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RESILIENT CHANNEL: ONE SCREW MAKES A DIFFERENCE

Effect of Screws Short Circuiting a Resilient Ceiling

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Resilient channels have been used for many decades as a means of acoustically isolating a ceiling from the rest of the structure. For almost as long, it likely has been known that resilient channels can be shorted out by misplaced screws. The question has been, what effect do those short circuits have on the acoustical performance. **Pliteq®** wanted to find out.

CONTENTS

INTRODUCTION

Previously, **Pliteq®** has published the white paper, "Resilient Channels: Guaranteed To Fail". That white paper looked at nine different ways resilient channel can fail. Recently, we revisited the subject while in the laboratory.

An open web truss floor (OWT) ceiling assembly was built with a ceiling isolated on resilient channels. Screws were added at the junction of the joist with the resilient channels to intentionally short circuit the channel. Sound Transmission Class (STC) and Impact Insulation Class (IIC) were measured at each stage.

THE ASSEMBLY

An OWT assembly with a direct gypsum concrete pour and a ceiling installed on resilient channels was built at Intertek-ATI floor/ceiling acoustical chamber in York, Pennsylvania. Intertek-ATI is accredited by The International Accreditation Service (IAS) to perform measurements according to ASTM E90 and E492. Details of the assembly are shown in **Figure 1**. The opening at Intertek-ATI is 3.023 m by 3.632 m (9 ft – 11 in by 11 ft – 11 in). Details of the floor plan are shown in **Figure 2**.

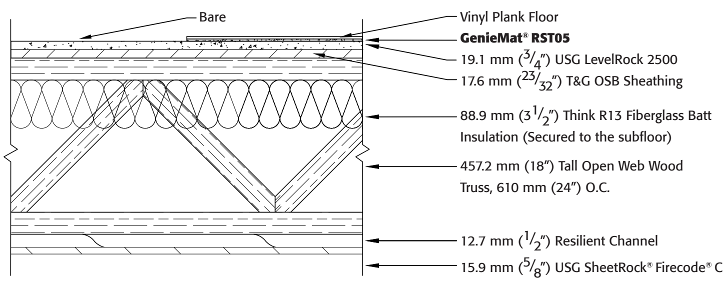


Figure 1: *Details of the Base Assembly used With and Without a Floor Covering*

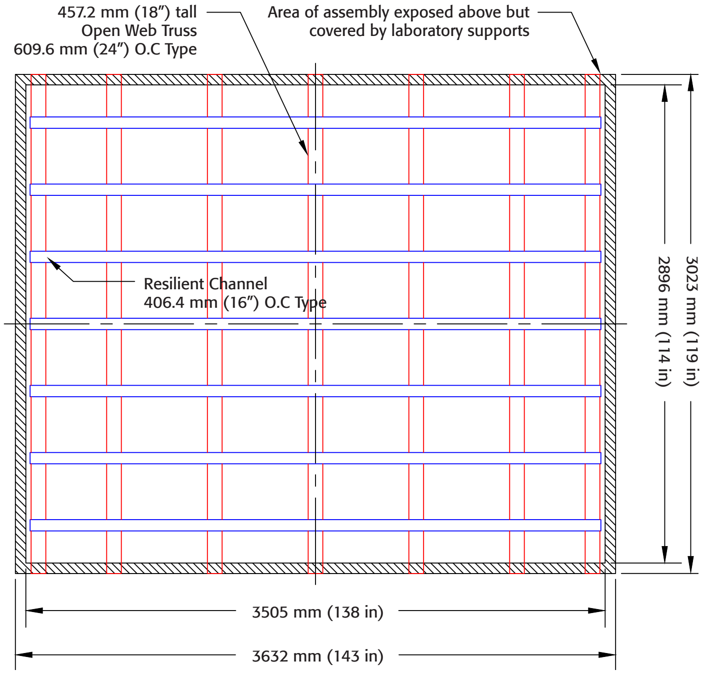
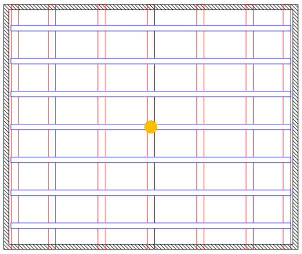


