INTRODUCTION

This Arriscraft•NOTE discusses the rain screen principle and compares cavity walls with rain screen walls.

Walls built as solid multi-wythe structures rely heavily upon the mass of the wall materials to resist moisture penetration. Researchers eventually realized that the exterior wythe of a masonry wall could not be made totally watertight. Exterior wall surfaces become wet, and openings eventually develop within the wall, thus permitting moisture infiltration.

In 1962 a Norwegian researcher, Birkeland, identified six major sources of moisture leakage:

- wind-induced air pressure differences,
- pressure-assisted capillary,
- gravity,
- kinetic Energy,
- air currents, and
- updrafts.

Conventional means of managing moisture resist most of the major causes of moisture leakage, but wind-induced air pressure is not quite so easily counteracted. Birkeland concluded that there was no practical method for obtaining total water tightness in wall systems composed of joints when a pressure gradient exists across the exterior rain barrier.

This research was further developed by the Canadian National Research Council, which published Canadian Building Digest 40, Rain Penetration and Its Control. This publication remains one of the primary reference sources on the topic. It states that, "*…through wall penetration of rain can be prevented by incorporating an air chamber into the joint or wall where the air pressure is always equal to that on the outside.*" This remains the basic principle of a rain screen wall.

Rain Screen Versus Cavity Wall

Rain screen wall systems and cavity walls are not one and the same. Admittedly, both incorporate a cavity to drain any moisture which may have entered the wall, but the cavity wall stops there. It does not allow air pressure in the cavity to be equalized with external pressures, and the interior wall assembly may or may not include air/vapour barrier membranes designed to restrict the movement of water vapour and air through the wall.

The basic premise of the rain screen principle is to control all forces that can drive moisture through the wall system. Its primary function is to restrict the passage of moisture through the wall caused by wind-induced pressures.

The critical components of a rain screen wall are:

- an exterior barrier containing protected openings that permit the passage of air but not water,
- a confined cavity behind the rain screen in which air pressure is essentially equalized with the exterior,
- insulation securely fastened to the outer face of the interior wall system, and
- an interior wall system, incorporating an air and vapour barrier capable of resisting the passage of air and water vapour, and capable of withstanding all required design loads.

In cavity wall systems the difference in air pressures across the exterior cladding is a significant force, causing infiltration of air and water on windward faces. The air pressure in the cavity becomes relatively less than the external air pressure along these building faces, and any moisture hitting the masonry veneer will be driven through any openings in the veneer and come in contact with the interior wall.

In a rain screen wall the cavity has had its air pressure equalized with that of the air outside by the presence of sufficiently designed openings. These openings allow air to flow freely within the cavity. Rain penetration into the cavity should be reduced because the effects of differential pressure have been essentially eliminated. The resultant wind load will be imposed on the inner layer of the wall assembly. For that reason it is important to install flashing membranes and air/vapour barrier membranes to produce an air-tight, weather-resistant assembly at the inner layer, thereby reducing the potential for moisture infiltration.

Equalizing the Pressure

In order to ensure the equalization of cavity pressure to external air pressure a number of requirements need to be satisfied, including:

- Compartmentalization of the air space;
- Adequate venting of the compartments; and
- Clear compartments free of mortar blockages.

Compartmentalization: Wind pressure flowing around a building creates a distribution of positive and negative pressures over the face of the exterior cladding. If the cavity of the rain screen wall is continuous, pressure equalization will not occur due to lateral airflow. To prevent lateral airflow within the cavity it should be divided into separate air chambers or compartments. The size of the compartments depends upon the degree of differential pressure anticipated at specific points around the building. Areas of the wall where higher differential pressures are anticipated should be designed with smaller compartments; whereas, areas having smaller differences in pressure may be larger.

A typical example where compartmentalization should be incorporated would be at external corners where high differences in

air pressure could result in lateral airflow across the cavity and thus a loss of pressure equalization.

Ventilation: To provide pressure equalization it is also necessary to design a series of openings within the rain screen veneer. These openings connect the cavity with the exterior and should be positioned at the top and bottom of each compartment. A typical method for incorporating these openings in sufficient quantity to ensure pressure equalization of the cavity is by placing cell vents and weepholes respectively at the top and bottom of all cavities. When the vent is in the form of an open head joint, a suitable spacing of 600 mm (24") on centre should prove adequate in most instances.

Mortar Blockage: When constructing a rain screen wall, it is equally important to ensure that the cavity remains free of mortar droppings and protrusions. Mortar droppings, which collect at the base of a cavity, block the free drainage of moisture as well as restrict the free flow of air between the cavity and the exterior. Restricted airflow inhibits pressure equalization.

Summary

This Arriscraft •NOTE describes the pressure equalized rain screen principle as it applies to masonry veneer and cavity wall systems and discusses recommended design guidelines to reduce rain penetration through exterior wall assemblies.

The rain screen principle is a superior method of designing and constructing a building envelope, controlling the many factors that contribute to moisture penetration. It is based on the principle of equalizing air pressures within the drainage cavity with those on the exterior face of the building, thereby reducing the possibility of moisture penetration resulting from difference in the wind-induced air pressure. When designed and constructed properly, this wall system provides the best possible protection against moisture infiltration and subsequent building damage.

The information and suggestions contained herein are based upon the available data and information published by the listed references and the experience of Arriscraft International architectural and engineering staff. More detailed information may be found by referring to any of the related references listed below.

The information contained herein must be used in conjunction with good technical judgement and a competent understanding of masonry construction. Final decisions on the use of the information contained in this Arriscraft•NOTE are not within the purview of Arriscraft International and must rest with the project designer or owner, or both. It remains the sole responsibility of the designer to properly design the project, ensure all architectural and engineering principles are properly applied throughout, and ensure that any suggestions made by Arriscraft International are appropriate in the instance and are properly incorporated through the project.

Related References

1. Brick Industry Association, Technical Notes on Brick Construction 27 (Revised), Brick Masonry Rain Screen Walls, August 1994.
2. Fornoville, Luc, Rain Resistant Masonry Construction, Third North American Masonry Conference, 1985.
3. National Research Council of Canada, Canadian Building Digest 40, Rain Penetration and Its Control, 1963.
4. Ontario Masonry Industry Promotion Fund, 4C 8303, Masonry Walls, Rain Screen, Composite and Cavity Walls, March 1983.
5. Ontario Masonry Industry Promotion Fund, 4C 8803, Masonry Single-Wythe TTW, Rain Screen Walls, March 1988.
6. Ontario Masonry Industry Promotion Fund, 4C 9003, Protective Rain Screen Applications, March 1990.
7. Ontario Masonry Industry Promotion Fund, 4C 9009, Venting Masonry Rain Screen and Cavity Walls, September 1990.

Arriscraft

P.O. Box 3190
875 Speedsville Road
Cambridge, Ontario
Canada N3H 4S8
Toll Free: (800) 265-8123
Telephone: (519) 653-3275
Fax: (519) 653-1337
E-mail: solutions@arriscraft.com
Web: www.arriscraft.com