Variational Methods and Structural Optimization

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1.The displacement field for a deep isotropic beam is given by

$$u(x,z,t) = u(x,t)$$
$$w(x,z,t) = z\psi(x,t)$$

where $u(x,t)$ is the axial displacement and $w(x,t)$ is the transverse displacement.$\psi(x,t)$ is the degree of freedom that represents the poisson's effect.The constitutive relations for the deep rod is given by

$$\left\{ \begin{array}{c} \sigma_{xx} \\ \sigma_{zz} \\ \tau_{xz} \end{array} \right\} = (\mathrm{E})/(1\text{-}\nu^2) \left[\begin{array}{ccc} 1 & \nu & 0 \\ \nu & 1 & 0 \\ 1 & 1 & \frac{1-\nu}{2} \end{array} \right] \left\{ \begin{array}{c} \epsilon_{xx} \\ \epsilon_{zz} \\ \gamma_{xz} \end{array} \right\}.$$

Derive equation of motion(using Hamilton's principle) for this deep rod and its associated force boundary conditions.