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ScienceDirect
Cement and Concrete Research 36 (2006) 2104–2105
Cement and Concrete Research

Discussion

A discussion of the paper "Dynamic properties impact toughness and abrasiveness of polymer-modified pastes by using nondestructive tests" by W.G. Wong, Ping Fang, J.K. Pan [Cem. Concr. Res. 33 (9) (2003) 1371–1374]

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Received 10 October 2003

The authors [1] have made a valuable contribution to the field of cement paste and concrete damping. Although others [2,3] have examined the role played by polymer admixtures in cement paste damping, those studies involved forced excitation at only two (very low) off-resonance frequencies. The authors [1] examined a different polymer, this time using resonant response, documenting the variation in damping over a wide range in admixture concentration.

An otherwise good presentation [1] is marred somewhat by an inconsistency in notation, which leaves the reader unsure as to whether damping increases or decreases as the polymer dosage is increased. One is also unsure of the numeric values involved.

One difficulty encountered in any study of damping is the selection of damping units. There are many, and there is no established convention regarding which one to use, except perhaps in polymers and acoustics. The concrete literature uses virtually every available definition, cluttering any comparison from one paper to the next. Between Ungar [4] and Lazan [5], one can assemble a cross-relationship between most of the accepted representations of damping, providing that damping is relatively small, say $\eta<0.3$ [6]. This set of relationships is given in Eq. (1).

$$\eta = \frac{Y}{2\pi} = 2\zeta = 2\frac{c}{c_{\mathrm{cr}}} = \frac{1}{Q} = \frac{\delta}{\pi} = b = \frac{\Delta}{27.3 f_{\mathrm{n}}} = \tan\lambda \tag{1}$$

where η=loss factor, dimensionless, Y=specific damping capacity, dimensionless, ζ=fraction of critical damping, dimensionless, c=viscous damping coefficient, N s/m, c_{cr}=critical damping coefficient, N s/m, Q=amplification at resonance (or quality), dimensionless, δ=logarithmic decrement, dimensionless, Δ=decay rate, dB/s, λ=loss angle, tan λ being termed the "loss tangent". The authors [1] initially make use of specific damping capacity Y, defined below in Eq. (2) as well as in their [1] Eq. (2). This usage is consistent with literature [5]. Note in Eq. (1) that Y is proportional to loss factor, η.

$$Y = \frac{\Delta W}{W} \tag{2}$$

Subsequently, the authors [1] define the means by which they calculated specific damping capacity Y using their [1] Eq. (4), restated below as Eq. (3), in which f_0 is the resonance frequency, f_2 is the half-power frequency greater than f_0 and f_1 is the half-power frequency less than f_0. (The half-power points are those at which the amplitude is 0.707 times the amplitude at f_0.) This methodology is called "half-power bandwidth" and is one of the most common approaches to damping calculations.

$$Y = \frac{f_0}{f_2 - f_1} \tag{3}$$

Unfortunately, the relationship shown in Eq. (4) is not the definition of specific damping capacity Y. Rather, it is the definition of Q, the amplification at resonance, which is the inverse of loss factor η, and thus, inversely proportional to Y. In addition to the right side of the equation being inverted, the 2π term is missing.

The authors' [1] Fig. 2 shows how "specific damping capacity" increases with polymer/cement ratio P/C. The text

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doi:10.1016/j.cemconres.2004.11.008

[1] states that damping is increasing. If damping increases, Q decreases. Thus, I have concluded that Fig. 2 actually shows how η increases with P/C, though it might actually show Y. However, one cannot be certain. Could the authors [1] kindly provide some clarification?

In addition, the damping of polymers alone varies with frequency and temperature, and the relationships are defined in part by the glass transition temperature, T_g [5]. Could the authors [1] kindly provide the T_g of the polymer used in this study?

References

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