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Thermoelastic Transient Memory Response Analysis of Spatio-Temporal Non-Localized Porous Hollow Cylinder Based on Moore-Gibson-Thompson Thermoelasticity Theory

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ABSTRACT

In this paper, a novel porous thermoelastic model is developed, building upon the existing framework of thermoelastic model. The objective of this study is to investigate the thermoelastic response behavior of porous materials. The Klein-Gordon (KG) operator is employed to describe the effect of spatio-temporal non-localization in the constitutive equation, and the memory-dependent derivative (MDD) is incorporated into the Moore-Gibson-Thompson (MGT) heat conduction equation. The model is applied to study the thermoelastic response of hollow porous cylinders under thermal shock, which accurately captures the complex micro-interaction characteristics and memory-dependent properties of the porous structure. Subsequently, the corresponding governing equations are established and solved by Laplace transform and its numerical inversion. In the calculations, the effects of time delay factor, kernel function, non-local parameters and coefficients related to the void fraction on the physical field distribution of hollow cylinders are investigated. The variation in volume fraction caused by porosity reveals the crucial role of spatio-temporal non-local effects in the influence of local deformation on neighboring regions in porous materials. Meanwhile, the transient response prediction results of different thermoelastic models are compared. The results show that, compared to the classical thermoelastic model that does not consider memory or nonlocal effects, the MDD has a significant impact on the transient response. This provides a more accurate method for predicting the dynamic response of the porous model.

KEYWORDS

Dynamic characteristics; Moore-Gibson-Thompson heat conduction; memory-dependent derivative; porous materials; spatial-temporal non-locality; hollow thermoelastic cylinder

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