



MOTORcycle
Rider
Integrated
SafeTy



DAINESE



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

Neck protection development & a proposal of the associated standard for the motorcycle riders

Meeting for admission to the 3rd year
22nd September, 2017 – CISAS (Padova)



Mohammed Nasim



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Primary & Secondary

GOALS

New PPE development (focus to neck)

- ❑ Designing
- ❑ Prototyping
- ❑ Virtual & lab testing

Associated Standard

- ❑ A draft proposal

Improvement of impact protection

- ❑ Energy absorbing material
- ❑ Comfort
- ❑ Virtual & lab test



IMPACT PROTECTION

- ❑ Hard shell effect
- ❑ Vent holes effect
- ❑ Temperature effect





IMPACT PROTECTION

- ❑ Hard shell effect
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ELSEVIER

Contents lists available at ScienceDirect

Polymer Testing

journal homepage: www.elsevier.com/locate/polytest



Product Performance

Understanding the impact properties of polymeric sandwich structures used for motorcyclists' back protectors



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ABSTRACT

Conventional back protectors are comprised of two main parts: elastomeric foams to absorb the impact energy; and thermoplastic polymers to distribute the impact force on a wider area before the absorption process. Thermal comfort is usually maintained by vent holes within the structure. In the present work, the impact behavior of a number of samples made of materials commonly used for manufacturing such protectors was studied. Nitrile butadiene rubber as the soft layer and polyethylene thermoplastic as the hard layer were considered. The variables for the analyses were the thickness of the layers, the sample temperature and the distribution of the vent holes in the sample. The key findings are: the force distribution capability of the hard part and the stability of the impact properties with respect to temperature variations are fairly dependent on the thickness of the soft part; and a reasonable distance between two consecutive vent holes is required for achieving optimal impact protection.

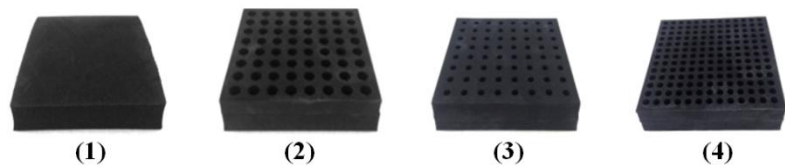
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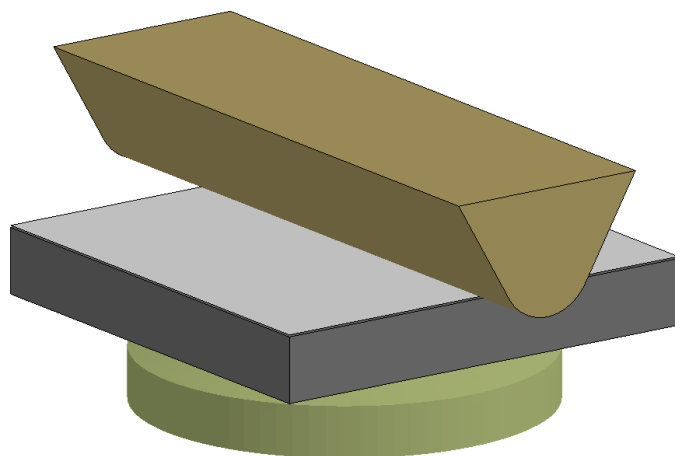
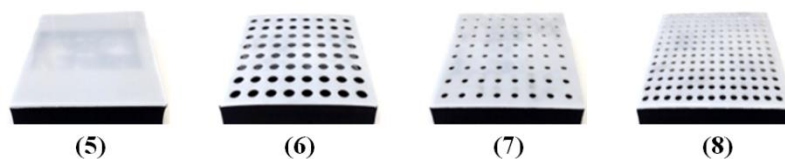
Impact properties