Figure 2: *Plan view of tested assembly to show locations of joists and resilient channels*

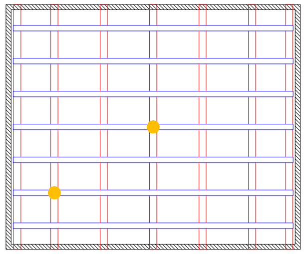
EXPERIMENTAL DESIGN

The assembly was tested according to ASTM E90 and ASTM E492 in eight different short circuit configurations. These short circuits were created by adding 1 to 49 screws into the drywall, each at an intersection of the resilient channel and the OWT. The assembly was tested with no short circuits. A screw was added to create one short circuit. The assembly was then retested. The number of short circuits was doubled for each of the next five configurations and was retested each time. The last configuration only included 49 short circuits since there were only 49 intersections between the resilient channel and the OWT. Each configuration was tested bare and with a floor covering consisting of LVT on **GenieMat® RST02**. The locations of each short circuit are shown in **Figure 3a-f**. Care was taken to distribute the short circuits across the assembly.

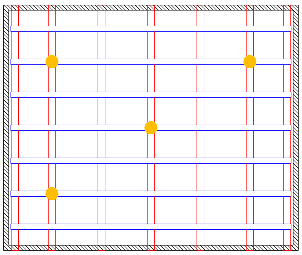
EXPERIMENTAL DESIGN (CONTINUED)



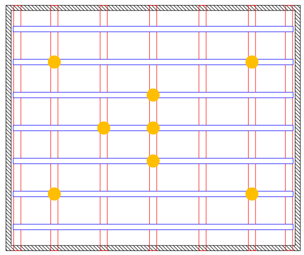
3a: *1 Screw*



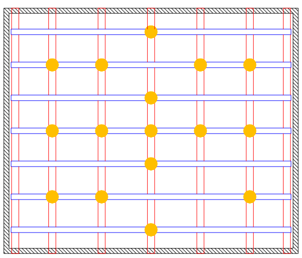
3b: *2 Screws*



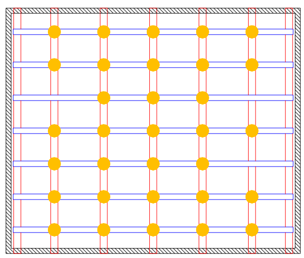
3c: *4 Screws*



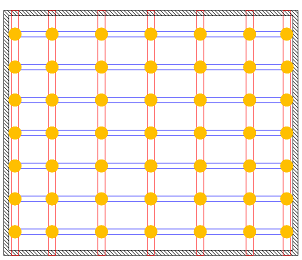
3d: *8 Screws*



3e: *16 Screws*



3f: *32 Screws*



3g: *49 Screws*

Figure 3: *Location of the short circuits for each configuration*

RESULTS AND ANALYSIS

A summary of single number metric results can be found in **Table 1** and **Table 2**. For the bare assembly, the STC ranged from 57 with no short circuits to 52 with 49 short circuits for a total change of 5 STC points. The bare IIC ranged from 40 with no short circuits to 36 with 49 short circuits for a total change of 4 IIC points. While the HIIC and LIIC ranged from 39 and 55 with no short circuits to 35 and 39 with 49 short circuits for a total decreased of 4 and 16 points respectively. The LIIC decreased after 1 screw was added, the STC decreased after 2 screws were added and the IIC and HIIC decreased after 4 screws were added.

For the assembly with the floor covering of LVT and **GenieMat RST02**, the STC ranged from 58 with no short circuits to 52 with 49 short circuits for a total change of 6 STC points. The bare IIC ranged from 52 with no short circuits to 43 with 49 short circuits for a total change of 9 IIC points. While the HIIC and LIIC ranged from 55 and 56 with no short circuits to 51 and 34 with 49 short circuits for a total decreased of 4 and 22 points respectively. There was decreased in the STC, IIC and LIIC after just one short circuit was added. The HIIC decreased after 2 screws were added. It appears that the higher performing assembly showed the effects of the short circuits sooner than the bare assembly. At least in terms of the single number metrics.

