

Sensing Impactor Evaluation

Flex PLI Low Speed Inverse Testing

Test Report

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Background

- Ongoing discussions in IWG DPPS about the choice of a sensing impactor.
- Due to the unavailability of impactors validated for the detection of different sizes/statures of pedestrians, one of the existing pedestrian legform impactors shall be used for the sensing verification of the system for the time being, alongside with a general wording in the regulations. (see next page)
- The preferred solution, the Flex PLI, should be validated as a sensing impactor by investigating its contact biofidelity.

General wording to be included in the regulations (IWG-DPPS-6-04)

Summary and next steps (1)



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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.

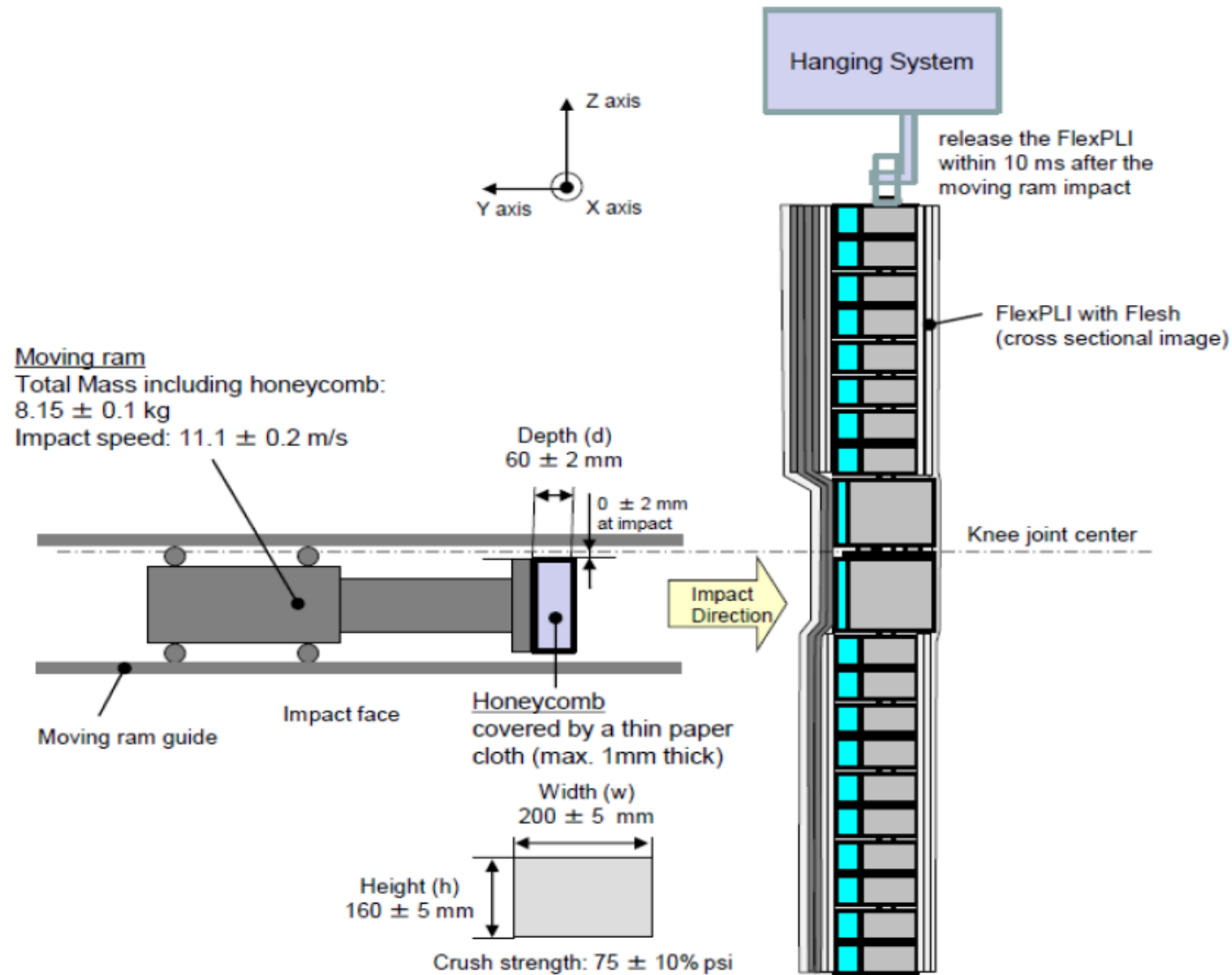
Nevertheless it is due care of the car manufacturer that the system will act as intended in the event of a collision for a variation of pedestrian statures”

