VALIDATION AND APPLICATION OF HUMAN MODELS FOR CRASH SCENARIOS

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Introduction

Numerical models of human body have been introduced in recent years in field of research as well in industrial applications. The Total human model for safety (THUMS) [Watanabe, 2001]], [Iwamato, 2002] developed by Toyota R&D Labs and the Wayne State University, USA has made it possible to simulate, reconstruct and effectively study the mechanical behaviour of human body in different impact scenarios.

Prior to any calculation, the computational model has to be validated against experimental data. However the tests should be available for different loading modes and isolated parts of the body for a number of specimens. The main focus in this study has been the bones of the lower extremity of the finite element model of THUMS. An improved model of the human bones would lead us to have a more precise mechanical response of the body in impact or crash scenarios in automotive industrial applications.

Methods

The THUMS lower extremity consists of (Foot bone, Tibia, Fibula, Patella, Femur, Ligaments, Muscles, Tendons, Skin and Soft Tissue). The model is available in PAM-Crash Finite Element Code. The FE Model of the Tibia is extracted for further investigations on material modelling. The model is initially validated against the quasi-static three-point bending experimental results [Yamada, 1970]. The test setup is shown in Figure 1. The dynamic three bending test has been published by [Kress, 1995], however the result exist only as peak values and cannot be fully compared.

Figure 1: Three Point Bending Test Setup

Results

The geometrical properties such as thickness of the cortical bone and mechanical properties such as Young Modulus, Ultimate Stress and Strain and Failure Strain has been varied to have an optimized result comparable to the experimental curve. Thickness of the cortical bone is an important factor which has to be considered. The thicker the bone is the more force and energy is required to cause a failure.

The results indicate a mesh dependent behaviour. The results for different explicit codes (LS-DYNA) and (PAM-Crash) can be compared. The model has been validated in LS-DYNA version [Asgharpour, 2010].

Material	**Density (kg/mm^3)**	**Young Modulus (MPa)**	**Poison Ratio**
Cortical	2000	17000	0.3
Trabecular	861	40	0.45

Table 1: Mechanical Properties of Tibia Cortical and Trabecular Bone

Discussion

This study has aimed to present a validation process for the long bones of the THUMS model. The loading mode, model geometry, mesh size and material properties of the human would all have an influence on the resulting force and fracture. The improved model would help us to predict the mechanical behaviour of the human body in automotive applications more effectively and precisely.

References

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