# The Evolution of EIFS, From Face-Sealed to Vented Façades

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To reduce building energy demands, while providing the desired aesthetics in a cost-effective manner, exterior insulation finishing systems (EIFS) have been used for decades as non-load bearing cladding systems. The main advantage of EIFS is the enhancement of the thermal performance by providing continuous insulation layers over the building structure. Although EIFS has a significant market share in North America, the 1990s Canadian leaky condominium crisis left EIFS with a reputation associated with water intrusion failures and high moisture damage repair and control costs. Since then, EIFS has seen significant improvements.

One of the key improvements is the addition of geometrically-defined drainage cavities behind the continuous insulation layer to allow water that has penetrated the outer EIFS lamina to drain out to the exterior, while providing an opportunity for enhancing the convective drying ability by introducing air flow and moisture exchange. EIFS with such cavities can be either vented or ventilated, depending on the vents' sizes, locations, and distribution (see Figure 1, below). The integration of these cavities has raised questions regarding their impact on the thermal performance of wall assemblies constructed of such EIFS.

As the demand for highly insulated buildings will only keep growing, and to support design decisions on current and future use of vented EIFS, it is vital to evaluate the reduction in the whole assembly's effective thermal resistance due to venting. It is also important to compare EIFS and their different applications in Europe and North America. Of equal importance is numerically evaluating the thermal resistances of vented EIFS with various thicknesses and cavity profiles.

## A GLIMPSE OF EIFS

Due to cement shortages after World War II, EIFS originated in Germany and Scandinavia in the 1940s. In 1959, E. Horbach obtained a patent for expanded polystyrene-based systems, and the first building application was demonstrated a few years later. In Europe, EIFS was applied over substrates with high moisture capacity, like concrete, or for retrofitting existing buildings by brick over-cladding in an attempt to upgrade the thermal performance while the use of face-sealed EIFS on moisture sensitive substrates was prohibited.

In North America, EIFS was introduced by Dryvit Systems Inc. in the 1980s and was mainly used for commercial buildings. However, due to the increased attention and demand for energy efficiency in the early 1970s, EIFS was also adopted for residential use. Contrary to European practice, EIFS was used as cladding systems for light-frame North American walls comprised of materials with significantly lower moisture capacities than concrete. North American EIFS also had reduced base coat thickness to allow for easier rendering and installation, affecting their durability and water penetration resistance. The early EIFS was designed and constructed to act as a perfect barrier against rain penetration but failed on many occasions, leading to the prohibition of face-sealed EIFS in Vancouver and North Carolina by 1995.

Nowadays, EIFS are manufactured as proprietary systems, where the insulation, adhesives, and / or fasteners and lamina are provided by a single EIFS manufacturer that is responsible for compatibility between components and performance-testing integrity.

Modern EIFS are constructed to a specific thickness (typically between two and six inches) of expanded polystyrene foam insulation attached to a structurally supported substrate using trowel-applied adhesive or by mechanical means. The expanded polystyrene insulation includes geometrically defined cavity spaces to facilitate water drainage and allow for cavity ventilation (see Figure 2, below). A liquid-applied membrane also covers the substrate to act as the main water / air control layer, while being vapour permeable, allowing the assembly to dry out to the exterior. The insulation board is covered with

