Proposal for
Sensing Impactor

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Introduction

During the discussions in the IWG there was common understanding about the due care of the car manufacturer that the system will act as intended in the event of a collision for a variation of pedestrian statures.

Due to the unavailability of impactors of different sizes validated for the detection of pedestrians, one of the existing pedestrian legform impactors shall be used for the sensing verification of the system for the time being.

During the intermediate Web meeting of the IWG-DPPS (28 November 2019), the use of the upper legform impactor was discussed as an alternative sensing impactor.

It was decided to summarize the pros and cons of all candidate legform impactors with the aim of a final decision on the sensing impactor for use within GTR9/UN-R127 as well as a proper documentation for the GTR9 preamble during the March 2020 IWG meeting.

Candidate impactors for consideration: WG 17 LFI, WG 17 ULI, FlexPLI and PDI-2.

Pros and Cons of Candidate Sensing Impactors

	WG 17 LFI	WG 17 ULI	FlexPLI	PDI-2
State of the art / Current Scope	Tool for homologation in Regulation (EC) No. 78/2009 50th percentile Pedestrian surrogate in Euro NCAP Pedestrian Testing Protocol (++)	Tool for homologation in Regulation (EC) No. 78/2009 and UN-R127/GTR9 (+++)	Tool for homologation in UN-R127/GTR9 50th percentile Pedestrian surrogate in Euro NCAP Pedestrian Testing Protocol (+++)	Tool for HTD Pedestrian surrogate in Euro NCAP Pedestrian Testing protocol (+)
Dynamic Certification (Injury Criteria)	Procedure and verification of 3 criteria (internal biofidelity) (+)	Procedure and verification of 5 criteria (internal biofidelity) (+)	Two procedures and verification of 7 criteria each (internal biofidelity) (++)	Not available (-)
Contact Biofidelity	not verified (-)	not verified (-)	not verified (-)	verified (+)
Representativeness	50th (/)	50th (/)	50th (/)	Various statures (++++)
Applicability	Yes (moving car) Feasibility in low speed testing with propelled impactor tbc (+)	No (needed mass reduction to 7.4kg for HTD approximation not feasible. New guiding system would be needed) (-)	Yes (moving car) Feasibility in low speed testing with propelled impactor tbc (+)	Yes (moving car) Feasibility in low speed testing with propelled impactor tbc (+)
Summary	+++	++	+++++	++++++

Discussion

According to the summary table, the PDI-2 would be first choice of sensing impactors, followed by FlexPLI.

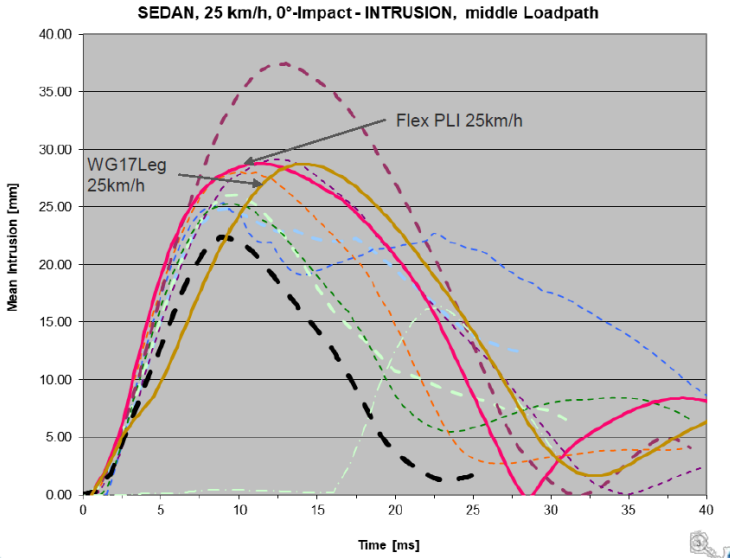
Since the PDI-2 is seen by many stakeholders as being too conservative, the applicability of the FlexPLI as best way forward for the time being was investigated.

Some investigations suggested the FlexPLI having an appropriate contact biofidelity to work as a pedestrian surrogate for sensing issues.

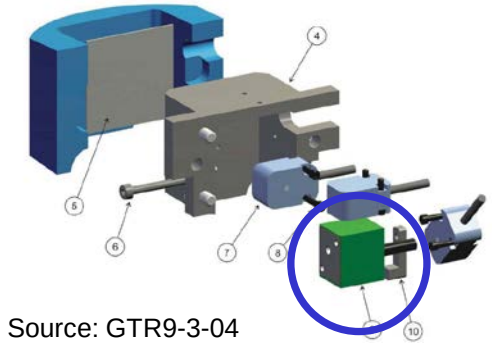
The acceleration measured in the FlexPLI might be the most convenient criterion for ensuring a defined contact biofidelity.

The FlexPLI passing the inverse certification ensures a good repeatability in knee elongations and tibia bending moments.

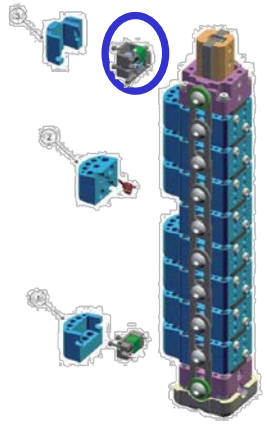
A good repeatability in the tibia top acceleration could indicate a robust contact biofidelity.



Source: IWG-DPPS 3-02



Source: GTR9-3-04



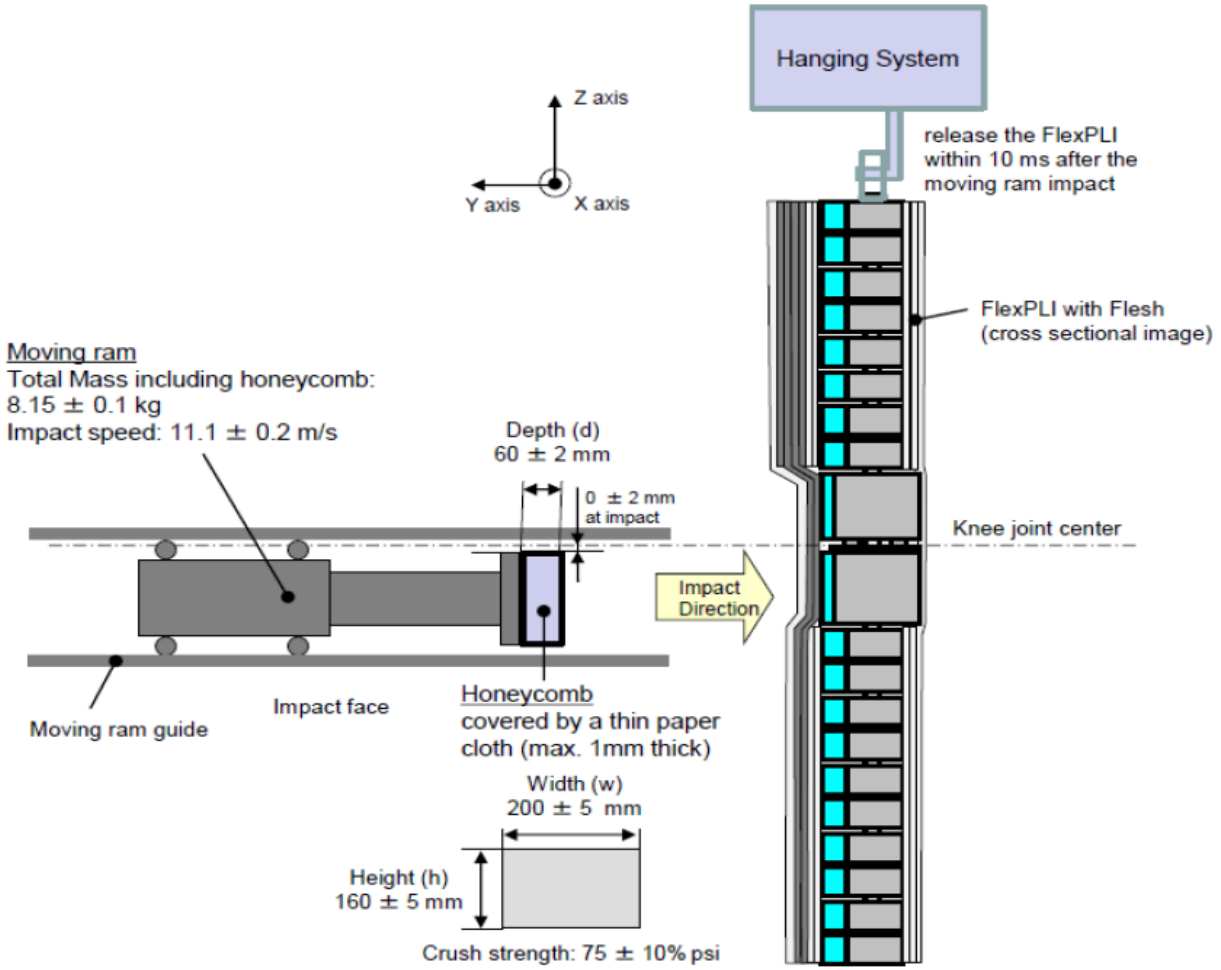
Procedure

A number of FlexPLI passing the inverse certification test were compared with regards to the repeatability and robustness of test results.

Injury criteria as well as femur channels
were compared with the tibia top acceleration signal.

15 impactors were used,
one inverse certification test was performed each

CFC 180 filter class was used for all channels



Results

Scatter in femur BM and accel. were higher than in tibia (and MCL); might be due to the test setup (linear impact at mid knee)

Highest scatter in acceleration

Very high range in acceleration

Highest deviation from mean value (and median) in acceleration

	Femur Up	Femur Mi	Femur Lo	ACC	MCL	Tibia Up	Tibia MiUp	Tibia MiLo	Tibia Lo
	[Nm]	[Nm]	[Nm]	[g]	[mm]	[Nm]	[Nm]	[Nm]	[Nm]
MV	73,2	134,6	189,1	248,2	18,6	254,8	232,9	175,3	96,3
Median	72,8	132,9	190	248,4	18,3	254	232,9	175,4	95,8
Range	13,2	30,5	35,5	65,7	3	22,5	19,6	6,6	10,5
Min	66,6	120,5	174,7	212,1	17,2	244,3	222,9	172	94
Max	79,8	151	210,2	277,8	20,2	266,8	242,5	178,6	104,5
SD	4,3	8,7	9,9	17,1	1,0	6,2	4,9	2,0	2,5
CV [%]	**5,9**	**6,6**	**5,2**	**6,9**	**5,2**	**2,4**	**2,1**	**1,1**	**2,6**
Max. Deviation from MV [%]	9,0	12,2	11,1	14,6	8,9	4,7	4,3	1,9	8,6
Max. Deviation from Median [%]	9,6	13,6	10,6	14,6	10,4	5,0	4,3	1,9	9,1

Summary and next steps (1)

For the time being, the FlexPLI appears to be the best available pedestrian surrogate to be used as sensing impactor, provided that

- a general wording for DPPS working as intended

> "If the vehicle is equipped with a Deployable Pedestrian Protection System as defined in paragraph 2.19 of the Regulation, the test provisions laid down for type approval can, due to the complexity of testing those systems, only represent spot checks. Nevertheless it is due care of the car manufacturer that any active devices of passive pedestrian safety will ensure the necessary protection (e.g. for a variation of speeds and pedestrian statures) in order to act as intended in the event of a collision with a pedestrian."

- a wording for the need of a number of pedestrian statures being detected by DPPS:

> "Considering the unavailability of impactors validated for the detection of pedestrians, the Flex PLI shall be used for the sensing verification of the system for the time being.
>
> Nevertheless it is due care of the car manufacturer that the system will act as intended in the event of a collision for a variation of pedestrian statures"

being included within the text of GTR9 and UN-R 127.

Summary and next steps (2)

Passing the inverse test does not necessarily provide for a robust acceleration within the FlexPLI.

Possible causes for the scatter in the accelerometer could be the use of Al honeycomb for the certification impactor.

Possible causes for the scatter in the femur could be the degrees of freedom within the femur part of the legform during the impact (upper edge of honeycomb impactor aligned with middle of knee joint)

To verify the repeatability of the acceleration, it is suggested to perform a series of tests

- either under an impact with the rigid plate w/o honeycomb under moderate speed (LT – 25 km/h)
- or by replacing the Al honeycomb by an appropriate EPP representative as typical for pedestrian protection in bumper area

However, prior to any further investigations, a general agreement on the sensing impactor must be reached.

Thank you