POLYMERIC SANDWICH DESIGN

Nitrile Butadiene Rubber (NBR) as soft layer

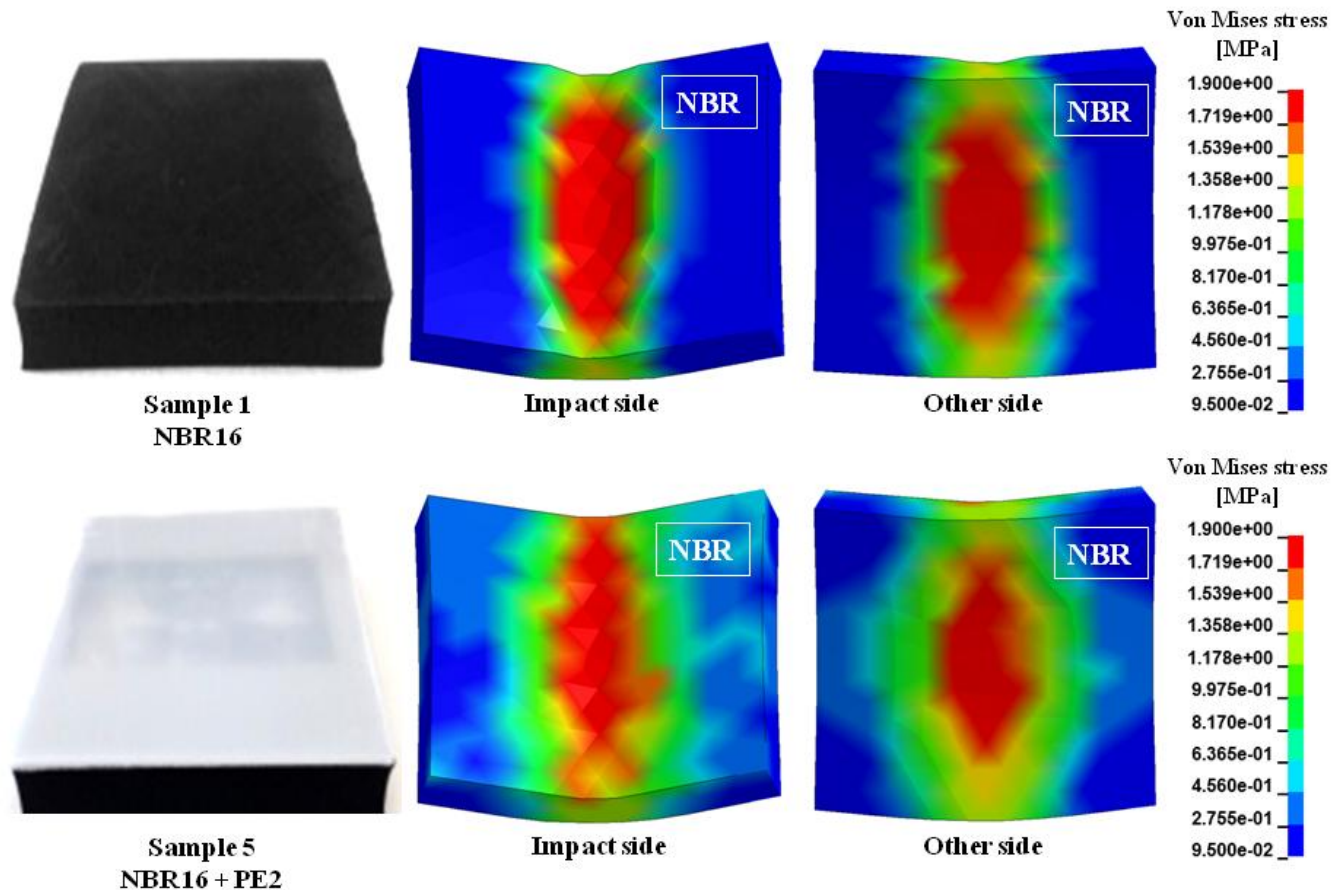
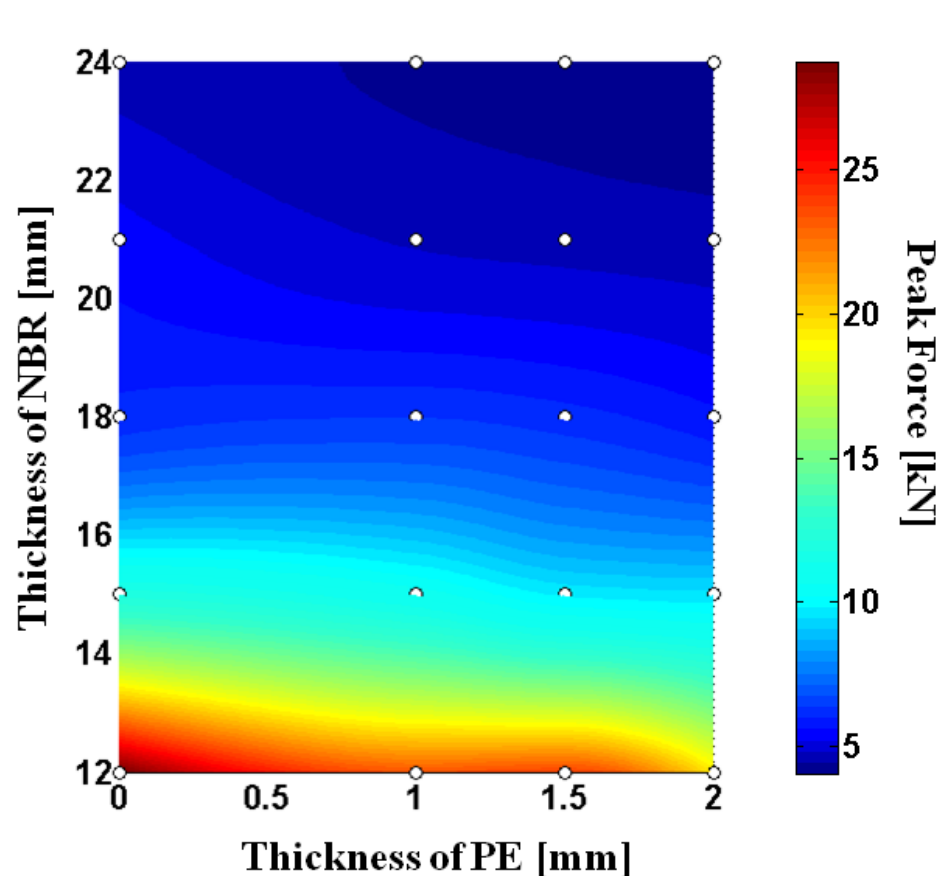


