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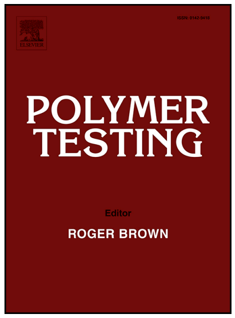

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Abstract

Polymeric engine mounts have been widely used as vibration isolators in vehicles. In general, understanding ageing-dependent stiffness is important for life cycle design. In this paper, a new experimental procedure is developed to study the ageing mechanisms of service-aged engine mounts using digital image correlation measurements. The present contribution demonstrates that the leading factors for ageing-dependent stiffness are, not only the elastic modulus variation, but also the creep deformation and micro-structural change. The results show that pure thermal effects, such as that used to simulate ageing, leads to a uniform change in the rubber component inside the mount. This is not the same as the service-aged mount behaviour. In addition, the cross-sectional creep deformation dominates the increase in rigidity. Finally, the results suggest that micro-structural change may also lead to the stiffness variation of the mounts with high working mileage.

Key words: elastomer ageing, engine mount, digital image correlation

1. Introduction

Elastomeric engine mounts have been used for many years as isolators for internal combustion engines. Their dynamic performance changes with operation time. Although this variation may not shift the resonance frequencies of the isolator that significantly, their change in performance does lead to more vibration energy being transferred into the vehicle. As a result, this variation is harmful to the overall vehicle and to the ride comfort, and therefore is of interest to the designer.

Several numerical and experimental prediction methods for engine mounts have been developed over the past decade [1-4]. Most of these studies pointed out that nonlinear stiffness should ideally be predictable, in order to design the dynamic characteristics. Understanding the factors that influence the elasticity of the engine mount becomes, therefore, essential, especially for a service-aged engine mount.

Thermal ageing is one of the main ageing mechanisms for an engine mount [5]. Thermal ageing is caused by the combination of oxidation, weakening of the reinforcing filler network and chemical degradation of the polymer network. Chemical degradation occurs through chain scissions and cross-linking, which alters the elastomer's stiffness. The rate at which these reactions occurs is dependent on the ambient conditions; temperature and humidity [6,7]. Generally, chain scission will soften the elastomers as the backbone covalent bonds rupture [8], while cross-linking stiffens the aged elastomer due to the creation of bonds between two adjacent polymer chains [7]. During ageing, both these chemical degradation mechanisms occur although one process typically dominates. This depends on the chemical compounds of the material, especially the additives of the rubber [9].

Cyclic loading is one of the other important factors when studying the ageing behaviour for engine mounts. The influences of harmonic excitation have been studied in [10,11]. Under dynamic loading, the breakage of a carbon black filler network is an additional significant factor for creating stiffness variation. However, no unique correlation between ageing time and stiffness has yet been found for different types of elastomers [5,12-15].

Most research focused on the ageing of the elastomer in an engine mount is carried out under laboratory conditions. The test specimens are normally prepared based on ISO:23529 [16]. As a result, the sample size is much smaller than the rubber used in a real engine mount. The rate of heat flow inside the elastomer is, therefore, much higher for a laboratory sample. This difference in thermal conditions introduces significant uncertainties to the estimation of stiffness variations. Furthermore, the

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