# How to Arrive at the True Value Propositions of EIFS

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*This is the first of two articles that explores the value propositions of EIFS by defining a framework for fair valuation that can be used to determine EIFS benefits and limitations. A second article to follow will examine the value propositions in the context of successful delivery through the EIFS Quality Assurance Program (EQI).*

A while back I received a copy of a recent ASHRAE research report (RP-1365) titled *Thermal Performance of Building Envelope Details for Mid and High-Rise Buildings*. A colleague of mine, Mark Lawton, from Morrison Hershfield's Vancouver office, had sent me the report and I have two things to say about it: first, the building science research is exemplary; and second, thermal bridging in most common building assemblies is very significant and often reduces the effective thermal resistance of wall assemblies by more that 50%. It's what most building scientists have had a gut feeling about for a long time now, and Mark Lawton's study confirmed our worst fears - much of the insulation we provide in our building envelopes is bypassed through thermal bridging.

Energy efficiency aside, the report also provided temperature indices at key locations of the building enclosure, and it became obvious the interior surfaces were often cold enough to support condensation, and hence the potential for mould growth. And the interstitial temperatures definitely indicated a high likelihood of air leakage leading to condensation and subsequent moisture damage. Thermal bridging is not just compromising energy efficiency, but also involves health and durability issues in our cold Canadian climate.

## Building Value Propositions for Exterior Wall Enclosures

So what is a building designer to do? Shortly after reviewing the thermal bridging report, friends and colleagues of mine from industry approached me to discover my thoughts on the EIFS value proposition. As someone who has no favourite building enclosure system, I agreed to give it some thought. The first thing I did was go back to *CBD-48 Requirements for Exterior Walls* by Neil Hutcheon, December 1963. (http://www.nrc-cnrc.gc.ca/eng/ibp/irc/cbd/building-digest-48.html) Like building physics, some things in the building science field will always hold true like this list of fundamental performance requirements.

**Principal Requirements of a Wall**

1. Control heat flow;
2. Control air flow;
3. Control water vapour flow;
4. Control rain penetration;
5. Control light, solar and other radiation;
6. Control noise;
7. Control fire;
8. Provide strength and rigidity;
9. Be durable;
10. Be aesthetically pleasing;
11. Be economical.

Since Hutcheon's time, additional objectives have been adopted, such as consideration of the environmental impacts associated with building methods and materials. There has also been a significant displacement of traditional methods and materials of construction over the past 50 years. This has proven both good and bad because traditional wall systems were not very energy efficient, but often made up for it by being quite durable. Today, designers need a more comprehensive framework of performance requirements to select appropriate wall systems.

## Framework for Assessing Exterior Wall Enclosure Performance

The table developed below is a helpful performance evaluation framework for selecting exterior wall enclosures. It contains all of the requirements highlighted by Hutcheon, expanding on some of these with greater detail, and adding environmental impacts and buildability in recognition of our contemporary context of year round construction and forecast skilled labour shortages.

| PERFORMANCE REQUIREMENT | FACTORS & CONSIDERATIONS | |
|---|---|---|
| **Structural Strength/Rigidity** | • Loadbearing/Non-loadbearing<br>• Wind Loading | • Seismic Loading<br>• Thermal Effects |
| **Control of Heat Flow** | • Effective Thermal Resistance | • Avoidance of Thermal Bridging |
| **Control of Air Flow** | • Stack and Wind Pressures<br>• Normalized Leakage Area | • HVAC Influences<br>• Internal Partitioning |
| **Control of Moisture Flow** | • Rain Penetration<br>• Vapour Diffusion | • Air Leakage<br>• Condensation Potential |
| **Control of Solar Radiation** | • Opacity/Emissivity<br>• Solar Orientation | • Fenestration (Wall/Glazing Ratio)<br>• Shading Devices |
| **Control of Sound Transmission** | • Airborne Sound | • Vibration |
| **Control of Fire** | • Fire Resistance | • Combustibility |
| **Durability*** | • Ultraviolet Degradation<br>• Corrosion<br>• Carbonation<br>• Freeze/Thaw<br>• Abrasion<br>• Fatigue<br>• Instability/Incompatibility<br>• Serviceability/Maintenance | • Biological Attack (mould, insects, animals, plants)<br>• Chemical Attack (soils, contaminants, pollutants)<br>• Efflorescence<br>• Subflorescence<br>• Spalling<br>• Retrofit/Refurbishment |
| **Economy** | • Initial Cost<br>• Maintenance Cost | • Operating Cost<br>• Life Cycle Cost |
| **Environmental Impacts** | • Resource Depletion<br>• Environmental Degradation<br>• Reduction of Biodiversity | • Greenhouse Gases<br>• Pollutants |
| **Buildability (Ease of Construction)** | • Seasonality<br>• Tolerances | • Coordination<br>• Sequencing |
| **Aesthetics** | • Visual<br>• Tactile | • Acoustic<br>• Olfactory |

* Another aspect of durability related to envelope assemblies is differential durability (Kesik 2002 ), a term used to describe how useful service life differs - both between components, and within the assemblies and materials comprising components. [Kesik, T., 2002. *Differential Durability and the Life Cycle of Buildings*. Proceedings of the ARCC/EAAE 2002 International Conference on Research, May 22-25, 2002, McGill University, Montreal, Canada (CD-ROM).]