Polyethylene (PE) thermoplastic as hard layer



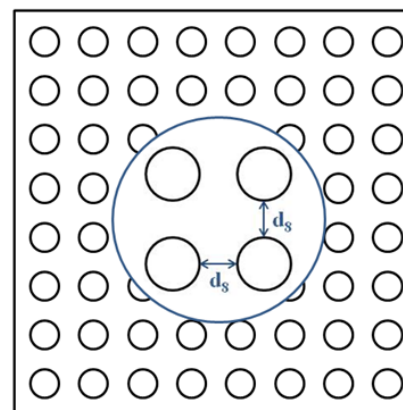
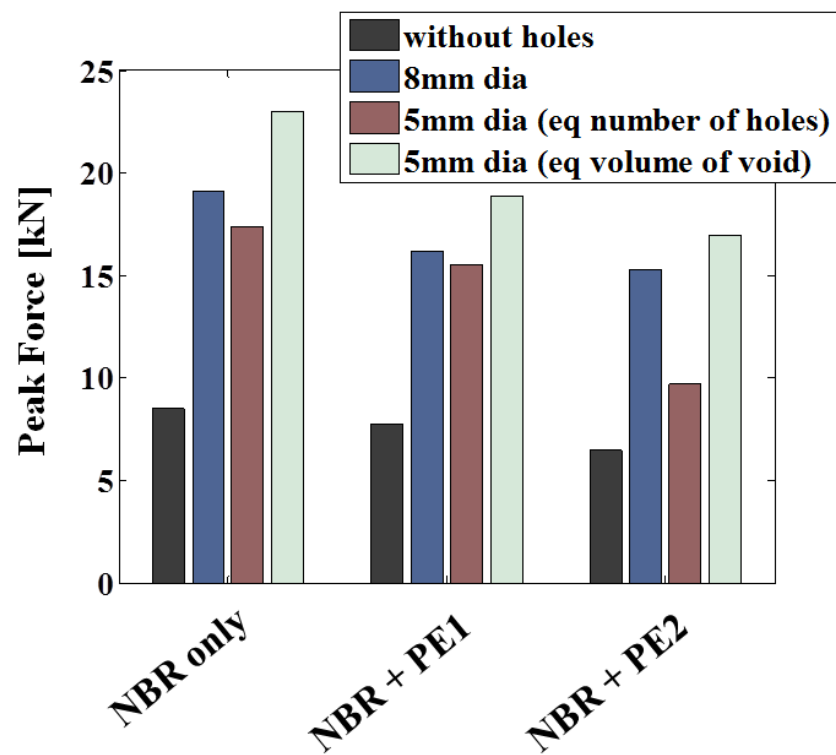


