



# Research & Development Highlights

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## Structural Requirements for Air Barriers

### Introduction

The National Building Code of Canada requires that buildings be provided with an effective barrier to air exfiltration and infiltration. The components within a building envelope which provide airtightness are called the “air barrier.”

To be effective over the life of a building, the air barrier must resist the damaging effects of winds, stack effects, and other forces. These forces must therefore be taken into account in its design. To assist in the development of design guidelines, Canada Mortgage and Housing Corporation (CMHC) commissioned a study on the requirements for structural design of air barriers.

### Basics of Structural Design

An air barrier may be subjected to significant air pressure due to wind effects on a building.

There are also lesser magnitude but longer acting air pressures, such as those due to stack effect. These loads can cause failure of some building materials due to creep. Other low magnitude but constantly fluctuating loads, such as daily wind gusting, can cause fatigue failure of some building materials.

The basic objective of structural design is to ensure that the strengths of a structure will exceed the loads acting upon it. The following chart indicates the types of loads which must be considered in structural design of air barriers, and the strengths required to resist them.

Type of Structural Failure			
Type of Loads	Static Strength	Fatigue Strength	Creep Strength
Extreme Wind			
Commonly Occurring Winds			
Stack Effect			
Mechanical Pressurization			
Restraint to Thermal Expansion Contraction			

### Structural Design Requirements

To prevent air barrier failure, the designer must take into account air pressure loads on the air barrier and the manner in which these loads are transmitted to the building’s structural frame.

The main sources of air pressure loads are:

1. external and internal wind pressures resulting from wind effects;
2. internal pressures resulting from mechanical system operation; and
3. internal pressures resulting from stack effect.

The report reviews what is known about the magnitude and frequency of these loads.

The transmission of the air pressure load by the air barrier will depend on the wall system used in the building. The report outlines air pressure load paths for four common types of wall system, and the design considerations which arise from them. These four types are:

- clad wood stud frame;
- brick veneer/steel stud wall;
- brick veneer/concrete masonry wall; and
- exterior insulation finishing system.

Different types of air pressure loads have different effects on the air barrier. Stack effect and mechanical pressurization loads act at low magnitudes for long periods of time, causing creep problems. Wind loads cause structural failure by exceeding adhesive strength, mechanical fastener strength, or material strength.

The report evaluates proposed methods of estimating these loads. It describes the system used in the National Building Code of Canada to calculate wind loads for structural members and cladding, but notes that this method may not be suitable for establishing wind loads on air barriers. Alternative approaches are also evaluated.

Determining the ability of air barrier materials and fasteners to resist these loads without structural failure is difficult. A limited amount of test information is available, and few of the standards governing air barrier materials

include explicit structural requirements. The report reviews current knowledge on the structural adequacy of five common air baffle materials and systems:

- gypsum board;
- rigid insulation, such as extruded polystyrene;
- polyethylene sheet;
- membranes, including thermo-fused, trowel- or spray-applied, and mechanically—fastened systems; and
- exterior insulation finishing systems.

## Conclusions

At the present time, it is logical to use the National Building Code of Canada provisions for cladding to assess structural adequacy of air bafflers. The first priority must be to establish a set of conservative structural guidelines which are applicable across the country.

As a minimum, air barriers should be designed to resist the wind loads for cladding specified in the NBC. However, it is prudent to seriously consider requiring that air barrier materials be capable of withstanding loads higher than those required for cladding.

The loads (particularly wind loads) which are identified in building codes are not presented in a format that enables a designer to identify the appropriate level of loading for a given building life and given probability of exceeding that level. However, there are many instances when it would be worthwhile to have the option of using other than the built-in assumptions of the Code. For example, it may be

reasonable to allow higher probabilities of failure for air bafflers utilizing materials such as interior gypsum board than for air bafflers such as exterior gypsum board in which structural failure will go undetected.

There is a severe lack of knowledge regarding the structural properties of air baffle material and fasteners. Without knowledge of the variability in these structural properties, it is not possible to rationally establish appropriate lower bound strengths for the variety of building materials being used as air bafflers. The practice of testing a wall construction to 1.5 x “ultimate” or “factored” code-based wind load is only appropriate for constructions where the test sample is very representative of the actual construction. For manufactured building components constructed of building material with strict quality control (such as steel or aluminium), this is reasonable. For more variable materials, however, it is not reasonable to test to only the factored wind pressure, since the test sample may not be representative of the actual construction.

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**Research Report:** *Structural Requirements for Air Barriers*

**Research Consultant:** Morrison I-Iersfield Limited

*A full report on this research project is available from the Canadian Housing Information Centre at the address below.*

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