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Erratum to
Response Spectra for Near-Source, Differential, and Rotational Strong Ground Motion

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In Jalali and Trifunac (2009), the section PSV Spectra at Short Periods contains errors in equations (12), (13), (14), and (15), and in two places within the text. $\mathrm{PSV}_{T\to\infty}$ should have been $\mathrm{PSV}_{T\to 0}$. The affected section is reprinted here, with corrections. Full references for citations within this erratum can be found in the original article.

PSV Spectra at Short Periods

It has been shown (Trifunac and Todorovska, 1997) that the relative displacement spectra at short periods (stiff structures) for in-plane differential horizontal ground motion (predominantly *P*, *SV*, and Rayleigh waves propagating along the longitudinal axis of the structure) become constant and equal to $\dot{u}_{g,\max}\tau$, where $\dot{u}_{g,\max}$ is the peak velocity of in-plane horizontal ground motion and τ is the travel time of the strong-motion waves from the extreme column to the center of the plan of the building $[\tau = L/(2C_x)]$. For out-of-plane excitation (predominantly *SH* and Love waves propagating along the longitudinal axis of a structure) and the resulting out-of-plane response (assuming that there is no coupling with in-plane excitation and in-plane response), it was shown that the relative displacement spectral amplitudes become $\sim 2\dot{u}_{g,\max}\tau$, where $\dot{u}_{g,\max}$ is the peak velocity of out-of-plane horizontal ground motion (Trifunac and Gičev, 2006). To calculate the PSV spectral amplitudes, we multiply the aforementioned values by ω_n.

The aforesaid estimates of the effects of differential ground motion on the high-frequency relative displacement spectrum amplitudes are based on the Taylor series approximation of ground strains and work well for excitation by long waves. When this assumption does not hold—that is, for excitation by short waves—the point derivative $\dot{u}_{g,\max}$ becomes an upper bound estimate and should be replaced by

$$\dot{\bar{u}}_{g,\max} = [u_{g2}(t + L/C_x) - u_{g1}(t)]/(L/C_x), \qquad (11)$$

where $\dot{\bar{u}}_{g,\max}$ is the largest value of $\dot{\bar{u}}_g$ during excitation. Consequently, at short periods, the PSV amplitudes for the fault-normal pulse d_F and for fault-parallel displacement d_N will be dominated by

$$\mathrm{PSV}_{T\to 0} = \omega_n \dot{\bar{u}}_{g,\max}\tau \qquad (12)$$

for in-plane excitation, and by

$$\mathrm{PSV}_{T\to 0} = \omega_n 2\dot{\bar{u}}_{g,\max}\tau \qquad (13)$$

for out-of-plane excitation.

For our example, with displacements d_F and d_N (see equations 4 and 5), the reduction factors are equal to $\dot{\bar{u}}_{g,\max}/\dot{u}_{g,\max} = \exp(-\alpha_F 2\tau)$ and $\dot{\bar{u}}_{g,\max}/\dot{u}_{g,\max} = (\tau_N/2\tau)[1 - \exp(-2\tau/\tau_N)]$, respectively. For *M* 8, these reduction factors are 0.86 and 0.99, for the time delay $2\tau = L/C_x = 0.1$. For *M* 4, the corresponding reduction factors are 0.25 and 0.91, respectively. The example illustrated in Figure 5 shows how well the asymptotes in equation (12) describe the PSV amplitudes for excitation by u_g only and for $\tau = 0.025$ and 0.050 as $T \to 0$. For irregular and more complex ground motion, relative to our examples of d_F and d_N, it is more conservative to work with the upper bounds based on $\dot{u}_{g,\max}$—that is, to use

$$\mathrm{PSV}_{T\to 0} = \omega_n \dot{u}_{g,\max}\tau \qquad (14)$$

for in-plane excitation and

$$\mathrm{PSV}_{T\to 0} = \omega_n 2\dot{u}_{g,\max}\tau \qquad (15)$$

for out-of-plane excitation.

In this article, at short periods the relative displacement of the system tends toward zero, while the relative velocity is not zero but rather equal to the initial velocity of the ground, $\dot{u}_g(t=0)$. Thus, there are two velocities contributing to the spectral amplitudes at short periods: initial velocity for synchronous motion, $\dot{u}_g(t=0)$, and the velocity for differential motion of the system, $\omega_n \dot{u}_{g,\max}\tau$. The maximum velocity of the system, subjected to horizontal differential ground motion at short periods, is $\mathrm{PSV}_{T\to 0} = [\dot{u}_g{}^2(t = 0) + (\omega \dot{u}_{g,\max}\tau)^2]^{1/2}$ by the square root of the sum of squares (SRSS) rule, where the first term is due to the synchronous horizontal ground motion and the second term is due to the horizontal differential ground motion. As can be seen from Figure 5, when $\tau \to 0$ (e.g., $\tau = 0.005$), the PSV amplitude tends to the asymptote $\dot{u}_g(t = 0)$, the initial velocity of the ground. For out-of-plane excitation, we would have $\mathrm{PSV}_{T\to 0} = [\dot{u}_g{}^2(t = 0) + (2\omega \dot{u}_{g,\max}\tau)^2]^{1/2}$.

Reference

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