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Evaluation of Test Method for Assessing the Propensity for a Subfloor Fastener to Cause Floor Squeaks

Prepared For

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BACKGROUND

Historically, floor squeaks have been a significant “call back” problem for home builders. Homebuyers do not want to hear squeaking sounds as they walk across the floor of their newly constructed home.

There are a number of causes of floor squeaks. The most prominent cause is due to relative movement between the subfloor material and the fastener, resulting in squeaks. Traditional fasteners initially hold the subfloor firmly to the supporting floor joist and relative movement is prevented. However, over time gaps are created and relative movement often occurs.

There are several reasons that relative movement occurs in the floor system and as a result squeaks arise:

- The subfloor material, typically oriented strand board (OSB or plywood) expands and contracts with changes in relative humidity or rain during construction. The swelling of the subfloor can cause traditional or prescriptive fasteners to withdraw slightly from the floor joist.
- After the home is completed the floor joist lumber dries out and shrinks. This decreases the holding power/friction of traditional nails against the wood, which as the floor is walked on and slight movement occurs, contributes to working the nails loose.
- Some subfloors have greater potential to squeak than others depending on the materials used in the construction and the care taken during installation.

In functional use, as someone walks across the completed floor, the subfloor can deflect, rubbing against the fastener, causing a noticeable and undesirable squeaking noise.

This report is an evaluation of a test method that can be used to determine if a subfloor fastener is likely to squeak. Paslode developed a test method and contracted with the Research Center to evaluate and validate the test method.

TEST METHOD DESCRIPTION

The test method causes movement between the fastener and a subfloor specimen by immobilizing the subfloor while pushing the fastener at thru the subfloor and then pulling it back until the nail head is flush. The amount of movement is approximately the twice the thickness of the nail head. The movement can be slightly offset to simulate a fastener that is not driven perfectly perpendicular. This movement cycle is repeated at least 1,000 times. The apparatus is located in an acoustics chamber and the noise level is measured with a decibel meter. A rise in the net noise level above a threshold amount determines the presence or absence of a squeak. Background noise level is measured when the test apparatus is operating without a fastener to determine the net noise increase that is attributable to the faster. A complete description of the test protocol is noted in the Appendix.

EVALUATION OF THE PROTOCOL

The evaluation considered a number of factors that potentially could affect the propensity of a nail to squeak. These included subfloor material type (OSB of varying density, plywood), subfloor material thickness, fastener size, material conditioning, misalignment and movement speed.

A review of the IRC¹ found that 6d and 8d nails are permitted for fastening subfloor materials up to 1/2 in. for 6d common and up to 1 in. for 8d common. These thicknesses represent the most common residential subfloor materials.

Included in the evaluation were OSB products of 7/16 in., 5/8 in., and 23/32 in. The density of the OSB products varied from 35 pcf to 44 pcf. 3/4 in. plywood (40 pcf) was also evaluated.

To address the concern that misaligned nails (e.g., nails that were not driven perpendicular) might aggravate squeaking, the testing was conducted with up to 5° offset where subfloor material was set at the offset angle to the axis of the movement.

The noise level (squeakiness) was measured using a model Sper Scientific Advanced Datalogging Sound Meter. The data was collected on the “slow” setting. Values were measured at the beginning of the cycling and after approximately 30 minutes. The measured value represented the average sound level over a two minute period. Immediately at the conclusion of the 30 minute cycling period the specimen was removed and the cycling continued to record/measure a background noise level. Besides the dBA measurements the technician classified the sound as either loud squeak (LS), squeak (S), slight barely audible squeak (SS), loud noise other than squeak (LN), noise other than squeak (N), or slight barely audible noise (SN). The background typically was considered a slight noise.

RESULTS & OBSERVATIONS

Over 100 test specimens were evaluated. A sampling of the data set results is provided in the tables below to illustrate the representative nature of the performance observed. This testing identified material density and nail size as the most critical factors. Testing also showed that there is a high degree of variability in sound levels from replicate testing. However, subfloor material and fastener combinations that are prone to squeak can be observed with this test protocol but a sufficient sample size of replicates is required to achieve an acceptable level of certainty. False negative conclusion (no squeak) is possible with too few replicates. Overall, the test method produced frequent nail squeaks that sounded very similar to actual floor squeaks due to movement between the subfloor material and fastener.

OSB Thickness	Nail Size	Offset	Density pcf	Avg. Sound dBA
23/32	8d	5	43.5	14.1
23/32	8d	0	43.5	15.5
5/8	6d	0	35.1	-1.2
5/8	8d	0	35.1	9.4
5/8	6d	5	35.1	0.5
23/32	6d	0	43.5	-0.4
5/8	8d	5	35.1	0.8
23/32	6d	5	43.5	18.7

¹ International Code Council, *International Residential Code*, 2012 Edition

The results below for two material thicknesses show the typical variability that was seen in the testing.

