CEN/TC 158 Working Group 11
- Shock absorption including measuring rotational kinematics

November 2018

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For ECE 22.06

- All or parts of the described test method from TC158-WG11 can be used in ECE22.06

- WG11 has since 2012 met 13 times and gathered a lot of experience and competence regarding rotational test methods, summarized in over 100 documents. Everything from the effect of the neck and other aspects sensitivity in the test set up has been studied in several studies.

- The test method is similar to the one used by FIM. The main difference is the head form that WG11 has defined a crucial. Neither the EN960 or the Hybrid III head form is suitable for oblique helmet impact tests.

- WG11 are happy to share any information to ECE 22.06

Background

- Oblique impacts are common in most sports (Otte et al. 1999, Verschueren 2009, Mellor and Chinn 2006)

- Oblique impacts could lead to a tangential force, depending on the Normal force and the coefficient of friction.

- Tangential force -> rotation

- The brain is more sensitive to rotation than pure translational motion. (Holborn 1943, Genarelli 1983.Kleiven et al. 2006, Deck et al 2007)
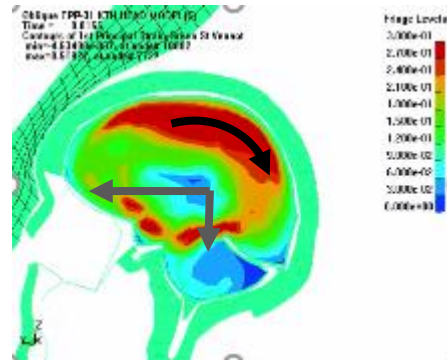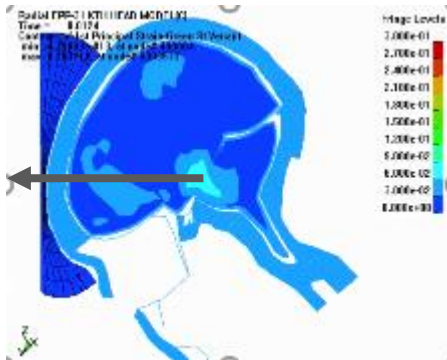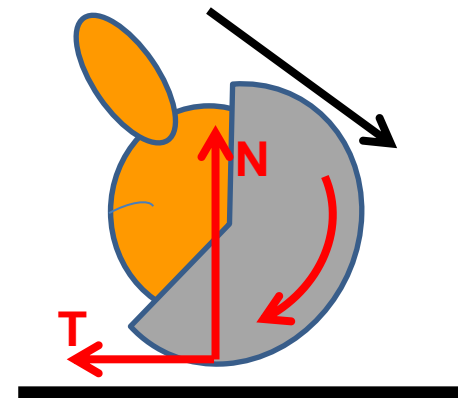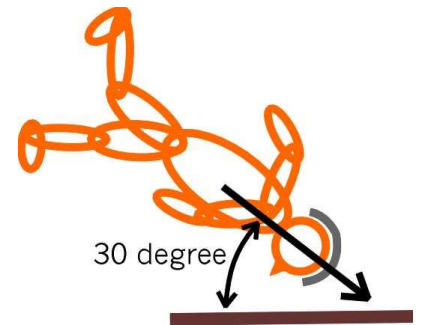
Objectives

- Define a method to measure rotational energy absorption in tangential impacts in <u>short duration impact situations</u> (5-10ms).

    - The test must be *simple, robust and cost effective*.

    - The first version of the test method is designed for *bike* and *equestrian* helmets.

    - Impact conditions based on *real accident* data
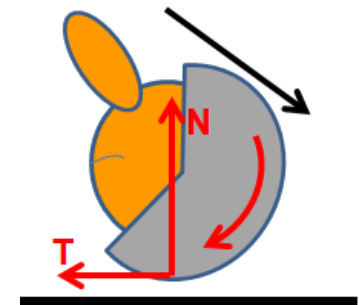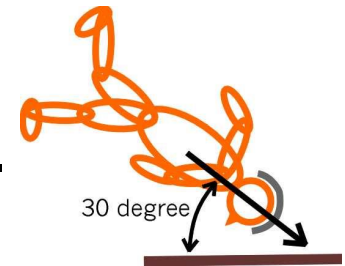
Proposal from CEN TC158-WG11

- Shock absorption test method A – Keep pure vertical drop against flat anvil or curbstone (EN1078, EN1384, EN1077) but add measurement of angular kinematics.

A

- Shock absorption test method B – Vertical drop towards an 45degree impact angle.