EFFECT OF HARD SHELL

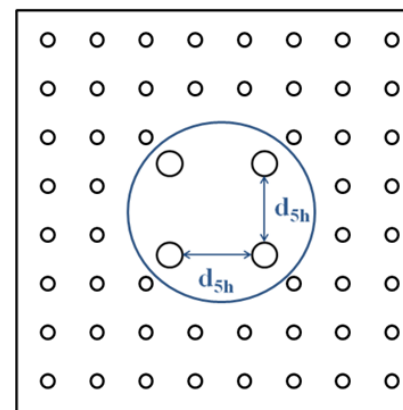




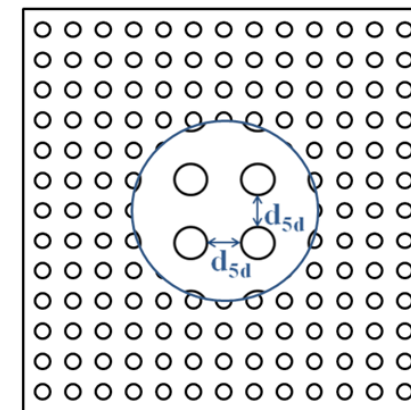
EFFECT OF VENT HOLES



(a) Vent holes of 8 mm diameter



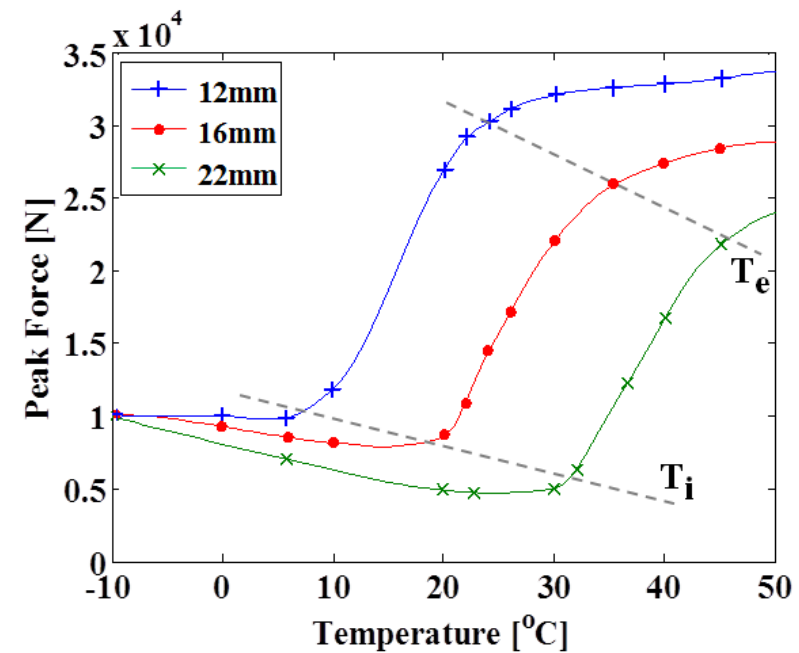
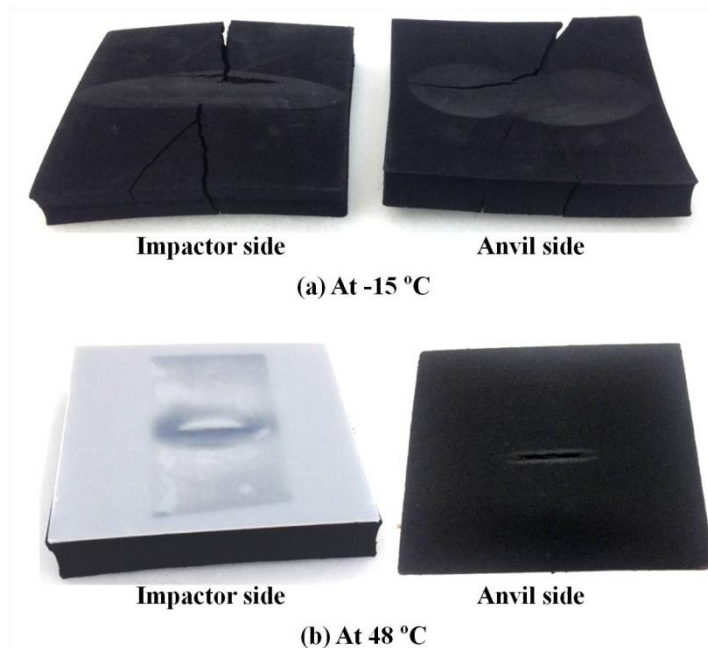
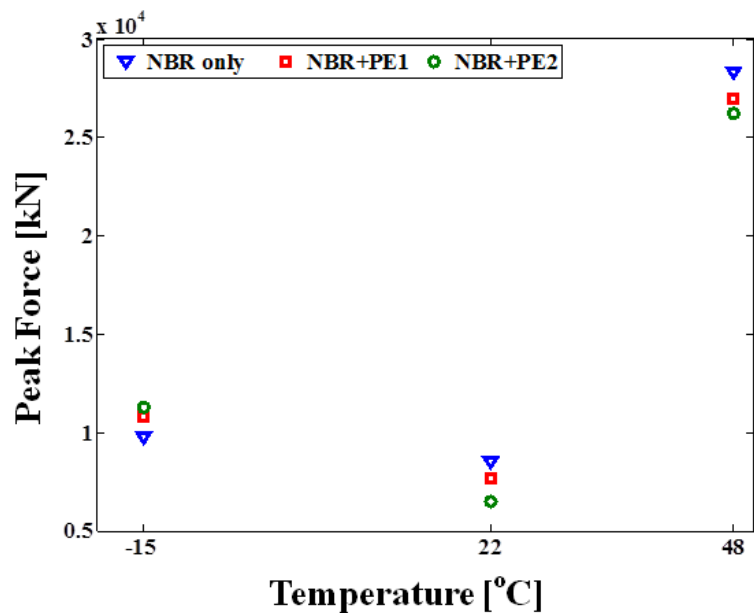
(b) Vent holes of 5 mm diameter (equal number of holes as in (a))



(c) Vent holes of 5 mm diameter (equal volume of void as in (a))