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

Background (cont'd)

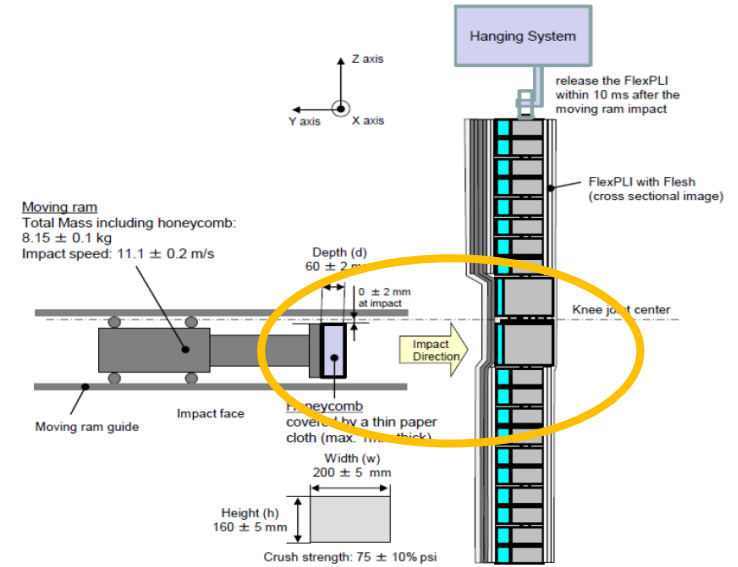
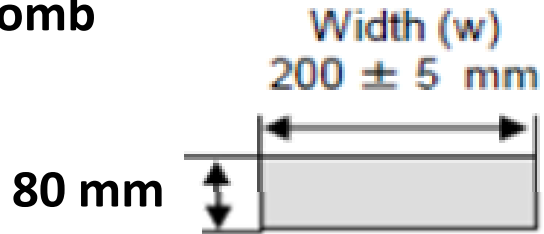
- The validation of the contact biofidelity should be carried out by inverse tests at the common lower bonnet deployment threshold of 25 km/h.
- Ten different impactors should be used.
- Two inverse tests with halved honeycombs should be carried out with each Flex PLI, one at the normal impact height of the inverse certification tests and one with the honeycomb impacting the legform 64 mm lower.
- The double integral of the corresponding accelerometer should be used for the evaluation.
- Background and justification of the details see IWG-DPPS-7-09.