B

  - No neck (free falling head)

  - <u>New</u> head form*

    – Size 50, 52, 54, 56, 58, 60 and 62cm

  - Head instrumentation: 9-acc-array or ARS
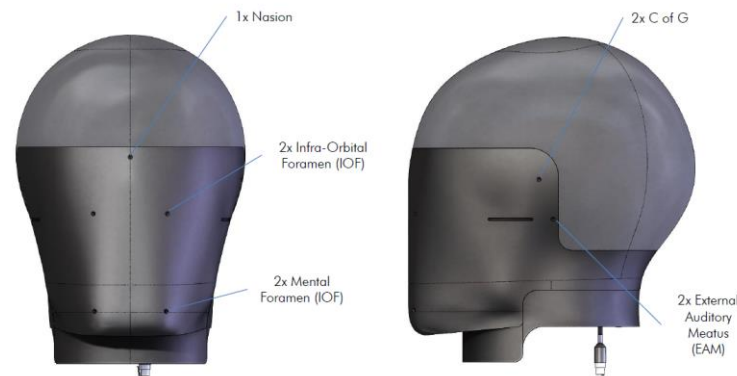
  - Impact surface: Rough grinding paper
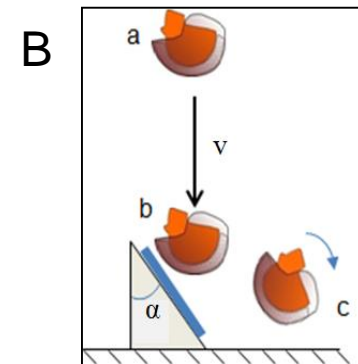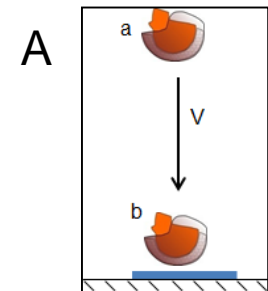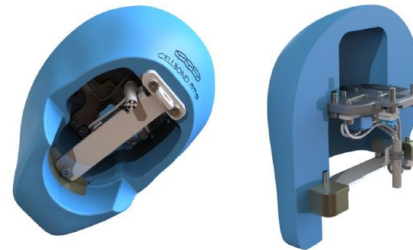
* HIII neck shall be possible to attach

Specification of new head form for oblique impact testing

1. Mass and CG v.s. circumference: close to antropometric data from 82 human cadaver heads plus 57 scanned heads – Data set 1

2. Moment of Inertia (Ixx, Iyy, Izz): close to antropometric data from 42 human cadaver heads plus 57 scanned heads – Data set 2

3. Head shape: Size 56-58cm similar to EN960 J head form. Size 50, 52, 54, 60 and 62 needs modifications

4. Coefficient of friction between helmet and head form: 0.3 (Trotta et al. 2018)

This is Version dated December 2017
Not final version
Will be modified

CELLBOND ATD Prototype – Landmarks (Opt 1)

CELLBOND **ATD**

1x Nasion

2x Infra-Orbital Foramen (IOF)

2x Mental Foramen (IOF)

2x C of G

2x External Auditory Meatus (EAM)

Trotta A, Aisling N Annaidh, Roy Owen Burek, Bart Pelgrims, Jan Ivens. Evaluation of the head-helmet sliding properties in an impact test. Journal of Biomechanics 75 (2018) 28–34

Impacting on Safety
www.cellbond.com

CENELEC 2010 6

The new head form

- The Head form will be made by Polyurethane and metal inserts. A first version of the size J is available. CAD files will be available