OSB Thickness	Nail Size	Offset	Avg. Sound dBA	OSB Thickness	Nail Size	Offset	Avg. Sound dBA
7/16	8d	0	9.5	3/4	8d	0	0.2
7/16	8d	0	8.1	3/4	8d	0	8.1
7/16	8d	0	2.1	3/4	8d	0	3.8
7/16	8d	0	6.3	3/4	8d	0	4.7
7/16	8d	0	10.5	3/4	8d	0	3.1
7/16	8d	0	1.1	3/4	8d	0	8.0
7/16	8d	0	22.4	3/4	8d	0	2.5
7/16	8d	0	14.6	3/4	8d	0	18.6
			Average				Average
			9.3				6.1

RECOMMENDATIONS

Due to variation in subfloor material density and variation of replicate testing results, a minimum of 10 replicates is recommended for evaluating any combination of nail and subfloor material prior to drawing any conclusion about the propensity of a particular fastener to squeak. It is also recommended that that fastener be evaluated in two subfloor materials and two thicknesses for each material.

The background sound level also demonstrated some variability and resulted in some cases of the nail movement resulting in a quieter sound than the background. This is another reason for multiple replicates as part of any evaluation process.

The sound meter had an option of a “FAST” or “SLOW” reading. Both options were evaluated and both gave generally the same results. The SLOW reading was chosen for the final analysis as it seemed to have slightly less variability.

Human perception of sound is a complex phenomena but it is generally agreed the changes in sound level of less than 3 dBA are not typically perceived by the average person. In setting a criteria for classifying a fastener’s propensity for squeaking, it is recommended that the average dBA net value (measured sound level during test less background sound level) of all the test runs recommended above not exceed 3 dBA; and that no individual test exceed 5 dBA.

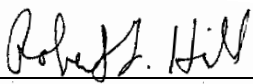
Verification of the test apparatus is recommended prior to evaluating any fastener to establish that the apparatus is providing expected performance. The verification test should be performed with a high density subfloor (40 pcf or greater) and 8d common nail at a 5 degree offset. Acceptable test apparatus performance is established when a replicate specimen squeaks by the 5th replicate tested. No additional replicate testing required after the first specimen that squeaked. If by the end of the 5th replicate no squeak is observed the test setup is insufficient and the test device should be taken out of service.

DECLARATIONS & DISCLAIMERS

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Testing by: 

Review by: 

APPENDIX A: STANDARD PRACTICE FOR OPERATING SUB-FLOOR SQUEAK TESTING APPARATUS

1. SCOPE

1.1 This practice describes the apparatus, procedure, and conditions required to capture a fasteners propensity for producing squeaks in a described situation. This practice is designed to mimic the movement seen between a fastener and sheathing substrate measuring force, displacement and cycle number while qualitatively listening for squeaks. This practice describes how to conduct a sub-floor squeak test and how to test assembly specimens. This practice does not prescribe the type of test specimen or exposure periods to be used for a specific product, nor the interpretation to be given to the results.

1.2 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1 *"Floor Squeaks: Causes, Solutions and Prevention"* by The Engineered Wood Association. APA Technical Note C468N (April, 2002).

2.2 *"Eliminating Sub-floor Nail Squeaks in Residential Construction"* Paslode® White Paper: July, 2010.

3. SIGNIFICANCE AND USE

3.1 This practice provides a controlled displacement method of a component assembly sample, utilized to produce test information for the interaction of fasteners and sub-floor materials subjected to any particular test permutation.

3.2 The test results are highly dependent on the type of materials and specimens tested and the evaluation criteria selected, as well as the control of the operating variables. In any testing program, sufficient replicates should be included to establish the variability of the results. See Section 5.

4. APPARATUS

4.1 The apparatus required for squeak testing consists of a device that can provide longitudinal displacement of a nail in a controlled fashion and necessary means of control. (A typical universal test machine is one such device but other apparatus may also be used.) The size and detailed construction of the apparatus are optional, provided the conditions obtained meet the requirements of this practice. The apparatus shall be designed to minimize background noise and it should be isolated from ambient noise such that the background sound level does not exceed 50 dBa.

5. TEST SPECIMENS

5.1 The type and number of test specimens to be used, as well as the criteria for the evaluation of the test results, shall be defined in the specifications. Performance of a fastener in any one material may be different than the performance in another material; therefore, a variety of different materials is recommended. The criteria shall also specify the number of replicates. Test specimens should encompass the highest density and lowest density and the thickest and thinnest dimension of each type of material recommended for the application.

