Self-heating and fatigue of superelastic shape memory alloy structures

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ABSTRACT

Several applications use superelastic shape memory alloys (SMA) parts in order to benefits from there large recoverable strain. These structures are generally subject to cyclic loadings, which can lead to fatigue rupture. Unfortunately, the fatigue of SMA has not been much studied and their fatigue is not taken into account in the dimensioning of SMA structures.

In this study, we focus on the fatigue and the self-heating properties of superelastic NiTi. We begin to determine fatigue properties of the material by using a fast method based on self-heating measurements firstly proposed for steels [1]. This measurements were realized on NiTi hourglass samples under cyclic loadings at various amplitudes.

A model describing the probabilistic apparition of superelastic inclusion in an elastic matrix is developed based on a macroscopic model of SMA behavior [2]. It permits to reproduce self-heating results and then, by choosing an adapted fatigue criteria, is able to predict fatigue properties of the samples. These results have been validated using classic fatigue tests on the hourglass samples. With this fast method, effects of process parameters as electropolishing or heat treatment on fatigue properties have been studied.

Finally, the model which has been identified on hourglass samples has been used to predict fatigue life of endondontic files under rotating bending loadings. These results have been validated by realizing rotating bending fatigue tests on these files.

REFERENCES

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