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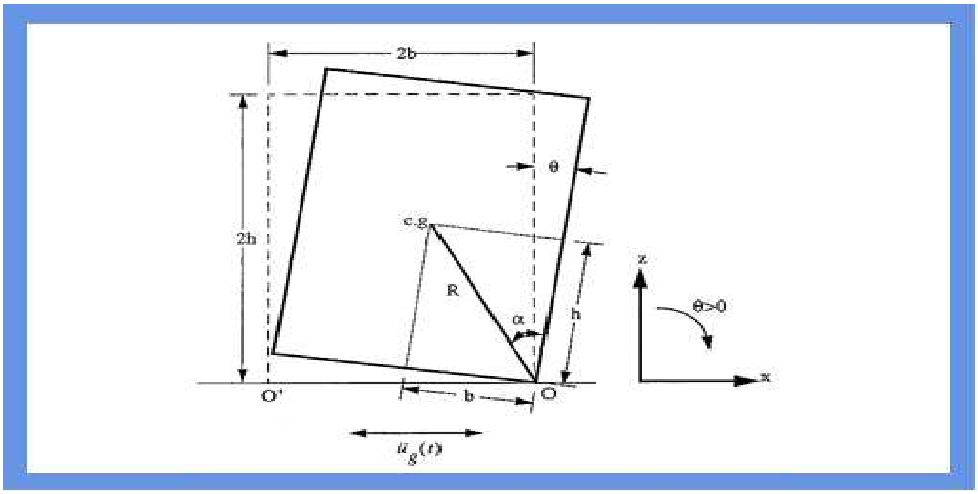
Theory:



The equations that govern the rocking motion under the simultaneous presence of,

$\ddot{u}_g(t)$ -- horizontal ground accelaration and,

$\ddot{v}_g(t)$ -- vertical ground acceleration are

$$I_o\ddot{\theta}_t + mg\left|1 + \frac{\ddot{v}_g(t)}{g}\right| R\,sin(-\alpha - \theta) = -m\ddot{u}_g(t) R\,cos(-\alpha - \theta)\,, \theta < 0$$

and,

$$I_o\ddot{\theta}_t + mg\left|1 + \frac{\ddot{v}_g(t)}{g}\right| R\,sin(\alpha - \theta) = -m\ddot{u}_g(t) R\,cos(\alpha - \theta)\,, \theta > 0$$

For Rectangular blocks,

$I_o = (4/3)mR^2$ [where, m = Mass of the Block.]

The above two equations are linearized to get the time history of angular displacement

$$\theta(t) = A_1\,\sinh(pt) + A_2\,\cosh(pt) - \alpha + \frac{1}{1 + \frac{\omega_p^2}{p^2}}\frac{a_p}{g}\sin(\omega_p t + \psi), \theta < 0$$

and,

$$\theta(t) = A_3 \sinh(pt) + A_4 \cosh(pt) + \alpha + \frac{1}{1+\frac{\omega_p^2}{p^2}} \frac{a_p}{g} \sin(\omega_p t + \psi), \theta > 0$$

Where,

$$A_1 = A_3 = \frac{\theta_o}{p} - \alpha \frac{\omega_p/p}{1+\omega_p^2/p^2} \frac{\cos(\psi)}{\sin(\psi)}$$

$$A_2 = \theta_o + \alpha - \frac{\alpha}{1+\omega_p^2/p^2}$$

$$A_4 = \theta_o - \alpha - \frac{\alpha}{1+\omega_p^2/p^2}$$

$$p = \sqrt{\frac{3g}{4R}}$$

where,

g = Frequency.

$$\psi = sin^{-1}\left[\alpha g/a_p\right]$$