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Effect of Anisotropy on The Creep Failure of Thick-Walled Cylinders

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ABSTRACT

Thick-walled cylinders are employed in a number of challenging applications in the engineering, oil, gas, structural, petrochemical, nuclear and pressure vessel industries. In majority of these applications, thick-walled cylinders are required to work in elevated thermal and/or mechanical loading environments where creep is prevalent. The continued deformation under creep may accumulate to such a value so large that the assumption of small strains becomes increasingly invalid. Furthermore, it is an established fact that the prolonged deformation under creep may cause an initially isotropic material to become anisotropic. These two factors combined together mandate the use of a large (finite) strain theory and anisotropy of the material to accurately assess the creep-failure-time (life) of the thick-walled cylinders. In this paper, we develop governing equations and derive their closed form and numerical solutions to predict the creep-failure-time of thick-walled anisotropic cylinders. To cover a wide range of anisotropy, we consider and analyze five cases of anisotropy. The results for the five cases are calculated and displayed graphically via a number of graphs. The results show that the use of a specific type of anisotropy presents the largest time to creep failure of the thick-walled anisotropic cylinders considering large strains and may extend the failure time of the cylinder. The author believes that the results from this research may aid the designers in a safer design of thick-walled anisotropic cylinders undergoing large strains.

Keywords: Creep; Anisotropy; Large Strain, Thick- Walled Cylinders