**Table 1.** Exterior wall enclosure performance requirements and their related factors and considerations.

No framework can claim to be a perfect means of assessing something as complex and multi-faceted as exterior wall enclosure performance. But in fairness to Neil Hutcheon, one of the founding fathers of modern building science in Canada, this framework certainly considers all of the big ticket items. If there is something missing or incomplete, it is unlikely to be a deal breaker or a tipping point in the decision making process.

## Exterior Wall Enclosure Performance Assessment Matrix

Translating a performance framework into an assessment matrix was the next task at hand. It is generally recognized that human beings are not very good at fine grained assessments involving multiple parameters. Ratings that require experience and judgement fall into a fuzzy area where rating something on a scale of 1 to 10 is difficult, and on a scale of 1 to 100 impossible to justify (for example, what's the practical difference between a score of 73 versus 72?). Personally, I like using a three-tier rating system with modifiers. This yields qualitative ratings such as "somewhat inferior" or "definitely superior" along with "subjective" for requirements that are difficult to measure quantitatively. After some research and talking to colleagues, I came up with a performance assessment of the present generation of EIFS in Table 2. Due diligence would require a more detailed and quantitative assessment of these performance parameters, but the qualitative approach is a practical way of eliminating exterior wall systems that are clearly not suitable to a particular application, or do not meet a client's performance expectations.

| PERFORMANCE REQUIREMENT | COMMENTARY | RATING: INFERIOR | RATING: AVERAGE | RATING: SUPERIOR |
|---|---|---|---|---|
| **Structural Strength/Rigidity** | • Lightweight, fully adhered, continuous cladding provides strong resistance to wind loads, reduces seismic and thermal loads. | | | Definitely |
| **Control of Heat Flow** | • High thermal resistance with minimal thermal bridging. | | | Definitely |
| **Control of Air Flow** | • Continuous air barrier behind extruded polystyrene. | | | Definitely |
| **Control of Moisture Flow** | • Drainage layer and flashings enhance moisture management.<br>• Exterior insulation reduces condensation potential. | | | Somewhat |
| **Control of Solar Radiation** | • UV resistant coating over continuous cladding system. | | | Somewhat |
| **Control of Sound Transmission** | • Airtight construction reduces airborne sound transmission.<br>• Insufficient mass for vibration and low frequency sound. | | | Somewhat |
| **Control of Fire** | • Combustible cladding with low flamespread.<br>• Fire resistance rating depends on backup wall assembly. | | Definitely | |
| **Durability** | • 30 to 50 year service life.<br>• 10 to 15 year maintenance cycle (caulking), painting as required.<br>• Poor impact and abrasion resistance. | | | Somewhat |
| **Economy** | • Low initial and maintenance costs.<br>• Thermal efficiency contributes to low life cycle cost. | | | Definitely |
| **Environmental Impacts** | • Relatively low for EIFS materials.<br>• Energy efficiency contributes to greenhouse gas reductions. | | | Definitely |
| **Buildability (Ease of Construction)** | • Winter heating and/or protection required.<br>• Forgiving tolerances, flexible coordination and sequencing. | | | Somewhat |
| **Aesthetics** | • Wide range of colours and textures.<br>• Readily combined with other facade materials. | | | Subjective (?) |

● Definitely ○ Somewhat (?) Subjective

**Table 2.** Performance assessment matrix for the present generation of EIFS in Canada.

By the present generation of EIFS in Canada, I am referring to fully adhered systems with a drainage layer (pressure moderated drain screen) designed, manufactured and installed according to CAN/ULC-S716 Standard for Exterior Insulation and Finish Systems (EIFS) - Parts 1, 2, 3 covering *Materials and Systems*, *Installation of EIFS Components and Water Resistive Barrier*, *and Design Application*, respectively. And it's important to keep in mind when comparing alternative wall systems to only consider those governed by comparable technical standards. The quality of design, workmanship and materials all affect the performance of wall systems and it's only fair to compare apples with apples.

## Meaningful Performance Indicators

Overall, EIFS scores very high based on the performance assessment matrix that was used. This approach relies heavily on expertise and experience, not unlike medical diagnosis, and it may be susceptible to subconscious biases. That's why it's important to unravel the subconscious processes that are involved in assessing the performance of building enclosures.[1] Perhaps I owe it to my formal education, but having been indoctrinated to systems thinking, I tend to view building enclosures, and especially walls, as entire systems going from the interior to the exterior surface. It does not make much sense commenting on the suitability of a cladding in the absence of a backup wall assembly. Concrete masonry block backup affords different possibilities and outcomes for cladding systems than steel stud backup walls. Lately I've been looking at performance indicators aimed at addressing a process that has been erroneously referred to as value engineering (when it really means someone is trying to save money by being cheap and stupid).

