Air Barrier Systems: Construction Applications

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Innovate or Stagnate

The road to an effective air barrier assembly was made up of apparent successes and baffling failures. In my view, the most significant reason for that turbulent past was that we used the wrong materials to do the job; field investigations show clearly that in many instances of poor performance, choice of material and/or system was more to blame than construction practice. This is not new; in hundreds of cases in construction history, failure occurred because of improper application or wrong choice of components.

"Traditional designs have evolved by trial and error to deal with observed problems. Trial by use still provides the ultimate test, but the development of designs based on the best understanding of the process and environmental factors involved, is a necessary first step. The chance of satisfactory performance is increased and drastic alterations to solve the problem after the fact are likely to be avoided" (Handegord, G.O. , from DBR/NRC Building Science Seminar, Walls, Windows and Roofs, Oct. 1971).

This is not to say that the materials presently available are no good and should be replaced by new ones. It is the way materials are used, the function they must fulfill and the environment they must withstand that determine how well they perform, and it is the way they are detailed and assembled that determines how well the wall performs.

At the beginning of the 80's, Construction Specifications Canada held a conference in Jasper, Alberta. The theme was "Educate or Litigate," quite an appropriate title considering what was happening in the industry. The four main causes blamed for the poor performance of building envelopes were Ignorance, Carelessness, Negligence and Greed; Ignorance is the one we can do something about. This is the basic purpose of the Building Science Insight Seminars: trying to learn from one another's experiences. The designer and the builder must act in cooperation with research organizations to minimize their risks from growing litigation over the performance of our buildings.

"It is obviously necessary to get back to science principles in the design and construction of enclosures for buildings. As the principles have been described, it is simple to design and achieve trouble-free walls, windows and roofs. In fact, it may not always be a simple matter without careful attention to detail in design and construction. The achievement of adequate air barriers seems to be one of the main difficulties. All details must be examined to ensure that continuity is possible and that construction is carried out in a manner that achieves it" (Baker, M. , from DBR/NRC Building Science Seminar, Walls, Windows and Roofs, Oct. 1971).

The previous papers examine the requirements of air barrier systems. Now let's examine how ordinary materials can be used in an innovative way to design, detail and construct effective air barrier systems for common types of walls.

Residential Construction

The Air Drywall Approach (ADA)

In the Air Drywall Approach, the interior gypsum board is the main component of the wall

air barrier system. The joints between boards are finished in the typical manner using joint compound and tape. Joints between the gypsum board and adjacent assemblies or materials are sealed with gaskets, as shown in Figure 1. In this approach, compression seals are used to achieve airtight joints between the drywall and other components of the assembly, such as drywall/wood plate and wood/wood joints. This is an innovative approach and thus requires extra effort from the designer and builder to counteract skepticism from regulatory authorities.

Commercial Construction

Gypsum board has been successfully used as an air barrier material in commercial and institutional construction. Two different techniques are used: the Accessible Drywall Approach and the Non-Accessible Drywall Approach. The essential difference is in the location of the plane of airtightness.

The Accessible Drywall Approach

The Accessible Drywall Approach is similar to the ADA in that the interior (exposed) layer of drywall constitutes the main component of the air barrier system, but the system relies on high performance sealants in lieu of gaskets to seal the drywall to other materials. The reason is that greater tolerances are usually needed in commercial construction and larger differential movements are anticipated due to longer spans.

The Accessible Drywall Approach provides easy access to the air barrier from the interior, allowing for easier inspection and repairs if needed, more quickly and economically.

The Accessible Drywall Approach works well with an all concrete structure. Sealants can be used to seal the drywall to the concrete floor and to the underside of the slab (Figure 2). Since the concrete floor itself is virtually impermeable to air, it ensures the continuity of the air barrier through its thickness. In areas where more movement is anticipated, such as the interface between drywall and concrete slab ceiling, a strip of reinforced elastomeric membrane is often used.

In a steel structure, achieving an airtight enclosure with the Accessible Drywall Approach may be complicated. It is difficult to achieve a durable seal between the wall air barrier and the metal deck or spandrel beam/column intersection. In this case, to achieve continuity of the plane of airtightness, the Non-Accessible Drywall Approach is a better option (Figure 3a).