Flex PLI inverse certification test setup

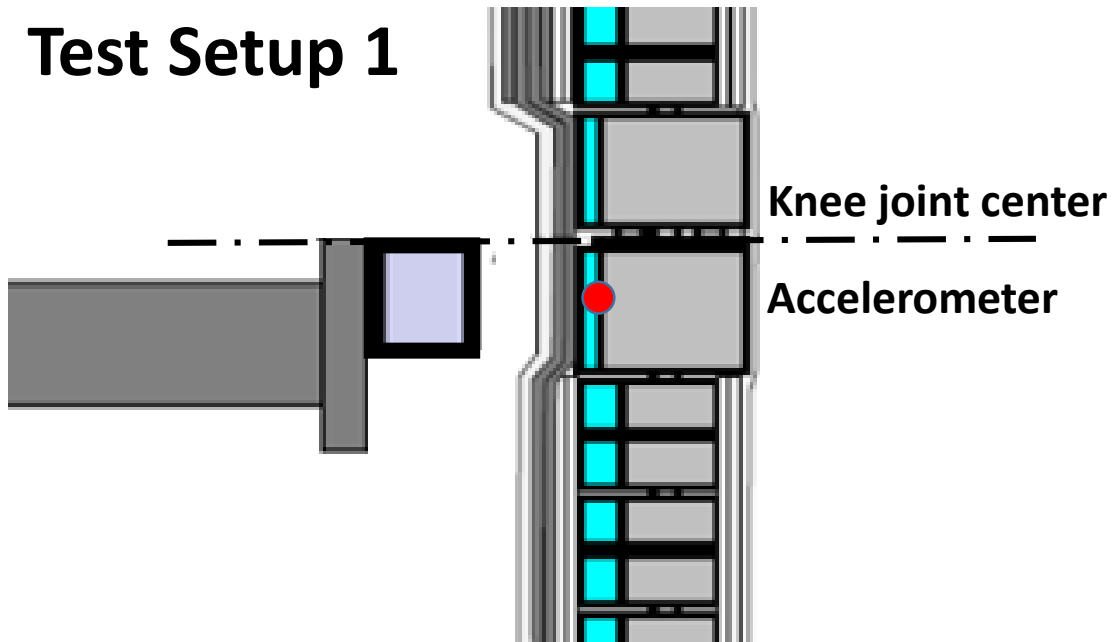


Test setups 1 and 2

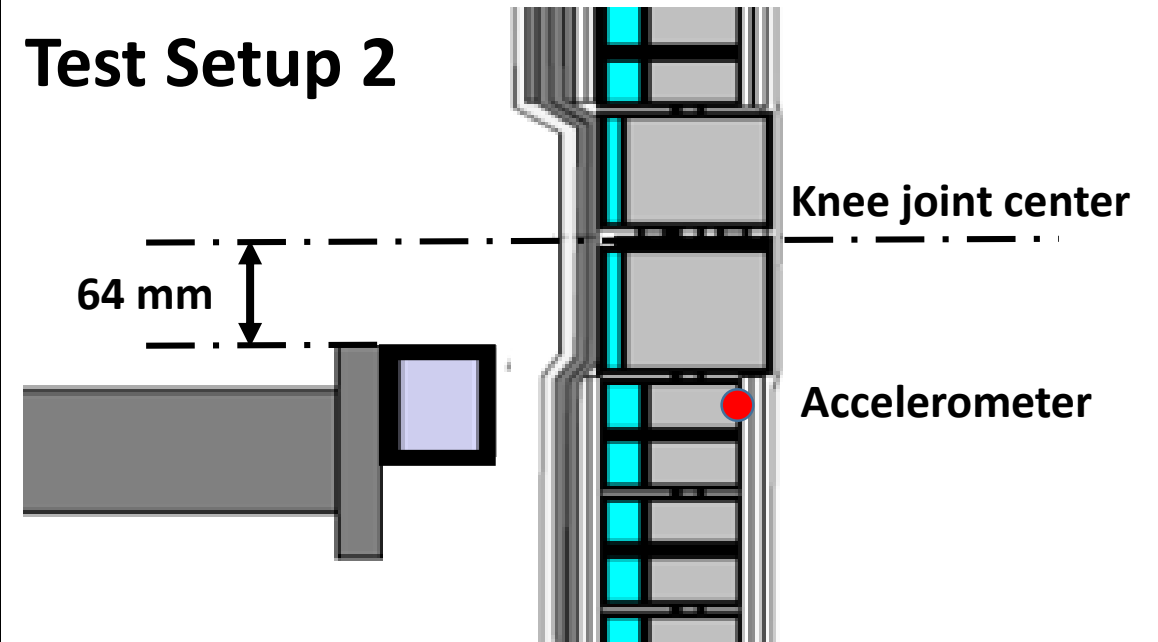
Halved Honeycomb Front view:



Test Setup 1

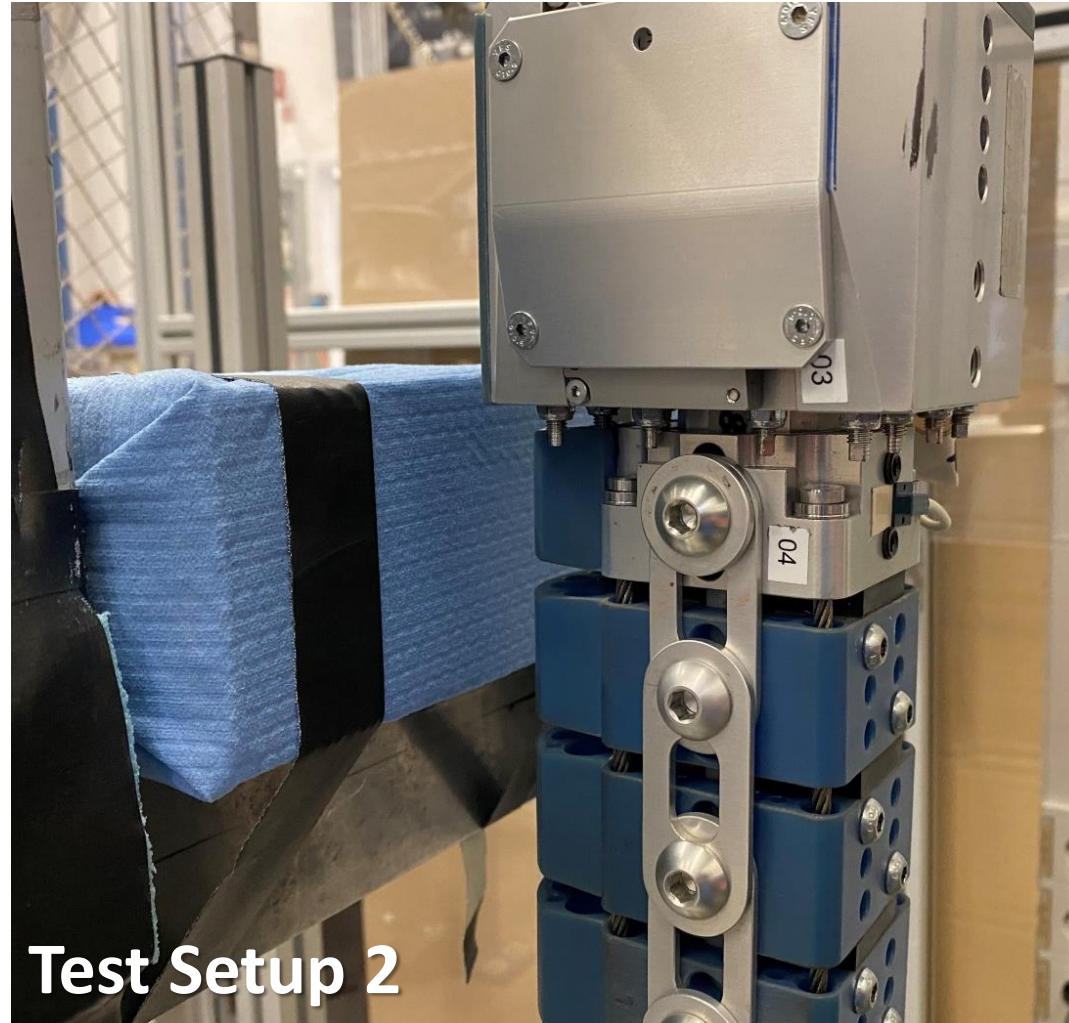


Test Setup 2

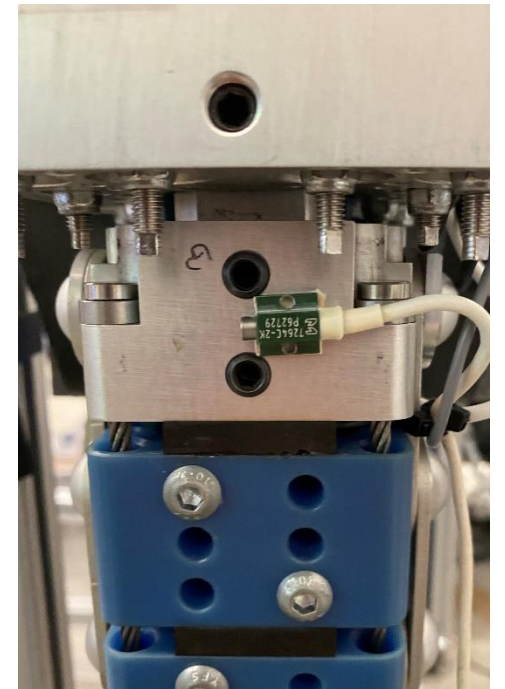


