

TABLE 4-1 Relations Among Elastic Constants

	E	ν	k	μ	λ
E, ν	E	ν	$\frac{E}{3(1-2\nu)}$	$\frac{E}{2(1+\nu)}$	$\frac{E\nu}{(1+\nu)(1-2\nu)}$
E, k	E	$\frac{3k-E}{6k}$	k	$\frac{3kE}{9k-E}$	$\frac{3k(3k-E)}{9k-E}$
E, μ	E	$\frac{E-2\mu}{2\mu}$	$\frac{\mu E}{3(3\mu-E)}$	μ	$\frac{\mu(E-2\mu)}{3\mu-E}$
E, λ	E	$\frac{2\lambda}{E+\lambda+R}$	$\frac{E+3\lambda+R}{6}$	$\frac{E-3\lambda+R}{4}$	λ
ν, k	$3k(1-2\nu)$	ν	k	$\frac{3k(1-2\nu)}{2(1+\nu)}$	$\frac{3k\nu}{1+\nu}$
ν, μ	$2\mu(1+\nu)$	ν	$\frac{2\mu(1+\nu)}{3(1-2\nu)}$	μ	$\frac{2\mu\nu}{1-2\nu}$
ν, λ	$\frac{\lambda(1+\nu)(1-2\nu)}{\nu}$	ν	$\frac{\lambda(1+\nu)}{3\nu}$	$\frac{\lambda(1-2\nu)}{2\nu}$	λ
k, μ	$\frac{9k\mu}{6k+\mu}$	$\frac{3k-2\mu}{6k+2\mu}$	k	μ	$k - \frac{2}{3}\mu$
k, λ	$\frac{9k(k-\lambda)}{3k-\lambda}$	$\frac{\lambda}{3k-\lambda}$	k	$\frac{3}{2}(k-\lambda)$	λ
μ, λ	$\frac{\mu(3\lambda+2\mu)}{\lambda+\mu}$	$\frac{\lambda}{2(\lambda+\mu)}$	$\frac{3\lambda+2\mu}{3}$	μ	λ

$$R = \sqrt{E^2 + 9\lambda^2 + 2E\lambda}$$

$$\begin{aligned}
 \sigma_r &= \lambda(e_r + e_\theta + e_z) + 2\mu e_r & \sigma_R &= \lambda(e_R + e_\phi + e_\theta) + 2\mu e_R \\
 \sigma_\theta &= \lambda(e_r + e_\theta + e_z) + 2\mu e_\theta & \sigma_\phi &= \lambda(e_R + e_\phi + e_\theta) + 2\mu e_\phi \\
 \sigma_z &= \lambda(e_r + e_\theta + e_z) + 2\mu e_z & \sigma_\theta &= \lambda(e_R + e_\phi + e_\theta) + 2\mu e_\theta \\
 \tau_{r\theta} &= 2\mu e_{r\theta} & \tau_{R\phi} &= 2\mu e_{R\phi} \\
 \tau_{\theta z} &= 2\mu e_{\theta z} & \tau_{\phi\theta} &= 2\mu e_{\phi\theta} \\
 \tau_{zr} &= 2\mu e_{zr} & \tau_{\theta R} &= 2\mu e_{\theta R}
 \end{aligned} \tag{4.3.2}$$

The complete set of elasticity field equations in each of these coordinate systems is given in Appendix A.

4.4 Thermoelastic Constitutive Relations

It is well known that a temperature change in an unrestrained elastic solid produces deformation. Thus, a general strain field results from both mechanical and thermal effects. Within the context of linear small deformation theory, the total strain can be decomposed into the sum of mechanical and thermal components as