Home Innovation
RESEARCH LABS™

Report of Results for NAIMA

11 Canal Center Plaza, Suite 103,
Alexandria, VA 22314

Wall Cavity Insulation Settling Test of Blown In Fiberglass Insulation

November 18, 2015

Report
4162.029.111815D

400 Prince George's Blvd. | Upper Marlboro, MD 20774
301.249.4000 | fax 301.430.6180 | www.HomeInnovation.com

Wall Cavity Insulation Settling Test of Blown In Fiberglass Insulation

Prepared for

NAIMA
(North American Insulation Manufacturers Association)
Attention: Mr. Charles C. Cottrell
11 Canal Center Plaza, Suite 103
Alexandria, VA 22314

Prepared by

Home Innovation Research Labs

400 Prince Georges Boulevard

Upper Marlboro, MD 20774-8731

www.homeinnovation.com

November 18, 2015

Report # 4162.029.111815D

Home Innovation
RESEARCH LABS™

Disclaimer

Executive Summary

The Home Innovation Research Labs conducted testing to investigate the settling performance of blown in fiberglass insulation in a 9’ high wall sheathed with OSB on the exterior and gypsum board on the interior. The wall contained a standard metal clad, exterior, residential door which was opened and closed 65,700 times using an automated system to open and close the door. The 65,700 cycles were intended to approximate the number of times a “typical” door would be closed over a time period of 60 years, assuming the door is opened and closed 3 times per day. The intensity of the door closing was intended to simulate a firm closure of the door, but not what would be considered “slamming” the door. The intensity of the door closing was set using an accelerometer to approximate the intensity of a similar door being closed in a test home at the lab.

The test was done in 2 sets of 32,850 cycles and both visual observations and time-lapse photography were used to record the possible settling of the blown in fiberglass insulation. The blown in fiberglass insulation in all four wall cavities did not show any significant or observable changes before and after the two sets of doors 32,850 (65,700 total) opening and closing cycles. The blown in fiberglass insulation showed no signs of settling due to the vibration caused by 65,700 opening and closing cycles of a typical residential exterior door.

Background

The North American Insulation Manufacturers Association (NAIMA) contacted Home Innovation Research Labs concerning conducting research on the settling performance of blown in fiberglass wall insulation. The fiberglass insulation was blown into wall cavities behind a fabric netting stapled to the wood studs. The objective of the research was to establish a repeatable method to vibrate a test wall and observe any movement and/or settlement of the blown in fiberglass cavity insulation. The test used a closing door as the method to vibrate the test wall because closing doors are a typical cause of vibration in homes. NAIMA consulted with the HI engineering staff to develop the wall design and door closure mechanism. The mechanical vibration was caused by the opening and closing of an exterior door 65,700 times to simulate 60 years of life at 3 openings per day. The test was done in 2 sessions of 32,850 door closings conducted over approximately 28 hours each. The door closing operation was designed to be of sufficient force to vibrate the wall. The closing impact and mechanism was measured and using an accelerometer and the readings were recorded to allow the test to be replicated by others. Viewing the wall from the interior side, the door was installed on the right side with the opening (door knob) side of the door adjacent to the 4 insulated wall cavities on the left side of the wall. Refer to page 3 for wall construction details. An automated pneumatic open/closure mechanism was used to repeat the opening and closing operation of the door. The wall test specimen was a 2x4 wood stud wall framed with the studs 16” on center with standard 14 ½” wide stud cavities. The exterior of the wall was sheathed with 7/16” OSB and the interior was covered with ½” gypsum board. A 6” long x 3” wide observation window was provided at the top of each cavity where insulation met the wall’s top plate to observe any possible settling during the testing. The wall was built 9’ tall to simulate a typical 9’ ceiling height.

Time-lapse photography was used to record any possible movement or settling through the observation window of each wall cavity. The top and bottom plates of the test specimen wall were anchored to a reaction wall intended to stabilize the wall test specimen. .
At the conclusion of the test, the test specimen was opened to expose the insulation for visual inspection and the results were recorded.

An agreement to conduct this testing was entered into on April 06, 2015, between NAIMA and Home Innovation Research Labs.