Test setups 1 and 2

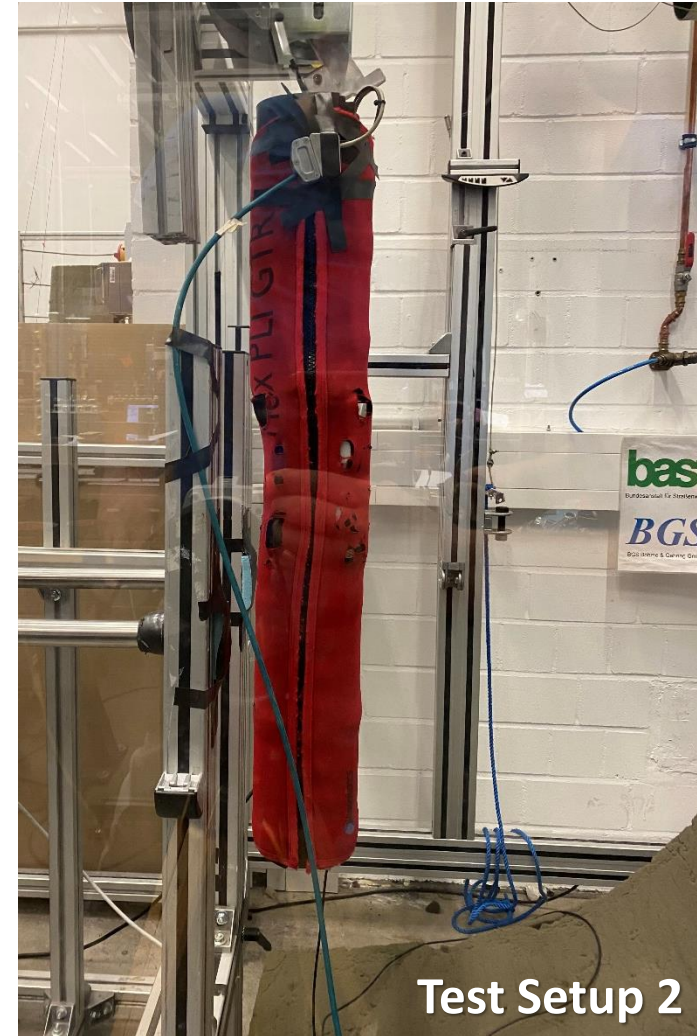
(alignment of honeycomb and impactor)



