$$M_z = \iint_R (xT_y^n - yT_x^n)\, dxdy = T$$

$$\iint_R T_x^n\, dxdy = \pm \iint_R \tau_{xz}\, dxdy = \pm \iint_R \frac{\partial \phi}{\partial y} dxdy$$

$$T = \iint_R (xT_y^n - yT_x^n)\, dxdy = -\iint_R (x\frac{\partial \phi}{\partial x} + y\frac{\partial \phi}{\partial y})\, dxdy$$

$$\iint_R x\frac{\partial \phi}{\partial x} dxdy = \iint_R \frac{\partial}{\partial x}(x\phi)\, dxdy - \iint_R \phi dxdy$$

$$= \oint_s x\phi n_x\, ds - \iint_R \phi dxdy$$

$$\iint_R y\frac{\partial \phi}{\partial y} dxdy = \iint_R \frac{\partial}{\partial y}(y\phi)\, dxdy - \iint_R \phi dxdy$$

$$= \oint_s y\phi n_y\, ds - \iint_R \phi dxdy$$

$$\left(\frac{\partial w}{\partial x} - y\beta\right) n_x + \left(\frac{\partial w}{\partial y} + x\beta\right) n_y = ٠$$

$$\frac{\partial w}{\partial x}\frac{dx}{dn} + \frac{\partial w}{\partial y}\frac{dy}{dn} = \beta\left(x\frac{dx}{ds} + y\frac{dy}{ds}\right)$$

$$\frac{dw}{dn} = \frac{\beta}{۲}\frac{d}{ds}(x^{۲} + y^{۲})$$

$$T = G\iint_R \left(\beta(x^{۲} + y^{۲}) + x\frac{\partial w}{\partial y} - y\frac{\partial w}{\partial x}\right) dxdy$$

$$J = G\iint_R \left(x^{۲} + y^{۲} + \frac{x}{\beta}\frac{\partial w}{\partial y} - \frac{y}{\beta}\frac{\partial w}{\partial x}\right) dxdy$$

$$\sigma_r = \frac{E}{۱ - v^{۲}}[\varepsilon_r + v\varepsilon_\theta - (۱ + v)kT]$$

$$\sigma_\theta = \frac{E}{۱ - v^{۲}}[v\varepsilon_r + \varepsilon_\theta - (۱ + v)kT]$$

$$\tau_{r\theta} = \frac{E}{۲(۱ + v)}\gamma_{r\theta}$$

$$\varepsilon_z = -\frac{E}{۱ - v^{۲}}\left[v(\varepsilon_r + \varepsilon_\theta) - (۱ + v)kT\right]$$

$$e = \varepsilon_r + \varepsilon_\theta + \varepsilon_z = \frac{E}{۱ - v}\left[(۱ - ۲v)(\varepsilon_r + \varepsilon_\theta) + (۱ + v)kT\right]$$

$$\sigma_z = \tau_{rz} = \tau_{\theta z} = \gamma_{rz} = \gamma_{\theta z} = ۰$$

$$\nabla^{۲}(\sigma_r + \sigma_\theta) + E\nabla^{۲}(kT) + (۱ + v)\left(\frac{\partial B_r}{\partial r} + \frac{۱}{r}B_r + \frac{۱}{r}\frac{\partial B_\theta}{\partial \theta}\right) = ۰$$

$$\sigma_x + \sigma_y = \frac{\partial^{۲} F}{\partial x^{۲}} + \frac{\partial^{۲} F}{\partial y^{۲}} = \frac{\partial^{۲} F}{\partial r^{۲}} + \frac{۱}{r}\frac{\partial F}{\partial r} + \frac{۱}{r^{۲}}\frac{\partial^{۲} F}{\partial \theta^{۲}}$$

$$\sigma_r + \sigma_\theta = \frac{\partial^{۲} F}{\partial r^{۲}} + \frac{۱}{r}\frac{\partial F}{\partial r} + \frac{۱}{r^{۲}}\frac{\partial^{۲} F}{\partial \theta^{۲}}$$

$$F = A_{۰} \log r + B_{۰} r^{۲} + C_{۰} r^{۲} \log r + D_{۰} r^{۲}\theta + A'_{۰}\theta$$

