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Study on behaviors of functionally graded shape memory alloy cylinder

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Abstract: For better controllability in actuations, it is desirable to create Functionally Graded Shape Memory Alloys (FG-SMAs) in the actuation direction. It can be achieved by applying different heat treatment processes to create the gradient along the radius of a SMA cylinder. Analytical solutions are derived to predict the macroscopic behaviors of such a functionally graded SMA cylinder. The Tresca yield criterion and linear hardening are used to describe the different phase transformations with different gradient parameters. The numerical results for an example of the model exhibit different pseudo-elastic behaviors from the non-gradient case, as well as a variational hysteresis loop for the transformation, providing a mechanism for easy actuation control. When the gradient disappears, the model can degenerate to the non-gradient case.

Keywords: Shape memory alloy; Gradient; Constitutive model

1. Introduction

Over the last two decades, as a new type of functional materials, Shape Memory Alloys (SMAs) have been utilized in various fields such as aerospace (Liang et al., 1996), naval (Garner et al., 2000), and biomedical applicationsinvolving surgical instruments (Ilyin et al., 1995), medical implants (Chu et al., 2004) and fixtures (Gyunter et al., 1995). Due to the interesting behaviors of SMAs, such as special shape memory effect, superelasticity and

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