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November 8, 2021

COMMENTS ON OUTDOOR TO INDOOR NOISE REDUCTION PERFORMANCE OF EIFS WALL SYSTEM WITH ROCKWOOL INSULATION

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Introduction

Laboratory airborne sound transmission tests do not directly correlate with the outdoor to indoor noise reduction in the field and thus the real-life impact for building occupants. To better understand the in-situ results of installing stone wool EIFS in a retrofit application, this project was conducted at a residential home in the New York City area. As part of the comprehensive acoustical study, results were measured for both the previous assembly and new stone wool EIFS cladding in-situ and compared against a calculated outdoor-indoor noise reduction.

In the most common EIFS installation, foam insulation boards rather than stone wool are attached to the façade and covered with a synthetic material that looks similar to stucco. In this common installation, the system is not known for providing significant improvement in the sound insulation of the building. The foam board used for thermal insulation is very light weight and does not contribute the sound absorption that could be provided by many other thermal insulators including ROCKWOOL. A search has revealed very little available data on the sound insulation properties of walls using this system.

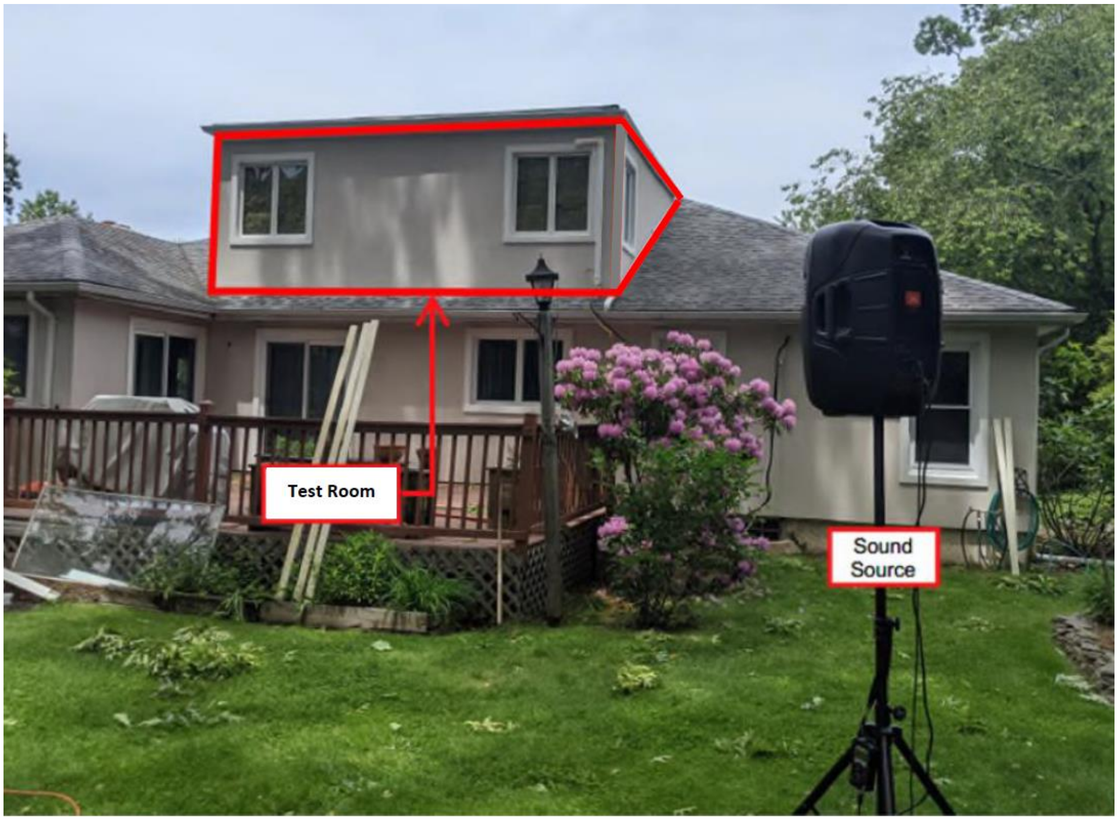
EIFS systems can also be installed using high-density stone wool insulation, such as manufactured by ROCKWOOL. This has potential acoustical advantages of additional weight and sound absorption. Separating layers of sound blocking materials such as sheathing and the EIFS surface material by a cavity containing sound absorbing material in theory improves the sound blockage at most frequencies compared to no cavity or space filled with a foam that does not absorb sound. The cavity does create a resonant frequency at which the sound blockage can be reduced. The performance would also be influenced by the degree of contact between the EIFS surface and the screws holding the stone wool in place.

