TECHNICAL ARTICLE

AIR LEAKAGE PATHS IN A TYPICAL WOOD FRAMED WALL ASSEMBLY

by Mr. Laverne Dalgleish, Executive Directors of the Air Barrier Association of America

The Air Barrier Association of America (ABAA) worked with Oak Ridge National Laboratories (ORNL) to conduct assembly testing on a wood framed wall to determine what are the gaps, cracks, and holes that would leak the most. The testing was conducted at Tremco's facility in Cleveland Ohio, where they have a fully automated test apparatus to conduct a ASTM E2357 Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies. The funding to ORNL was supplied by the Department of Energy (DOE) Building America Program.

This research was an extension to the ABAA Research Project on Air Barriers which was to determine whether there was energy savings when you make a building very airtight.

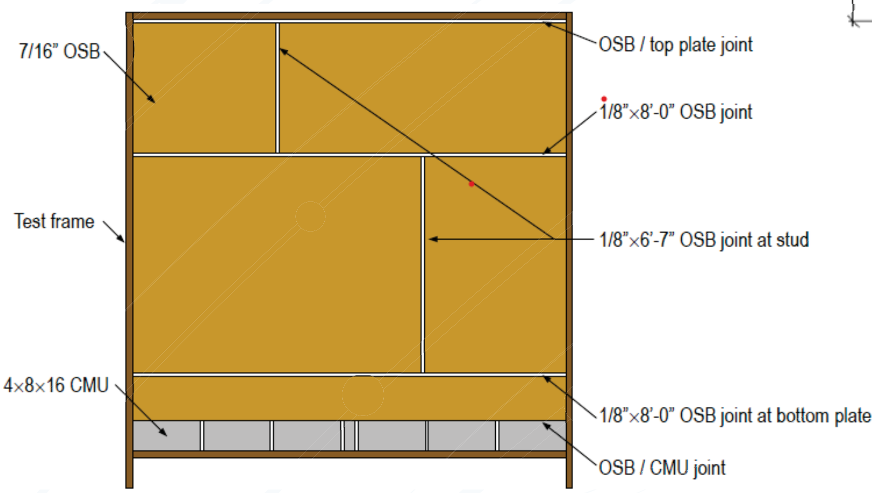

Figure 1: Schematic of Test Wall Assembly

The baseline specimen was a more detailed ASTM E2357 test specimen, where the wall was purposely made very leaky. The specimen was framed in a wooden buck for ease of mounting into the test apparatus. A foundation was simulated with CMU and a wood mud sill was installed with spacers between the mud sill and the CMU to represent typical site conditions. Simulated floor joists with a header was then installed and then a strip of sub floor was installed. The sub-floor was shimmed to replicate the drying and movement of wood framing members on the construction site. A wall was then framed using 2 x 4's with a single bottom plate and a double top plate. The wall was sheeted with OSB. A 1/8-inch gap was maintained between the sheets of OSB which is a standard practice on job sites to allow for the expansion and contraction of the material due to temperature and moisture content.

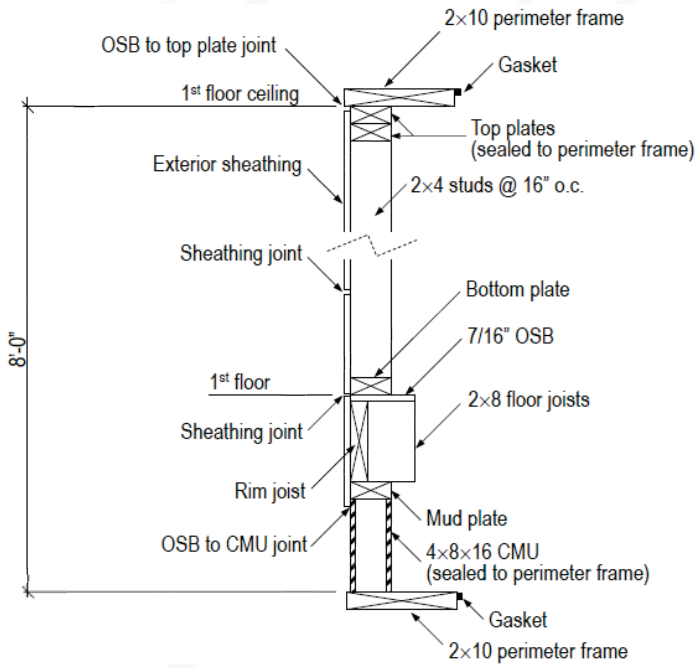

Figure 2: Cross Section of Mock-up Assembly

Details on the construction of this wall specimen was documented so that the base specimen could be replicated for additional testing with various types of air barrier materials being installed. To identify how much air would leak through a specific air leakage path, it was decided on to test the complete wall specimen to start with and then to seal one crack, gap or hole at a time and test after each air leakage path was sealed. The baseline wall was inserted into the test apparatus and the wall proved to be so leaky, that it was impossible to create a 25 Pa pressure difference across the specimen. This confirmed that the goal of making the baseline specimen very leaky was achieved. Now we talk about a air leakage rate at 75 Pa but this is the reported leakage rate. In ASTM E 2357 we actually test at 600 Pa, then 800 Pa and finally 1200 Pa. You will find that all testing is conducted at multiple pressure differences and normally much higher than the reported test pressure.

