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An effective new approach to isolate plumbing stub-outs in residential construction

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ABSTRACT

Noise from plumbing systems is often an annoyance in multi-family and private residences. Isolating the plumbing from the wall studs and building structure is a common method of noise mitigation. A new approach to isolate plumbing for a shower was installed and the results were measured in the field. The same method and product may be effectively used for plumbing to toilets, sink, and at other "stub-out" locations. This paper summarizes the noise reduction achieved and compares the performance with other common methods and products.

1 INTRODUCTION

Plumbing noise is created primarily by the turbulence of water flowing through piping, valves, and fixtures. It is dependent on factors including water pressure, flow rates, piping material, and the method of supporting the piping.[1] Once plumbing noise is generated, it is transmitted in a building through airborne and structure-borne paths. Airborne noise can be mitigated by changing wall and ceiling construction where pipes are concealed, by wrapping the piping with insulation or limp barrier materials, and by careful placement of piping in non-sensitive locations. Often the dominant path of plumbing noise transmission is structure borne. Wherever piping, pumps, and fixtures are mounted rigidly to a wall stud, floor joist, or other component of the building structure, sound and vibration are transmitted into the building. Plumbing noise can travel large distances and be radiated by walls, ceilings, and floors as airborne noise. Structure-borne noise can be mitigated by breaking the rigid connection between the piping and the building structure with a resilient support.

Many methods are available and are commonly used to isolate plumbing. This study focuses on a new product to isolate copper piping in a wall cavity at "stub-out" locations. A "stub-out" location is any location where the plumbing terminates at a fixture such as a toilet, shower, or sink faucet.

Using an ISO noise generator to generate plumbing noise, Morin[2] demonstrated that up to 19 dBA of attenuation could be achieved by resiliently mounting piping. The most attenuation was achieved by using 13 mm (½") thick Armstrong Armaflex closed cell foam pipe insulation as the resilient material. A good quality manufactured resilient pipe fastening system ("Acousto-plumb") achieved 13 to 15 dBA of attenuation.

The Kinetics Noise Control IsoMax Stub-out clip is a new product that was introduced to me at the same time that I was embarking on a major bathroom renovation in my home, which is a single family house. As part of the renovation, plumbing would be run for a new shower. Plumbing noise audible in the Master Bedroom was a concern. This "do-it-yourself" shower

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project provided an excellent opportunity to evaluate the ability of the IsoMax Stub-out clip to mitigate structure-borne plumbing noise generated by water flow through copper pipe and shower valves and fixtures. Similar performance is expected for copper pipe at faucets, toilets, and other plumbing fixtures, in either single family homes or multi-family buildings.

2 FIELD TEST SET-UP

The test piping was newly installed 13 mm (½") copper hot and cold water piping serving a second floor shower. The hot and cold water was plumbed to a Kohler Forte Rite-Temp Pressure Balancing shower valve. From the pressure balancing shower valve, a 13 mm (¾") copper pipe was routed to a 3-way Kohler Mastershower 3-way transfer valve. The transfer valve can be set to send water to any one of three devices (i.e., the main shower head, a hand shower, etc.). In this case, only two devices were installed. Per the valve manufacturer's guidelines, one outlet was piped to the main shower head and two outlets were piped in a loop to the second device, which is a hand shower. The pressure balancing shower valve allows full flow to the transfer valve and is adjusted to control the temperature. For this series of tests, the transfer valve was set to send water only to the main shower head.

During all sound level tests, the pressure balancing shower valve was opened one-quarter turn to a "warm" water position that allows both hot and cold water to flow at approximately equal rates. The warm water was captured in a bucket so that the sound of water falling on walls or a floor basin was not present. The static water pressure of the system was 517 kPA (75 psi). Refer to Figure 1 for a plan of the test rooms.