The Non-Accessible Drywall Approach

In the Non-Accessible Drywall Approach, exterior drywall sheathing is the main component of the air barrier system. The joints between boards are taped with a reinforced self-adhesive tape, and joints between boards and other components are sealed using strips of elasto-

Figure 1 Air sealing at wall/floor junction Air Drywall Approach

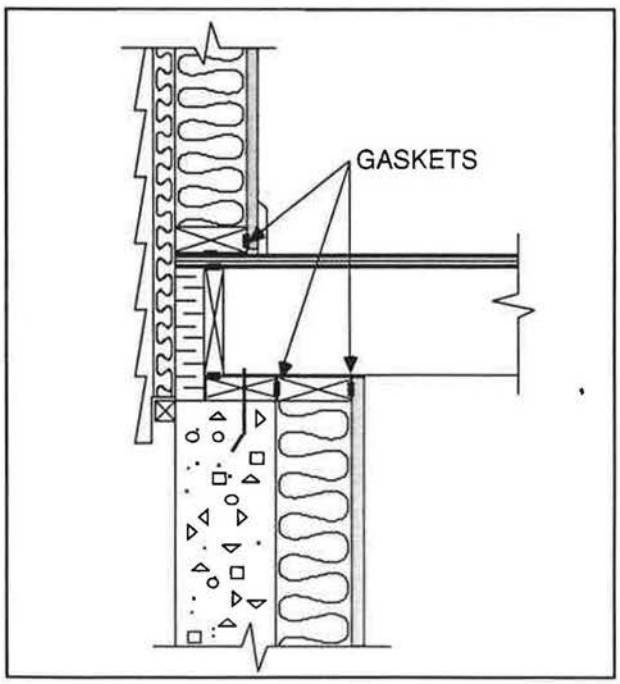
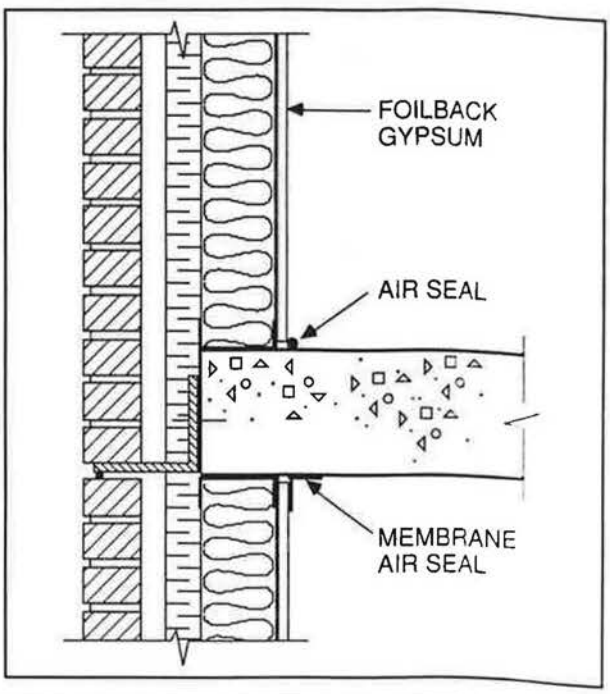


Figure 2 Air sealing at wall/floor junction Accessible Drywall Approach



meric membrane (Figure 3b). If aluminium foil-backed gypsum board is used, the foil should face the inside stud cavity because the sealants and strips of elastomeric membrane applied on the outside of joints should adhere to the paper liner of the drywall, which provides better adherence than foil. In this case, the insulation should not be placed in the stud space, but rather it should be fastened in place on the outside of the gypsum board. This approach usually presents the advantage of fewer perforations than those associated with the Accessible Drywall Approach (outlet boxes, supply piping and wiring to mechanical services, etc). This external location is particularly advantageous with a steel structure because the air barrier can usually be extended past the steel columns and floors with few complications.

Since the gypsum board and air seal materials will be nearly inaccessible once the insulation and exterior cladding are installed, the materials specified to join the drywall to other components must be durable and attachedso that the long term performance of the system is ensured. As a result, waterproof flexible membranes are usually preferred to sealants for connections between airtight materials (Figure 3b).

A daylight walk through the building before the insulation and interior finish are installed will highlight holes and cracks in the air barrier that have been missed. Careful inspection and perhaps field testing before closing the system are particularly important because the air barrier system is not as accessible for repair or maintenance as with the other method.

Metal Air Barrier Systems

The use of sheet metal as the air/vapour barrier in curtain wall construction and other pre-engineered metal walls is well established. A major advantage of these systems is that the supplier is usually the designer, manufacturer and installer of the wall so that the building owner has to deal with only one firm if the walls do not perform as specified.