Test Method

The test method was developed by both Home Innovation and NAIMA. It includes the construction of the test wall, design and setup of the door closing vibration mechanism, installation of the insulation in the wall cavities, setup of the time lapse photography, and the vibration testing of the wall insulation.

Test Wall

An “L shaped” 2x4 wood frame wall was built for the cavity insulation settling test. The longer side of the wall was anchored to a reaction wall and contained a standard metal clad residential exterior door. The shorter side of the wall was built to support the longer wall during door opening and closing operations. This “L shaped” wall was built on a 2x4 wood sub-floor approximately 8’x9’ which was anchored to a concrete floor. Figures 1 - 3 show the details of the test wall configuration. The door was located in the longer test wall section and was hinged on the side closest to the reaction wall. The door knob side was located adjacent to the 4 wall test cavities.

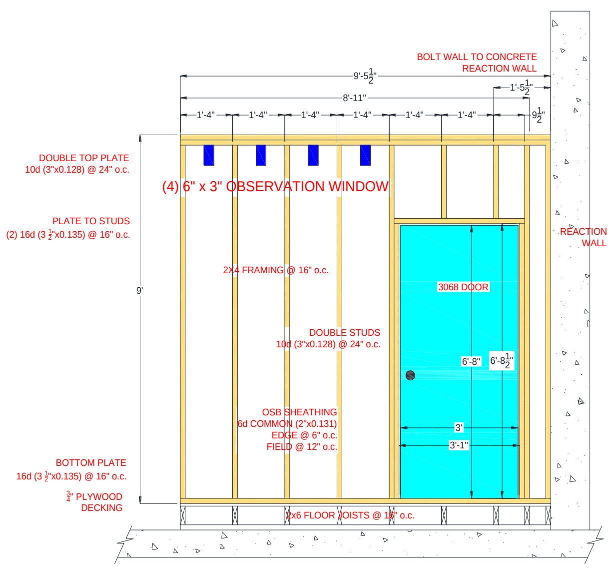


Figure 1. Wall Interior/Gypsum Side

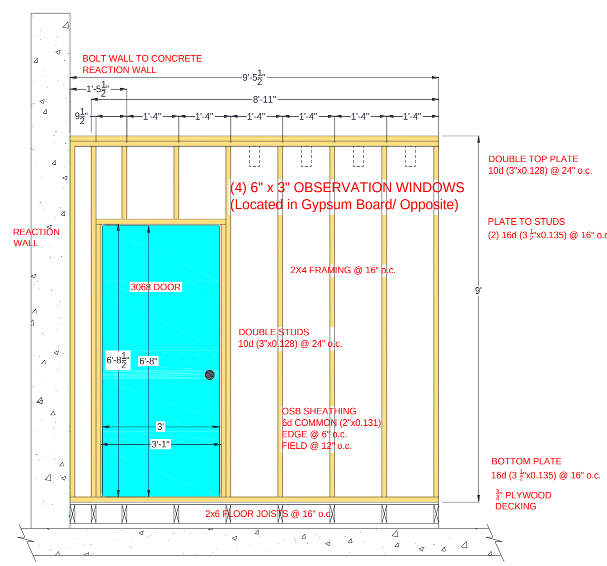


Figure 2. Wall Exterior/OSB Side

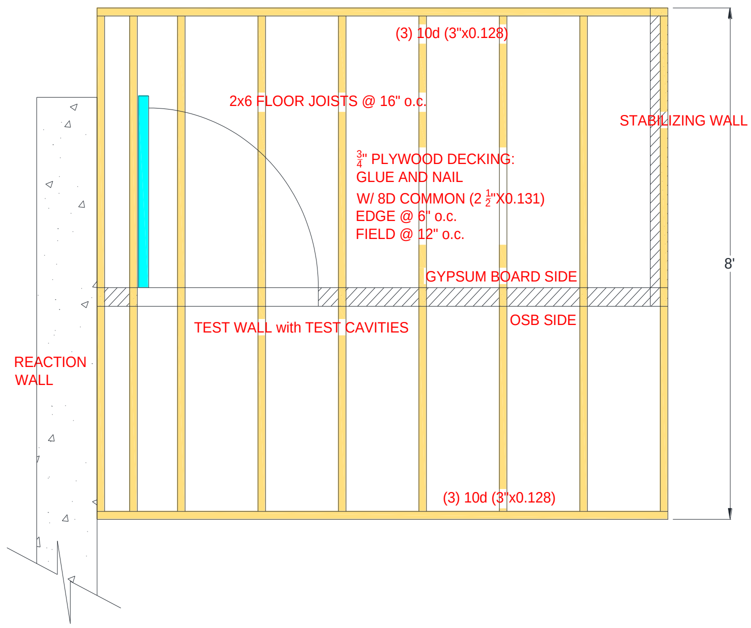


Figure 3. Plan View

Figure 4. Photo of the Test Wall

The four full cavities (as shown in Figure 4) between and door and the shorter stabilizing wall were the cavities where the insulation to be tested was installed. On the exterior of the wall, one 7/16" thick OSB sheathing was installed and ½" gypsum board was attached to the studs using drywall screws after the insulation was installed. There are four 6" x 3" observation windows at the top of the gypsum board, centered on each of the 4 wall cavities where the insulation meets the top plate of the wall. These windows were made using 1/4" thick polyethylene sheet cut to fit in place. The polyethylene observation window was installed flush with the back side of the gypsum board so it was in contact with the insulation.

Vibration Mechanism

As Figure 4 shows, the exterior door was installed in the longer section of the test wall was anchored to the reaction wall (yellow color in Figure 4). The automated pneumatic open/closure mechanism, as shown in Figure 5, was attached to the door on the exterior/OSB side of the wall. It includes three sections: a cylinder operated by compressed air, a control system of the cylinder operation, and a vibration measurement instrument.

