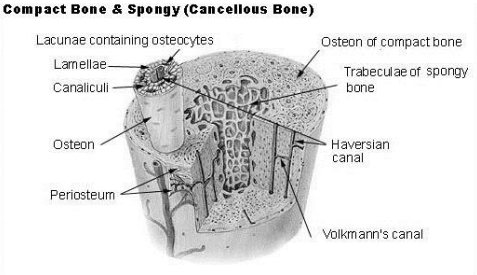
Enhanced Modelling of Human ribs

- Material and element modelling



To develop future advanced occupant restraint systems for protection of occupants in future autonomous vehicles there is a need for detailed human substitutes. Today detailed finite element human body models (HBMs) are developed for the development. These models enable evaluation of human injury risk on a detailed level.

Significant efforts have been put into increasing the level of detail in HBMs, and today's state-of-the-art models have about 2 million elements, modelling structures down to a few millimeters in size. There are also very detailed models of subject specific ribs. Common to all these models is that the actual rib fracture location is only predicted in a subset of the reconstructed tests. Ribs and other bones in today's HBMs are usually modelled as being isotropic, with a von Mises yield criterion, despite that physical tests have shown that the cortical bone is transversely anisotropic with a pressure dependent yield surface.

In addition it is important to bridge the gap between details subject specific rib models (element size 0.2mm) and ribs in full human body models (element size 2mm). How much can the detailed models be simplified, while still keeping the predictability?

Objective and Method

The aim of this project is to study if anisotropic material modelling, often used to describe the behavior of composite material, can improve the rib fracture predictability. It will include the following steps:

- Review published material data relevant for anisotropic modelling of human ribs,
- Review suitable LS-DYNA material models,
- Reconstruct some physical tests (i.e. of ribs) in LS-DYNA and,
- Analyze and compare different material models to evaluate the influence of material model simplifications.
- Analyze and compare different modelling simplifications, e.g. element formulations and mesh densities

The project is suitable for 2 students with good knowledge in strength of material and finite element modelling.

Learning outcomes:

Students will learn and develop skills in performing explicit FE simulations in the software LS-DYNA with focus on composite material modelling.

Supervisors/Examiners (at Applied Mechanics)

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