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Executive Summary

The National Research Council of Canada (NRC) was contracted by Logix Brands Inc. to investigate the sub-slab ventilation and pressure communication associated with Heat-Sheet Heavy product manufactured by Logix Brands Ltd. The tests were conducted using NRC's in-house developed Radon Infiltration Building Envelope Test System (RIBETS).

This report presents the setup and results of sub-slab ventilation and pressure communication tests with Heat-Sheet Heavy product and 4" (0.1 m) of clean granular material (gravel) being installed in the RIBETS consecutively. A layer of clean granular gas permeable material (gravel is commonly used for this purpose) is part of the prescriptive solution specified in the National Building Code 2015Section 9.13.4.

Based on the comparative sub-slab ventilation measurement results, the following observations and conclusions can be made.

- Under the test conditions, the in-line radon fan could withdraw air from beneath the Heat-Sheet Heavy at a flow rate of 9.91 cfm and result in a pressure of -2.04 Pa beneath the Heat-Sheet Heavy.
- Under the test conditions, the in-line radon fan could withdraw air from the 4" of clean granular material (gravel) layer at a flow rate of 6.42 cfm and result in a pressure of -2.00 Pa in the gravel layer.
- In comparison to the results from sub-slab ventilation test of gravel, the higher flow rate and slightly lower pressure beneath the Heat-Sheet Heavy demonstrate that Heat-Sheet Heavy product performed better than a gravel layer of 4" (0.10 m) thickness as a sub-slab gas permeable layer, under the test conditions. Thus, as a gas permeable layer, Heat-Sheet Heavy is a suitable replacement to a 4" layer of gravel.

1 Introduction

Radon is a naturally occurring radioactive gas, which can be found in varying amounts in all types of soil and bedrock. It is acknowledged that long term exposure to high levels of radon increases the risk of developing lung cancer, and the risk is considerably greater for tobacco smokers.

The most common techniques to prevent radon entry include sealing soil gas entry routes into the building, Active Soil Depressurization (ASD), Passive Soil Depressurization (PSD), increasing overall ventilation rates, and avoiding depressurization inside the building.

Since 2010, the National Building Code (NBC) of Canada has incorporated a number of measures to reduce the likelihood of radon entry into new homes, such as a layer of gas permeable material (e.g. 4” of clean gravel is commonly used for this purpose) under the foundation slab to facilitate sub-slab depressurization for the removal of soil gas, an air barrier laid over the gas permeable layer, and a capped rough-in pipe stub not less than 0.1 m in diameter to allow for connection to a possible ASD system should high radon levels be found after occupancy.

Heat-Sheet Heavy is a system of structural collection and insulation panels with down facing interconnected channels and Polyvinyl Chloride (PVC) adapters for insertion of radon rough-in pipe stubs or full collection piping. Such a system can be laid under the slab and the air barrier system to provide sub-slab ventilation for radon mitigation. However, no testing has been previously carried out to verify if the product can be used to replace the 4” (0.1 m) of gravel that is typically used under the slab as the gas permeable layer.

In order to determine the performance of Heat-Sheet Heavy product, the NRC radon project team conducted comparative sub-slab ventilation and pressure communication tests with Heat-Sheet Heavy product and a 4” (0.1 m) of gravel being successively installed in the floor assembly of the Radon Infiltration and Building Envelope Test System (RIBETS).

2 Test Method

2.1 Sub-slab ventilation test for gravel and Heat-Sheet Heavy

The RIBETS facility was designed and built as a mock-up house with 6’ by 6’ (1.8 m by 1.8 m) footprint, and the conceptual design of the RIBETS is shown in Figure 1. The facility usually included a radon dosing compartment and a radon receiving compartment. The two compartments were separated by a floor assembly, which consisted of (from bottom to top) a perforated stainless-steel plate, a gas permeable layer, a layer of air barrier, a floor slab, and a 4” (0.1 m) PVC radon rough-in pipe cast through the floor slab. The dosing and the receiving compartments were heated by baseboard heaters with thermostats set to 21 °C.

To prepare the RIBETS for the comparative testing of Heat-Sheet Heavy and a 4” (0.10 m) depth of gravel, the project team first modified the floor assembly of the RIBETS to include an 8” (0.20 m) gravel layer above the stainless steel plate, a sand layer of 6” (0.15 m) thickness on landscape cloth, a gravel layer of 4” (0.10 m) thickness, a continuous sheet of 6 mil polyethylene membrane air barrier, and a tape sealed varnished wood floor, from the bottom to the top. A PVC radon stack of 4” (0.10 m) diameter was inserted through the varnished wood floor into the 4” (0.10 m) gravel layer. Two copper pressure taps were installed into the floor assembly, sampling the pressures in the 4” (0.10 m) gravel layer beneath the 6 mil poly membrane and between the air barrier and the varnished wood floor. Both the air barrier and the varnished wood floor were taped to the PVC radon stack and concrete wall.

