

**Examination of the
handling and the repeatability of tests
with the Flexible Pedestrian Legform Impactor (G-Level)**

**1st Meeting of the Flex-PLI Technical Evaluation Group
Paris September 5th - 6th, 2005**

Bernd Lorenz, Oliver Zander

**Federal Highway Research Institute (BAST)
Section Passive Vehicle Safety, Biomechanics**

- FlexPLI (G-level) prototype no. 1 at BASt
- First test series in Europe
- Tests performed in week 34-35

Concept for initial planned test programme:

- comparison tests on „pedestrian friendly“ cars according to Euro NCAP results (EEVC limits)
- investigation of calibration procedure, handling, durability, repeatability and reproducibility

Cars tested by Euro NCAP

Mercedes A-Class



Green rated lower leg test area

L1a(a): -141,5 g / -3,4 mm / 8,6 °
L1b: -132,4 g / -3,1 mm / 8,6 °
L2a: -113,0 g / -2,7 mm / 11,5 °
L3b: -143,0 g / -3,7 mm / 8,4 °

VW Golf V

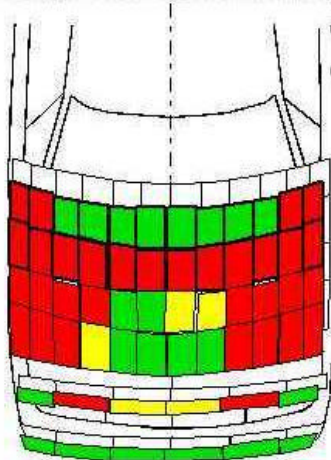


Borderline to green bumper area

L1b: -136,5 g / -2,4 mm / 15,7 °
L2a: -123,3 g / 2,9 mm / 13,1 °
L2b(b): -135,6 g / 2,7 mm / 13,4 °

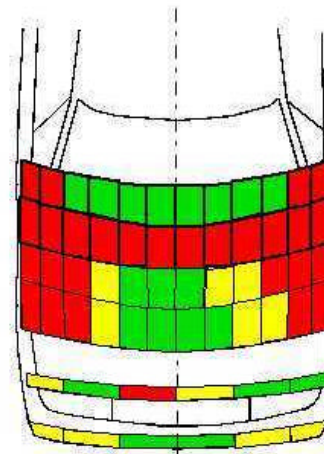
Mercedes A-Class

Adult Headform assessment (sum)	4,00
Child Headform assessment (sum)	3,98
Upper Legform assessment (sum)	2,55
Legform assessment (Sum)	6,00
OVERALL PEDESTRIAN	16,52
ROUNDED OVERALL PEDESTRIAN	17
PEDESTRIAN PROTECTION STAR RATING	2

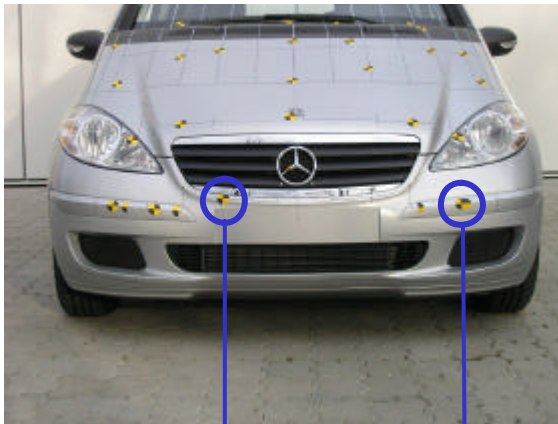


VW Golf V

Adult Headform assessment (sum)	4,00
Child Headform assessment (sum)	4,93
Upper Legform assessment (sum)	4,46
Legform assessment (Sum)	5,44
TOTAL PEDESTRIAN	18,83
ROUNDED TOTAL SCORE	19,00
STAR RATING	3,00

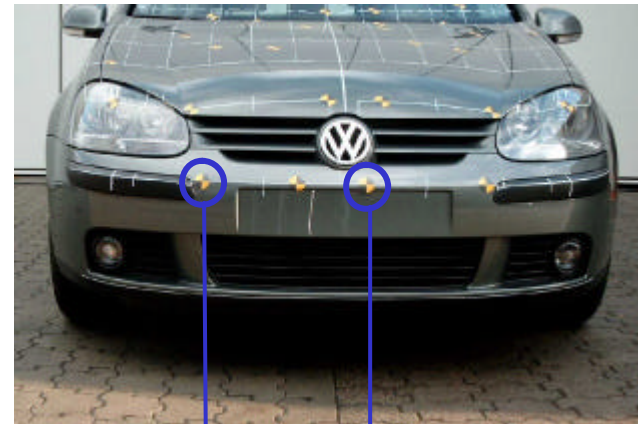


Mercedes A-Class



- L2a: 3 tests
(left end of number plate area)
- L3b: 3 tests
(left part of headlamp area)

