

A MULTIAXIAL DIFFERENTIAL FLOW LAW FOR POLYCRYSTALLINE ICE

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1. INTRODUCTION

Boundary value problems in applied ice mechanics involving multi-axial states of stress and complex loading histories, such as those encountered during ice-structure interaction, are increasingly being solved using numerical models including the finite element method (Jordaan, 1986). Constitutive models are required to characterize the ice deformation by viscoelastic flow in numerical simulations.

In problems where only "steady state" flow is of interest, an elastic - power law creep model of ice (sometimes without the elastic component) is adequate. The most widely used model of steady state or viscous flow of polycrystalline ice is Glen's power law. The multi-axial generalization of the differential model follows from conventional elasticity theory and from the rate theory of flow. The latter is based on normality of the viscous deformation-rate to a scalar valued flow potential expressed in terms of an equivalent stress measure. Palmer (1967) has derived the multi-axial law for incompressible flow of isotropic ice, while Shyam Sunder, Ganguly and Ting (1987) have presented an orthotropic model of incompressible flow.

Both the elastic and "transient" flow behavior of ice, however, are of great importance in a broad range of ice mechanics problems (Gold, 1977, Sinha et al., 1987). The most widely used flow law for ice under uniaxial loading is the creep compliance function proposed by Sinha (1978, 1979). This formulation postulates that grain boundary sliding governs transient deformation, and that the compliance function is linearly dependent on stress and nonlinearly dependent on time. For conditions other than constant stress creep, monotonically increasing stress in particular, Sinha (1983) has applied the nonlinear compliance function in conjunction with a convolution