Figure 5. Open/Closure Mechanism of the Test Wall

1. **Attachment of the Cylinder**

   The cylinder that opens and closes the door causing the cyclic vibration to the test wall was attached to the door on the exterior side through the rod using bolts and brackets as shown in Figure 6. The cylinder body was anchored to a wall parallel to the test wall.

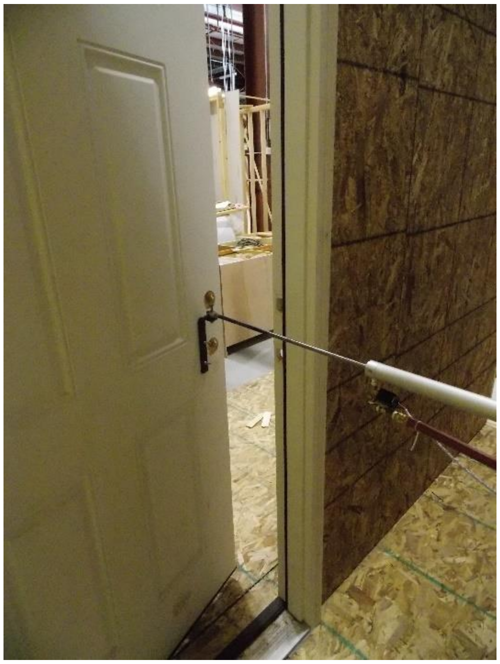


Figure 6. Cylinder of Vibration Mechanism

2. Control of the Vibration Mechanism

A PLC (programmable logic control) control using a control box and a laptop computer was used to regulate the flow of the compressed air to and from the cylinder as shown in Figure 7. All control valves, contacts and wiring are contained in the control box. The computer has the control software program that can be used to change the total number of vibration cycles and frequency of the cycling, start and stop of the air supply thus the testing, and record the actual total number of the cycles. Also the software program terminates the cycling when the actual number of cycles reaches the setpoint value (specified number of cycles). The magnitude of the vibration, was adjusted by a regulator valve on the compressed air supply line. The desired vibration was achieved by regulating the pressure of the air supply once the measured impact was reached using an appropriate vibration measurement instrument.

Figure 7. Control of the Vibration Mechanism

3. Vibration Measurement Instrument

A portable vibration analyzer with an accelerometer (shown in Figure 8) was used to measure the vibration impact the cylinder creates to the test wall. This instrument can output instant measurements of impact in the unit of acceleration, mm/s^2, which was used for this test. The measurements were done with the accelerator probe (with magnetic surface) in contact with each of the twelve (12) 2” x 2” x 1/8” metal pieces attached perpendicular to the exterior surface of the OSB. The locations of these twelve measurement points are shown in Figure 9, viewing from the exterior side of the OSB and the door.