VW Golf V



- L1b: 3 tests
(bumper vertical bracing rib)
- L2b: 3 tests
(manufacturer's emblem)

Overview test programme Flex-G (planned)



1-2 tests with reduced impact speed on each vehicle

Dynamic certification before each test

Mercedes A-Class

3 tests L2a (left end of number plate area)

3 tests L3b (left part of headlamp area)

= 6 tests ($v = 40$ km/h) in total

VW Golf - V

3 tests L1b (bumper vertical bracing rib)

3 tests L2b (manufacturer's emblem)

= 6 tests ($v = 40$ km/h) in total



Rectangular cross section

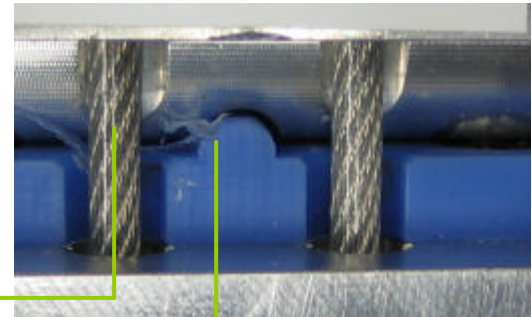
Plastic pads in knee joint

Cylindrical shaped plastic pads at the front

Limitation of flexion in impact direction

Steel cable for limitation of flexion

Wear of knee pads



Certification procedure



Test programme Flex-G (performed)

Mercedes A-Class (series-production)



L1a - symmetrical identical
point to L3b
(left part of headlamp area)

$v = 24 \text{ km/h}$

VW Golf V (series-production)



L2b

(manufacturer's emblem)

$v = 24 \text{ km/h}$

Mercedes A-Class (series-production)



L1a - symmetrical identical
point to L3b
(left part of headlamp area)

$v = 24 \text{ km/h}$

VW Golf V (series-production)



L2b

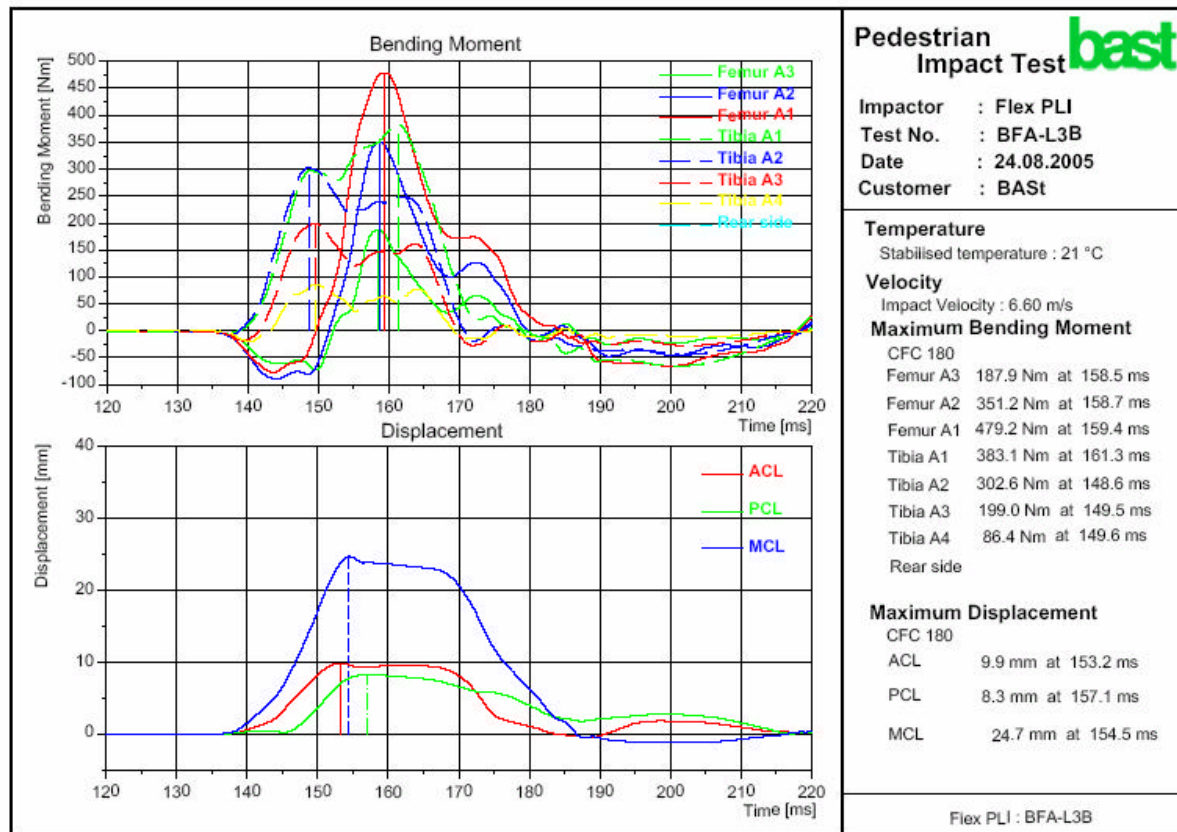
(manufacturer's emblem)