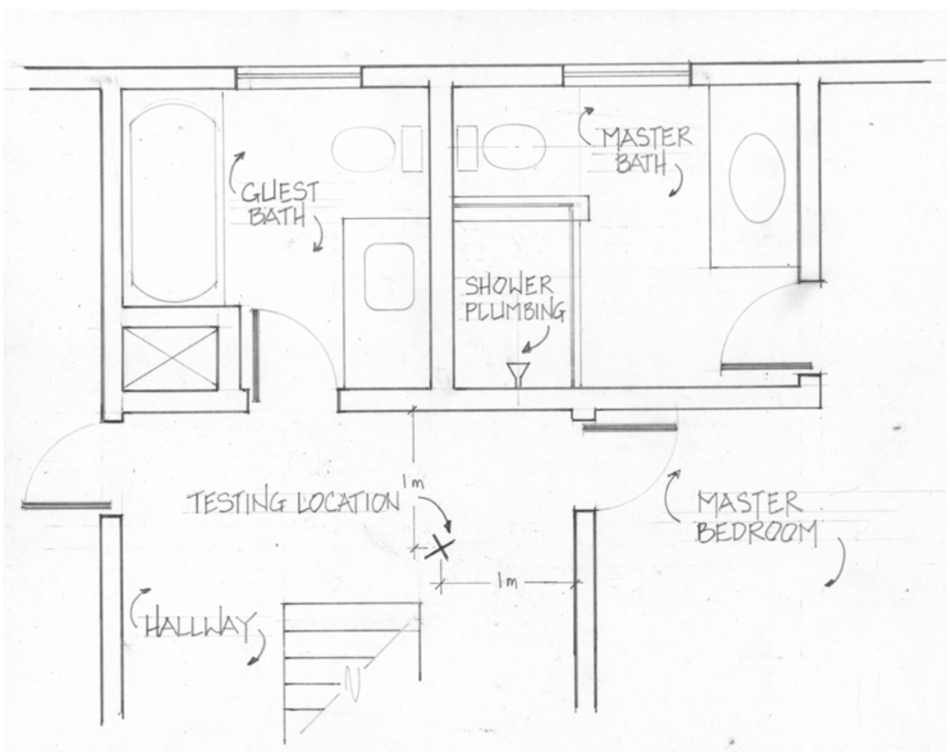

Figure 1: Plan View of Test Area

The Hallway was well isolated from airborne plumbing sound generated in the Master Bathroom. The 13 mm (½") hot and cold water pipes serving the shower penetrate the 2x4 wood wall plate at the base of the shower wall. They are routed under the shower basin and then down through a plumbing chase to the first floor and basement of the house.

Piping upstream of the Master Bathroom is rigidly mounted to wood wall studs and floor joists using conventional copper pipe clamping methods.

Structure-borne sound originating upstream of the Master Bathroom contributes to the measured sound pressure levels in all of the different conditions measured.

3 TEST PROCEDURES

Sound pressure levels were measured on the hallway side of the wall containing the hot and cold water pipes that served the new shower. I measured noise from water flow under four conditions.

3.1 Condition 1 - Piping with rigid connections in the shower wall

The hot and cold water pipes penetrate the floor into the wall cavity and cross at 45° angles before terminating at the pressure balancing shower valve. From the shower valve, a single 19 mm (¾") copper pipe runs vertically to the 3-way transfer valve. From the transfer valve, 13 mm (½") copper pipe is routed to the main shower head above and to the hand shower. All pipes above the floor penetration were rigidly fastened to the wall studs and wood blocking with standard pipe clamps. This is how the piping is typically installed if no measures are taken to resiliently support the pipes.

3.2 Condition 2 - Piping with no rigid connections in the shower wall

The shower fixtures were fully plumbed as in Condition 1, but the piping was not fastened to the wall. It was “freestanding” in the wall cavity. This condition represents the “best case” condition with no structural connections to the pipes.

3.3 Condition 3 - Piping with no connections and batt insulation in the wall cavity

This condition was the same as Condition 2, but unfaced fiberglass batt insulation was placed behind and around the piping in the wall cavity. The intent of this condition was to reduce any airborne sound radiated into the wall cavity that may have been transmitted through the gypsum board face of the wall.

3.4 Condition 4 - Piping supported with IsoMax clips

The hot and cold water pipes were fastened to wood blocking that was supported from the wall studs using the Kinetics Noise Control IsoMax Stub-out clips. Fiberglass batt insulation was placed between the piping and the wall. The same number of supports were used in Condition 1 and Condition 4.