The project team then replaced the 4" (0.10 m) gravel layer with Heat-Sheet Heavy product, and a 4" (0.1 m) PVC radon stack was inserted through the varnished wood floor into the in the Heat-Sheet Heavy. Two copper pressure taps were installed into the floor assembly, sampling the pressures in the grooved pedestals of the Heat-Sheet Heavy and between the air barrier and the varnished wood floor. Two copper pressure taps were installed into the floor assembly, sampling the pressures in the grooved pedestals of the Heat-Sheet Heavy and between the air barrier and the varnished wood floor. The overall surface area of the Heat-Sheet Heavy test sample was approximately 2.6 m^2.

Figure 1 and Figure 2 illustrate the installation of the Heat-Sheet Heavy product in the RIBETS for the current project.

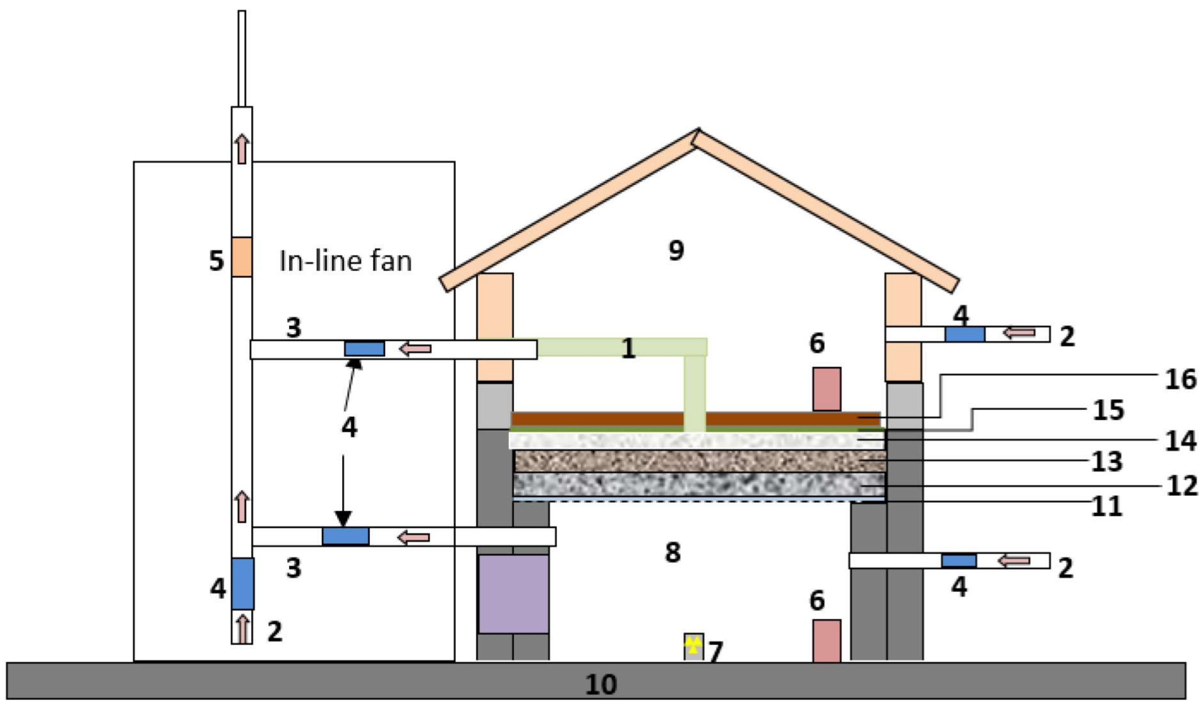

Figure 1: The RIBETS with sub-slab gas permeable layer in the floor assembly.
1-Radon stack; 2-Makeup air stacks; 3-Exhaust stacks; 4-Control dampers; 5-In-line radon fan; 6-Baseboard heaters; 7-Radon source; 8-Dosing compartment; 9-Receiving compartment; 10-Concrete foundation pad; 11-perforated stainless-steel plate; 12-Gravel (8"); 13-Sand (6"); 14- Heat-Sheet Heavy or gravel; 15-Air barrier (6 mil polyethylene); 16-Varnished wood floor.