Table 1: *Summary of STC and IIC results of all assemblies tested*

Short Circuit Screws	Bare Assembly				Assembly with LVT and GenieMat RST02			
	STC	IIC	HIIC	LIIC	STC	IIC	HIIC	LIIC
None	57	40	39	55	58	52	55	56
1 Screw	57	40	39	53	57	51	55	51
2 Screw	56	40	39	53	57	51	56	50
4 Screw	56	37	37	48	57	50	55	48
8 Screw	56	37	36	47	56	49	54	48
16 Screw	55	37	36	42	55	47	53	40
32 Screw	54	36	35	40	54	44	51	39
49 Screw	52	36	35	39	52	43	51	34

RESULTS AND ANALYSIS (CONTINUED)

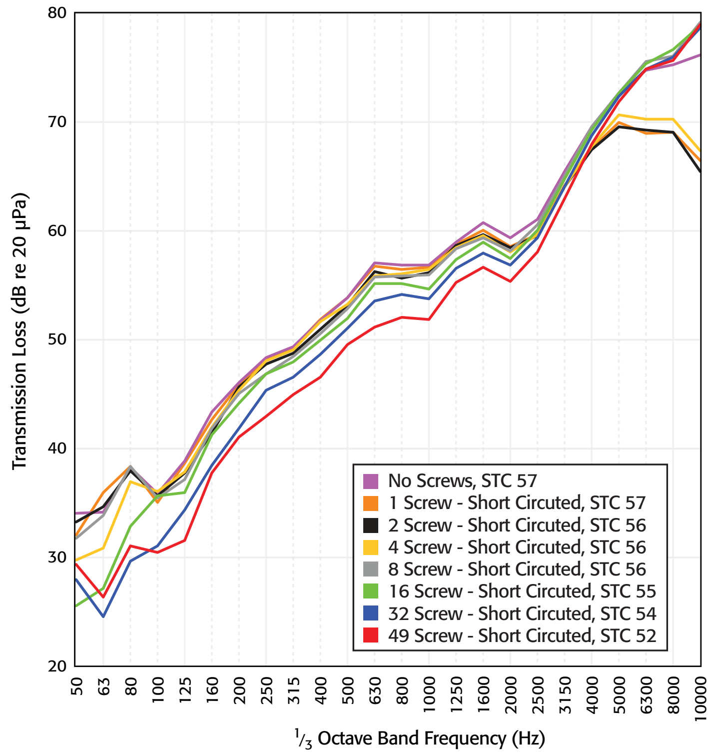
__Table 2:__ Difference in STC and IIC due to short circuit crews relative to assembly with no short circuits

Short Circuit Screws	Bare Assembly				Assembly with LVT and GenieMat RST02			
	STC	IIC	HIIC	LIIC	STC	IIC	HIIC	LIIC
1 Screw	0	0	0	2	1	1	0	5
2 Screw	1	0	0	2	1	1	-1	6
4 Screw	1	3	2	7	1	2	0	8
8 Screw	1	3	3	8	2	3	1	8
16 Screw	2	3	3	13	3	5	2	16
32 Screw	3	4	4	15	4	8	4	17
49 Screw	5	4	4	16	6	9	4	22

RESULTS AND ANALYSIS (CONTINUED)

The 1/3 octave band transmission loss (TL) and normalized impact sound pressure levels (NISPL) for each test are shown in **Figure 4** and **Figure 5**. Note, that while ASTM requires results to be presented in whole dB, the laboratory measures to the tenth dB for use in ISO standards. For the purpose of illustration, the tenth dB data is used in this whitepaper. The results for the assembly without a floor coving are shown in **Figure 4** and the results for the assembly with the LVT and **GenieMat RST02** are shown in **Figure 5**.