6. PREPARATION OF TEST SPECIMENS

6.1 Conditioning – unless otherwise specified the testing shall be conducted on material dry as received.

6.2 Test Specimen Assembly

6.2.1 Materials conditioned per 6.1 are used to prepare test specimens. The minimum sub-floor wood specimen size shall be 2 in. circular. One fastener shall be driven into the center of the test specimen as follows:

- a) Fasteners shall be driven in a manner representative of actual practice
- b) Pneumatically driven fasteners are to be driven through the appropriate pneumatic tool
- c) bulk nails are to be hammer driven
- d) the fastener shall be driven perpendicular to the surface of the wood specimen within 5 degrees.

6.2.2 The sub-floor wood member shall be backed by a 2x4 or other suitable backing member so as to provide support for the subfloor member and to prevent the back side of the subfloor member from inappropriate damage, such as splitting or blow-out. After assembly, carefully remove the backing material to expose the fastener shank for testing.

7. ALIGNMENT

7.1 Bending load on the nail is found to have important effect on squeaking. It creates uneven contacts, concentrates the friction at corners and is found to facilitate squeaking. Test specimens shall be evaluated with and without an offset. For specimen evaluated with an offset, a 5° +/- 1° offset from perpendicular to the wood specimen shall be created to one side of the upper fixture. This provides an increase in the normal force interaction between the fastener and wood specimen. This phenomenon, depicted in Figure A1, is common as a home goes through changes in moisture content causing dimensional changes and misalignment between the joist and subfloor, and inconsistencies in the straightness of a joist.

8. TEST PROCEDURE

8.1 The wood subfloor specimen is held fixed to the loading fixture. The fastener penetrating the wood specimen is held by the lower part of the fixture and forced to move cyclically against/thru the wood sample. Allowance for fastener rotation is not required.

8.2 Displacement of the cyclic test shall be set at 0.050 to 0.100 in. peak to peak nail movement, approximately twice the thickness of a typical nail head and representative of a typical nail head pop.

Unless otherwise specified cycling frequency shall be 0.1 to 0.5 Hz. A cycle shall have four distinct phases:

1. upward movement of the nail shank (in one-half to one second)
2. pause (approximately one-half to two seconds)
3. downward movement of the nail shank (in one-half to one second)
4. pause (approximately one-half to two seconds)

Testing shall be conducted at room temperature (between 65°F and 75°F).

8.3 A decibel meter having shall be used to monitor noise levels and collect data. The meter shall be calibrated to NIST standards and shall have a minimum operation range of 30 - 120 dBA over a minimum frequency range of 30 - 5,000 Hz.

8.4 Unless otherwise specified cycling shall continue for a minimum of 30 minutes or 1,000 cycles whichever is longer or until a noticeable squeak has been produced.

8.5 Monitor the sound level for the entire test period. For the peak sound level period, average a 3-minute data acquisition for each test sequence using the "slow" setting on the meter.

8.6 At the conclusion of the test period conduct a baseline sound level measurement (3 minute average).

9. EVALUATION OF RESULTS

9.1 A careful and immediate examination shall be made as required by the specifications covering the material or product being tested.

9.2 A squeak for any test sample shall be defined as having a cyclic peak noise measurement more than 3.0 dBA greater than the peak unloaded apparatus measurements.

10. RECORDS AND REPORTS

The following information shall be recorded, unless otherwise prescribed in the specifications covering the material or product being tested:

10.1 Sub-floor type, thickness, density and conditioning

10.2 Type of fastener and its dimensions, or number or description of part.

10.3 Cycle rate.

10.4 Total cycles.

10.5 Fastener type.

10.6 Report any testing deviations.

10.7 Results of all testing.

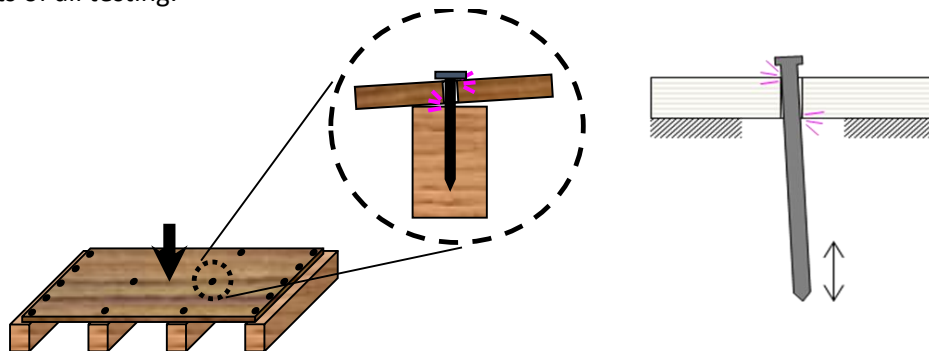


Figure A1. Squeaking occurs between nail and subfloor



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