CHOOSE BRICK FOR ENERGY-EFFICIENT, HIGH-PERFORMANCE WALL ASSEMBLIES

Recent research conducted by the National Brick Research Center (NBRC) allowed the dynamic thermal performance of typical non-residential wall assemblies to be studied. The major findings regarding wall assemblies with brick veneer compared with other assemblies are outlined and discussed further below.

SUMMARY OF FINDINGS

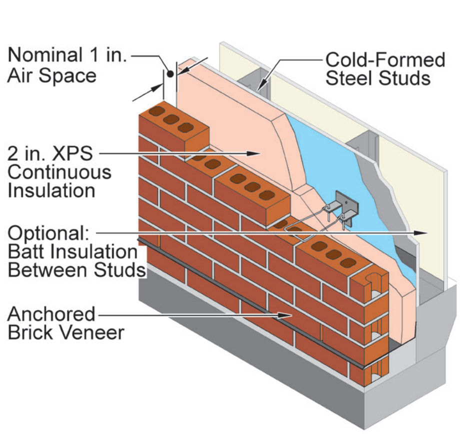
- Steady-state measurements (R-value) alone cannot accurately describe the thermal performance of a brick veneer wall assembly.
- The wall assembly may never reach equilibrium (steady state) in a given day.
- Heat transfer through a brick veneer wall is 82% radiation, 15% conduction, 3% convection.
- Thermal mass significantly reduces energy consumption, up to 50%.
- The extent of savings due to thermal mass will vary based on climate.
- Open weeps into the air space do not degrade R-value or thermal performance.
- Ties are not thermal bridges.
- Thermal bridging of cold-formed steel studs is a significant concern. Continuous insulation is more effective than batt insulation.
- Brick + continuous insulation + CMU is the best-performing wall assembly.
- Inclusion of a radiant barrier can result in further energy savings.

BRICK OUTPERFORMS EIFS AND LIGHTWEIGHT CLADDINGS

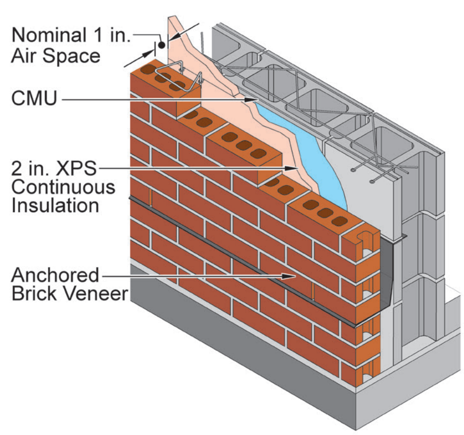
A brick veneer wall assembly can decrease energy usage by up to 50% compared with an EIFS-clad wall and 41% compared with a wall clad with a lightweight, low-R-value material.

HOW DOES BRICK VENEER ACHIEVE THIS PERFORMANCE?

- **THERMAL MASS.** Brick absorbs heat and stores it, releasing it slowly.
- **AIR SPACE.** This space separates brick from backing and has insulative properties.
- **CONSIDERATION OF REAL-LIFE CONDITIONS.** Typical assessments ignore thermal mass and temperature fluctuations, both daily and seasonally.



