Modelling systems with rubber components

A technical discussion meeting organised by the Rubber in Engineering Committee of the Institute of Materials

Friday 10th March 2005, 2.00pm

at: **Institute of Materials, 1 Carlton House Terrace, London**

Attendance is free of charge for members of the IOM, there may be a nominal charge for non-members.3 Those wishing to attend must register (and receive confirmation of places available) by mid-day 10th March with: Roly Whear, Jaguar Cars Ltd Tel: 01926 646643 Mob: 0796 999 6715 e-mail: rwhear1@jaguar.com

1: Generic Model of Elastomer Mounts, Peter Pfeffer, Bath University

In modern machines, such as vehicles, elastomer mounts and bushings are becoming ever more important in order to achieve the required NVH performance; consequently, it is becoming increasingly essential to be able to analyse the performance of these elastomer mounts during the virtual prototyping stages of design. A generic elastomer model that is capable of modelling both the amplitude (triboelastic) and frequency (viscoelastic) dependent behaviour of such materials whilst also minimising computational requirements and input parameters is described. The model is mechanical based consisting of two distinct modules; a linear Poynting-Thomson model capable of modelling the viscoelastic effects is connected in parallel to a non-linear logarithmic force element capable of modelling the triboelastic effects. The model requires only five user defined parameters for operation which relate to physical parameters which can be derived from standard measurements or from extrapolation of similar mounts. Accurate dynamic results have been obtained in terms of both frequency and amplitude dependency over a large frequency range.

2: Measurement and Modelling of Carbon Black Filled Natural Rubber components, Paul Allen, RMCS Shrivenham

A novel measurement and modelling methods for Carbon Black Filled Natural Rubber (CBFNR) components is presented that describes the materials asymmetric hysteresis loop shape, its stress relaxation and its strain rate dependent (non-Newtonian) viscosity. The model has been developed for use in 'initial value time domain computer simulations'. It is robust and easily implemented in multibody dynamic analysis software such as MSC.ADAMSTM. Results are presented for two tracked vehicle components. The Warrior Armoured Personnel Carrier's solid rubber road wheel tyre and the vehicles track link bush. But because of its simplicity: the model is likely to have uses as a general-purpose descriptor of internal damping in many materials modelling problems.

3: The use of a Power Law for combining Frequency and Amplitude Effects in Rubber. Don Turner, Avon Rubber

For many years the dynamic properties of rubber were described as being viscoelastic despite behaviour despite the fact that frequency had a much less than linear effect on the stiffness and amplitude had a large effect. In 1986 it was shown that a series of frictional sliders connected elastically could represent well the shape of the hysteresis loop and the effect of amplitude. The term triboelasticity was coined to differentiate from viscoelasticity. What was needed was a method of combining the two. In 1977 a model was proposed for the stress relaxation of unvulcanised rubber using a Maxwell model with a power law viscous element. It was therefore a simple move to add a spring in parallel to the Maxwell element to accommodate the elasticity induced by cross-linking. Figures are shown to illustrate the effect of each parameter in the system. It is seen that one element can represent rubber behaviour reasonably at most over a decade of amplitude or frequency. Thus many models for actual simulations require several elements.

4: Application of Power Law Models in Vehicle Ride Modelling, Roly Whear, Land Rover

This presentation will describe briefly the method and results of implementing a non linear frequency and amplitude dependant power law elastomer model in multibody dynamic analysis of motor vehicle ride. This is then extended to the development of a non-linear time domain hydramount model which is demonstrated on the ride analysis of an arbitrary vehicle with hydramounts installed as the main mass carriers for the power unit. The analyses will investigate the vehicle and powerunit response over smooth, medium and rough roads with and without using the new model.