$v = 24 \text{ km/h}$

Test programme Flex-G (performed)



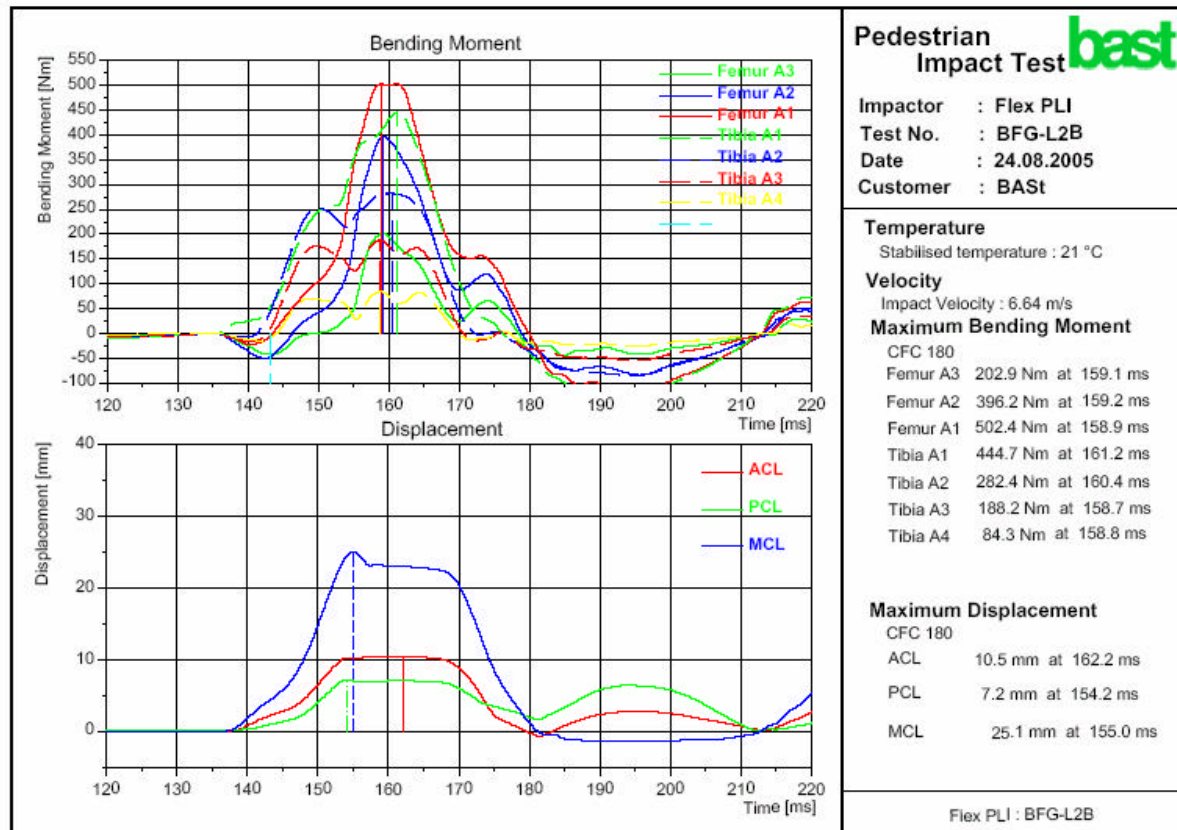
Mercedes A-Class (series-production) $v = 24 \text{ km/h}$