From this data, it can be observed the short circuits seemed to negatively effect the low frequencies more than the high frequencies. The TLs went down and the ISPLs went up. There also is some strange behavior in the TLs above 4000Hz. The TL, and to a lesser extent the NISPL, increases as screws are added. The reasons for this are not clear. Upon review with the laboratory, no error in the measurement could be found. None of the measurements appear to be effected by background noise at those frequencies. The uncorrected receiver room levels showed this trend so we know they were not effected by any background noise or reverberation time correction. Further, the first two conditions were measured on one day and the rest were measured on the next day. After this analysis, we concluded that the increase is indeed real.



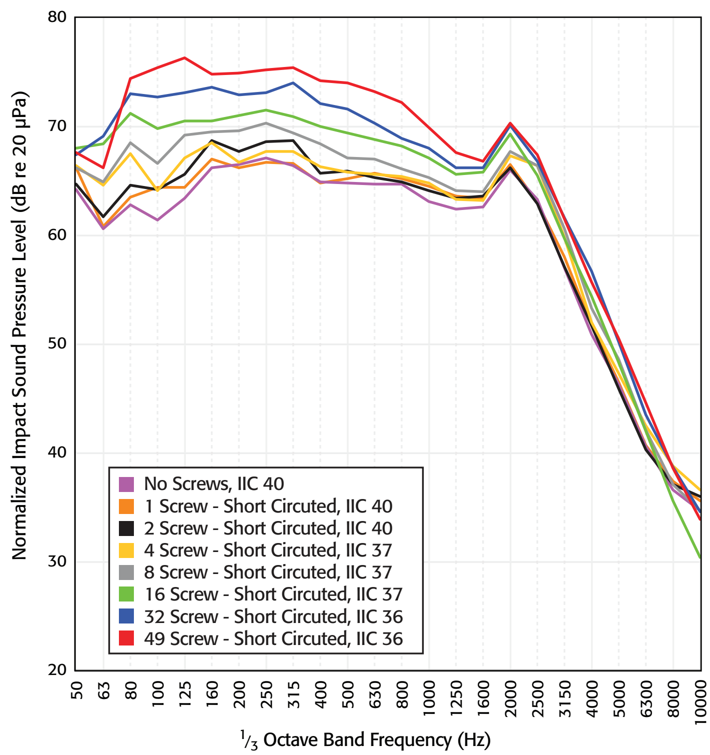


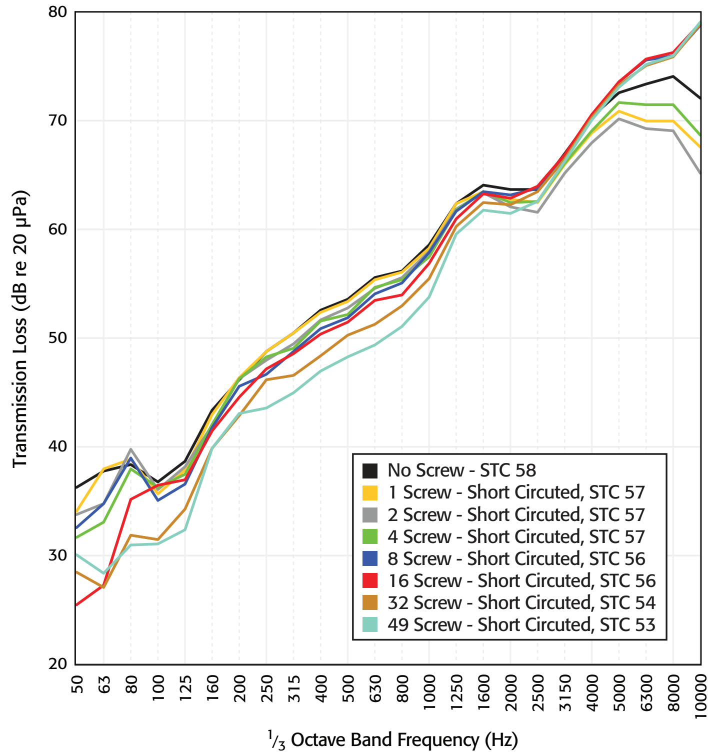
__Figure 4:__ Airborne Sound Transmission (Top) and Impact Sound Pressure Levels (Bottom) of the bare assembly with various numbers of screws shorting out the RC

RESULTS AND ANALYSIS (CONTINUED)

To examine the effect of the short circuits more closely, the difference in TL and NISPL relative to the perfectly installed assembly are shown in **Figure 6** and **Figure 7**. Further, the largest one-third octave band performance decrease, and the frequency at which it occurred, for TL and NISPL are shown in **Table 3**.