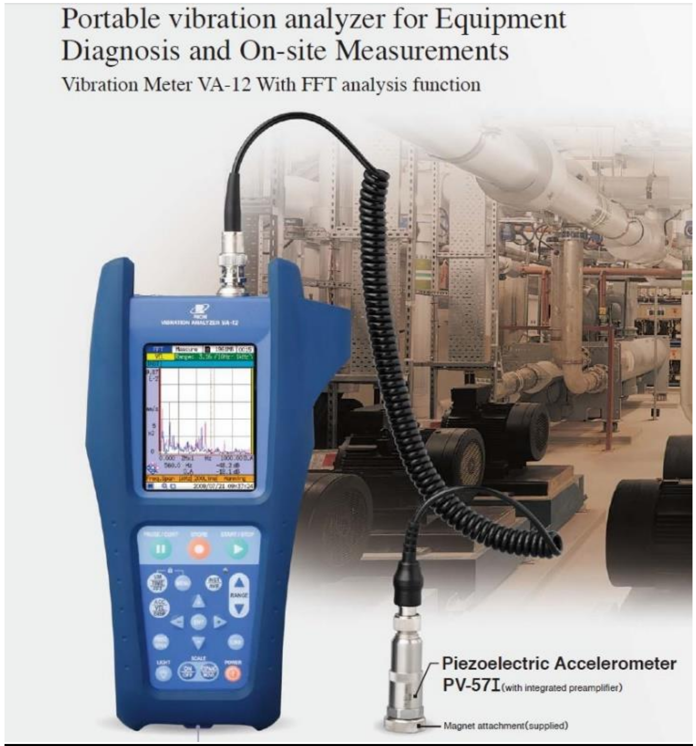


Figure 8. Vibration Measurement Instrument

	1	2	3	4
	5	6	7	8
Door				
	9	10	11	12

Figure 9. Vibration Measurement Points on the Exterior Side of OSB

Installation of Wall Cavity Insulation – Blown in Fiberglass

The installation of the blown in fiberglass wall cavity insulation was conducted by a local insulation contractor and witnessed by the NAIMA representative. The installation was conducted on July 23, 2015. Figure 10 shows the installed insulation before drywall was installed.

Figure 10. Test Wall with Blown in fiberglass Insulation Installed

After the cycling was complete, the cavity fiberglass blown in insulation material was collected for the weight measurements and density determination. The results are listed in the following table:

Table 1. Density Results of the Fiberglass Blown In Insulation of the Test Wall

Quadrant	**3**	**2**	**1**	**0**	**Door**
Bag (lb)	0.135	0.135	0.130	0.130	
Gross (lb)	4.175	4.640	4.350	4.405	
Net (lb)	4.040	4.505	4.220	4.275	
Density (pcf)	1.38	1.54	1.44	1.46	
Total weight (lb):	17.04	Ave. Density (pcf):		1.46	
Density (pcf) = Net (lb) / ((13.9375*3.5*103.625)/12^3)					

Time Lapse Photography

Four time lapse cameras were installed before the vibration cycling started. Each camera was located 2-foot in front of the center of the 6”x3” observation window. The cameras take photos of the observation windows once every 30 seconds. With sufficient memory storage and power supply these cameras can run several days to cover the wall vibration cycling period.

Vibration Test Procedure

The vibration energy was measured using the accelerometer as shown in Figure 8. The magnitude of the door closing impact on the test wall was adjusted by trial and error to appropriately simulate the real life operation of an exterior door on a residential house. Once the desired impact magnitude was determined and achieved, the full cycling of 32,850 open/close operations of the door was started. However, the vibration mechanism was not changed or adjusted during the 2 separate sets of 32,850 cycles. It was only adjusted after the first set of 32,850 open and closing cycles were completed and new settings were applied to the second full set of cycling.

1. **Determination and Setpoint of Vibration**

   The door closing mechanism was adjusted to an impact similar to a normal door being closed in a residential house. NAIMA staff used the accelerometer on a door installed in a test home inside the Home Innovation lab to estimate the magnitude of the impact and it was set to impact at an acceleration value of approximately 1 mm/s^2 with the wall empty.