Anchored Brick Veneer on Cold-Formed Steel Studs



Anchored Brick Veneer on CMU

THE BRICK INDUSTRY ASSOCIATION | NBRC National Brick Research Center

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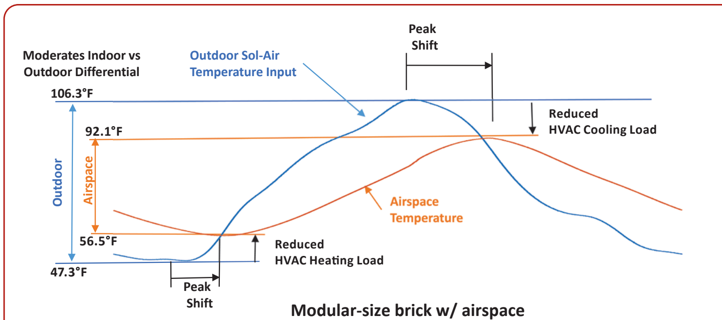
WALL ASSEMBLY		STEADY-STATE TESTING (R-VALUE)		DYNAMIC TESTING (HVAC Demand/Load)
BACKING	CLADDING			
COLD-FORMED STEEL STUD WALL SYSTEM (with batt insulation)	**BRICK + XPS c.i.**	**20.7**	**BEST PERFORMANCE**	**BEST PERFORMANCE**
	EIFS	18.7	10% lower	42% higher
	Lightweight Cladding[1] + XPS c.i.[2]	19.9	4% lower	38% higher
COLD-FORMED STEEL STUD WALL SYSTEM (no batt insulation)	**BRICK + XPS c.i.**	**11.7**	**BEST PERFORMANCE**	**BEST PERFORMANCE**
	EIFS	8.6	26% lower	50% higher
	Lightweight Cladding[1] + XPS c.i.[2]	10.8	8% lower	38% higher
CMU WALL SYSTEM	**BRICK + XPS c.i.**	**10.2**	**BEST PERFORMANCE**	**BEST PERFORMANCE**
	EIFS	7.8	24% lower	46% higher
	Lightweight Cladding[1] + XPS c.i.[2]	9.5	7% lower	41% higher

[1] Lightweight cladding with a low R-value, such as fiber cement or uninsulated metal panel
[2] Extruded polystyrene foam insulation (continuous insulation)

MORE THAN R-VALUE ALONE. Dynamic testing better simulates the actual thermal performance of a wall assembly as it reacts to heat. It more accurately accounts for the thermal contribution of the brick veneer by including its thermal mass—an attribute not accounted for by the steady-state testing typically used to determine the R-value of a wall assembly. The term "steady state" implies equilibrium. Real-life conditions are not steady state, as temperature fluctuates throughout the day and night and varies with the season. Due to these temperature fluctuations over the course of a 24-hour day, the wall assembly may never reach equilibrium. During these dynamic conditions, thermal mass helps augment the performance of the wall.



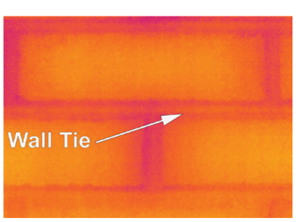
Modular-size brick w/ airspace
Thermal mass delays and reduces temperature and heat flow through a material

BRICK'S THERMAL MASS MAKES ALL THE DIFFERENCE. Dense materials like brick have thermal mass, which acts to slow the movement of heat through the wall. As illustrated, this results in 1) shifting the energy demand to later in the afternoon or evening, 2) reducing the overall HVAC system load, and 3) moderating indoor temperature swings. As a result, significant long-term energy savings can be achieved.

THE AIR SPACE BEHIND THE BRICK ALSO PLAYS A SIGNIFICANT ROLE. In a brick veneer wall, radiation is the primary means of heat transfer across the air space. Over 75% of energy is transferred using radiation, not convection. As such, the weeps or top vents (if used) do not result in a reduction of performance.

DID YOU KNOW?

Radiant Barrier Increases Brick Performance. Adding a radiant barrier facing the air space can increase the R-value of a brick veneer wall assembly by as much as R-2.6, which results in notable energy savings.



Veneer ties are not visible in infrared (IR) photos taken during hotbox testing, illustrating that ties are not thermal bridges.

WHAT ABOUT THERMAL BRIDGING?

COLD-FORMED STEEL STUDS. For wall assemblies with a cold-formed steel stud backing, the studs are significant thermal bridges, so batt insulation is not effective. The use of continuous insulation over the exterior face of the backing is critical to achieving necessary performance.