Curtain Wall Systems

Lightweight, pre-engineered curtain walls allow for speedy erection and faster closing-in of a building. In this case, the air barrier is made of glass, metal pan, metal extrusions and a variety of gaskets, tapes and sealants (Figure 4). However, leakage paths may occur through the

Figure 3a Flexible membrane air seal at wall/floor junction—Non-Accessible Drywall Approach in steel structure

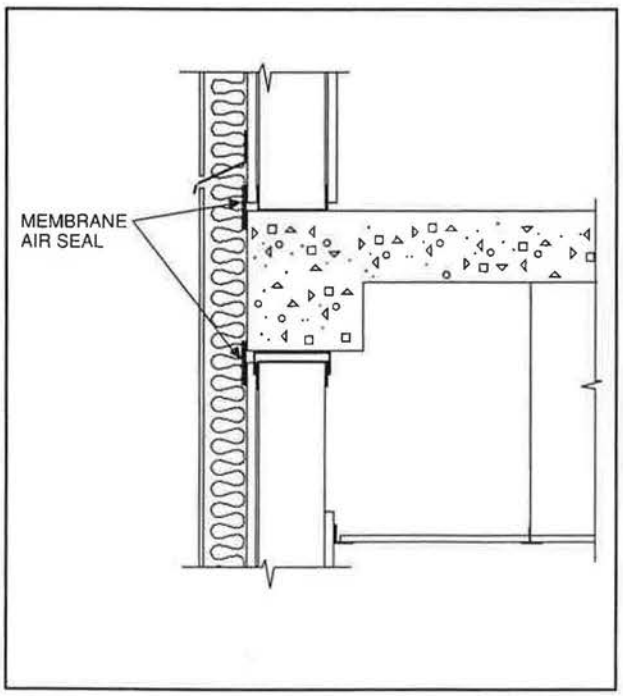
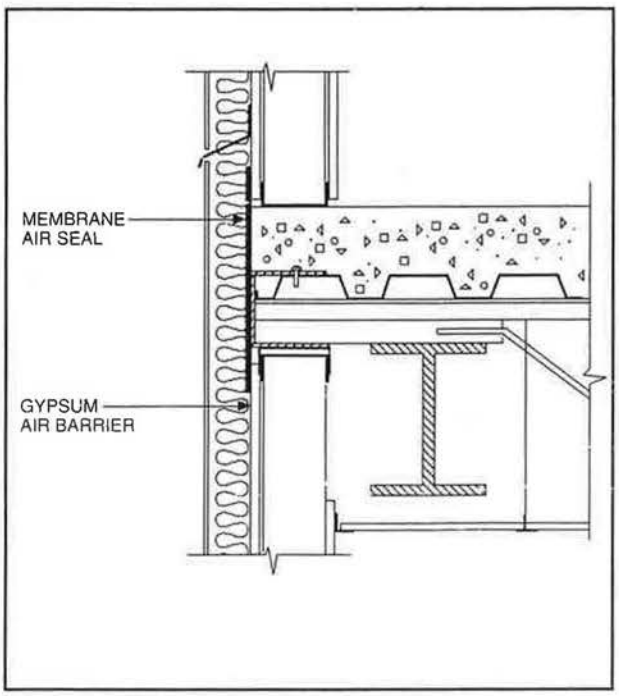


Figure 3b Flexible membrane air seal at wall/floor junction—Non-Accessible Drywall Approach in concrete structure



interconnected passages in hollow sections at intersections and corners; these are not easy to identify in two dimensional drawings. They can be discovered by careful on-site inspection and testing. Curtain walls are the only wall system where an air leakage standard has been in use for some time.

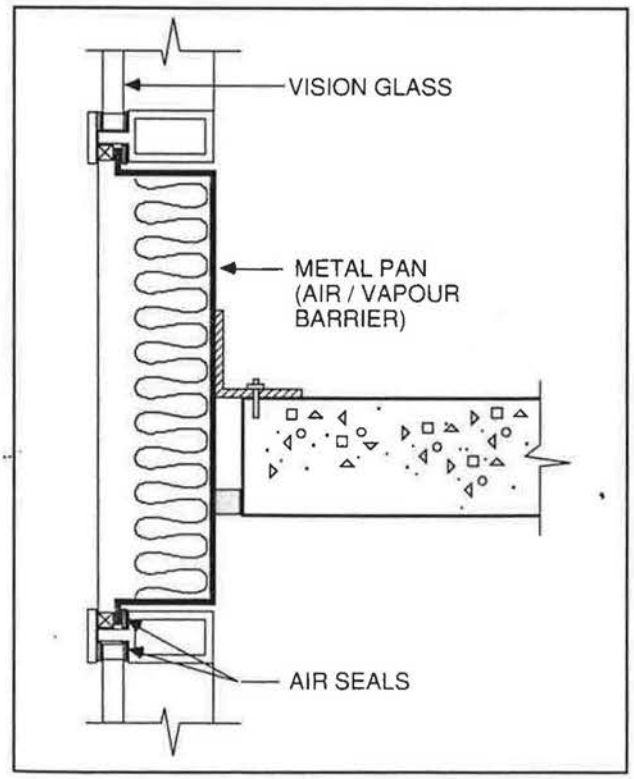
Sheet Metal Wall Systems

Less sophisticated in their approach than curtain walls, pre-engineered metal walls became very popular for warehouses and factories. The interior sheet steel liner often acts as both inside finish and air/vapour barrier. As well, over the last ten years, attractive and functional office buildings, medical complexes, laboratories and research institutions have been designed and built with these systems, using conventional interior finishes such as drywall or wood panelling. Compared to curtain walls, these walls usually offer a potential for a more continuous and thicker layer of thermal insulation.