Additional Accelerometer



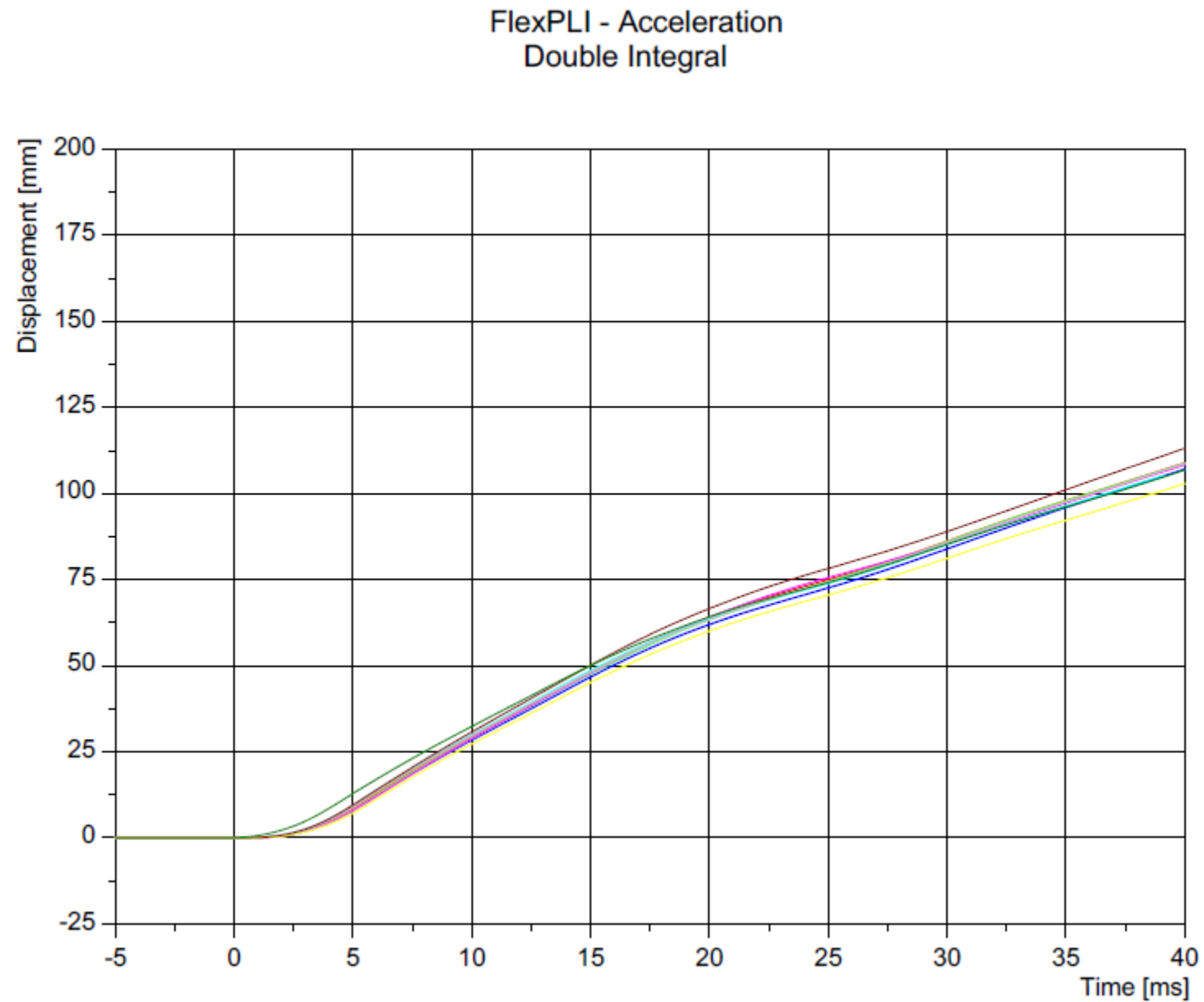
Test Execution: Setups 1 and 2



Test Execution

- 10 different Flex Pli impactors were used for this test series.
- With all impactors the inverse certification test was performed immediately before and after the tests for this project.
- With some impactors the pendulum certification test was also performed before and after the tests on request of the impactor owner. (This was not covered by the project budget.)
- Two tests were carried out with each Flex PLI
 - Setup 1: „Knee“, impact speed 25 km/h
 - Setup 2: „Tibia“, impact speed 25 km/h
- The following parties provided a Flex PLI for this investigation: Audi, BMW, Daimler, Jaguar, Porsche, Renault, VW, BAST (two OEMs provided two impactors).

Test Results (1)

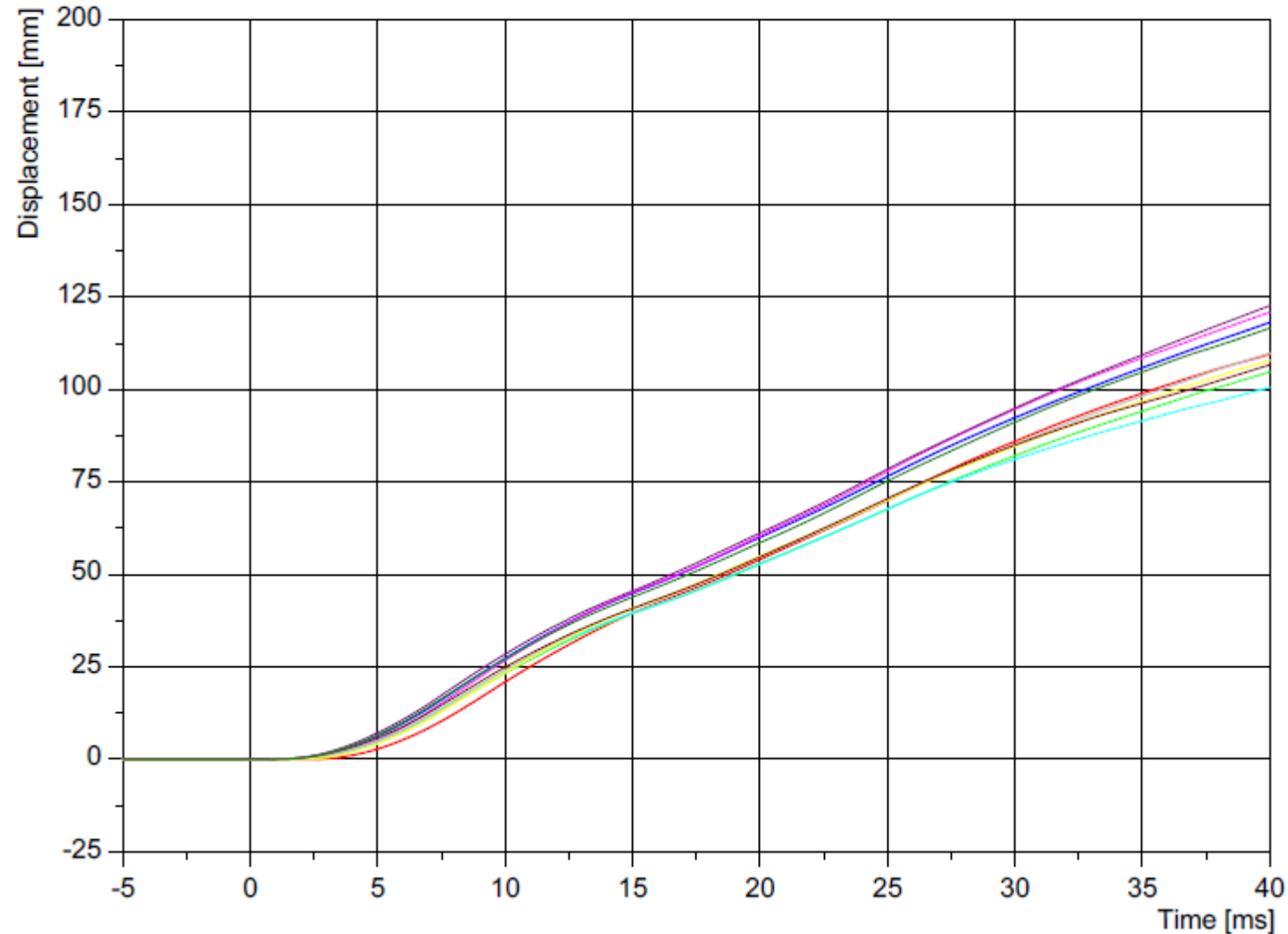


Test Setup 1
„ Knee “

Impactor No.: 1
Impactor No.: 2
Impactor No.: 3
Impactor No.: 4
Impactor No.: 5
Impactor No.: 6
Impactor No.: 7
Impactor No.: 8
Impactor No.: 9

Test Results (2)

