

# Facade Design Essentials

Understanding Weathertightness and Airtightness



## INTRODUCTION

Facade design plays a pivotal role in the overall performance, aesthetics, and sustainability of buildings. It not only defines the building's external appearance but also acts as the primary barrier between the indoor environment and external elements such as weather, noise, and pollutants.

Weathertightness and airtightness are critical design parameters for modern facades as they directly influence a building's durability, energy efficiency, and occupant comfort. Understanding weathertightness and airtightness is significant as both address important performance criteria.

Weathertight facades reduce the risk of moisture damage, which can lead to mould, insulation deterioration, and structural issues. The quality of airtightness in a weathertight structure specifically ensures minimal air leakage, improving thermal performance and reducing the need for excessive heating or cooling. Both these two elements are crucial for maintaining the longevity and energy efficiency of modern buildings.

This paper explores the concepts of weathertightness and airtightness, explaining how they contribute to the overall performance of a building. Furthermore, it reviews different types of facade systems, showcasing their individual advantages in achieving reliable performance.





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A well-designed airtight facade that incorporates all aspects of weathertightness reduces heat loss, prevents moisture-related damage, and minimises drafts while maintaining a controlled and healthy indoor environment.

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## WEATHERTIGHTNESS

Weathertightness is a fundamental design principle in façade building, ensuring that the elements do not damage the façade system by the ingress of moisture and air from external sources into the building envelope. By creating a barrier against inclement weather, weathertight facades help to protect the structural integrity of the building by for instance preventing the accumulation of moisture within walls, which can lead to material deterioration, mould growth, and reduced thermal performance. The facade must be designed to handle various moisture-related forces, such as gravity, capillary action, and pressure differentials, while allowing any incidental moisture to drain or dry out effectively.

The main purpose of a facade system is to create a weathertight building envelope, and its design and component selection must be carefully considered by the façade engineer or specifier. Different environmental factors including wind, rain intensity, the building's location and the impact level of exposure to moisture need to be considered by architects and designers during the design phase.

Weathertightness is not the same as watertightness. Submerged under water, almost all buildings would fail, so they are not watertight. Instead, most buildings are designed to manage rather than completely block water ingress. Buildings should be viewed as modifiers of weather (or climate). They don't fully seal the structure against water or air, but limit and control these elements.

## AIRTIGHTNESS

Airtightness refers to the ability of a building's façade to prevent unwanted air from entering or escaping through gaps, cracks, and openings in the building envelope. Weathertight buildings are generally also airtight, but it is important to understand that airtightness refers only to air movement whereas weathertightness refers to air and moisture movement. In the façade airtightness is achieved by installing a suitable airtight water barrier designed to block or control air leakage and resist fluctuations in air pressure, ensuring that unintended air movement is minimised. This contributes to maintaining a stable indoor environment and reducing energy consumption for heating and cooling.

The blower door test (see AS NZS ISO 9972:2015) is a widely used method to measure a building's airtightness by using a calibrated fan temporarily sealed into an exterior door. The fan creates a pressure difference between the inside and outside, forcing air through any gaps in the building envelope. By measuring the airflow needed to maintain a pressure of 50 Pascals (Pa), the test calculates how airtight the building is, with results shown as leakage area, airflow rate, or air changes per hour. The fewer gaps a building has, the less air is required from the blower door fan to change the building's pressure.







## FACADE DESIGN STRATEGIES

Achieving weathertightness and the associated airtightness involves carefully selecting materials and designing the building envelope, including walls, roofs, windows, and doors, to resist moisture intrusion. The complexity of modern facades requires thoughtful integration of components to ensure a continuous protective barrier.

When specifying materials and products for weathertight facades, the “4Ds framework” — deflection, drainage, drying, and durability — guides the design process. Deflection ensures that cladding systems, eaves, and other features direct water away from the building. Drainage provides a secondary line of defense, allowing water that bypasses the outer layer to safely exit. Drying helps remove any remaining moisture through ventilation or diffusion, while durability ensures that materials can withstand the effects of long-term exposure to weather. By following these principles, designers can create high-performance and durable facades that protect the building from moisture-related damage.

Sealing the weather barrier and all penetrations creates a weathertight and airtight barrier that reduces infiltration, or uncontrolled air movement, which can cause energy loss and discomfort. In winter, exfiltration can lead to warm, moist indoor air entering cold wall cavities, causing condensation, mould, or rot. In summer, infiltration allows humid air inside, leading to similar moisture issues. Airtightness helps maintain a controlled indoor environment, lowering heat loss, enhancing comfort, and protecting the building’s fabric from moisture-related damage.

The benefits of airtight buildings are numerous, including lower energy costs, improved comfort, fewer building defects, reduced condensation, and lower carbon emissions. Airtightness is also a key design principle of Passive House design. However, achieving airtightness must be balanced with proper ventilation to maintain good indoor air quality. While airtightness improves energy efficiency and comfort, inadequate ventilation in overly sealed buildings can lead to poor air quality and condensation issues, potentially impacting occupant health.