2. **Measurement of Actual Vibration during First Cycling**

   Accelerometer readings were taken after the insulation was installed and during the vibration cycling. The average impact of the accelerometer readings was 0.93 mm/s^2 as shown in Table 2 below. The decrease was likely due to the increase in mass of the wall from the insulation being installed.

Table 2. Accelerometer Readings of the Test Wall during the First Cycling

	1	**2**	**3**	**4**
Door	1.03	0.97	0.88	0.92
	5	**6**	**7**	**8**
	1.32	1.02	0.75	1.06
	9	**10**	**11**	**12**
	1.06	0.80	0.57	0.83
Complete Wall Acceleration Average			**0.93**	mm/s^2

3. Measurement of Actual Vibration during Second Cycling

A second set of 32,850 cycles was started and the accelerometer readings were taken during the vibration cycling. The average impact of the accelerometer readings was 0.85 mm/s^2 as shown in Table 3 below.

Table 3. Accelerometer Readings of the Test Wall during the Second Cycling

	1 0.97	**2** 0.87	**3** 0.85	**4** 0.90
Door	**5** 1.20	**6** 0.92	**7** 0.73	**8** 0.96
	9 0.96	**10** 0.66	**11** 0.50	**12** 0.70
Complete Wall Acceleration Average			**0.85**	mm/s^2

Results

The blown in fiberglass insulation in all four wall cavities did not show any significant or observable changes, including settling, before and after the two sets of doors 32,850 opening and closing cycles. Tables 4 and 5 show the photos for each cavity before and after the 2 sets of 32,850 cycles each (65,700 total).

Table 4. Observation of Cavity Insulations for the First Cycling

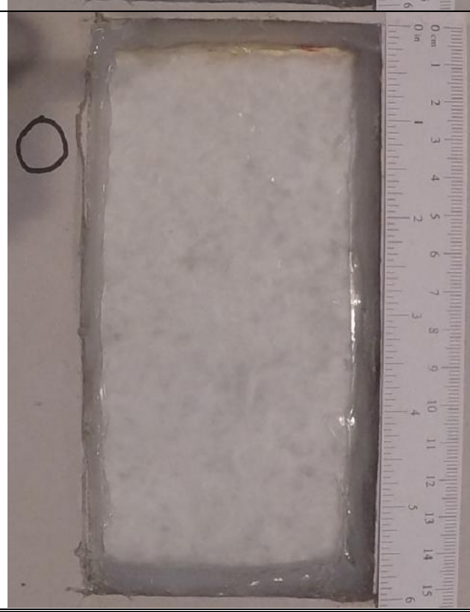
Cavity No.	0	1
Start First of Cycling (0 cycles) (07/25/15)		
End of First Cycling (32,850 cycles) (07/26/15)		

Table 4. Observation of Cavity Insulations for the First Cycling (Continued)

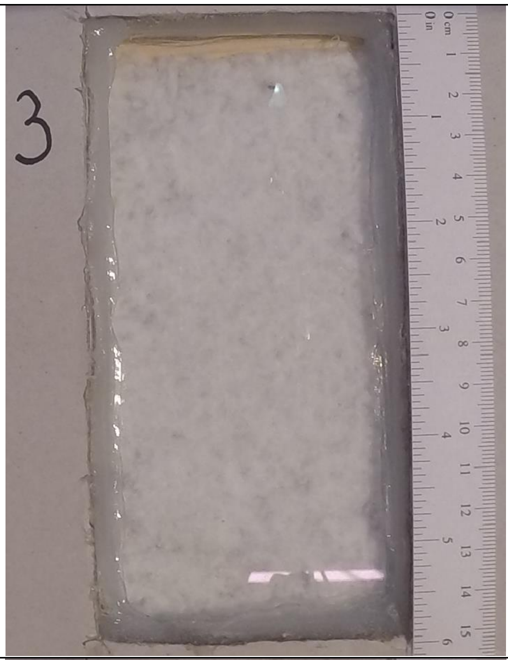
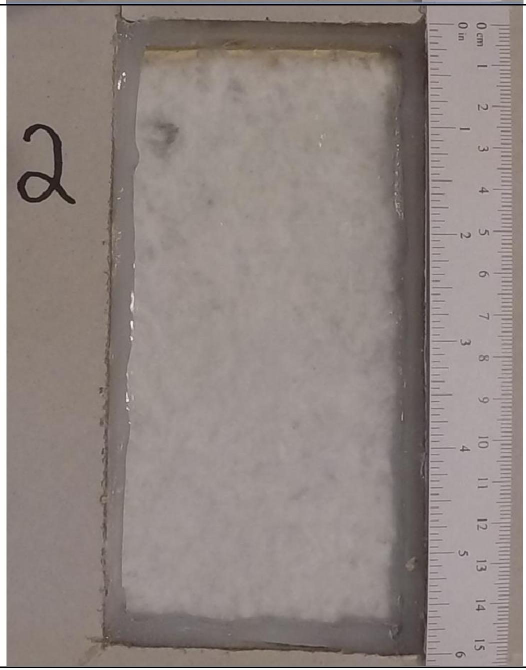
Cavity No.	2	3
Start of First Cycling (0 cycles) (07/25/15)		
End of First Cycling (32,850 cycles) (07/26/15)		