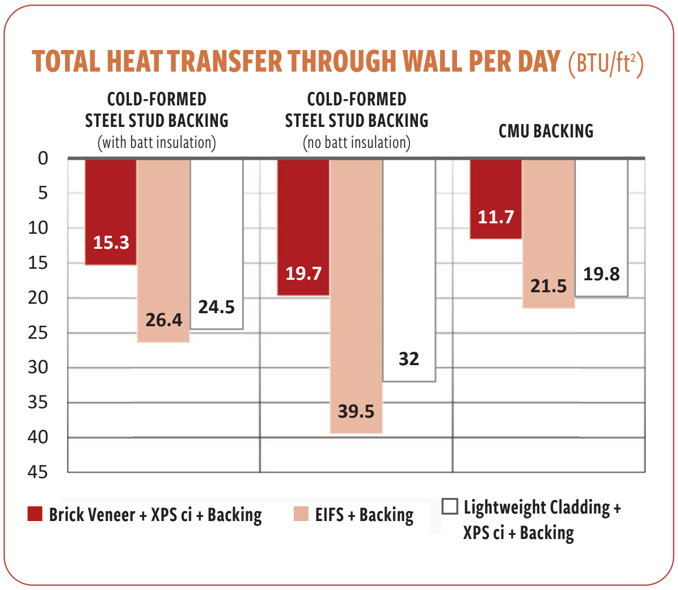
BRICK VENEER TIES. Brick ties are often mistakenly identified as thermal bridges. While metal elements in a wall assembly can act as thermal bridges, in this case, the small size of the veneer ties compared with the thickness of the veneer as well as the thermal mass "heat sink" properties of the brick prevent the veneer ties from acting like thermal bridges, as demonstrated by photos obtained during hotbox testing.

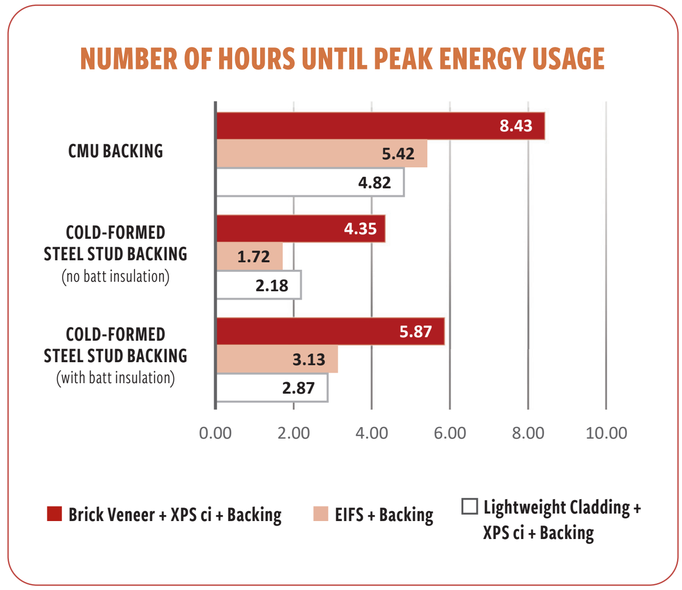
TESTING RESULTS CONFIRM:
BRICK VENEER OUTPERFORMS EIFS BY UP TO 50%

PERFORMANCE VERIFIED BY RESEARCH. NBRC evaluated the performance of several typical commercial wall assemblies by constructing full scale wall specimens and subjecting them to conditions representing the change of temperatures in a given day (Sol-Air cycle). A modified ASTM C1363 hotbox was used to compare the thermal performance of wall assemblies with brick veneer and EIFS. The modified hotbox allowed the research project to use dynamic testing. Researchers found that all assemblies with anchored brick veneer provided better thermal performance than a comparable wall assembly with an EIFS cladding, no matter the backing used in the specimens.

When comparing the wall assembly combinations, walls with EIFS cladding allowed the most heat to pass through the assembly, even compared with the baseline wall assembly (backing only) that does not include cladding.

For all three backing types, the wall assemblies with brick veneer and continuous insulation perform significantly better than the other wall assemblies—ranging from a 38% to 50% reduction in energy usage.





CONTINUOUS INSULATION. For the test specimens that included continuous insulation, the thickness of insulation was held constant at 2 in. for all wall assemblies. However, the expanded polystyrene (EPS) insulation used in EIFS has less thermal resistance per inch than the extruded polystyrene (XPS) insulation used as continuous insulation in the other wall assemblies. XPS is more frequently used as continuous insulation than EPS. This difference in insulation type primarily accounts for the increased heat transfer for specimens with EIFS cladding compared with the baseline cold-formed steel stud backing with continuous insulation.

Since all the wall assemblies have the same amount of insulation, the primary explanation for the difference in performance is the contribution of the anchored brick veneer due to its thermal mass and the air space behind it.

