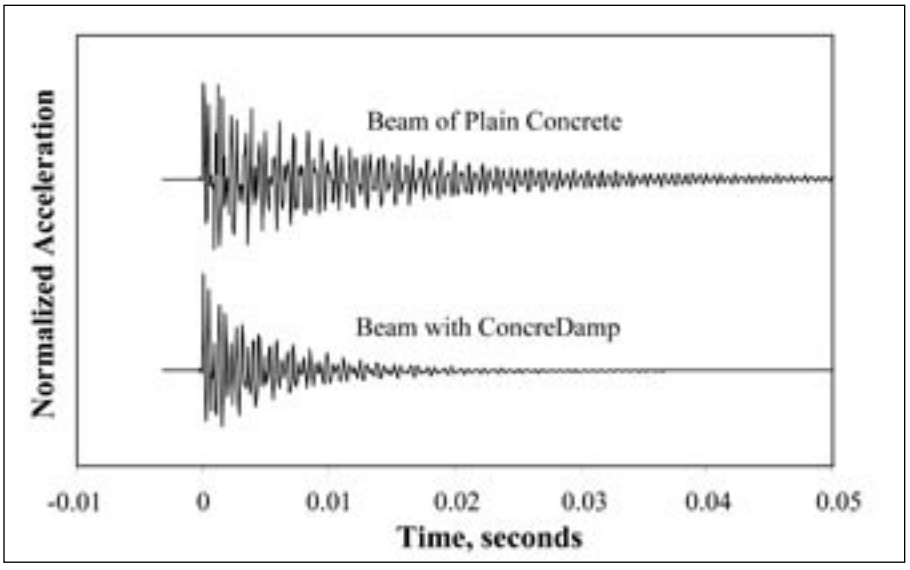
Reducing Floor Vibrations

A polymer admixture provides increased damping in concrete

BY HAL AMICK

ConcreDamp is a polymer admixture designed to increase concrete's damping properties and therefore increase the decay of impact-induced vibrations. The liquid additive, manufactured by Durasol Chemical Co., Amesbury, MA, is similar to styrene-butadiene rubber (SBR) admixtures that are commonly used in pavement to improve durability, but has been modified by adding vegetable gum in the suspension.



Acceleration response of beams subjected to a hammer blow, with and without ConcreDamp admixture. Accelerations have been normalized to show the same maximum acceleration in both cases, but the vibration clearly decays much more rapidly in the beam containing the damping admixture

APPLICATIONS

Throughout its nearly 30-year history, ConcreDamp has been used in concrete floors for hospitals as well as laboratories.[1] The benefits of the admixture are most apparent when floor vibrations involve resonant response, as when a floor responds to pedestrian footfalls[2] or when vibrations propagate through a slab as body or surface waves.

In slabs-on-ground, the energy associated with surface wave propagation extends to a depth of about one wavelength. At low frequencies—for example, below 100 Hz—this depth can be several meters, and the damping properties of the soil will affect propagation to a greater extent than the damping properties of the slab. However, at frequencies above a few hundred Hertz—such as those associated with impacts of hard heels or a dropped hammer—the wavelength may be contained entirely within the slab. In these cases, increased concrete damping can be beneficial.

The admixture is most effective in applications involving very low amplitude vibrations, such as in floors, where damping can be increased several times over. It's less

effective in applications involving high amplitudes—such as earthquake engineering—because the damping contributed by concrete cracking, yielding of steel reinforcement, and slippage at connections can be much larger than what is contributed by the admixture.

EFFECTS ON DYNAMIC MODULI

Because of the polymer, the damping and dynamic moduli (Young's modulus and shear modulus) of polymer-modified concrete are functions of frequency and temperature. In application, each polymer therefore has ideal ranges of temperature and frequency—both are governed by the polymer's glass transition temperature.[3]

ConcreDamp is most effective at room temperature and at frequencies between 1 and 2000 Hz. This includes the range of resonant frequencies for most floors and many situations involving structureborne sound. One of the most interesting effects is its reduction of impact noise from a person in hard heels walking across a floor containing the admixture. As with other polymeric admixtures with optimal performance at room temperature, most of the damping effectiveness is lost as temperatures approach or drop below freezing.

EFFECTS ON STRENGTH

A common misconception is that variants of SBR-based admixtures increase concrete strength. The primary reason for this perception is that SBR behaves as a water-reducing admixture, allowing a reduced water-cementitious material ratio (*w/cm*) for a given workability. However, with a constant *w/cm*, the addition of ConcreDamp will produce a slight decrease in compressive strength. The reduced compressive strength, $(f'_c)_{\text{ConcreteDamp}}$, can be estimated using the equation

$$(f'_c)_{\text{ConcreteDamp}} = (1 - 9\ p/c)(f'_c)_0$$

where *p/c* is the mass ratio of polymer solids to cement, and $(f'_c)_0$ is the compressive strength of a similar mixture without ConcreDamp.

References

1. Amick, H., and Monteiro, P.J.M., "Construction of Nanotechnology Facilities," *Concrete International*, V. 26, No. 3, Mar. 2004, pp. 68-72.

2. Moiseev, N., "Effect of a Viscoelastic Admixture on Transient Vibration in a Concrete and Steel Floor," *Vibration Control in Microelectronics, Optics and Metrology*, SPIE Proceedings, V. 1619, San Jose, CA, Nov. 1991, pp. 192-202.

3. Amick, H., "Damping Properties of Polymer-Modified Concrete," *Proceedings from the 75th Shock and Vibration Symposium*, Virginia Beach, VA, Oct. 2004, available for download in the "Papers" section of www.colingordon.com.

Selected for reader interest by the editors.

—Durasol Chemical Co.

CIRCLE

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