Test programme Flex-G (performed)



VW Golf V (series-production) v = 24 km/h



Test programme Flex-G (performed)

Mercedes A-Class
(modified)



likely to be softest impact point

$v = 30...40 \text{ km/h}$

VW Golf V
(modified)



L2b
(manufacturer's emblem)

$v = 24...40 \text{ km/h}$

Test programme Flex-G (performed)



Mercedes A-Class (modified)



likely to be softest impact point

$v = 30...40 \text{ km/h}$

VW Golf V (modified)



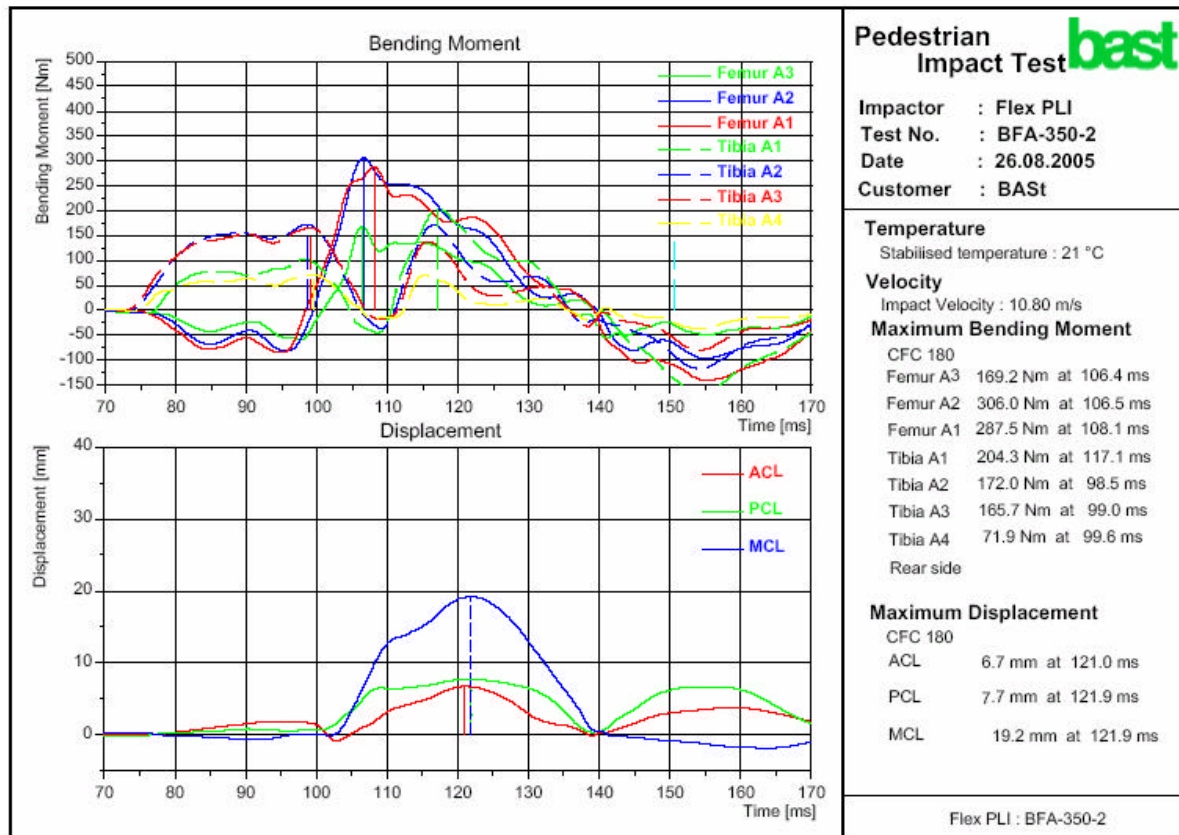
L2b
(manufacturer's emblem)

$v = 24...40 \text{ km/h}$

Test programme Flex-G (performed)