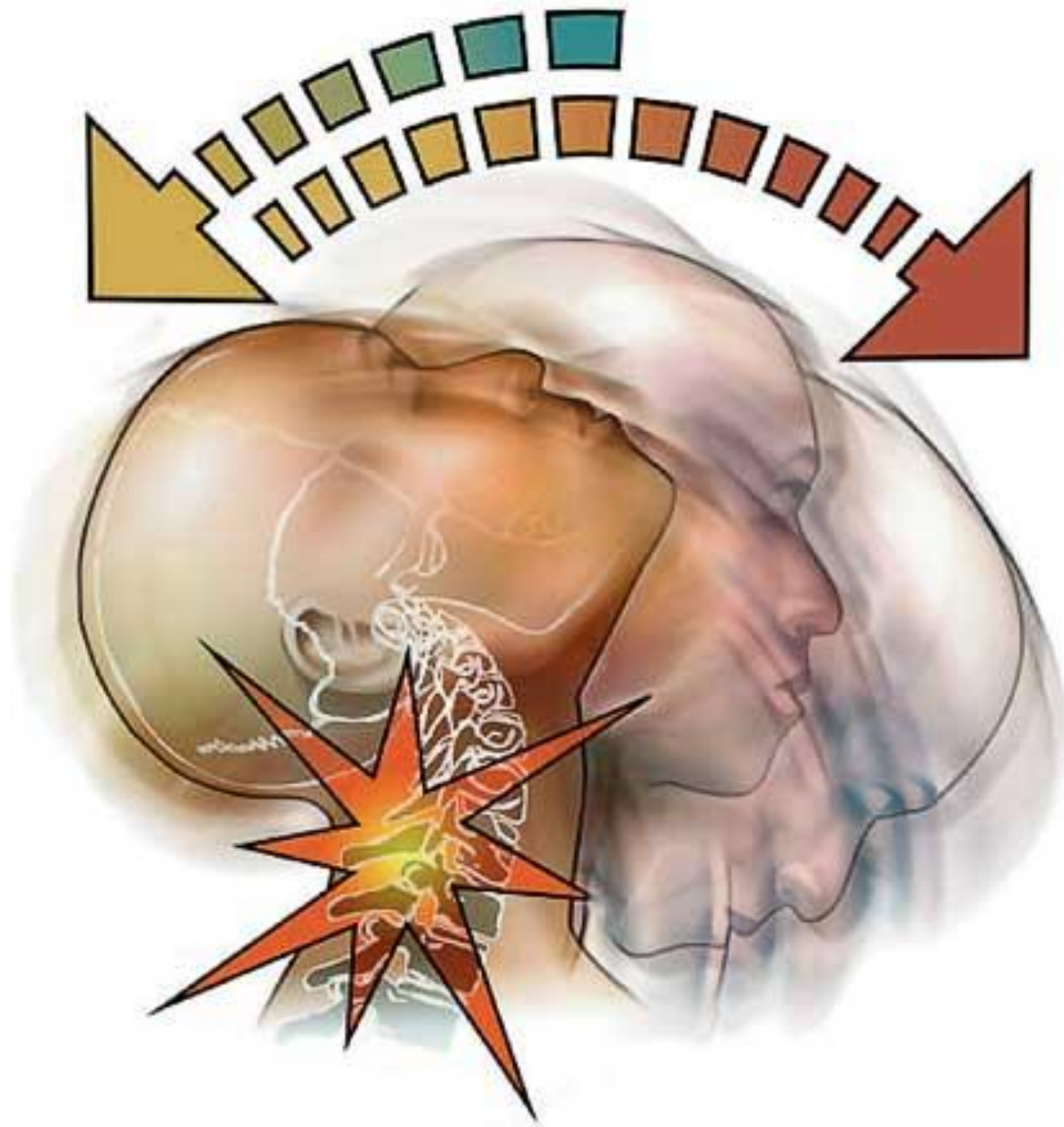
EFFECT OF TEMPERATURE





NECK INJURY PROTECTION

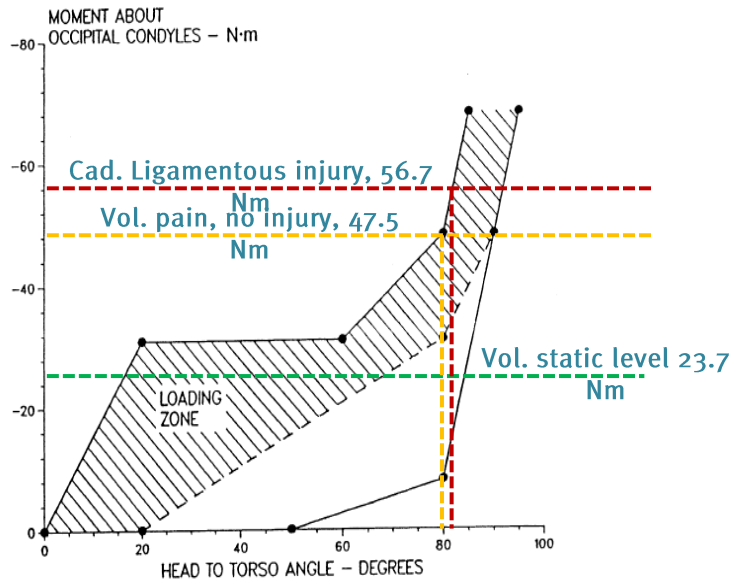
- ❑ Biomechanics
- ❑ Prototypes
- ❑ Evaluation
- ❑ D-neck
- ❑ Standards



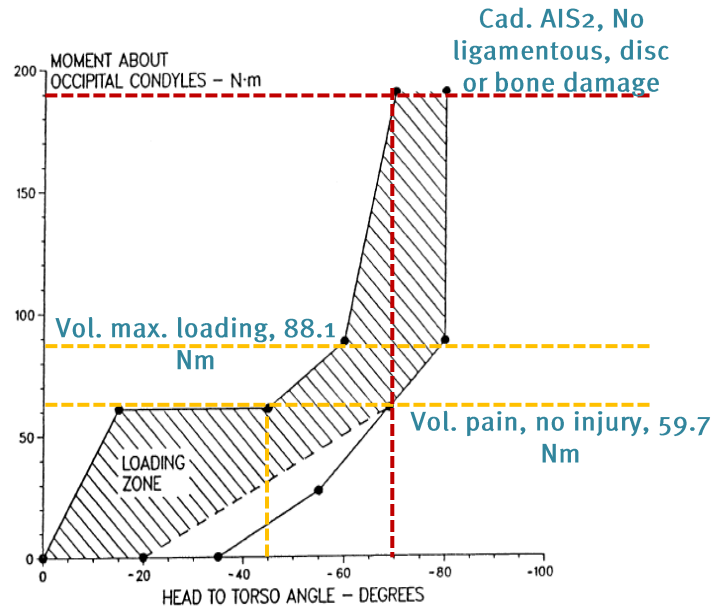


TOLERANCE LIMITS

Neck extension corridor



Neck flexion corridor



load case	threshold
flexion	190 Nm
extension	57 Nm
axial tension	3300 N
axial compression	4000 N
shear (anterior and posterior)	3100 N

K.-U. Schmitt, P. Niederer, F. Walz, 2004

FMVSS 208
Federal Motor Vehicle Safety Standard for occupant safety in frontal crash



Prototypes

CONCEPTs

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Using foams

PROTOTYPE 1

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Using elastic & rigid bands

PROTOTYPE 2

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Using airbag


PROTOTYPE 3

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Prototypes and Dainese Hybrid Neck Brace

