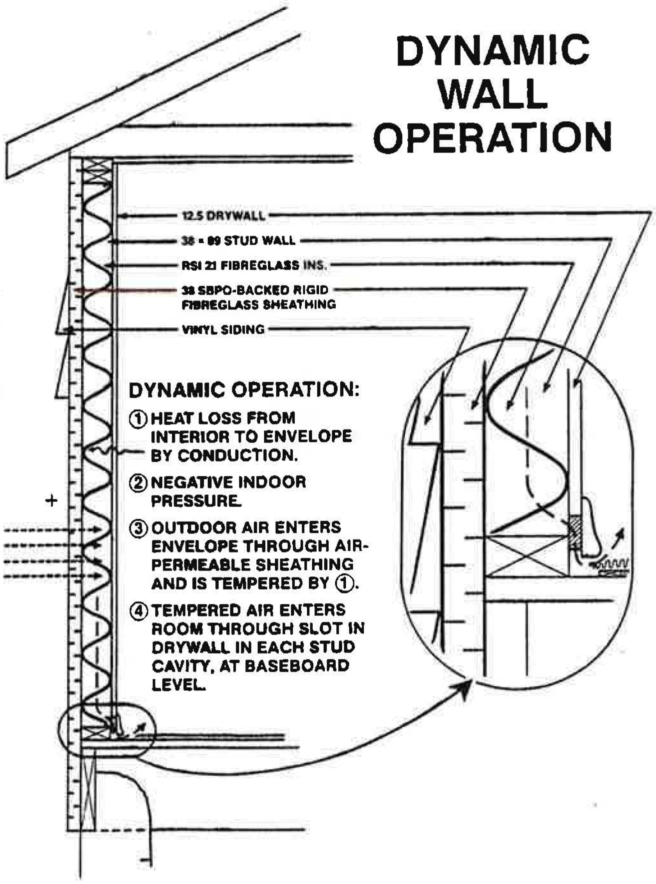
Dynamic Walls:
Demonstration project results

The building industry is under pressure to provide affordable energy-efficient housing without sacrificing quality. The recognition of indoor air pollution as a health hazard is increasing the pressure.

Improved airtightness has resulted in requirements for mechanically assisted combustion air systems and mechanical ventilation. Consumers are beginning to accept the higher costs of tighter building envelopes and the associated incremental costs for induced draft or direct vent gas appliances. In Alberta consumers are not readily accepting the higher costs of heat recovery ventilators nor the high operating costs resulting form mechanical ventilation without heat recovery. Thus a ventilation strategy that is effective, reliable, and relatively inexpensive is essential for consumer acceptance of an energy-efficient house.

The Dynamic Wall is a ventilation strategy that has the potential to meet these criteria. It is an idea first conceived in Sweden, but developed into a practical application of the theory in Canada by Dr. John Timusk at the University of Toronto. (see SOLPLAN REVIEW No. 14)

The construction details of a dynamic wall house ensure that the house is sufficiently airtight to direct incoming ventilation air through the "dynamic" portions of the envelope, sufficiently air-permeable to allow air to be brought in at very low velocity. The heat loss through the exterior wall by conduction warms the cooler air being brought in. It offers the potential to provide ventilation air with less chances for mechanical failure and without the costs associated with heat recovery ventilators.



Alberta Demonstration House

A demonstration house in Sherwood Park, Alberta was built by Lincolnberg Homes in the winter of 1988-89 to test the dynamic wall concept, to determine if the dynamic wall system works according to theory and can be used in production housing. It also was to see if the home owner would benefit in terms of space heating, air quality and comfort. The house was monitored by Will Mayhew of Howell Mayhew Engineering using an extensive computerized monitoring system during the 1989-90 heating season.

Specifically, the objectives of the project were:
- to demonstrate and assess the construction methods;
- to determine the cost-effectiveness of the concept in Alberta;
- to analyze the operation of the dynamic wall system; and
- to determine how other components and systems in the house interact with the dynamic wall.

The house is a typical four-bedroom, two-storey tract house with an attached two-car garage. It generally conforms to conventional wood-frame practices with the following exceptions:
- Glasclad sheathing in place of standard 10 mm spruce plywood
- Non-naturally-aspirated gas-fired appliances were installed
- A central exhaust-only mechanical ventilation system was installed.
- ADA techniques that were employed eliminated the potential for short-circuiting of the dynamic wall.

Exterior wall construction included vinyl siding, TYVEK backed rigid fibreglass sheathing (GLASCLAD), fibreglass batt insulation, and ½" drywall. Small holes at the base of the wall (behind the baseboard) allow the air into the house. The way the dynamic wall works is illustrated in the detail.