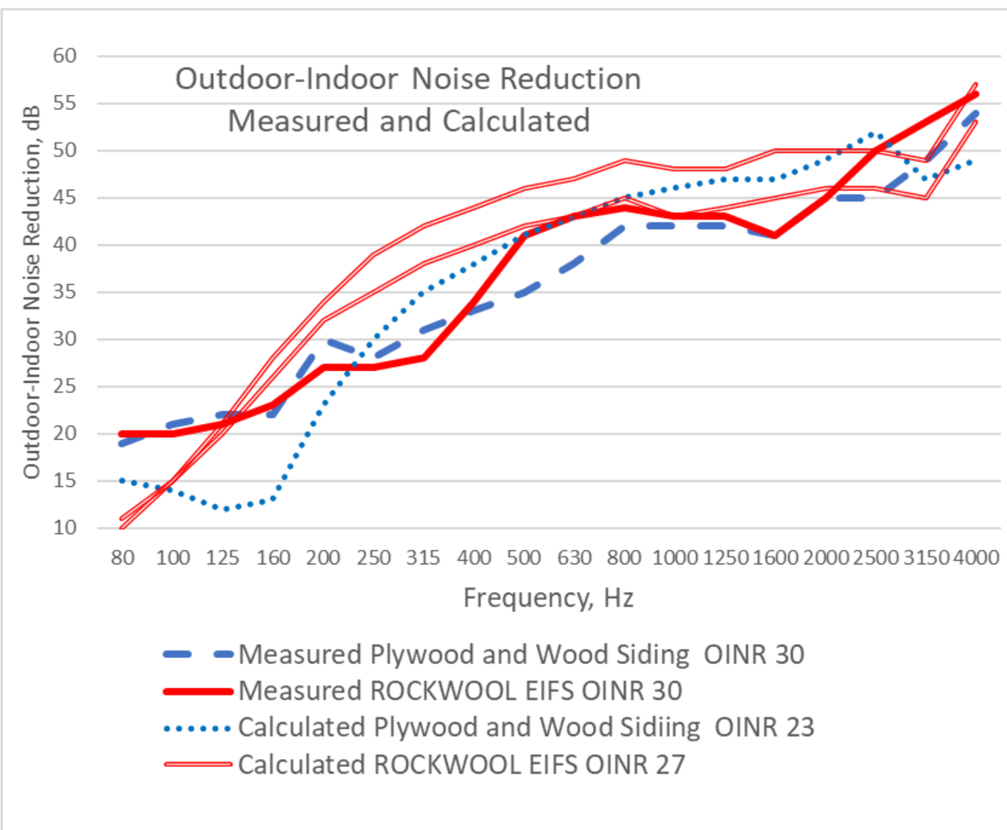
Acoustical Testing (In-situ)

As an initial effort to evaluate its sound insulation capability, such a system was installed as a replacement for the existing siding on a residential bedroom. The original wall construction from inside out was half-inch gypsum, 2 by 4 wood studs 16 inches on center with fiberglass batts, two layers of nominal half-inch plywood sheathing, and wood siding. After initial testing, both the siding and one of the plywood sheathing layers were removed, and replaced with an air and water barrier membrane, 3 inches of stone wool insulation attached with number 12 screws spaced at 12 inches on center, and an EIFs finish. The finish weighed 1 to 1.2 pounds per square foot. The bedroom was on the second floor with a long side and parts of two short sides exposed.

Outdoor-to-indoor noise reduction tests were performed in accordance with ASTM E966 using the flush microphone option by the firm AKRF. The loudspeaker was placed at a 45-degree angle to the long side where one of the short sides was also exposed to the sound while the other short side was shielded. Two windows on the primary long side and one on the exposed side were covered with layers of stone wool and two layers of gypsum. A small window on the shielded side was not covered. During the testing there was no noticeable flanking through any of the windows. A photograph of the test site is shown on the next page.