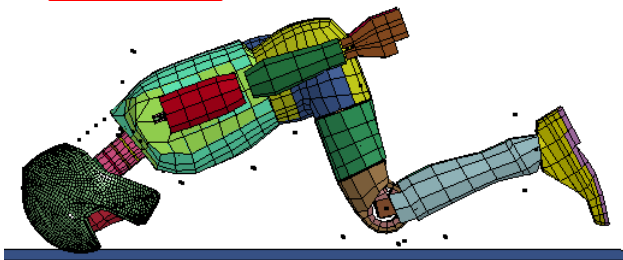
COMPARISON

TYPE	WEIGHT	COMFORT (TO WEAR)	COMFORT (WHILE RIDING)	RIDER'S DYNAMICS	FUNCTIONAL POSSIBILITY	PROBLEMS	INJURY PROTECTION ?
	610 gm	(Ref)	(Ref)	(Ref)	Extension Flexion Lateral bending Torsion	- Placing and keeping the brace fixed - Shear effect due to hardness laterally	
Prototype 1	235 gm	▲	▲	■	Extension Flexion Lateral bending Torsion	- Position of the foams - Shape of the foams - Shear effect due to hardness laterally	
Prototype 2	90 gm	▼	▲	▲	Extension Flexion Lateral bending Translation	- Fixing the system with helmet & jacket - Opening	
Prototype 3	220 gm (deflated)	▲	▲	▲	Extension Flexion Lateral bending Compression	- The thickness during the inflated condition - Difficulty in properly designing the geometries	

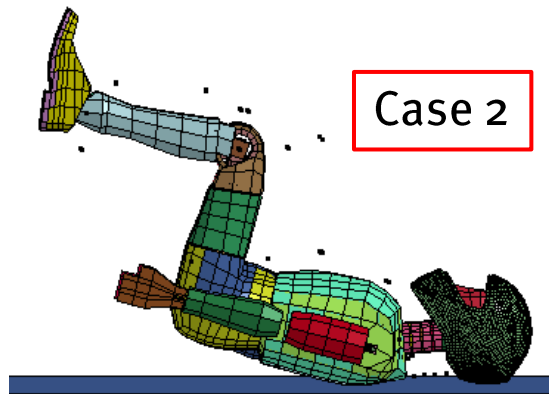


DIFFERENT SCENARIOS

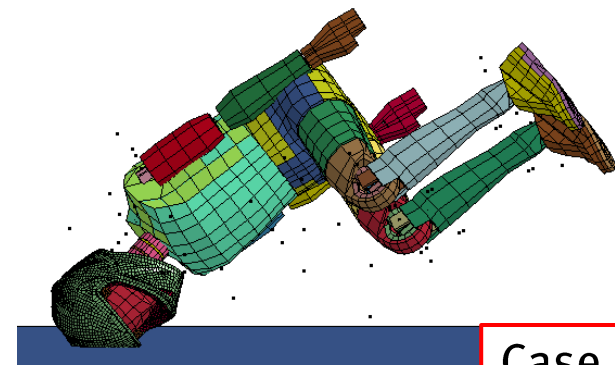
Case 1



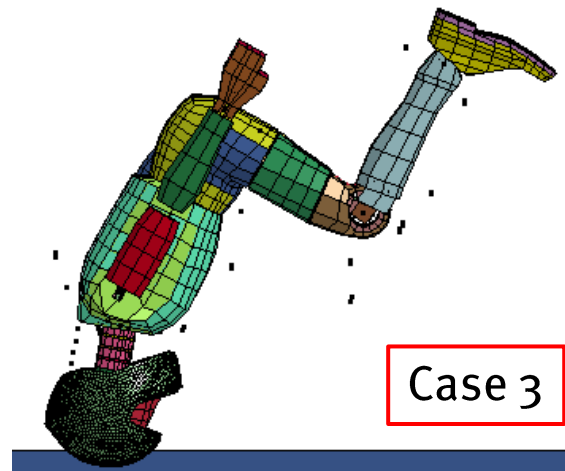
Case 2



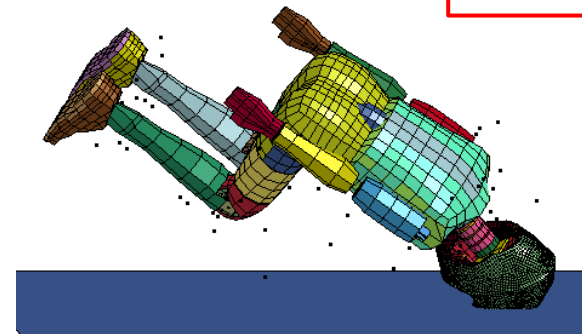
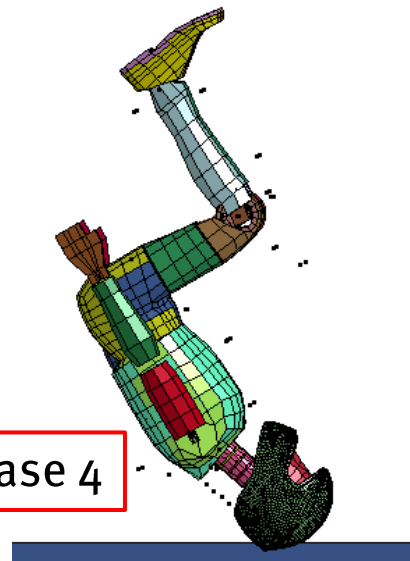
Case 5



