Development of a belt force actuator for controlled seat belt systems

Ewout van der Laan  
Department of Mechanical Engineering  
Technische Universiteit Eindhoven  
P.O. Box 513, 5600 MB Eindhoven  
The Netherlands  
Email: E.P.v.d.Laan@tue.nl

Bram de Jager, Frans Veldpaus  
Department of Mechanical Engineering  
Technische Universiteit Eindhoven  
P.O. Box 513, 5600 MB Eindhoven  
The Netherlands  
{A.G.de.Jager, F.E.Veldpaus}@tue.nl

1 Introduction

The loads exerted by the seat belt on a human body during a vehicle crash, are essential in the injury mechanisms of the chest [1]. Injury risk can be reduced when the seat belt load is controlled based on crash conditions, e.g., impact severity and occupant type [2]. In this study, a semi-active actuator for this control system is developed.

2 Sled setup

An experimental sled setup is developed (Fig. 1) to test the belt force actuator and to demonstrate its potential for injury reduction. A mass representing an occupants torso (4), is mounted on a cart (2), that impacts against a deformable crumple tube (5) at high speed (12 ms\(^{-1}\)). A force actuator (1) is connected to a belt (3), and will be used to control the torso body acceleration. The sled setup is modeled, see Fig. 2, and simulations with measured cart accelerations are used to obtain actuator specifications.

3 Semi-active belt force actuator

A semi-active actuator design is chosen, comprised of an hydraulic cylinder, see Fig. 3. During impact, the belt force causes the cylinder to extend and fluid outflow is controlled by a very fast spool valve, actuated by a voice coil.

4 Simulation results

The valve dynamics are modeled and combined with the sled model. An outer feedback controller is designed to track a desired torso acceleration. A local feedback controller calculates the current through the voice coil to track the desired force, see Fig. 4. The actuator shown in Fig. 3 has been built, and experimental results are expected early 2009.

References