Table 5. Observation of Cavity Insulations for the Second Cycling

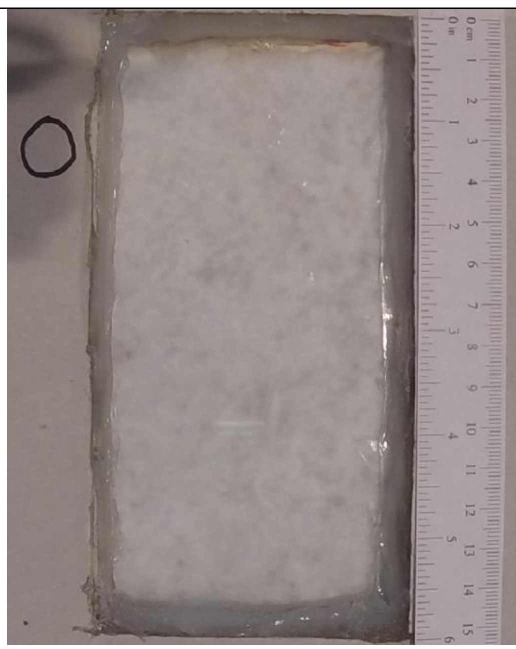
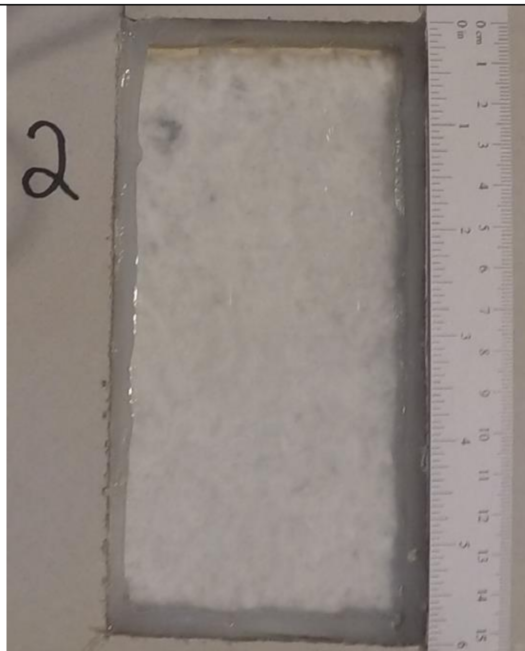
Cavity No.	**0**	**1**
Start of Second Cycling (32,850 cycles) (07/28/15)		
End of Second Cycling (65,700 cycles) (07/29/15)		

Table 5. Observation of Cavity Insulations for the Second Cycling (Continued)

Cavity No.	**2**	**3**
Start of Second Cycling (32,850 cycles) (07/28/15)		
End of Second Cycling (65,700 cycles) (07/29/15)		

Declarations & Disclaimers

This is a factual report of the results obtained from laboratory tests of the samples provided and installed by an independent insulation contractor. The report may be reproduced and distributed at the client’s discretion provided it is reproduced in its entirety. Any partial reproduction must receive prior written permission of the Home Innovation Research Labs.

Home Innovation Research Labs is accredited as a test lab by the International Accreditation Service.

This test report does not constitute a product endorsement by Home Innovation Research Labs or any of its accrediting agencies.

Testing and Report by: