



Informal document **GRSP-57-12**
(57th GRSP, 18-22 May 2015,
agenda items 3(a) and 13)

Pedestrian Safety

Bumper Test Area

Presented by the experts of OICA
for the discussion on gtr No. 9 and UN R127



Background

- The new bumper test area is determined by either using corner gauges in an angle of 30° or by the width of the bumper beam, whatever is the wider area
- If the bumper beam width defines the test area, the test area contains – by definition – zones with angles above 30°
- Document GRSP-56-03 (Japan):
“Proper evaluation cannot be guaranteed beyond the 30 deg. area.” *)
- Discussion 56th session of GRSP:
OICA and India had explained that there are concerns with the impactor performance outside the 30 degrees area due to limited impactor abilities *)
- It is not the intention of OICA to re-discuss the principle definition of the test area but the limitations of the impactor should be considered appropriately

*) 30° stated refers to the angle of the lateral plane of impactor motion while the 60° in the regulation language refer to the longitudinal plane of the vehicle surface. The same point is meant to be addressed.

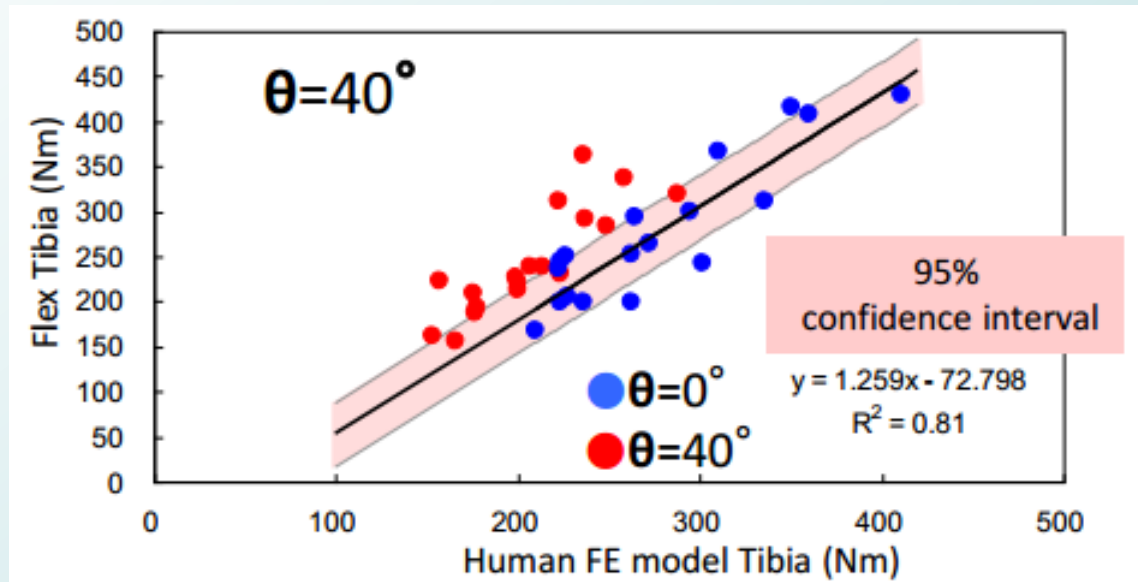


Proposals

- In order to mitigate the test tool limitations, it is suggested to at least come back to the proposal already discussed in TF-BTA and GRSP:
For the measuring point, an offset of 42 mm in y-direction into the test area should be generally acceptable
- Given the technical uncertainties shown in this presentation, compliance with the new bumper test area definition would need changes to the bumper shape, requiring a full duration of vehicle development for transitional provisions. Thus, OICA proposes the transitional provisions of 1 Sept. 2019 for new models
- GRSP may think about disregarding test results outside 30° impact angle when achieved with the FlexPLI in its current build level

Issue: Test Result Confidence

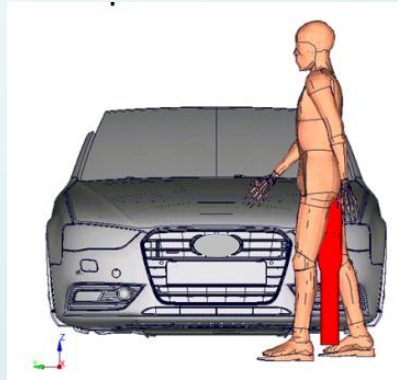
- At impact angles above 30°, FlexPLI test results have a limited confidence
- There is no specific angle outside 30° to be identified from which the degradation occurs
- It is generally agreed that FlexPLI confidence level and reproducibility are acceptable in areas with surface sweep less than 30° to the lateral plane



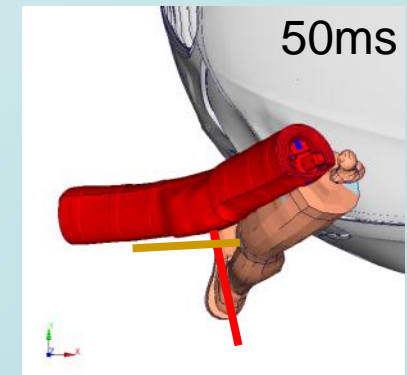
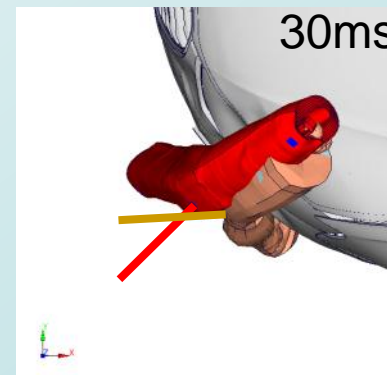
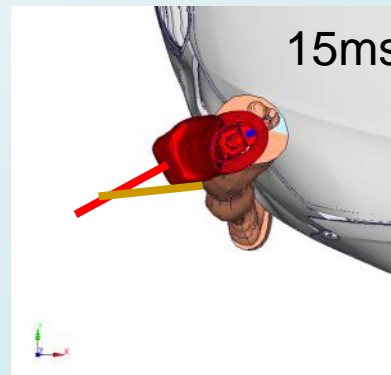
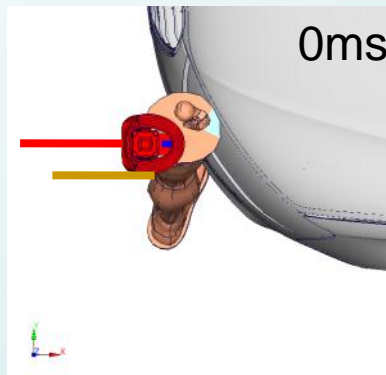
Reference: GRSP-56-03
(Japan for GRSP)

Issue: Impactor Behavior @ High Angles (Simulation)

- The FlexPLI is designed to have a two-dimensional behavior to assess surfaces impacted or swept close to the normal angle (which was also observed with the EEVC LFI)
- Rotation of and within the flexible legform impactor has never been proven to be compliant in terms of biofidelity and differs to full body simulation kinematics



Comparison of human model and impactor model simulation; reference: TF-BTA-3-03r1 (OICA for IG sub-group)

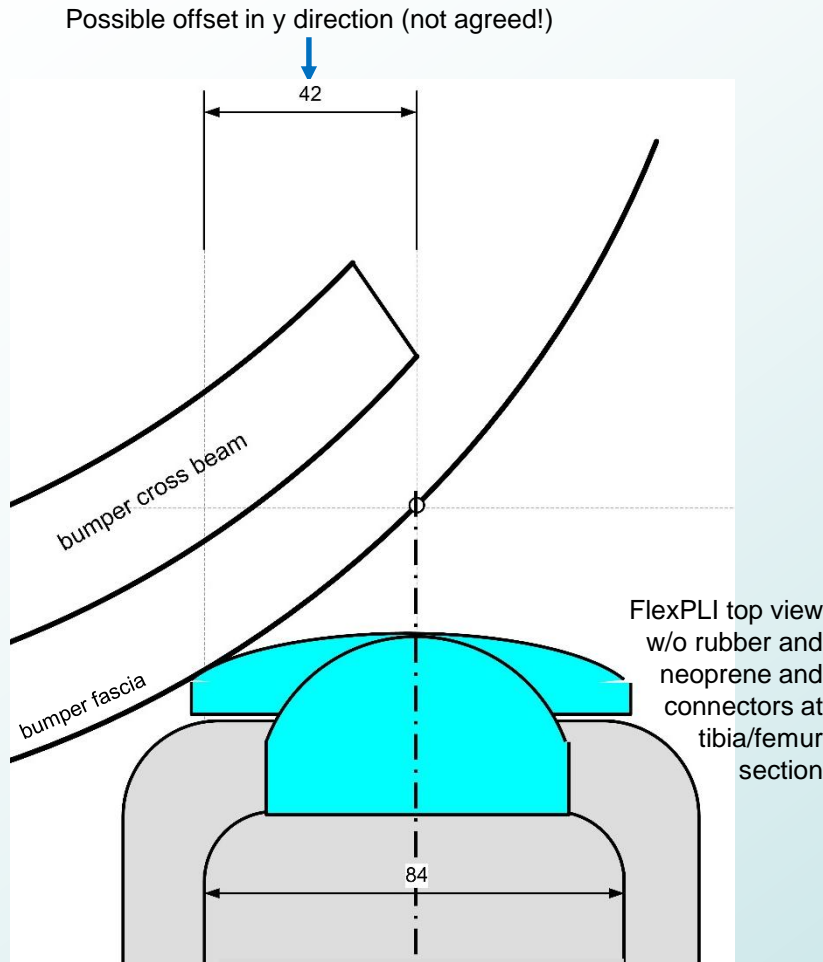


Issue: Impactor Behavior @ High Angles (Testing)

- Testing of surfaces with extreme angles results in an uncontrollable behavior of the impactor which creates the risk of equipment damages



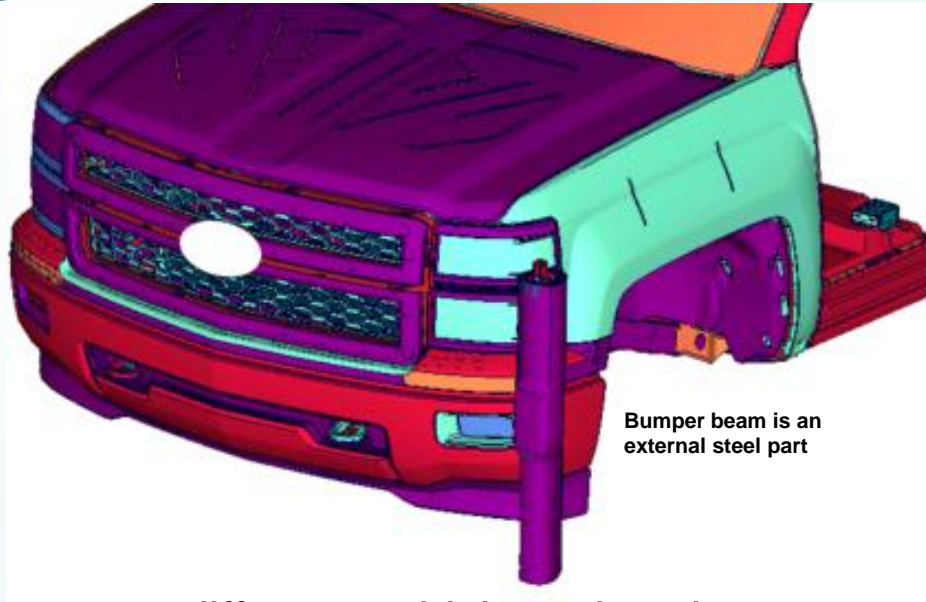
Issue: Reliable, Reproducible & Repeatable Testing



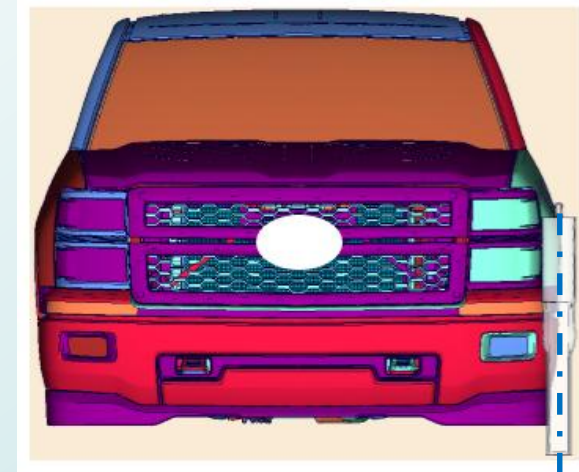
- Due to the new definition of the test area to reach as far as bumper beam the FlexPLI impacts the surface at an angle greater than the justified 30°
- Areas result with limited contact of the vehicle to the legform
- This may result in occurrence of total and relative rotation of the leg as well as sliding along the surface
- This may also result in glancing blows outside the 30 degree area which produce inconstant, non-repeatable data
- Reliable, reproducible and repeatable tests require engagement of full width of the legform against bumper beam

Example: Bumper beam ends at a FlexPLI impact angle of about 45°

Issue: Design Conflicts



- To respect different vehicles other than consumer metric optimized fleet of European vehicles other markets with specific needs should also be reflected
- Assuming the bumper beam to be the limit of the zone the very outer end will be assessed by glancing blows
- Also, a pedestrian hit by that area of the vehicle is unlikely to have head contact on the bonnet
- Gain in protection in percent is even less than for Europe but assessment of those front ends is even more ambiguous



For this vehicle, an offset of 42 mm along the contour (as discussed in TF-BTA) would change the measuring point by 4 mm in y-direction





Issue: Cost Benefit Analysis

- Accident data indicate that the effectiveness achieved by the extension of the test area is limited
- Considering all the shortcomings in VRU protection gain, vehicle development and testing, a cost-benefit analysis is still to deliver a rationale for this extension proposal

Car-caused ligament injuries (Germany)

Reconstructed pedestrian accidents (w/o fatally injured pedestrians) GIDAS 2002-2013	2,522
Cruciate ligaments' ruptures caused by car front GIDAS 2002-2013	7
Percentage (all injury severities)	0.28
Pedestrian accidents / year, (w/o fatally injured pedestrians) Destatis 2013	31,584
Estimated cruciate ligaments ruptures / year caused by car front Based on Destatis 2013	≈ 88 per year
Share of cruciate ligament ruptures related to the extended test area (new 30° definition): 10- 20% *)	≈ 18
Estimated injury reduction potential of the new BTA (effectiveness 14% *)): Reduction of cruciate ligaments ruptures	≈ 2.5 per year

Overall ligament injuries (Germany)

Total number of cruciate ligament injuries per year in Germany overall cases	≈ 50,000 – 100,000 per year
---	-----------------------------

References:

de.wikipedia.org/wiki/Kreuzbandriss
www.kybun.de/anwendungen/therapie/knie/studie-knie-kreuzbandriss.html
www.oped.de/media/files/presse_lexikon/Sportverletzungen_Knie.pdf

*) Percentages according to the TRL study for the European Commission (referred to during the 56th GRSP session, see report) and assuming that all ligament injuries would be addressable by the test procedure



Summary

- Confidence of FlexPLI at impact angles $> 30^\circ$ is deteriorating
- Test scatter at impact angles $> 30^\circ$ is increasing, resulting in much reduced repeatability and reproducibility
- Behavior of FlexPLI at impact angles $> 30^\circ$ is not biofidelic
- Data shows that the effectiveness of design measures addressing FlexPLI impact behavior at impact angles $> 30^\circ$ is limited
- Reliable, reproducible and repeatable tests require engagement of full width of the legform against bumper beam
- The Bumper Test Area decided on in the previous session of GRSP lacks a sufficient cost benefit analysis

Test procedure should provide for controllability of the impactor interaction with the vehicle structure and sufficient leadtime to design vehicles accordingly



Thank you!

For detailed questions please refer to the authors, Mr. Thomas Kinsky / General Motors Europe Engineering, Mr. Winfried Schmitt / BMW, Mr. Franz Roth/ Audi and Mr. Benjamin Buenger / General Motors Europe Engineering, as representatives of the International Organization of Motor Vehicle Manufacturers OICA