade reconstruction to do. The front, west side and back of the building need wall insulation where mentioned in the original three reports, with examples shown here. The most costly and time consuming area will be the east wall of the building with its exterior steel plating skin and an interior that needs a total insulation rehab from the basement rooms to the third floor. The front door and a few windows were found to have thermal issues and they were also mentioned in the original report.

It's suggested they consider consulting an architect with emphasis on correcting the parapet issue, a structural roofing consultant, emphasizing if the roof is adequate for additional equipment placement loads, and an insulation contractor to add input and cost analysis considerations for their Cambridge rehab project.

REFERENCES

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Dave Sawyer is the owner and lead thermographer of Sawyer Infrared .com. SI is a Boston based Infrared Inspection and Consulting Company. Dave is an ITC Level III Thermographer and Building Science Thermographer (CBST). He was first introduced to IR technology thru Inframetrics in 1980, while attending college. In August of this year a Resnet – Hers certification was pursued thru KBSI. You can view additional information about the company and their offered services at *SawyerInfrared.com.*

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