Several observations can be made:

- Both assemblies showed the largest increase in NISPL in the 80 Hz to 160 Hz range for all short circuit configurations.
- Both assemblies showed the largest decrease in TL in the 50 Hz – 125 Hz range for all short circuit configurations.
- Even 1 screw changed the TL of at least one 1/3 octave band by 3 dB for both assemblies.
- In the most extreme case, the short circuits in both assemblies caused the TL to decrease by approximately 10 dB at 63 Hz.
- In the most extreme case, the short circuits in both assemblies caused the NISPL to increase by 14 or 16 dB at 100 Hz.
- The floor covering seemed to mitigate some of the high frequency loss of performance compared to the bare assembly.



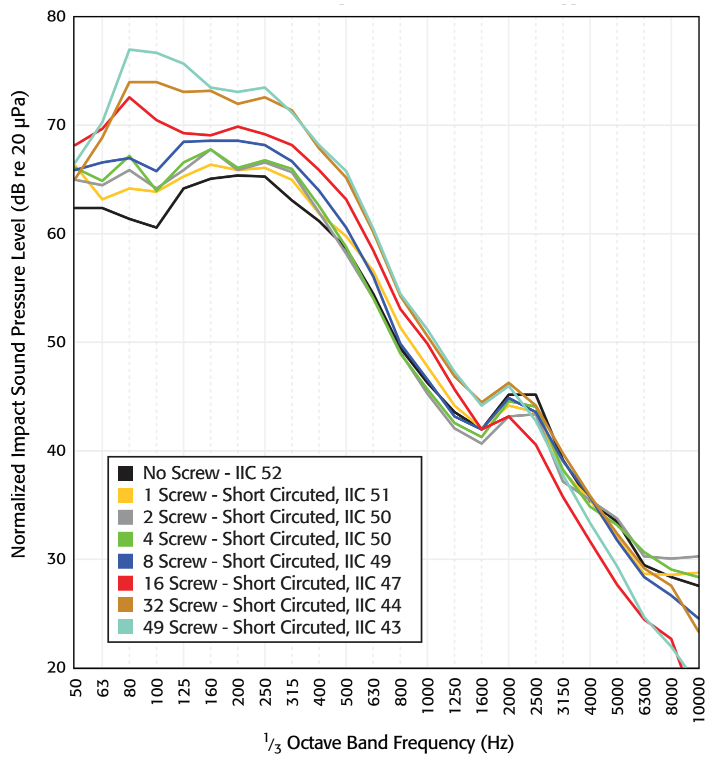


Figure 5: *Airborne Sound Transmission (Top) and Impact Sound Pressure Levels (Bottom) of the assembly with a floor covering and with various numbers of screws shorting out the RC*

RESULTS AND ANALYSIS (CONTINUED)

