Calculation of the 1-axial stress conditions prior drilling the hole:

$$\sigma'_r = \frac{\sigma_x}{2}(1+\cos(2\alpha))$$

$$\sigma'_\theta = \frac{\sigma_x}{2}(1-\cos(2\alpha))$$

$$\sigma'_{r\theta} = -\frac{\sigma_x}{2}\sin(2\alpha)$$

Calculation of the stress distribution after KIRSCH*:

$$\sigma_r = \frac{\sigma_x}{2}(1-\frac{1}{r^2}+\frac{\sigma_x}{2}(1+\frac{3}{r^4}-\frac{4}{r^2})\cos(2\alpha)$$

$$\sigma_\theta = \frac{\sigma_x}{2}(1+\frac{1}{r^2}-\frac{\sigma_x}{2}(1+\frac{3}{r^4})\cos(2\alpha)$$

$$\sigma_{r\theta} = -\frac{\sigma_x}{2}(1-\frac{3}{r^4}+\frac{2}{r^2})\sin(2\alpha)$$

Superposing both conditions as above and considering the linear-elastic material behavior the calculation for the relaxing strains can be expressed by:

$$\varepsilon_r = \frac{\sigma_x(1+\nu)}{2E}\left(\frac{1}{r^2}-\frac{3}{r^4}\cos(2\alpha)+\frac{4\nu}{r^2(1+\nu)}\cos(2\alpha)\right)$$

$$\varepsilon_\theta = \frac{\sigma_x(1+\nu)}{2E}\left(-\frac{1}{r^2}-\frac{3}{r^4}\cos(2\alpha)-\frac{4\nu}{r^2(1+\nu)}\cos(2\alpha)\right)$$

The consideration of the elastic constants:

$$A = -\frac{1+\nu}{2E}\left(\frac{1}{r^2}\right)$$

$$B = -\frac{1+\nu}{2E}\left(\left(\frac{4}{1+\nu}\right)\frac{1}{r^2}-\frac{3}{r^4}\right)$$

$$C = \frac{1+\nu}{2E}\left(-\left(\frac{4}{1+\nu}\right)\frac{1}{r^2}+\frac{3}{r^4}\right)$$

yields finally:

$\varepsilon_r = \sigma_x(A+B\cos(2\alpha)$ and

$\varepsilon_\theta = \sigma_x(-A+C\cos(2\alpha))$

*KIRSCH, G. et al: “Thermal Stress in a Viscoelastic-Plastic Platewith Temperature depending Yield Stress” Journ. Appl.Mech., 27 (1898), pp.205-207