- Head form will be designed to carry different Instrumentation

  - 9-accelerometer-array or

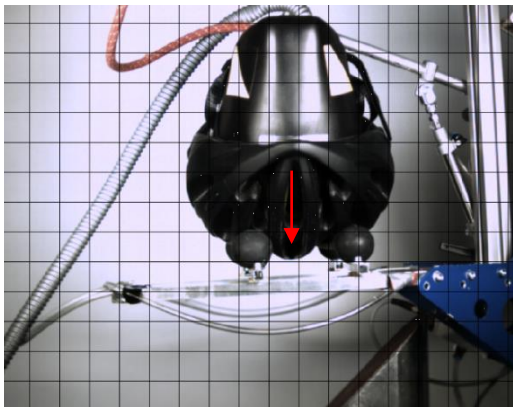 - 3 LINACC + 3 ARC or

  - Onboard system
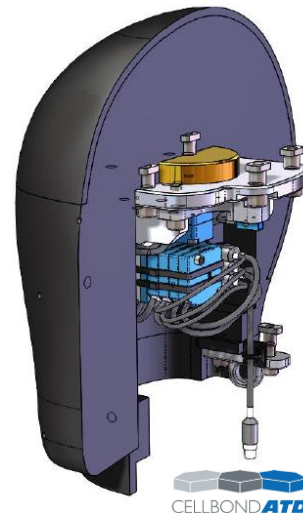
Impact directions used in round robin tests
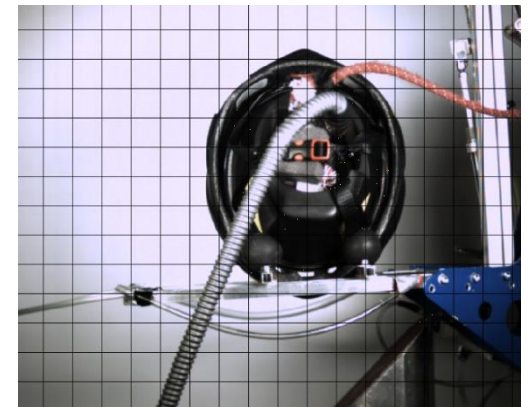
Impact directions used in Round Robin study
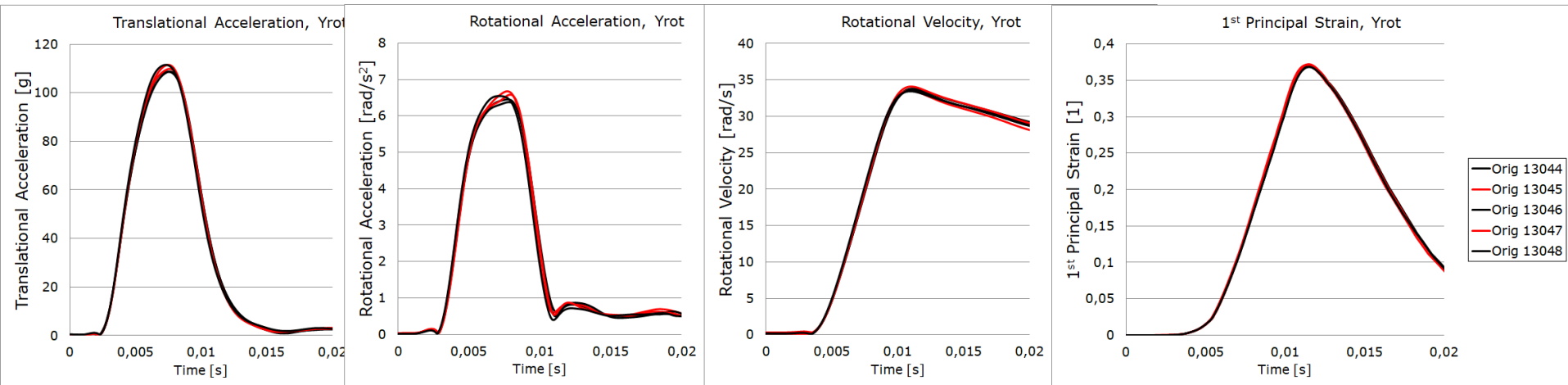
X-Rotation	Y-Rotation	Z-Rotation

Example of test results from Round Robin test - Yrot impact direction

Impact	Name	Resultant Translational Acceleration [g]	Resultant Rotational Acceleration [krad/s²]	Resultant Rotational Velocity [rad/s]	1st Principal Strain [1]	BRIC
Yrot	Orig 13044	111,5	6,7	33,5	0,37	0,62
Yrot	Orig 13045	108,7	6,5	33,9	0,37	0,63
Yrot	Orig 13046	109,8	6,6	34,1	0,37	0,63
Yrot	Orig 13047	108,7	6,4	33,7	0,37	0,62
Yrot	Orig 13048	111,4	6,5	33,4	0,37	0,62
Mean		110,03	6,53	33,70	0,37	0,63
Standard Deviation		1,24	0,10	0,24	0,00	0,00
Spread (2*STD/Mean)		**2%**	**3%**	**1%**	**1%**	**1%**

KTH: 80% risk for concussion (Kleiven 2007)
BRIC: 73% risk for AIS 2 (Takhounts 2013)

Proposal from CEN TC158-WG11

- A pass/fail criteria shall include all 6DOF accelerations over time (duration) into account. A Pass/Fail criteria shall therefore be either:

  - A: 6DOF (3 linear and 3 rotational) acceleration based pass fail criteria (HIP, HIC+BrIC or similar)

  - B: An injury risk assessment tool based on the computed strain from an FE head model

  - WG11 will give a recommendation for the both alternatives A and B in EN13087-11

A

$$BrIC = \sqrt{\left(\frac{\omega_x}{\omega_{xC}}\right)^2 + \left(\frac{\omega_y}{\omega_{yC}}\right)^2 + \left(\frac{\omega_z}{\omega_{zC}}\right)^2}$$

B
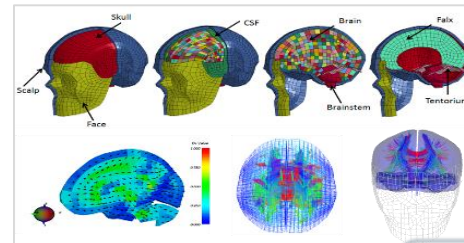
Timeline for PrWI 13087-11

- The fundaments in the test method is specified in a draft specification PrWI 13087-11.

- The main part that remains is the final specification of the new head form.

    - Finalizing the specification head form   Dec 2018

    - First head form produced   Jan 2019

- Final test method EN 13087-1 ready for voting round 1.   March 2019

Questions

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