***Effective R-Value/$/m$^2$*** - The first one is the effective R-value per dollar of cost per m$^2$ of the entire exterior wall assembly, inboard to outboard. Since energy prices are poised to spiral sharply in the years ahead, yet many owners/investors are still concerned with initial costs, this is a performance indicator that balances these two concerns. I have not done the numbers in detail, but my back of the envelope accounting yields a very high score for EIFS, especially now that we can quantify thermal bridging so accurately.

***Cost/m$^2$/year or Cost/m$^2$ Over Service Life*** - A complete exterior wall system has a cost that includes the initial expenditure followed by operating (energy) and maintenance costs. Maintenance costs may include exterior cleaning, caulking, painting, etc., as well as the cleaning and painting of interior finishes, if applicable. One approach is to translate these into a total cost per year, but remember to escalate the energy prices and take inflation into account for materials and labour. It's also important to decide on a reasonable service life for the wall - this number may be different among alternative wall systems.[2] Another approach is to convert all of these costs into a net present value over the estimated service life. Either way, it is possible to compare economic performance between any number of competing alternatives. EIFS is generally less materials intensive with a lower initial cost than other wall systems, and its higher effective thermal resistance yields smaller operating costs, resulting in a lower than average total system life cycle cost.

***Savings Contribution to Building System Benefits*** - This is an indicator that stems directly from systems thinking and real value engineering. Assume that a particular wall assembly has a lower initial cost but a comparable performance in all other regards to alternative wall assemblies. It is interesting to calculate the ratio of savings contribution to benefits derived from the intelligent re-investment of cost savings. For example, if the savings from an exterior wall system were invested toward improving the quality of windows and glazing, then the durability, operating and maintenance costs savings (benefits) could be comparatively assessed among competing wall systems. To be rigorous, reductions in the capacity, and therefore the cost, of HVAC equipment arising from better performing windows should be included in the analysis. Using this technique for all manner of components, assemblies and equipment is an objective way to compare the total value obtained per dollar of building investment. The savings obtained from deploying EIFS can afford significant improvements to weak links in the building enclosure to help deliver high performance buildings cost effectively.[3]

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[1] For a systematic assessment of EIFS performance, refer to: Day, Kevin C. *Exterior Insulation Finish Systems: Designing EIFS (Clad Walls) for a Predictable Service Life*. 8th Conference on Building Science and Technology, February 2001.

[2] The Model National Energy Code for Buildings (MNECB 1997) assumed a 30-year useful service life for exterior wall enclosures. This does not suggest the wall is not serviceable beyond this point, but specified maintenance will be required to continue satisfying all of the performance requirements.

[3] The energy efficiency requirements in the 2012 Ontario Building Code and ASHRAE 90.1-2010 give continuous exterior insulation systems a significant advantage under the performance compliance path.

## The EIFS Value Proposition

So how does the present generation of EIFS stack up? Technically speaking, EIFS walls can cost effectively achieve thermal efficiency, moisture management and air leakage control. The materials and methods used for EIFS have relatively low environmental impacts compared to many other alternatives. Low initial costs for EIFS also allow challenged building budgets to direct savings to improving weak links in critical components like windows and doors. From a durability perspective, EIFS perform as well as many competing alternatives provided they are detailed using best practices, and avoid being located at the base of buildings where they may be vulnerable to impacts, abrasion and chemicals. In terms of their future adaptability to climate change, EIFS are full adhered cladding systems that typically have higher resistance to wind loads than mechanically fastened alternatives. But does all of this mean EIFS is a superior value proposition?

First, let's look at the major limitations of EIFS:

1. The impact resistance of EIFS is being continually addressed with new formulations for supplemental reinforcing layers, but as with many other vulnerable cladding materials, it is advisable to avoid the use of EIFS in areas prone to high abuse by impact and abrasion.
2. EIFS requires that acceptable application temperatures be maintained and this can be either restrictive and/or costly during cold weather; and
3. Like many other cladding systems, EIFS has specific limitations to be observed where codes require a non-combustible cladding due to limiting distance restrictions.

On the positive side of the ledger:

1. The thermal efficiency of EIFS is a major advantage provided by continuous insulation;
2. Reduced air leakage is a beneficial feature of the water resistive barrier and insulation adhesive that is applied to the entire surface of the exterior wall;
3. Reduced condensation potential is a widely acknowledged advantage of continuous, exterior insulation;
4. Versatility and adaptability to a wide variety of exterior wall types; and
5. Low carbon footprint that is quickly offset by energy savings (reduced greenhouse gas emissions).

The big question remains: Will these advantages be realized on every EIFS project?

With the introduction of the new EIFS Quality Assurance Program by the EIFS Council of Canada, the value proposition will be predictable and consistent across Canada. This is a critical consideration in a construction industry that is challenged with a lack of qualified personnel, highly variable technical skill levels, and an inability to innovate cost effective building solutions. Let's face reality, costs for new buildings continue to rise but there has been almost no appreciable improvement in performance. The present generation of EIFS is more like our auto and electronics industries, delivering products that have been designed and assembled according to recognized standards under a consistent quality assurance program. This is a major development in our building industry and may well prove to be more significant than all of the other performance advantages that are provided by EIFS.

In my next article, I will examine the EIFS Quality Assurance Program value propositions.