$$\frac{A_{۱}}{۲} r\theta\, sin\theta + (B_{۱} r^{۳} + A'_{۱} r^{-۱} + B'_{۱} r \log r) cos\theta$$

$$-\frac{C_{۱}}{۲} r\theta\, cos\theta + (D_{۱} r^{۳} + C'_{۱} r^{-۱} + D'_{۱} r \log r) sin\theta$$

$$+\sum_{n=۲}^{\infty}(A_n r^n + B_n r^{n+۲} + A'_n r^{-n} + B'_n r^{-n+۲})\, cos\, n\theta$$

$$+\sum_{n=۲}^{\infty}(C_n r^n + D_n r^{n+۲} + C'_n r^{-n} + D'_n r^{-n+۲})\, sin\, n\theta$$

$$\left(\frac{d^{۲}}{dr^{۲}} + \frac{۱}{r}\frac{d}{dr}\right)\left(\frac{d^{۲} F}{dr^{۲}} + \frac{۱}{r}\frac{dF}{dr}\right) = ۰$$

$$\frac{۱}{r}\frac{d}{dr}\left\{r\frac{d}{dr}\left[\frac{۱}{r}\frac{d}{dr}\left(r\frac{dF}{dr}\right)\right]\right\} = ۰$$

$$J(r) = \frac{۱}{r^{۲}}\int_{r_{۰}}^{r} \xi^{۲}\, \Theta(\xi) d\xi$$

$$\varepsilon_r = \frac{\partial u}{\partial r} = \frac{۱}{E}\sigma_r - \frac{v}{E}\sigma_\theta$$

$$\varepsilon_\theta = \frac{u}{r} + \frac{۱}{r}\frac{\partial v}{\partial \theta} = \frac{۱}{E}\sigma_\theta - \frac{v}{E}\sigma_r$$

$$\gamma_{r\theta} = \frac{۱}{r}\frac{\partial u}{\partial \theta} + r\frac{\partial}{\partial r}\left(\frac{v}{r}\right) = \frac{۲(۱+v)}{E}\tau_{r\theta}$$

$$u(r,\theta) = -\frac{۱+v}{E}\frac{C}{r} + \frac{۱-v}{۲E}Ar\log r - \frac{۳-v}{۴E}Ar$$

$$+\frac{۱-v}{۲E}Br - \frac{۱-v^{۲}}{۲E}r[H(r)-I(r)] + f(\theta)$$

$$v(r,\theta) = -\frac{۱+v}{E}\frac{D}{r} - \frac{۱+v}{E}r[G(r)-J(r)] + \frac{df}{d\theta} + rg(\theta)$$

$$u(r,\theta) = -\frac{۱+v}{E}\frac{C}{r} + \frac{۱-v}{۲E}Ar\log r - \frac{۳-v}{۴E}Ar$$

$$+\frac{۱-v}{۲E}Br - \frac{۱-v^{۲}}{۲E}r[H(r)-I(r)] + M\cos\theta + N\sin\theta$$

$$v(r,\theta) = -\frac{۱+v}{E}\frac{D}{r} + \frac{A}{E}r\theta - \frac{۱+v}{E}r[G(r)-J(r)]$$

$$-M\sin\theta + N\cos\theta + Lr$$

$$H(r) = \frac{۱}{۲}\rho\omega^{۲}(r^{۲}-a^{۲})$$

$$I(r) = \frac{\rho\omega^{۲}}{۴r^{۲}}(r^{۴}-a^{۴})$$

$$G(r) = -\frac{۱}{۲}\rho\alpha(r^{۲}-a^{۲})$$

$$J(r) = -\frac{\rho\alpha}{۴r^{۲}}(r^{۴}-a^{۴})$$

$$\frac{C}{b^{۲}} + \frac{B}{۲} - \frac{\rho\omega^{۲}}{۸b^{۲}}(b^{۲}-a^{۲})[(۳+v)b^{۲}+(۱-v)a^{۲}] = ۰$$

$$\frac{D}{b^{۲}} + \frac{\rho\alpha}{۴b^{۲}}(b^{۴}-a^{۴}) = ۰$$