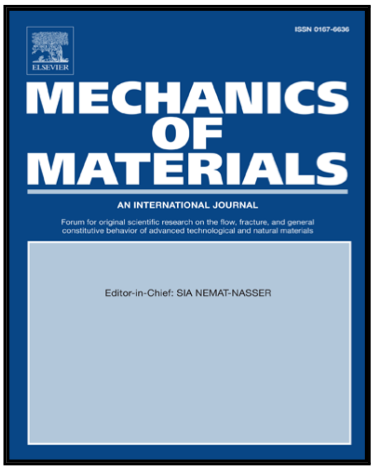
Accepted Manuscript



Study on the Optimal Loading Rates in the Measurement of Viscoelastic Properties of Hydrogels by Conical Indentation

J.F. Chen , K.J. Xu , L.Q. Tang , Z.J. Liu , L.C. Zhou

PII: S0167-6636(17)30744-5
DOI: 10.1016/j.mechmat.2018.01.006
Reference: MECMAT 2841

To appear in: *Mechanics of Materials*

Received date: 25 October 2017
Revised date: 21 December 2017
Accepted date: 25 January 2018

Please cite this article as: J.F. Chen , K.J. Xu , L.Q. Tang , Z.J. Liu , L.C. Zhou , Study on the Optimal Loading Rates in the Measurement of Viscoelastic Properties of Hydrogels by Conical Indentation, *Mechanics of Materials* (2018), doi: 10.1016/j.mechmat.2018.01.006

Study on the Optimal Loading Rates in the Measurement of Viscoelastic Properties of Hydrogels by Conical Indentation

J. F. Chen[a], K. J. Xu[a], L. Q. Tang*[a,b], Z. J. Liu[a], L. C. Zhou[a]
[a]*Dept. of Engineering Mechanics, School of Civil Engineering and Transportation;*
[b]*State Key Laboratory of Subtropical Building Science,*
South China University of Technology, 581 Wushan Road, Guangzhou, Guangdong, China
[*]*lqtang@scut.edu.cn*

Abstract

It has been reported that the measurement results by the method of indentation for soft viscoelastic materials are affected apparently by experimental conditions, such as strain rate and indentation depth. In order to enhance the effectiveness of the method of indentation and find optimized loading rates in tests, the Lee-Radok's solution was modified with Hay's correction to describe the indentation response for soft viscoelastic materials, further, a pseudo dissipative work was defined in a normalized indentation loop and its variation against the loading rate was obtained. It is found the pseudo dissipative work exists several maximal values related to the viscous properties of materials, and the corresponding loading rates can be regarded as the optimal loading rates in indentation tests. Based on the theoretical analysis, a new method how to determine the optimized loading rates in indentation was recommended, which was verified by tests of indentation and uniaxial compressive creep for a PVA hydrogel.

Key words: optimal loading rate, indentation, viscoelastic, hydrogel

Introduction

Polymer hydrogel, which consists of a network of polymers and solvent, is a kind of potential material in various fields, particularly in tissue engineering, environmental technology and biomedical engineering. The good biocompatibility and ability to absorb a large amount of water makes hydrogel a potential material in cartilage repairing [1,2], wound dressing [3,4], water purification [5,6] and soil remediation [7,8]. Intelligent hydrogel, which gives sensitive responses to external stimuli, has been used in drug delivery [9,10]. Therefore, studies on the mechanical properties of hydrogel are necessary and helpful for the improvement of its application. The fundamental mechanical behavior of hydrogel is viscoelastic, or time dependent [11,12]. Lu et al. [13] developed a coupled viscoelastic and Mullins-effect model to characterize the deformation behavior of the tough gel under uniaxial cyclic loading. Hong et al. [14] formulated a theory of the coupled mass transport and large