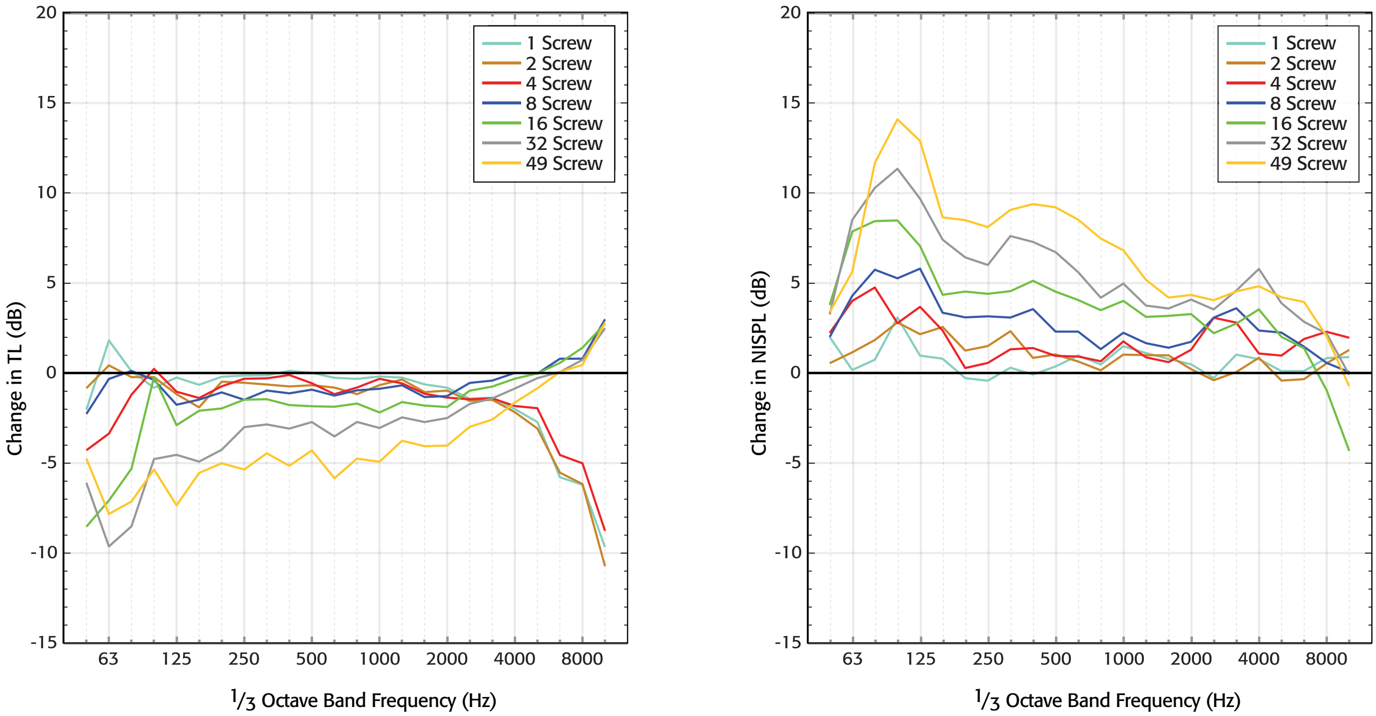


Figure 6: *Change in TL (Left) and NISPL (Right) of bare assembly with varying degrees of short circuiting*