FlexPLI - Acceleration Double Integral

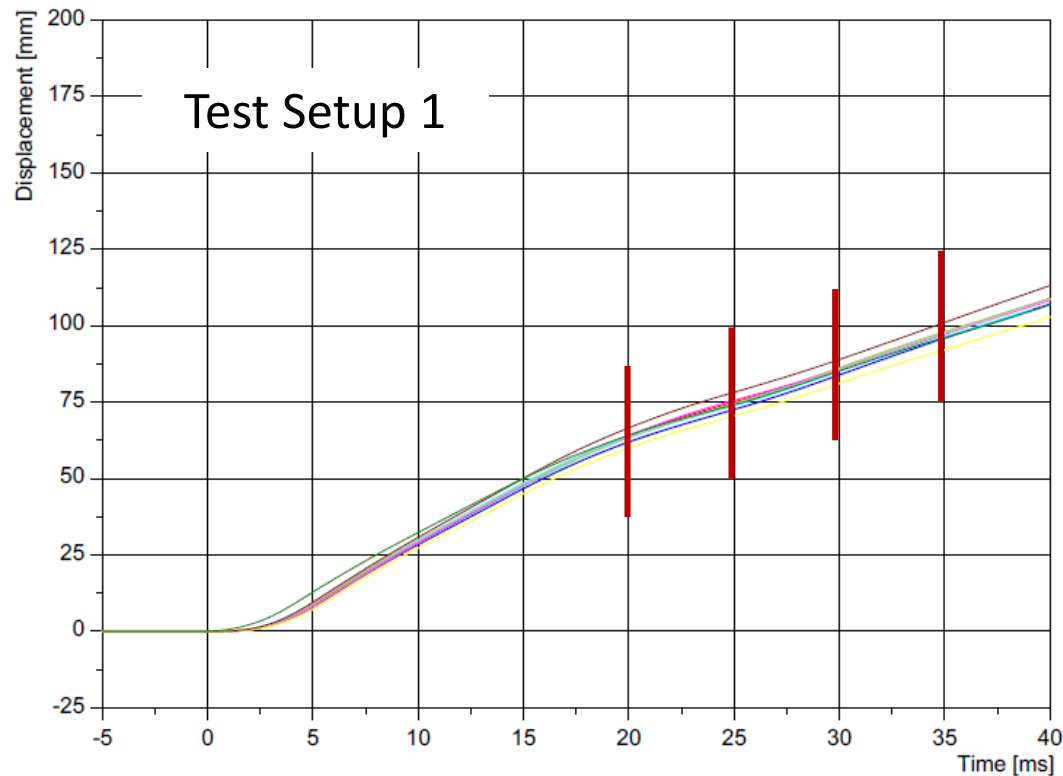


Test Setup 2 „Tibia“ (- 64 mm)

- Impactor No.: 1
- Impactor No.: 2
- Impactor No.: 3
- Impactor No.: 4
- Impactor No.: 5
- Impactor No.: 6
- Impactor No.: 7
- Impactor No.: 8
- Impactor No.: 9
- Impactor No.: 10

Evaluation

- Determination of coefficient of variation (CV) for the double integral of the acceleration at four relevant points in time: 20 ms, 25 ms, 30 ms and 35 ms



Evaluation

Setup 1

Setup 2

Test Type and Timing	Knee - 20	Knee - 25	Knee - 30	Knee - 35	Tibia - 20	Tibia - 25	Tibia - 30	Tibia - 35
Reading (Displacement)	mm	mm	mm	mm	mm	mm	mm	mm
MV	63,4	74,3	85,3	96,9	56,4	72,4	87,7	100,4
Median	63,6	74,3	85,6	97,2	54,9	70,3	85,5	98,6
Range	6,5	7,7	7,8	8,9	8,4	10,8	13,8	17,9
Min	60,0	70,5	81,2	92,2	52,7	67,6	81,1	91,5
Max	66,5	78,2	88,9	101,1	61,2	78,4	94,9	109,4
SD	1,8	2,1	2,1	2,3	3,3	4,2	5,1	6,2
CV [%]	2,8	2,8	2,4	2,4	5,8	5,7	5,8	6,2
Max. Deviation from MV [%]	5,4	5,3	4,9	4,9	8,4	8,3	8,3	8,9
Max. Deviation from Median [%]	5,7	5,3	5,2	5,1	11,5	11,5	11,0	11,0

- Green: Good
- Yellow: Acceptable

Evaluation

General Observations

- Overall repeatability good or acceptable
- Higher repeatability of displacement in knee tests (setup 1)
- Higher ranges in tibia tests (setup 2)
- Highest deviations from mean values and median in tibia tests

Summary

- All impactors passed successfully the inverse certification test before and after the 25 km/h tests.
- The performed pendulum certification tests were also successful.
- Two inverse tests with 25 km/h were carried out with each of the ten different Flex PLIs: The first at standard impact height (knee), the second 64 mm lower (tibia).
- The coefficient of variation (CV) was between 2.4 and 2.8 in the knee test (setup 1) and between 5.7 and 6.2 in the tibia test (setup 2) at all evaluated points in time.
- Thus, the repeatability was good or acceptable at all relevant points in time.

Conclusion

- It could be shown that the double integral of the filtered impactor acceleration signal, representing the displacement, was within a small range of intrusion with satisfactory coefficients of variation.
- The FlexPLI seems to be an appropriate pedestrian surrogate to be used as sensing impactor and the sensing verification of a deployable pedestrian protection system.
- Nevertheless, as the Flex PLI can only represent a limited range of typical load cases, it remains the due care of the car manufacturer that the active device of passive pedestrian safety acts as intended in the event of a collision with a pedestrian for a variation of pedestrian statures. This fact will be addressed by corresponding wordings of GTR9 and UN-R127.

Thank you

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