A well-designed weathertight facade reduces heat loss, prevents moisture-related damage, and minimises drafts while maintaining a controlled and healthy indoor environment. This balance is essential for optimising building performance and sustainability.

### Ventilated facade systems

Ventilated facade designs are popular due to their ability to enhance thermal and energy efficiency and manage moisture through an air gap between the cladding and the external weather barrier. They also improve acoustic performance and improve the longevity of the façade structure. This gap improves ventilation in the façade, in turn moderating the exchange of heat and air that circulates between the interior and exterior of the building, dissipating any radiant heat, reducing thermal movements of the façade components, and keeping the external insulation and weather barrier dry.

An efficient weather barrier plays a crucial role in a ventilated façade system. The barrier can be rigid or pliable and should be airtight and wind and moisture resistant.

## WEATHER BARRIER TYPES

### Rigid weather barriers

Rigid air barriers, commonly made from materials like fibre cement or gypsum, play a crucial role in enhancing both air and weathertightness in façade design. These barriers add durability and resistance to moisture, acting as an additional protective layer that helps prevent water and air penetration through the cladding. Their rigidity provides the strength to withstand high wind pressures, ensuring the facade remains structurally sound and prevents water and air ingress even under extreme conditions. Together with the insulation in the framing cavity, they also contribute to thermal and acoustic performance of the external wall. They assist in regulating vapour diffusion, playing a crucial role in managing condensation and preventing moisture-related issues.

An added benefit is that weather barriers can protect the structure against the elements before cladding stage, allowing internal trades to keep working in inclement weather conditions.

### Pliable membranes (sarking)

A pliable membrane or sarking is a flexible weather barrier that plays a significant role in improving both air and watertightness in façade design by acting as both an air and water barrier. These membranes, typically used for weatherproofing where a rigid air barrier is not required, help protect the building from wind-driven rain and water ingress, ensuring that moisture does not penetrate the external envelope. They also help control air infiltration and reduce unwanted air leakage and energy loss. Depending on their vapour permeance level they can also help control vapour diffusion, assisting with condensation management.

When classified as water barriers, in accordance with AS 4200.1, these materials provide an essential layer of weather protection. These membranes must be installed as per AS 4200.2 for optimal performance.

## TECHNIQUES TO IMPROVE WEATHERTIGHTNESS AND AIRTIGHTNESS

### Materials

The choice of materials plays a pivotal role in achieving optimal weather and airtightness. High-performance weather barriers, flashings and insulation materials help improve thermal efficiency while minimising air and moisture intrusion. Selecting materials suitable for the specific climate and building structure is key to ensuring long-term durability and performance.

### Design

Effective design begins with a thorough understanding of site-specific conditions. For weather and airtightness, this means tailoring the cladding, drainage systems, and insulation based on the environment's exposure to wind, rain, and temperature fluctuations. Ventilated facades offer a good solution as the drained cavity behind claddings enable moisture to escape, reducing the risk of water damage and encouraging ventilation for drying.

In contrast, direct-fixed cladding offers limited drainage options, increasing the risk of moisture retention and intrusion.

### Installation

Proper installation and quality workmanship are critical to maintaining both weather and airtightness. The correct installation of membranes; thorough sealing of all penetrations to ensure continuous seals around windows, doors, and other openings, and generally following best practice installation techniques are essential.

### Testing

Testing is crucial to validate that optimal weather and airtightness levels have been achieved. Techniques such as the aforementioned blower door test assess air leakage by quantifying how well a building's envelope prevents air infiltration.

To ensure weatherproofing performance, it is paramount that the weatherproofing performance of an external wall assembly is assessed through appropriate testing as per the relevant standards.

Proper testing helps identify any weak points, allowing for timely repairs or modifications to ensure long-term performance of the building and the facade.







## DESIGN HIGH-PERFORMANCE FACADES WITH WEATHER DEFENCE™

Siniat's Weather Defence™ rigid air barrier board is an innovative solution that helps designers achieve high-performing, weathertight and airtight facades. This board is ideal for rainscreen and ventilated facade systems, offering numerous benefits that contribute to both weathertightness and airtightness. It also improves the thermal and acoustic performance of the façade.

Weather Defence™ is designed to suit a variety of building types, including lightweight steel, modular, and timber frame constructions. The board complies in facades where non-combustibility is required, while its Class 4 vapour permeability makes it suitable for all climate zones. Weather Defence™ is quick to install, easy to score and snap, and be left exposed for up to 12 months, allowing internal trades to get the job done in inclement weather conditions.

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Weathertightness is crucial for maintaining both the longevity and energy efficiency of modern buildings, while also improving the thermal and acoustic performance of the façade.