A piece of 13 mm (½") thick gypsum board was temporarily installed over the plumbing on the shower side (for each of the four conditions) to simulate a finished wall.

3.5 Sound Pressure Level Measurements

For each test, the shower valve was turned to the same warm water setting. Two 10 second duration measurements were taken during each of two trials, so a total of four measurements were taken for each condition. The showerhead discharged water into a bucket so that there was minimal airborne noise from water splash in the shower.

All measurements were taken with a Larson-Davis Model 2900 Type 1 sound level meter on “slow” response, together with a Brüel & Kjær Type 4165 13 mm (½") random incidence microphone. Calibration was checked before and after each series of measurements with a Larson-Davis CA250 Precision Acoustic Calibrator. Background sound levels were measured at the time of each series of tests.

4 TEST RESULTS

The A-weighted sound pressure levels are shown in Table 1 together with the attenuation achieved when compared to the rigidly mounted condition.

Table 1: Measured Sound Pressure Levels and Attenuation Achieved

Mounting Condition	L_p (Re: 2 x 10^{-5} PA) dBA	Attenuation dBA
Condition 1: Rigid	56	---
Condition 2: No Connections	36	-20
Condition 3: No Connections, + batts in Cavity	37	-19
Condition 4: IsoMax	42	-14

The one-third octave band data is shown below in Figure 2.

