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Geometry of Principal Stress Trajectories for Rigid and Elastic Plastic Models

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The present paper deals with the system of equations comprising a piecewise linear yield criterion together with the stress equilibrium equations under plane strain, plane stress and axial symmetry. This system of equations can be studied independently of any flow rule and its solution supplies the distribution of stress. It is shown that this problem of plasticity theory is reduced to a purely geometric problem. The stress equilibrium equations are written relative to a coordinate system in which the coordinate curves coincide with the trajectories of the principal stress directions. The general solution of the system is constructed giving a relation connecting the two (or three) scale factors for the coordinate curves. This relation is used for developing a method for finding the mapping between the principal lines and Cartesian (or cylindrical) coordinates with the use of a solution of a hyperbolic system of equations. In particular, the mapping between the principal lines and Cartesian (or cylindrical) coordinates is given in parametric form with the characteristic coordinates as parameters. In the case of plane strain problems, the mapping between the principal lines and characteristic coordinates is found from solutions to the telegraph equation. Fof this case, a boundary value problem for the region adjacent to an external boundary which coincides with a principal stress trajectory is formulated and its general solution is given.