Case 3



Case 4



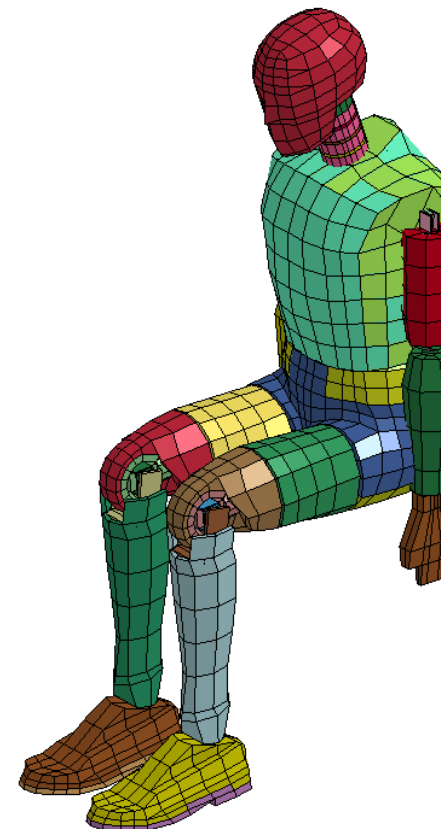


Physical and FE models

DUMMY



HYBRID III 50th PERCENTILE MALE



HYBRID III FE MODEL DEVELOPED AND DISTRIBUTED BY LSTC CORP.

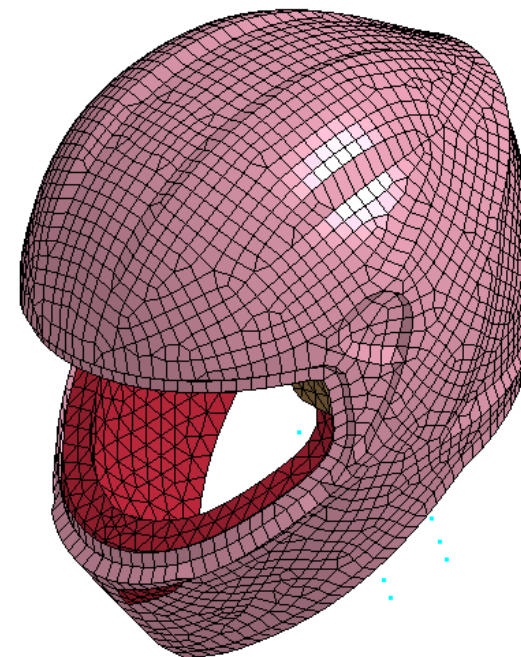


Physical and FE models

HELMET



PISTA GP AGV E2205 MULTI GRAN PREMIO



*** COMPOSITE SHELL + EPS PADDING**

*The helmet model has been provided by Alessandro Cernicchi from Dainese©



Physical and FE models





NECK PROTECTING DEVICES

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Results of the simulations





KEY REMARKS

- ❑ Stiff material  lateral flexion
- ❑ C-brace  low-side frontal impact
- ❑ Stiff hump  low-side rear impact
- ❑ Collar  high-side frontal impact