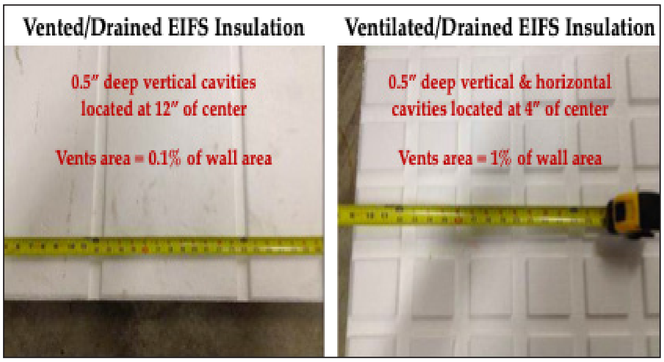


*Figure 1. Vented vs. ventilated EIFS.*

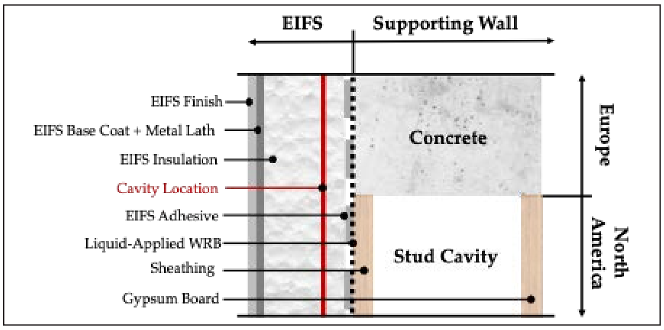


*Figure 2. Typical EIFS construction in North America and Western Europe.*

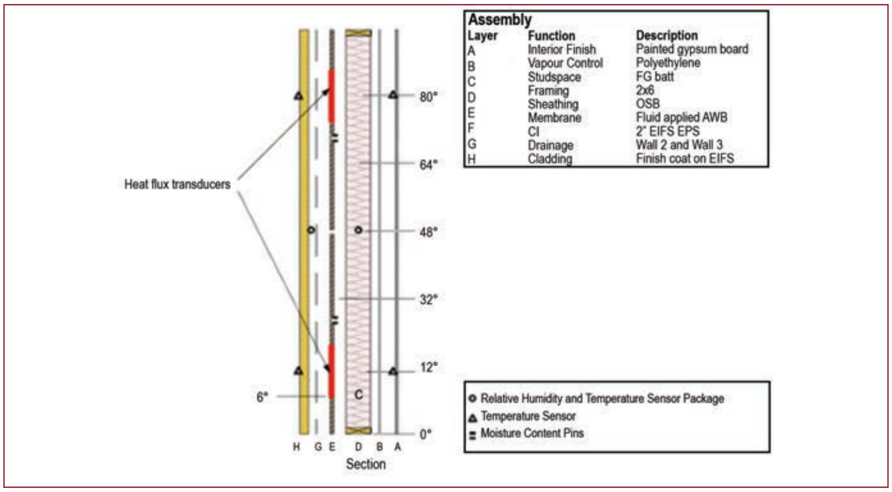


*Figure 3. Field-tested wall assembly.*

| Assembly | Northern Wall RSI ($m^2 \cdot K/W$) | Southern Wall RSI ($m^2 \cdot K/W$) |
|---|---|---|
| FS-2 | 4.80 | 4.50 |
| V-2-12 | 4.68 | 4.37 |
| V-2-6 | 4.64 | 4.28 |
| FS-4 | 6.26 | 6.09 |
| V-4-12 | 6.19 | 6.00 |
| V-4-6 | 5.97 | 5.83 |
| FS-6 | 7.81 | 8.07 |
| V-6-12 | 7.80 | 7.96 |
| V-6-6 | 7.54 | 7.64 |

*FS: Face-sealed; V: Vented
*First value: Insulation thickness in inches (2, 4, or 6)
*Second value: Cavity spacing in inches (6 or 12)

*Table 1. Summary of calculated effective thermal resistances.*



a durable base coat embedded with fiber mesh reinforcement to provide strength and dimensional stability. The base coat is finally covered with a finish coat (typically acrylic polymer), giving the final appearance of a building's façade.

## THERMAL PERFORMANCE IMPACTS OF VENTED EIFS

RDH Building Science Laboratories conducted a full-scale wall testing in southern Ontario to measure the heat flux through face-sealed and vented EIFS (see Figure 3 on this page). The face-sealed assembly was used as a baseline to determine the effects of venting on the thermal performance. The field tests provided in-service performance relative to real-world conditions, while data collected from the tests was used to calibrate computational fluid dynamics models developed by the authors using COMSOL MULTIPHYSICS®. The calibrated models were then used to simulate EIFS assemblies with various insulation thicknesses and cavity profiles applied on different building orientations, thus receiving and absorbing various amounts of solar radiation.

Reductions in the thermal resistances of vented EIFS assemblies were minimal and observed in the range of 1.4 to 5.3 per cent for south-facing walls and 0.1 to 4.6 per cent for north-facing walls (see Table 1 on this page). Reducing the spacing between cavities further reduced the thermal resistances due to increased ventilation. It was also found that thermal resistances of the light- and medium-insulated south-facing EIFS were lower than their northern counterparts, mainly due to the thermal storage ability of the construction materials. However, heavily insulated EIFS reduced this flux of heat and, eventually, the south-facing walls' thermal resistances overcame their northern counterparts. ■

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*For more information, please visit https://doi.org/10.1016/j.jobe.2020.101446.*