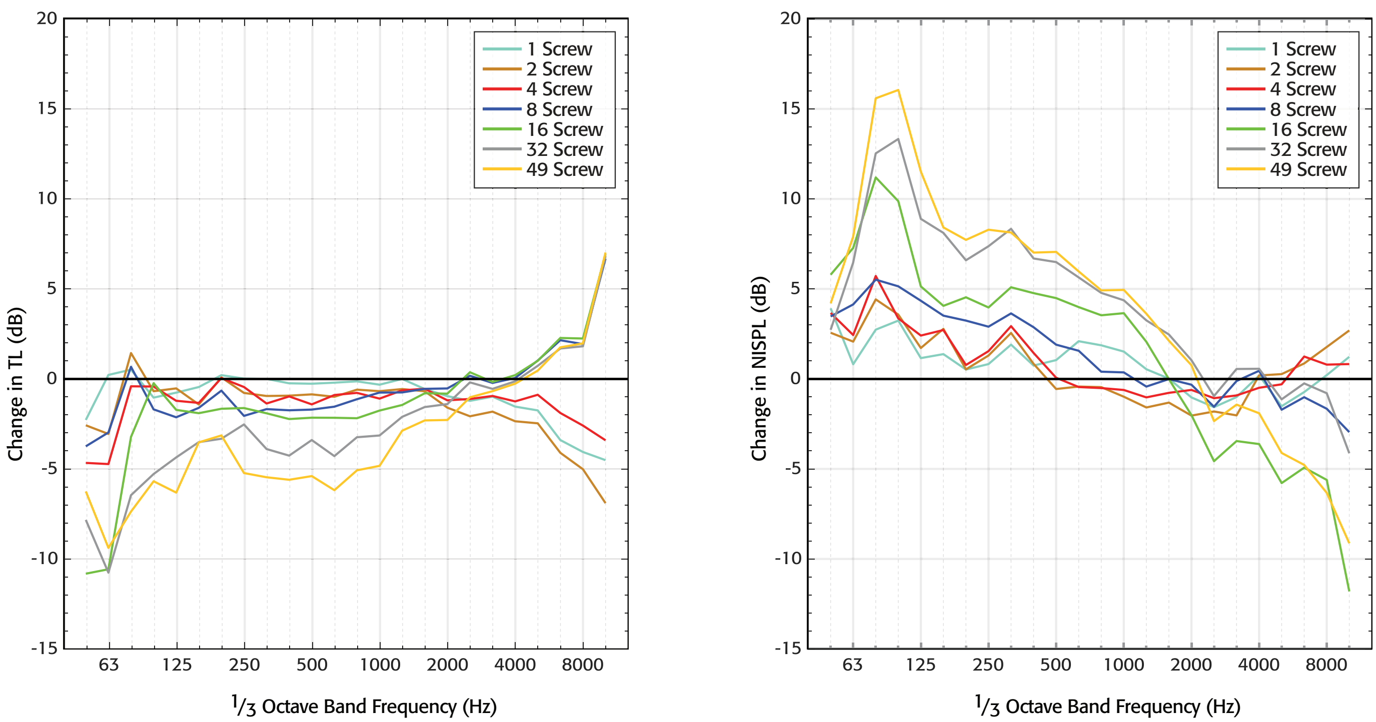


Figure 7: *Change in TL (Left) and NISPL (Right) of assembly with LVT and* ***GenieMat RST*** *with varying degrees of short circuiting*

RESULTS AND ANALYSIS (CONTINUED)

Table 3: *Largest 1/3 octave band decrease in impact and airborne performance*

		Bare Assembly				Assembly with LVT and GenieMat RST02			
		Difference in TL (dB)	1/3 Oct Band (Hz)	Difference in NISPL (dB)	1/3 Oct Band (Hz)	Difference in TL (dB)	1/3 Oct Band (Hz)	Difference in NISPL (dB)	1/3 Oct Band (Hz)
Short Circuits	1 Screw	-9.7	10k	3.1	100	-4.5	10k	3.9	50
	2 Screw	-10.7	10k	2.8	100	-6.9	10k	4.4	80
	4 Screw	-8.8	10k	4.7	80	-4.7	50 & 60	5.7	80
	8 Screw	-2.3	50	5.8	125	-3.7	50	5.5	80
	16 Screw	-8.5	50	8.5	100	-10.8	50	11.2	80
	32 Screw	-9.6	63	11.3	100	-10.7	60	13.3	100
	49 Screw	-7.8	63	14.1	100	-9.4	60	16.0	100

HIGH FREQUENCY PERFORMANCE

As noted above, the TL and to a lesser extent NISPL, above 2 kHz increased in performance relative to the baseline for all assemblies with 8 or more short circuiting screws. As noted above, the results were confirmed with the laboratory. The question remains as to what is causing this behavior.

We have two working theories. The first involves a change in radiation efficiency when the ceiling changes from a series of line sources centered along the resilient channel to a collection of point sources centered on the screws. However, there could be some other mechanism that is changing the radiation efficiency. The second involves the modal behavior of the drywall. There may have been a mode that allowed most of the ceiling to have lower amplitudes than where the first few screws were located. Adding screws may have interfered with that mode and caused more of the drywall to move with the same amplitude as the screws.

In either case, there is more work to be done to determine the mechanism. Feedback from the reader is welcome.

CONCLUSION

As discussed in **Pliteq's** previous white paper "Resilient Channels: Guaranteed to Fail", using resilient channels for acoustical performance in floor/ceiling assemblies often does not work as intended. This current white paper shows that even one screw short circuiting the resilient channel can make a difference in the TL and NISPL performance. In the extreme, short circuits can radically change a floor/ceilings STC and IIC performance.

For Your Project Specific Questions
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