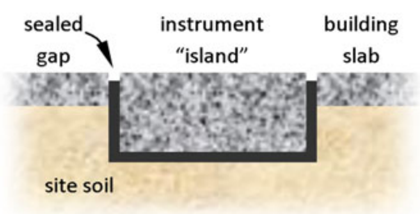
Isolated Concrete Slabs

Lab designers sometimes try to provide **vibration isolation** by introducing a joint in the slab around sensitive instruments like electron microscopes. But does it work? Byron Davis of Vibro-Acoustic Consultants explains why "isolated" slabs don't perform as advertised.

Faced with the daunting requirements of cutting-edge scientific instruments, design teams sometimes try to reduce laboratory vibration by creating a physical break in the floor slab. Modestly-sized tools like AFMs, NMRs, SEMs, and TEMs might have such a break only around the instrument itself. The theory is that a miniature trench around tools can create a quiet "island". The gap is filled with some resilient material and sealed; sometimes sand is placed below.



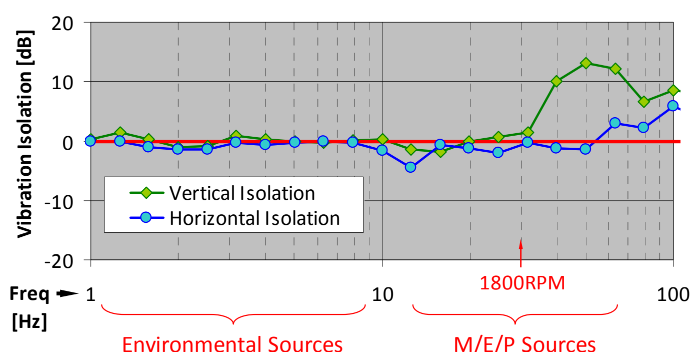
Although superficially appealing, these joints add cost and risk to the project. But more importantly, they are largely ineffective. This is because the waves don't exist only in the slab; rather, the waves extend deep into the soil, which provides a continuous medium beneath both the normal building slab as well as the isolated slab. At the frequencies of interest, the waves reach tens or even hundreds of feet into the earth. A shallow joint isn't enough to block the waves because the slab is just "going along for the ride" on top of the vibrating soil. Even a deep trench won't help in most cases.

Joint isolation data from a real-life experiment are shown at right. For this test, we simultaneously measured vibrations on both sides of a vibration isolation joint. One sensor was on the main slab-on-grade floor while the other sensor was on a separated "island" designed for a TEM (transmission electron microscope). The trench was as deep as the main slab (6") while the island was a thick pad (36").

The plot relates vibration isolation in decibels; therefore, numbers above zero imply *improvement* in the vibration environment, while values below zero imply *degradation*. That's right: these gaps can actually make things worse instead of better. Zero on the plot means "no effect".

In the plot, isolation is practically 0dB from 1~10Hz. This means that the gap therefore neither helps nor hurts. At these frequencies, lab vibrations tend to be dominated by environmental vibration sources like road and rail traffic. These often lie beyond the control of the design team, so mitigation would be very valuable. But at these frequencies, the isolated slab provides no benefit at all.

At higher frequencies, local mechanical/electrical/plumbing systems are important, since rotating systems emit forces at their shaft speeds. Even as high as 30Hz (1800RPM) the joint offers no benefit. Since the fans and pumps that create lots of vibration in buildings operate at speeds of 600~1800RPM (10~30Hz), the joint isn't even helping isolate against these common nearby vibration sources.



The data do indicate improvement at yet higher frequencies; however, sources at these frequencies are often less energetic, easier to mitigate at the source, and are usually under the design team's direct control. Additionally, most instruments (including high-end microscopes like SEMs and TEMs) are less sensitive to vibrations at high frequencies, anyway.

In short, **the vibration isolation joint only helps at the least problematic frequencies**. What's worse, the joint degrades the horizontal vibration environment due to the loss of restraint normally provided by the slab. At 12.5Hz, the data imply about 5dB of amplification, almost **doubling** the vibration impact of machines operating near 750RPM.

This isn't to say that trenches *never* work; however, designers should generally look suspiciously upon the idea and engage a qualified vibration consultant for the project.

Vibro-Acoustic Consultants specializes in vibration and noise design in demanding settings, serving clients around the world. Contact Byron by visiting www.va-consult.com

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