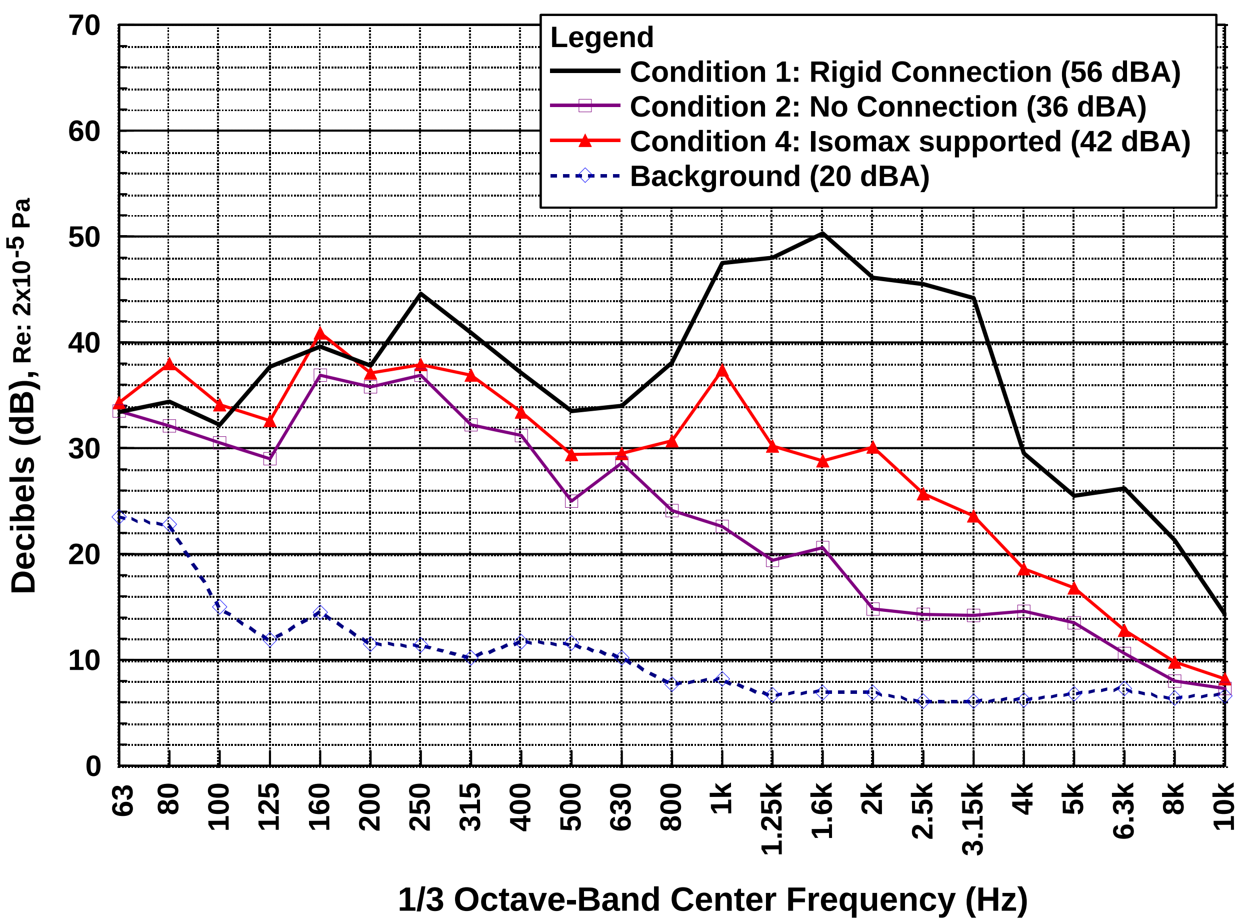

Figure 2: Plumbing Sound Pressure Levels

Condition 3 was intended to determine if placing fiberglass batt insulation in the wall cavity would reduce airborne noise. The Condition 3 sound levels were the same or slightly higher as Condition 2, so airborne noise does not appear to be significant. The fiberglass batts were also included in the wall for the IsoMax Stub-out clip installation.

The IsoMax Stub-out clips achieved similar plumbing noise attenuation to the "Acousto-plumb" system in the Morin[2] study. Each plot is the logarithmic average of four tests. Background sound levels were measured at the time of each series of tests, but the background sound levels were relatively constant and only one representative measurement is shown in Figure 2.

From the one-third octave band data, you can see that above 100 Hz, the Condition 2 data begins to show attenuation. Above the 630 Hz band, the attenuation is dramatic when compared to the rigid Condition 1.

The Condition 4 data shows that the IsoMax clips begin to provide some attenuation at approximately 250 Hz. The attenuation is only about 4 decibels until greater attenuation begins to occur in the 800 Hz band. Above 1,000 Hz, the attenuation is dramatic and exceeds 20 decibels in some bands.

5 CONCLUSIONS AND OBSERVATIONS

The Kinetics Noise Control IsoMax Stub-out resilient clip achieved 14 dBA of noise reduction which is comparable to at least one other good quality manufactured plumbing isolation system that has been tested. While the test methods were not performed to ISO standards with a standardized source, the field test set-up should be similar to many conditions commonly encountered in multi-family and single family homes with wood frame construction.

The IsoMax Stub-out clips are intended for use at stub-out locations where rigid blocking would typically be used. The clips could be used at other locations but would not be as cost-effective since two clips with blocking are always needed. Other systems such as the Acousto-plumb system would only require an isolated clamp and would be easier to install.

I learned several lessons installing these clips myself. While the IsoMax clips are reliable and relatively easy to install, they are not foolproof and can be "short-circuited" if misalignment is severe enough to cause the blocking bracket to touch the metal "frame" of the clip. There are also many opportunities for short-circuiting any plumbing isolation system if the installer is not careful and aware of the intent of the plumbing isolation. With ceramic tile on the surface, it is quite easy for mortar to get into the wall around the plumbing and valves and create rigid connections with the wood studs or the face of the wall. This could significantly degrade the effectiveness of the isolation, but most tile installers are not aware of the problems this can create. Good quality control and education of the contractor is essential to successful plumbing isolation.

6 REFERENCES

[1] John J. Van Houten, "Noise Control in Plumbing Systems," Chapter 8 in *Noise Control in Buildings - A Guide for Architects and Engineers*, edited by Cyril M. Harris (McGraw Hill, New York, 1994).

[2] Michel Morin, MJM Acoustical Consultants, Inc., Montreal, Quebec, Canada, *Research Project on Plumbing Noise in Multi-Dwelling Buildings*, for Canada Mortgage and Housing Corporation (1990)