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Figure 3: Test Wall Ready for Material Application

The next issue that the crew faced was to find a sealant that would set up in a short period of time so that the testing could almost be done continuously. Normal sealants and caulks require a curing time which would drag out the testing process. Finally, an answer was found, which was to use a hot glue gun. This material set up as soon as it was cooled and provided a structural seal that withstood the loads imposed upon them by the test procedure which created a pressure difference across the wall assembly. To give you an idea of the loads placed on the wall assembly, a steel stud framed wall will move back and forth ¾ of an inch during the 800 Pa cycling part of the test. Even wood studs flex due to the loads.

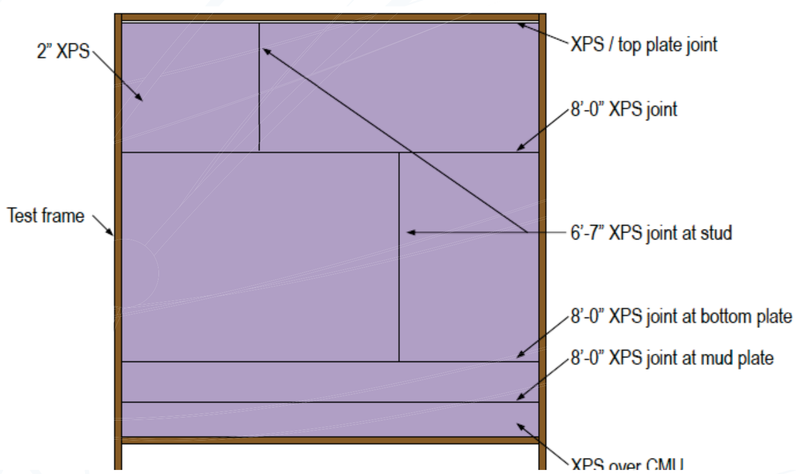


Figure 4: Test Wall with Exterior Foam Sheathing

Now the crew was ready to conduct the testing. Some assumptions were made as to what air leakage path would be the largest and how leaky the different paths would be in relation to each other. The first assumption was the horizontal joints between the sheets of OSB. It was felt that if you could see through the gap, a lot of air could pass through the hole. To no one's surprise that air leakage path turned out to be the biggest. It was measured at 6.35 CFM/ft² at a pressure difference of 75 Pa.

I have been told forever that the foundation wall/joist header or the bottom plate to the sub floor is a huge leakage area. Turns out that is correct. It was measured at 1.91 CFM/ft² at a pressure difference of 75 Pa.

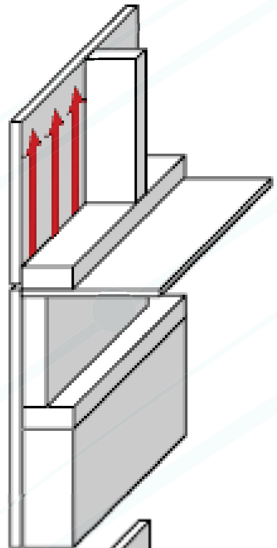
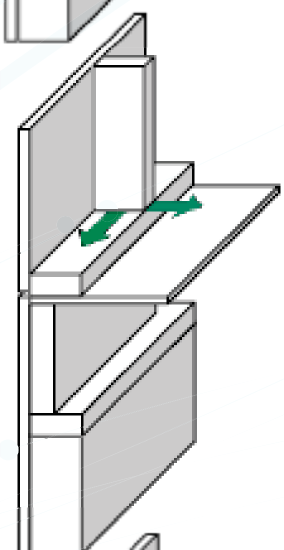


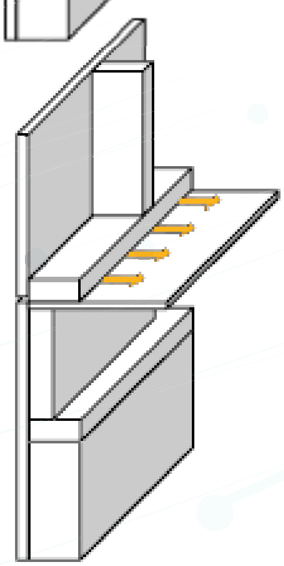
Figure 5: Typical Air Leakage Paths at Wall/Foundation Intersection

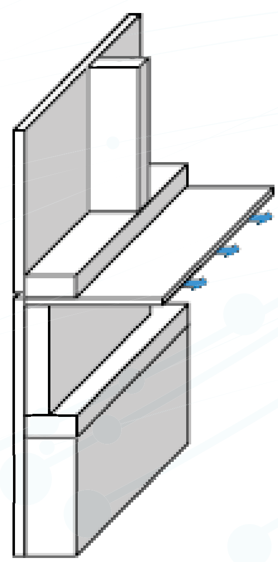
A large leakage gap that surprised the crew was the vertical joints between the sheets of OSB. Now these joints are located on a framing member and the OSB is fastened to the stud at this point. In looking at the air leakage path, you would assume that this is extremely airtight and can be ignored for air sealing. This leak was measured at 0.8 CFM/ft² at a pressure difference of 75 Pa.



