THOMO

NEWSLETTER

Development of a Finite Element Model of the Human Thorax and Upper Extremities

Issue 3-4, June 2011

Covering period from 04/01/2010 to 03/31/2011

In this Issue :

Review of existing data for the validation of the thorax model (WP2)

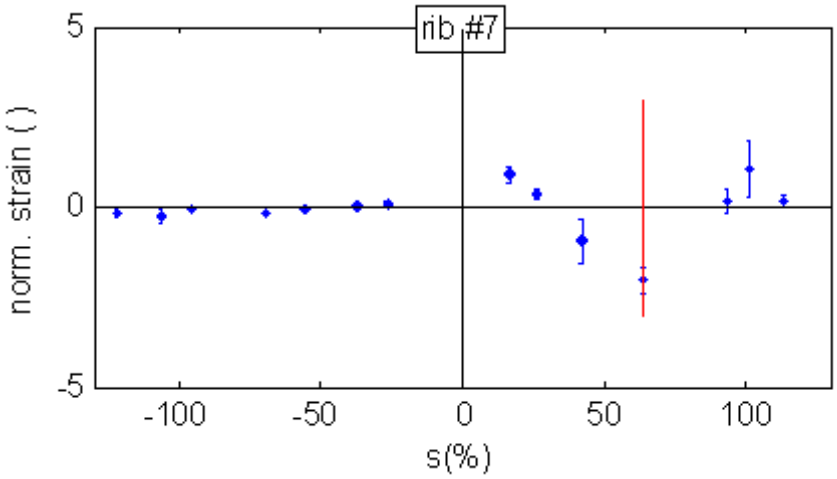
The first review represents an amount of 57 publications coming from the main journals, proceedings, reports, dissertations, publications on Biomechanics of Impact. They regard whole body thorax tests in frontal and side directions with different loading conditions (airbag, rigid surface, belt), rib cage tests, and isolated rib tests. For each configuration, the boundary conditions have been described as precisely as possible. The number of post-mortem human subjects per configuration, with their characteristics (age, weight…) is given, as well as the injuries. The mechanical responses, in the form of corridors (if they exist) are also supplied. The normalization process (if applicable) is at last mentioned. It represents a very good starting point for the validation database for a thorax model.

Acquisition of new biomechanical data (WP2)

In 2009 and 2010, **twelve dynamic tests** on post-mortem human subjects, closed to a 50th percentile male, have been performed in different loading conditions. The ribcage was instrumented with strain gauges glued on the ribcage. The test analysis in side impact, gathering existing test results performed in similar conditions, shows that strain patterns can be defined and are in good accordance with rib fracture location (see figure).

In impactor test conditions and also in unfolded airbag conditions, corridors of the 5th rib have been presented in November 2010, at a **workshop** organized by the National Highway Transport Safety Association in Phoenix and specifically dedicated to the thorax...

Acquisition of new biomechanical data (WP2) (continued)



Example of strain profile obtained on the seventh costal arch in side impactor test. The vertical red line represents the location of rib fracture (right rib). S=0% represents the costo-transverse process ; at s=100 %, location of the costo-chondral joint. In ordinate, a positive value indicates tension.

In side and oblique impactor conditions, **six small females** were tested, with the same instrumentation than for the 50th percentiles specimen. The strain profiles will be compared with those obtained on the medium male.

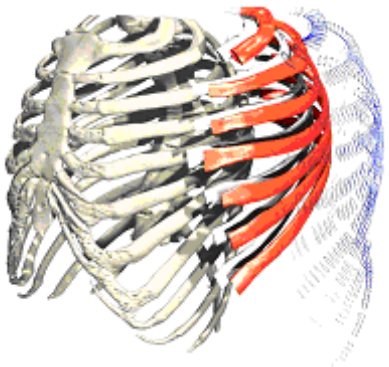
For the eighteen specimens, CT-scan data were acquired and are available. **For each specimen**, the following dataset was the following:

- head and neck with standard and high resolutions.
- thorax, abdomen and pelvis with a standard resolution.
- lower extremities.

These datasets have been used to define the global geometrical rib properties of each specimen. The results will be used as input for the personalization of the Global Human Body Model.

Local geometrical rib properties (WP2)

The local geometrical rib properties have been acquired on one post-mortem human subject. A total of 91 samples of 40mm in length each, representing all the 10 left ribs have been scanned with µ-CT device. A surface model of these ribs has been built with a distinction of the limit between cortical and spongy bone. From these data, many investigations have been made on cortical bone properties variation along one rib and between different ribs.