This study was sponsored by ROCKWOOL





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Findings and Impact

The results for the two tests are plotted on the prior page specifically for the 45-degree incidence angle as shown by the heavy solid red line for the ROCKWOOL and EIFS system and the heavy dashed blue line for the original plywood and siding. A higher result is better. At some mid to higher frequencies the result with the ROCKWOOL EIFS system is up to 5 dB better than the original wall with an extra layer of plywood and wood siding. At some lower frequencies the original wall appears to be slightly better.

The ASTM standard E966 allows only one type of single number rating to be reported based on this test. That is the Outdoor Indoor Noise Isolation Class (OINIC) calculated in accordance with E1332 using the OINR data and the source spectrum specified in E1332. The OINIC is a rating of the isolation of the room, and not a rating of the wall construction itself. The resulting OINIC is 30 for both results. This is better than normally expected for a wood siding wall. The source spectrum in E1332 is an average that is not representative of a particular source. Results were also calculated using the E1332 method with spectra representative of low-speed road traffic, high speed road traffic, commercial aircraft, and diesel trains without horns. Results were the same for the two constructions for all sources except high-speed freeway traffic for which the ROCKWOOL and EIFS was one point better. It should be noted that this performance is particularly good and is significantly better than expected for the original wall.

The transmission loss (TL) of the two wall systems as it would be measured by ASTM E90 in a laboratory was also calculated using the INSUL computer program. These are transmission loss values based on random incidence of the sound onto the wall. This differs from the outdoor to indoor situation. The outdoor sound field is a free field with sound from a particular direction. The ability of the wall to block sound varies with that angle of incidence. There are no known laboratories to measure what would be the outdoor-indoor transmission loss (OITL). Thus, ASTM also defines field measured results of Field OITL and Apparent OITL which differ depending on the conditions met. Lacking OITL data, it is commonly assumed that the laboratory TL is equal to the OITL at an angle of 45 degrees or fore a situation where the sound is distributed along a line such as a travel path parallel to the wall surface. Making that assumption, these calculated TL values were used to compute the expected OINR for the room which is shown by the dotted and double lines on the graph. The EIFS surface was approximated by a quarter inch of gypsum. The net exposed wall area not including windows was used. Two lines are shown for the calculated ROCKWOOL and EIFS system which differ depending on the assumed degree of contact between the screws through the ROCKWOOL and the EIFS surface. The lower line assumes all screws are making strong contact with the EIFS while the upper line assumes only half the screws make strong contact. The OINR for these calculated results are 23 for the original wall and 27 for both results with the ROCKWOOL and EIFS. The OINR is strongly influenced by the performance at the lower frequencies below 200 Hz. Both systems tested better than expected at the lowest frequencies, with the original wall system performing much better than expected at 125 and 160 Hz where a stiffness resonance related to the 16-inch on center stud spacing normally limits performance. At higher frequencies both systems tested more poorly than predicted.

A more familiar single-number metric for a wall is the Outdoor Indoor Transmission Class (OITC). The OITC is computed from laboratory tests (ASTM E90) of sound transmission loss (TL) between two enclosed rooms. The OITC is related to the OINR by the size of the exposed surface and the absorption in the room. In our particular case the OITC would be about 1 to 2 points higher than the OINR shown.

Another factor could have possibly affected the results. Efforts were made to minimize any differences in the two measurements except for the change to the wall. However, the second-floor bedroom slightly protrudes and overhangs the first floor. After completing the measurements two small openings were found in the underside of the overhang area. During the initial tests with the original wall construction, these openings had been covered with plastic or aluminum .03 to .05 inches thick. It is not clear exactly what effect if any these openings may have had.

In any case, with all information considered, the test comparison indicates the ROCKWOOL EIFS system is at least comparable to the two layers of wood (plywood sheathing and siding) added to the base wall with one layer of sheathing. Based on theoretical analysis, those two layers of wood add about 4 dB to the transmission loss and expected noise reduction of the base wall. Theoretical analysis indicates the EIFS system should about 8 dB. This is just one test of each construction. Any time testing is done multiple times on the same construction, results vary. Comparisons are more reliable when based on the average of the results of several tests of each design. Thus, additional tests averaged could give a difference between the baseline and ROCKWOOL EIFS constructions as expected based on theory. Additional testing would be useful with an effort to find a more optimal test location if outdoor-to-indoor testing is done.

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