Masonry Wall Systems

The greatest architectural masterpieces of the past were masonry construction. In my view, masonry wall systems are still the most durable, fire- and sound-proof construction one can get.

Figure 4 Plane of airtightness in curtain wall system



However, the problem today is that we do not build masonry walls anymore: some trades put up the blocks, others the insulation, others the bricks, while still others caulk the joints, as well as all the cracks that develop thereafter.

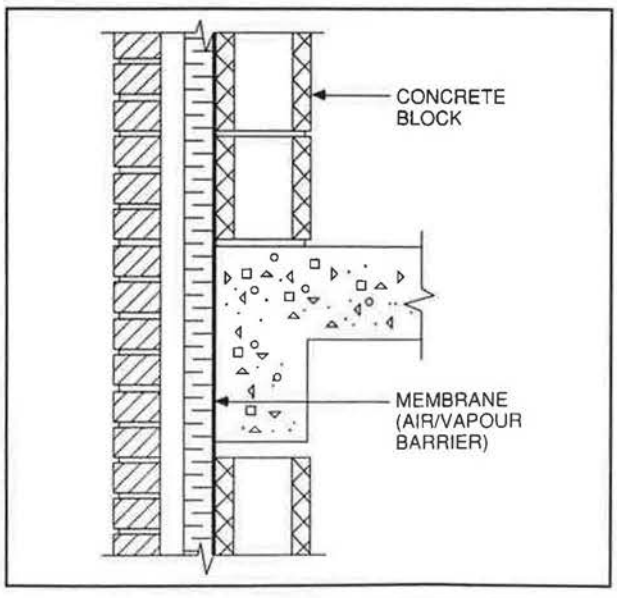
There are ways to build modern masonry walls that have all the advantages, the beauty and durability of the masterpieces of the past. The masonry industry has to examine practical ways for achieving an effective air barrier system applicable to masonry construction. Here are a few of the new air barrier technologies that will have to be considered, implemented and eventually mastered.

Factory-made elastomeric membranes offer real potential to provide airtightness to masonry walls. These membranes are applied on the entire surface of the masonry backup wall and are used to make airtight connections with other building components (Figure 5). There are two types of product available: thermofusible, and peel and stick membranes.

Thermofusible Membranes

These membranes are usually made with SBS modified asphalt on both sides of a polyester or fibreglass mat; they look like roll roofing but without a granular finish. They are fused to a substrate by melting the backing and softening the elastomeric bitumen with a propane torch. To prevent them from sticking together in a roll, their surface is usually covered with fine sand, talc or better, with a thin sheet of polyethylene.

Figure 5 Elastomeric membrane in masonry wall



They are available in a variety of thickenesses to suit the requirements of the job. The insulation is usually held in place with metal clips heat welded to the membrane.

Peel and Stick Membranes

Peel and stick membranes are prefabricated sheets consisting of a rubber modified asphalt and a polyethylene carrier. The sheets are self-adhesive, and installation consists of removing the release paper and pressing the membrane onto a primed masonry surface. The sheets are overlapped slightly in both directions to ensure that the building is completely wrapped. The insulation is usually fastened through the membrane into a backup wall, or held in place by compression wedges if wire type masonry anchors are used.

Conclusion

"As is evidenced by the variety of buildings that are daily completed in Canada, there is no dearth of creative genius and ingenuity of designers and builders within the construction industry. And there is no doubt that the present unsatisfactory performance of many buildings and building elements can be overcome by concerted team effort and overall discipline on the part of all concerned with building. Only with knowledge of science principles and an explicit philosophy can conflicts and inconsistencies in design, and misunderstood requirements and faulty execution in construction, be eliminated from the present building industry where there now is a proliferation of new building types, inadequately understood new methods and materials, and a quickened pace of construction" (Baker, M. , from DBR/NRC Building Science Seminar, Walls, Windows and Roofs, Oct. 1971).

This was written in 1971, almost 15 years ago!!

"How very little since things were made
Things have altered in the building trade."

A truthful song
R. Kipling