Results of the simulations

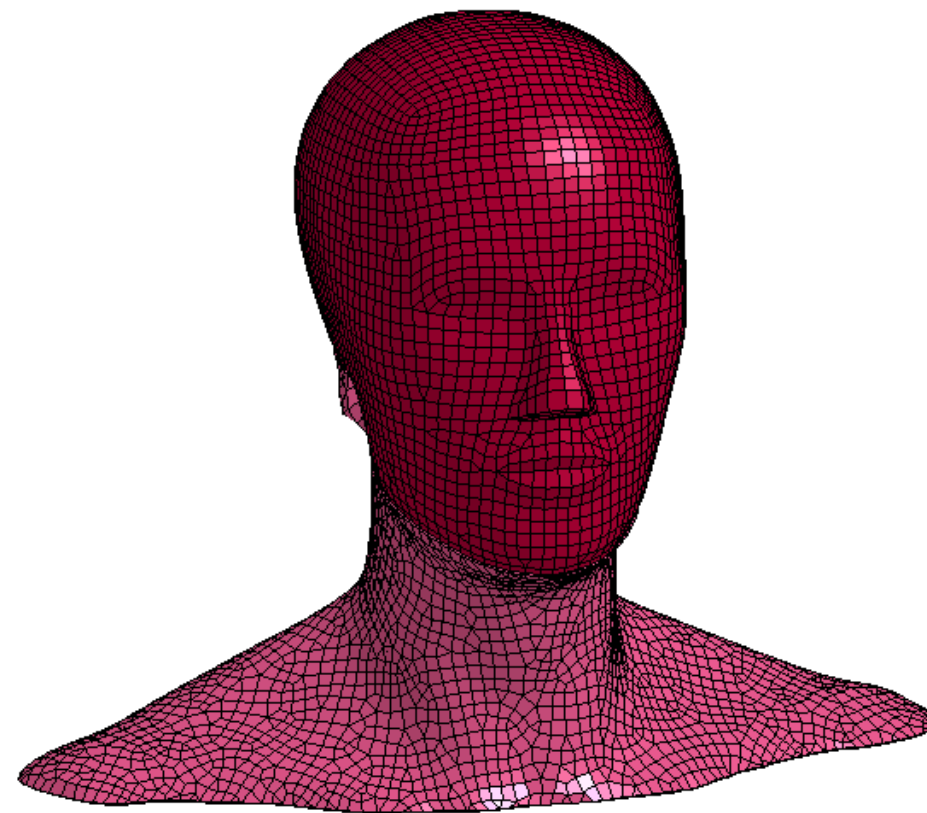
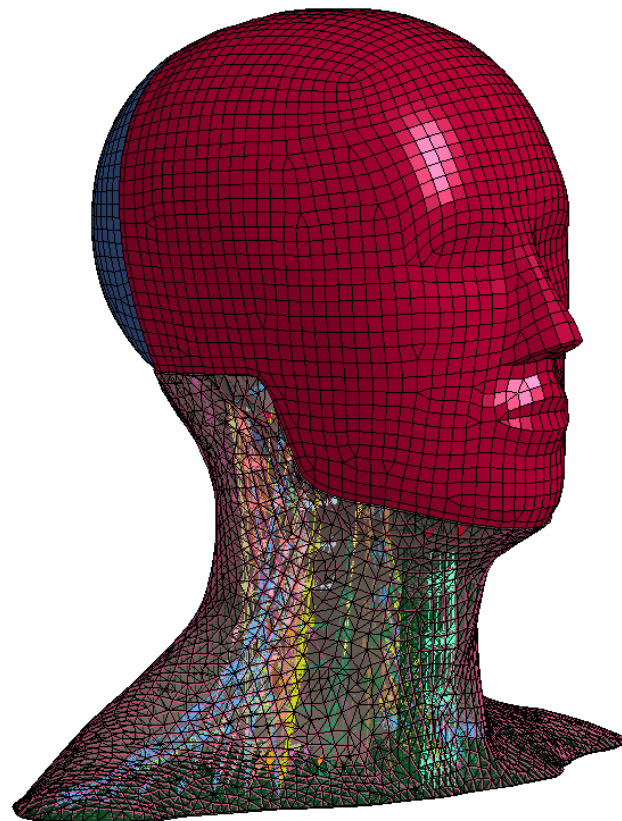
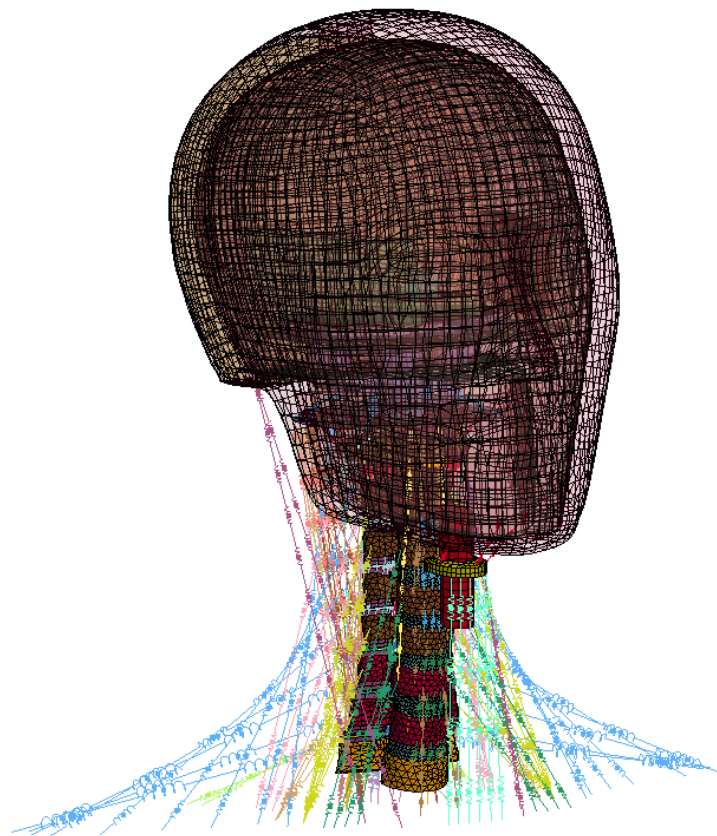
KEY REMARKS

- ❑ Stiff material  lateral flexion
- ❑ C-brace  low-side frontal impact
- ❑ Stiff hump  low-side rear impact
- ❑ Collar  high-side frontal impact
- ❑ **Acceptance of the results?** 



A simple 3d neck model

DEVELOPMENT OF D-NECK MODEL





A draft proposal

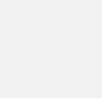
STANDARDS

- ❏ Ricotest: **me-int 088 rev. 10 neck brace disciplinary.**
- ❏ Numerical analyses.
- ❏ Experimental test setup.
 - » Head position relative to torso.
 - » Neck axial and shear forces.



Summary

MILESTONES



March 2015



October 2015

March 2016

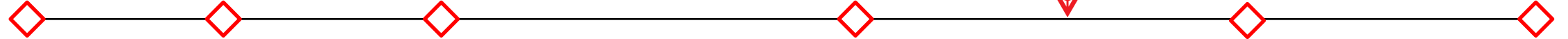
March 2017



January 2018



September 2018



Innovative PPEs



Standards



Writings





A list of

PUBLICATIONs

Deliverable

M. Nasim, M. Brasca, A. Cernicchi, E. Silani; *Standards in PPE, A survey*, http://www.motorist-ptw.eu/wp-content/uploads/2015/10/MOTORIST-D3.5_Standards-in-PPE-a-survey.pdf, 2015.

Conference

M. Nasim, M. Brasca, *Impact properties of polymeric materials used for motorcyclists' personal protective equipment*, International Conference on Impact Loading of Structures and Materials, 2016.

M. Nasim, The introduction to the personal protective equipments for motorcyclists, MCAA General Assembly and Annual Conference, 2016. (Poster).

Journal

M. Nasim, M. Brasca, S. F. Khosroshahi, U. Galvanetto, *Understanding the impact properties of polymeric sandwich structures used for motorcyclists' back protectors*, Polymer Testing. Vol. 61, pp 249-257. Doi: doi.org/10.1016/j.polymertesting.2017.05.025.



GRAZIE



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