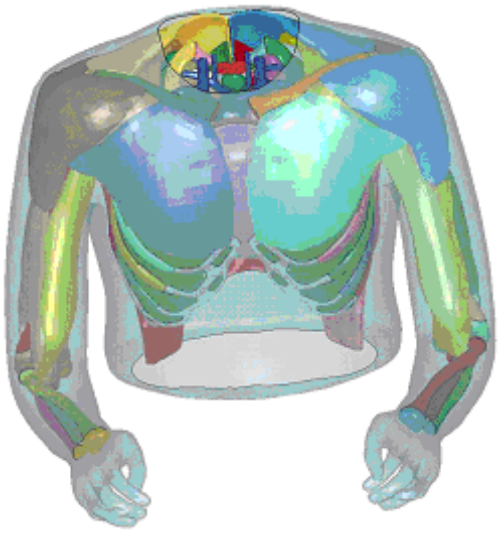
Reconstructions of the ribcage using CT-scan data and µCT-scan data (red part)

Description of THOMO WP1

Workpackage 1 aims to develop a baseline template thorax model for the 50th percentile male. After receiving the model from the GHBMC, several tasks will be dedicated to the model checking and improvement for the needs of the project. Several tasks are dedicated to the clean-up, meshing and numerical stability, taking into account that some entities could be simplified or aggregated depending on their mechanical significance.
Moreover, the problems raised during different projects by the shoulder complex justify the necessity for the modeller to have a better description of the muscles attachments and of the way they act in extreme motions. This will be done through a filmed autopsy of the shoulder complex.
At last, as an help for the understanding of rib fracture mechanism, a simplified model based on the theory of resistance of materials will be defined.

Global Human Body Model (WUT and UWB)

For the implementation of the THOMO project, an access to the Global Human Body Model has been acquired.
The thorax model consists of more than 500000 deformable elements. The main anatomical parts are modelled, including the complete ribcage, the inner organs and the muscles. The model runs with the LS-DYNA code. The model development is done in close cooperation with the Centre of Expertise for the Thorax (University of Virginia).



Thorax part of the Global Human Body Model

Publications

6th Injury Biomechanics Symposium
Conference in Ohio State University – May 16-18, 2010 | USA
Olivier MAYEUR, Pascal DRAZETIC, Fahmi CHAARI, Hervé GUILLEMOT, Rémi DELILLE
"A new method to determine rib geometry for a personalized FEM of the thorax."

COVER PMHS Workshop in *Nanterre – June 1, 2010 | FRANCE.*
Share data on PMHS tests done within THOMO and THORAX projects
Internal communication (THOMO and THORAX partners)
Understand overlaps between projects.
Share success but also difficulties.

6TH WORLD CONGRESS ON BIOMECHANICS August 1-6, 2010 Singapore
Olivier MAYEUR (UVHC) *"A new method to determine rib geometry for a personalized FEM of the rib". Abstract/Oral presentation*

ISN _COVER Workshop on Biomechanics experiments with human subjects September 14, 2010, Hannover, Germany,
Pascal BAUDRIT, Tiphaine LEPORT (CEESAR)
"Introduction into THOMO Project PMHS testing for THOMO" .*Oral presentation*

IRCOBI 2010 September 15-17, 2010. Hannover, Germany
Olivier MAYEUR, Fahmi CHAARI, Rémi DELILLE, Hervé GUILLEMOT, Pascal DRAZEIC (UVHC)
"Virtual Human Thorax Model: A new method to determine rib geometry" Abstract/Paper

NHTSA Biomechanics Workshop, November 2nd, 2010 , Scottsdale, Arizona, USA
Pascal BAUDRIT, Tiphaine LEPORT (CEESAR)
"Rib strain fields corridors in side and oblique impact based on PMHS tests" .*Oral presentation*

The International Conference on Advances in Mechanical Engineering and Mechanics ICAMEM. December 18-20, 2010. Hammamet, Tunisia
Olivier MAYEUR, Fahmi CHAARI, Rémi DELILLE, Hervé GUILLEMOT, Pascal DRAZEIC (UVHC)
"Virtual Human Thorax Model Reconstruction: from Medical Imaging to Finite Element Model"
Abstract/Paper

Agenda:

4th Steering Committee: 20-21 January 2011, at CEESAR in Nanterre, France.
1st International THOMO Workshop: 7 April 2011 at UVHC, in Valenciennes, France.
5th Steering Committee: 9-10 June 2011, at WUT in Warsaw, Poland.

Organizations

CEESAR, Centre Européen d'Etudes de Sécurité et d'Analyse des Risques, FR
UVHC, Université de Valenciennes et du Hainaut Cambrésis, FR
UWB, University of West Bohemia, CZ
WUT, Warsaw University of Technology,PL

Co-funded under the 7th FP
SEVENTH FRAMEWORK PROGRAMME

Website http:// www.thomo.eu