COMPARING WALL ASSEMBLIES WITH BRICK VENEER. Brick veneer with continuous insulation over CMU was the best-performing wall assembly, exceeding the performance of brick veneer over cold-formed steel studs by 24% to 41%, depending on the presence of batt insulation in the stud cavity.

LIGHTWEIGHT, LOW R-VALUE CLADDING. Wall assemblies with continuous insulation and no cladding were also tested. These assemblies are similar in thermal performance to walls that incorporate claddings that are lightweight with a low R-value. The brick veneer wall assembly outperforms the assembly representing generic cladding by an average of 39%.

DELAY OF PEAK ENERGY USE. Peak energy use occurred an average of almost 3 hours later for the brick veneer wall assemblies compared with the EIFS wall systems. For office buildings with brick veneer walls, maximum HVAC system use would occur after typical working hours when the building is not occupied. Significant long-term energy savings can occur if less energy is used during high-occupancy hours.

BRICK VENEER CAN MEET THE DEFINITION OF MASS WALL IN THE ENERGY CODE AND CAN ALSO EXCEED EXPECTED PERFORMANCE FOR FRAMED WALL ASSEMBLIES

Currently, the prescriptive requirements within the energy codes and standards are specified as a function of climate zone and wall assembly construction. There are different requirements for mass walls than for framed wall assemblies. In some cases, walls consisting of brick veneer anchored to cold-formed steel or wood stud framing may qualify as a mass wall because its definition varies between energy standards. The increased heat capacity provided by anchored brick veneer gives designers choice and flexibility to comply with either the requirements for mass walls or framed wall assemblies. If a designer chooses to follow the requirements for a lightweight wall, the resulting wall assembly with brick veneer will perform better than predicted by the code.

BRICK PROVIDES BENEFITS IN NEARLY ALL CLIMATE ZONES

Adding brick veneer can provide energy efficiency benefits in multiple climate zones. Using a climate model, researchers analyzed the performance of brick veneer wall assemblies in major U.S. cities. The results indicate that the thermal mass benefit of brick varies between climate zones. As shown in the table below, brick veneer can improve energy performance up to 25% when compared with claddings without thermal mass, such as EIFS. As long as there is a reversal of the direction of heat flow during the evening or seasonally throughout the year, the presence of brick veneer in the wall assembly will result in reduced energy usage.

CLIMATE MODEL - Real World Estimates of Energy Usage (HVAC Demand/Load)

CLIMATE ZONE	LOCATION	**Cold-Formed Steel Stud Backing** (with Batt Insulation)	
		Brick Veneer + XPS c.i[1]	EIFS[2]
2A	Houston	BEST PERFORMANCE	20.8% Higher
3A	Atlanta		22.9% Higher
	Dallas		21.0% Higher
4A	New York		21.3% Higher
	St. Louis		22.0% Higher
5A	Chicago		23.4% Higher
5B	Denver		25.3% Higher

[1] ***Brick Veneer Wall Assembly:*** *Nominal 4 in. brick veneer, 1 in. air space, 2 in. extruded polystyrene (XPS), ⅝-in. fiberglass mat-faced gypsum sheathing, 2×6 18-gauge cold-formed steel stud framing with R-21 batt insulation, ⅝ in. gypsum board*

[2] ***EIFS Wall Assembly:*** *Exterior Insulation Finish System with 2 in. expanded polystyrene (EPS), ⅝ in. fiberglass mat-faced gypsum sheathing, 2×6 18-gauge cold-formed steel stud framing with R-21 batt insulation, ⅝ in. gypsum board*

SOLAR REFLECTANCE

Light-colored exterior surfaces are often recommended as a way to reflect the sun's heat and reduce the energy load on a building. However, this principle applies differently to wall assemblies with air spaces and high thermal mass, like brick veneer. Because the thermal mass of the assembly can prevent the transmission of large solar load to the interior of the building, a dark-colored wall with thermal mass has significantly lower energy usage than a dark-colored lightweight wall.

CONCLUSION

Brick veneer wall assemblies consistently provide significantly more energy savings than other assemblies. For further information, refer to BIA *Technical Note* 4B, Commercial Energy Code Compliance.

