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Thermal Performance of Window Details

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OBJECTIVES

Bassetti asked our team to use THERM software and thermal imaging technology to test, analyze, and compare window performance at two recently built schools. Not only will this information be used to enhance future designs, but we are assisting the firm with creating a troubleshooting and how-to guide for future use.

01. Identify

Identify thermal weaknesses through thermal analyses of drawn details + infrared images of window details on site

02. Compare

Compare between THERM analyses and infrared images for selected details and between the two schools to analyze differences and evaluate the accuracy of the tools

03. Document

Document difficulties and recommendations to create a replicable process

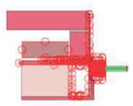
METHODS + TOOLS

THERM Software

Used for two-dimensional heat transfer models testing thermal performance of architectural details as designed

Challenges

- Transferring details (tried combinations of AutoCad, Rhino, Adobe Illustrator + Revit)
- Redrawing + editing to exclude voids, overlaps, inaccuracies, complex polygons,
- Finding thermal properties for each material + heat transfer coefficients of various boundary conditions
- Bugs + non-existent errors



FLIR Infrared Camera

Produces images of infrared radiation (thermograms) showing heat emitted by on-site details as they perform in real life

Challenges

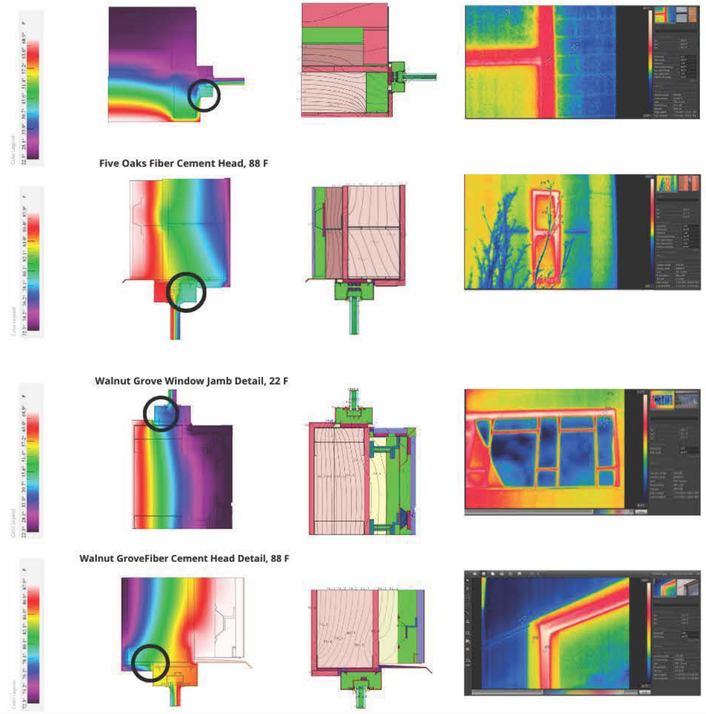
- Reflections
- Out-of-focus images
- Emissivities + other material-specific characteristics affecting temperature readings

FINDINGS

Identifying Thermal Weaknesses

Five Oaks Middle School

Walnut Grove Elementary

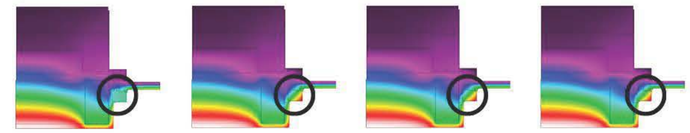


Thermal Temperature Comparison

DETAIL COMPONENT	CAMERA TEMPERATURE	THERM TEMPERATURE	TEMPERATURE DIFFERENCE
Exterior Glass	58.4 F	40 F	18.4
Exterior Frame	60.5 F	40 F	20.5
Exterior Brick	58.4 F	36 F	22.4
Interior Glass	66.1 F	57 F	9.1
Interior Frame	65.2 F	51 F	14.2
Interior Gypsum	66.9 F	69 F	2.1

Real thermal performance worse than ideal thermal performance predicted by Therm

Testing Potential Window Frame Improvements

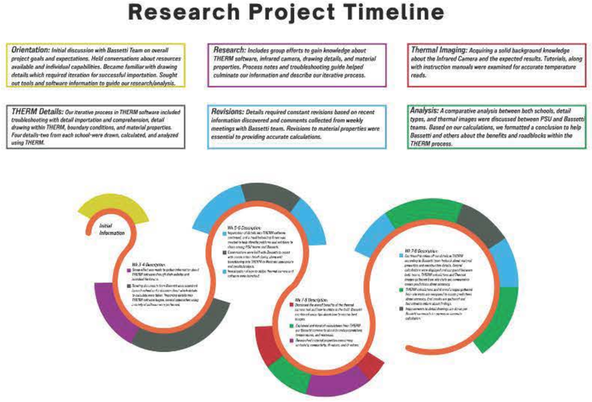


Original Aluminum | Fiberglass | PVC | Softwood

Fiberglass, PVC, and softwood window frames all outperform the aluminum window frames used in the schools

Completed Bassetti projects Walnut Grove + Five Oaks → PSU Research Project → Inform thermal design of future Bassetti Projects

Research Project Timeline



DISCUSSION

Using Therm as a Design Tool

- Inserting, redrawing + editing details
- Specifying each material + thermal properties for custom materials + boundary conditions
- Non-user-friendly program: steep learning curve, limited capabilities, lack of support, many error messages, color infrared calculation freeze the program, etc.

- If details are properly set up, users can easily compare thermal performance of details and change materials of components and see the effect on thermal performance
- Users can also redraw components to test differing shapes + thicknesses, but this can take longer given Therm's limitations as a drawing tool

Our process notes and troubleshooting guide will help Bassetti staff successfully navigate the challenges of using THERM and thermal imaging as design tools for improving thermal performance of window details.