Figure 2: Installation of Heat-Sheet Heavy in the RIBETS: Grooved pedestals of Heat-Sheet Heavy Radon Removal (left), Heat-Sheet Heavy Radon Removal and 6 mil poly membrane installed (middle), and varnished wood floor panel on top of 6 mil poly membrane installed (right).

A sub-slab ventilation test was conducted by turning on the in-line radon fan to activate the radon stack in the RIBETS. The testing period for sub-slab ventilation test was approximately 2 hours per scenario. During the sub-slab ventilation test, the following parameters were measured in the RIBETS: 1) the flow rate within the radon stack; and 2) the pressure reading in the lower compartment of the RIBETS; 3) the pressure from beneath the gas permeable layer; 4) and the pressure above the gas permeable layer.

After a 4” (0.1 m) layer of gravel was installed on top of the sand within the floor assembly of the RIBETS, the sub-slab ventilation test was repeated following the same procedure.

2.2 Measurement parameters and Instrumentation

The main control and data acquisition system of the RIBETS was in the trailer beside the dosing and receiving compartments. All the control parameters and the online test data could be accessed remotely, to ensure safe operation during radioactive gas dosing test.

Table 1 provides the measurement parameters and the instrumentation used in the sub-slab ventilation tests.

Table 1. Measurement parameters and instrumentation

Parameter	**Equipment**	**Measurement location**	**Interval**
Airflow rate	Nailor 36 FMS with Setra 265	With the stack	Every 15 seconds
Pressure	Setra 265	Beneath the gas permeable layer and above air barrier	Every 15 seconds

3 Results

During sub-slab ventilation and pressure communication tests, the in-line radon fan was turned on to withdraw air from the grooved pedestals of the Heat-Sheet Heavy product or from the 4” gravel layer. The airflow rates through the radon ASD stack downstream from the in-line radon fan and the pressure in the gas permeable layer were recorded continuously. The duration of each of the sub-slab ventilation and pressure communication test scenarios was approximately 2 hours. Table 2 and Table 3 present the average testing results of floor assemblies consisting of Heat-Sheet Heavy and gravel, respectively.

Table 2. Sub-slab ventilation and pressure communication test results: floor assembly with Heat-Sheet Heavy

Test Condition	**Flow in radon stack connected to Heat-Sheet Heavy** (cfm)	**Pressure in bottom compartment of RIBETS** (Pa)	**Pressure under Heat-Sheet Heavy Radon Removal** (Pa)	**Pressure above air barrier** (Pa)	**Pressure in top compartment of RIBETS** (Pa)
Fan off	0.00	0.42	0.19	0.38	-0.17
Fan on, make up air dampers to bottom compartment closed	9.90	-1.35	-2.04	-0.34	-0.24
Fan on, make up air dampers to bottom opened	9.91	-0.66	-2.04	-0.30	-0.33

Table 3. Sub-slab ventilation and pressure communication test results: floor assembly with gravel

Test Condition	**Flow in radon stack connected to gravel** (cfm)	**Pressure in bottom compartment of RIBETS** (Pa)	**Pressure in gravel** (Pa)	**Pressure above air barrier** (Pa)	**Pressure in top compartment of RIBETS** (Pa)
Fan off	0.00	0.39	0.15	0.30	-0.15
Fan on, make up air dampers to bottom compartment closed	6.35	-0.27	-2.00	-1.32	--1.69
Fan on, make up air dampers to bottom opened	6.49	-0.07	-2.00	-1.28	--1.64

4 Summary and Conclusions

The following observations and conclusions can be made based on the comparative sub-slab ventilation evaluations of 4” clean granular material (gravel) and Heat-Sheet Heavy.

1) Under the test conditions, the in-line radon fan could withdraw air from beneath the Heat-Sheet Heavy at a flow rate of 9.91 cfm and result in a pressure of -2.04 Pa beneath the Heat-Sheet Heavy.
2) Under the test conditions, the in-line radon fan could withdraw air from the 4” of clean granular material (gravel) layer at a flow rate of 6.42 cfm and result in a pressure of -2.00 Pa in the gravel layer.
3) In comparison to the results from sub-slab ventilation test of gravel, the higher flow rate and slightly lower pressure beneath the Heat-Sheet Heavy demonstrate that Heat-Sheet Heavy product performed better than a gravel layer of 4” (0.10 m) thickness as a sub-slab gas permeable layer, under the test conditions. Thus, as a gas permeable layer, Heat-Sheet Heavy is a suitable replacement to a 4” layer of gravel. 4” (0.10 m) of clean granular material is part of the prescriptive solution specified in the National Building Code 2015 Section 9.13.4.