The house was built air-tight. Blower door test results indicated an air change rate of 0.93 ACH before the ½" dynamic air inlet holes were drilled in the interior drywall (with the dynamic holes it was 1.31 ACH). Ten months after completion it was still tight - 1.57 ACH. The loosening was due to a combination of ambient test conditions and airtightness deterioration.

The mechanical system was designed to operate a dynamic (negative pressure) mode.

The incremental cost of building the demonstration house was about $4,200.00 more than a conventional house of similar size. Annual energy cost savings were estimated to be $370.00.

Dynamic wall operation

Dynamic wall operation depends on pressure and temperature differences between inside and outside as well as wind speed and wind direction. The degree of tempering (the heat gain) of dynamic air was found to be about 74% of the indoor-outdoor temperature difference. The temperature of incoming air was notably affected by solar radiation.

An exhaust-only mechanical ventilation system with non-naturally-aspirated gas appliances not affected by negative pressures are required for operation in the dynamic mode.

What was found

Measurements indicated that about 30% of total ventilation air was entering through the dynamic system air inlets. At a total ventilation flow of 137 cfm, the pressure drop across the building envelope was about 5 Pa and the flow through the dynamic air holes around 48 cfm .

In windy conditions, significant increases in flow developed on the windward side of the house. The combined wind and stack effects were not enough to reverse flow through leeward dynamic holes upstairs but there was a definite wind effect on the flow through individual walls.

Ventilation air was well distributed throughout the house, but it relied on the forced warm air heating system to mix ventilation air with return air, thus being capable of providing approximately 37 cfm of continuous ventilation per occupant (based on four occupants). There was effective distribution of ventilation air without any additional ductwork.

Because of the action of negative pressure, the dynamic wall eliminates the potential for wall moisture problems as moist indoor air is not able to penetrate the construction.

No discomfort was caused by cold drafts or cold wall radiation when the house was operating in the dynamic mode. However, when operation was in the static mode (no dynamic air) with the fresh air and combustion air ducts open as in conventional housing, the home owner commented that the house felt cooler. Surface temperatures dropped 1°C with the temperature stabilizing approximately 10 minutes after the switch from static mode.

The temperature of the dynamic air entering the house varied with the indoor-outdoor temperature differential. It is also a way to collect significant amounts of solar energy at no additional cost. When daytime temperatures were -18°C, the solar radiation heating the south wall raised the temperature of the dynamic air entering the house by more than 5°C.

The belief persists that negative pressure within the building envelope could encourage the entry of radon to the living space. Although Alberta is not considered a high-risk area for radon, the house was checked. A radon sampling pump located at one of the dynamic air inlets was also used to monitor the presence of glass fibre particulates. Six small fibres were detected. (No standards for glass fibre concentrations have been set for residential occupancies).

No significant levels of indoor air pollutants were measured (Formaldehyde levels were very low). The occupants found the dynamic house comfortable to live in.

The dynamic wall concept was found to be both achievable and, in spite of the uncontrollable variables, is workable in Alberta. Exterior sheathing was roughly one-half of the incremental cost so cost savings could be realized if cheaper sheathing materials are identified. Reductions may also be possible by simplifying the mechanical system and the way dynamic air enters the house.

The findings suggest that operating at 0.3 ACH, adequate quantities of ventilation air are being delivered and distributed throughout the house.

Another aspect of the dynamic wall is that it may allow the use of relatively thin walls. This will provide more usable space, as decreasing the wall thickness in a 2,000 sq. ft. house by one inch can increase the net floor area by some 20 sq. ft.

Dynamic Wall Demonstration Project, undertaken with funding under the Innovative Housing Grants Program of Alberta Municipal Affairs, Edmonton. L. Nakatsui (Lincolnberg Homes) and W. Mayhew (Howell Mayhew Engineering), Edmonton, Alberta.

Letter to the Editor

Sir,

I recently subscribed to your publication and have found the last two issues to be informative. I was surprised to see in the Job-Site Innovator items a commendation given to a Nova Scotia builder for the laminated header. What he has come up with (to his credit) is a section of a structural foam-core panel. These have been around for many years (in the form of walk-in coolers and freezers) and are now widely accepted for their energy efficiency, strength and ease of construction in residential, commercial and industrial buildings.

There is at least one manufacturer of structural panels in Canada (using an EPS core): Thermapan Industries in Ontario. If the idea of the laminated header is attractive, the next logical step is to build the entire structure of panels. I might add that the panels are also the most efficient air barrier and vapour retarder of any building system I have seen.

Chris Norman
South Gillies, ON