The balance of the air leakage paths was sealed and tested and the drop in air leakage at a given rate was recorded.

The other interesting observation was that 92% of the air leakage at the wall/roof intersection is the joint between the OSB and the top plate. Also 70% of the air leakage at the wall foundation area was between the OSB sheathing and the bottom plate.





AIR LEAKAGE SITE

AIR FLOW RATE	CFM50 /ft²	CFM50 /stud	CFM75 /ft²	CFM75 /stud
1/8” Vertical OSB Joint at Stud	0.61	NA	0.8	NA
OSB/CMU Joint	1.11	NA	1.46	NA
Wall/Roof Joint	1.11	NA	1.46	NA
OSB/Top Plate Joint	1.03	NA	1.35	NA
OSB/Stud Joint	0.07	0.09	0.09	0.12
Top Plate to Top Plate Joint	0.01	NA	0.01	NA
Wall/Foundation Joint	1.46	NA	1.91	NA
OSB/Bottom Plate Joint	1.05	NA	1.37	NA
OSB/Stud Joint	0.28	0.37	0.36	0.48
Bottom Plate/Subfloor Joint	0.12	NA	0.15	NA
Subfloor/Rim Joist Joint	0.01	NA	0.02	NA
1/8: Horizontal Joint	6.03	NA	6.36	NA

Table 1. Air Leakage Rates at Wall Joints.

This data provided some guidance to the next step which was to start with the same baseline wall assembly and then to install a specific type of air barrier material. This procedure was to determine two things: 1) to see how each type of air barrier material sealed the cracks, gaps and holes and 2) to determine how common installation deficiencies affected the performance of the building assembly.

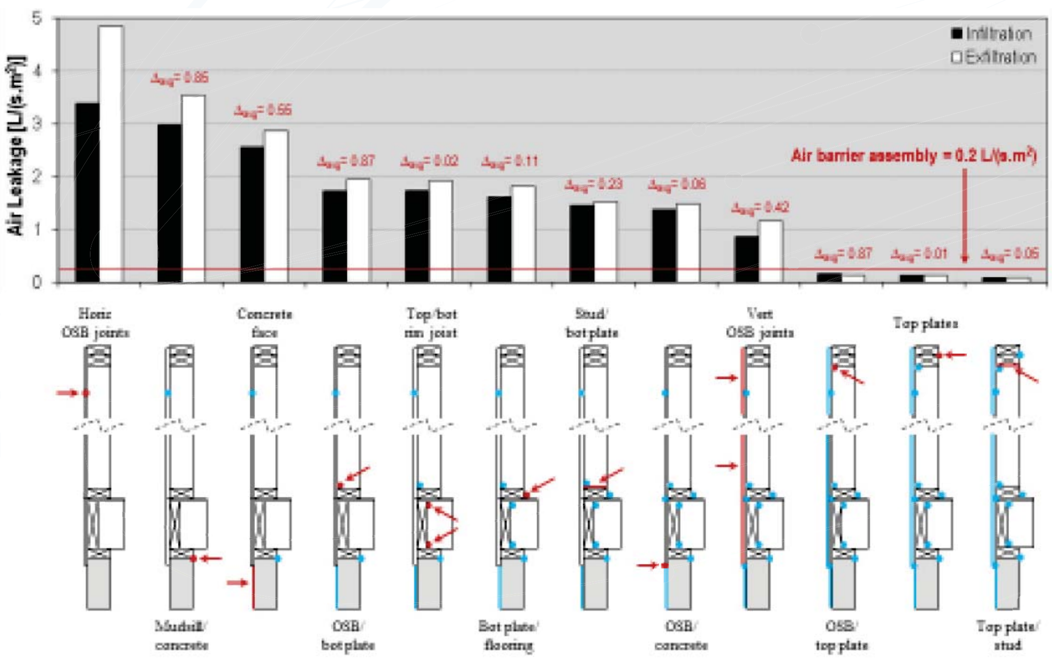


Figure 6: Comparison of Air Leakage at Different Joints

Knowing where typical air leaks are located and their significance, guides an air barrier installer to ensure that these locations are completely sealed. It also provides guidance when retrofitting existing buildings to reduce the air leakage rate of a building.

ADDITIONAL INFORMATION CAN BE OBTAINED AT:

ABAA Articles I Air Barrier Association of America

www.airbarrier.org/technical-information/abaa-articles/