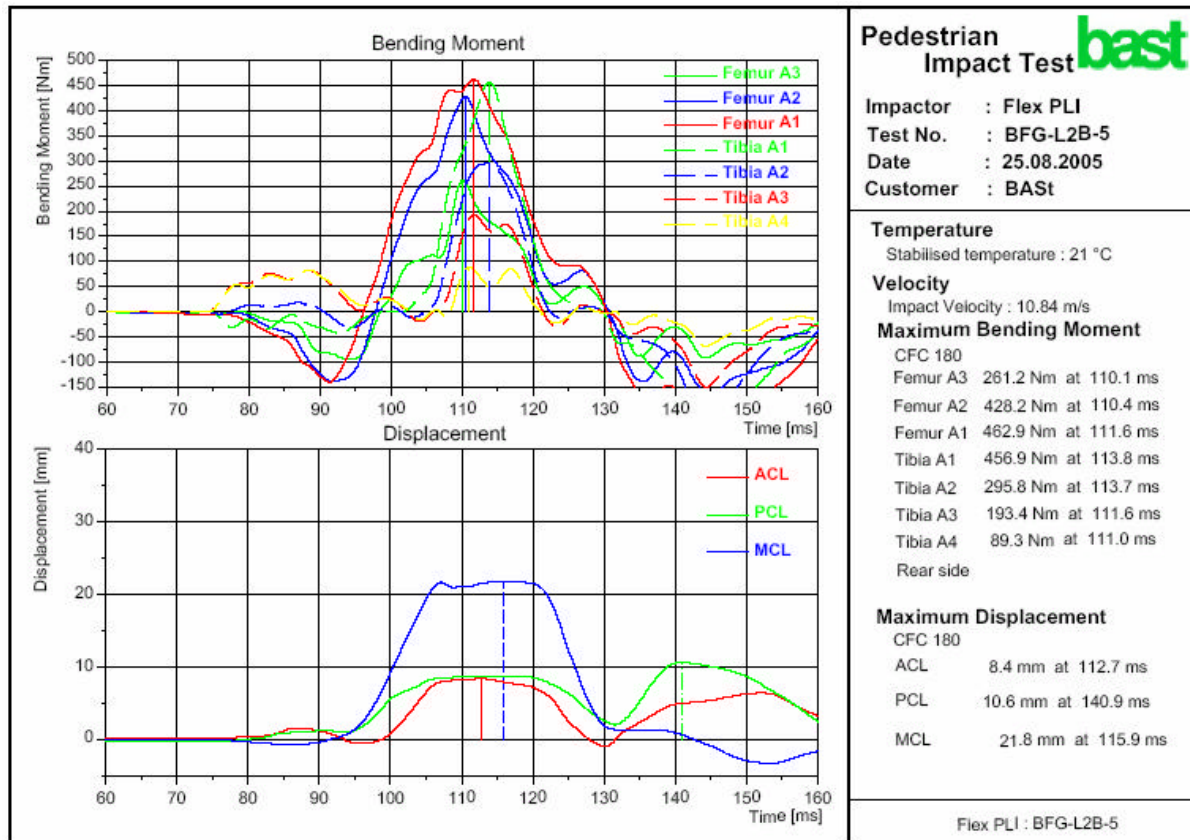
Mercedes A-Class (modified) $v = 40 \text{ km/h}$



Test programme Flex-G (performed)



VW Golf V (modified)
v = 40 km/h



Overview test programme Flex-G (performed)



Visual check of impactor after each test

Dynamic certification test (if necessary)

Mercedes A-Class

1 test L3b (left part of headlamp area)
4 tests (likely to be softest impact point)

note:

impact point L2a likely to be too hard

VW Golf - V

7 tests L2b (manufacturer's emblem)

note:

impact point L1b likely to be too hard

Test matrix Flex-G (performed)



Test	Impactor	Vehicle	Vehicle front assembly	Impact location y [mm]	Impact height [mm]	v [m/s]
<i>BFA-L3B</i>	<i>Flex G</i>	<i>A-Class</i>	<i>Series-production</i>	530	0,00	6,60
<i>BFG-L2B</i>	<i>Flex G</i>	<i>VW Golf</i>	<i>Series-production</i>	51	0,00	6,64
BFG-L2B-1	Flex G	VW Golf	Modification #1	51	0,00	6,64
BFG-L2B-2	Flex G	VW Golf	Modification #2	51	50,00	6,64
BFG-L2B-3	Flex G	VW Golf	Modification #2	51	50,00	8,16
BFG-L2B-4	Flex G	VW Golf	Modification #2	51	50,00	9,44
BFG-L2B-5	Flex G	VW Golf	Modification #2	51	50,00	10,84
BFG-L2B-6	Flex G	VW Golf	Modification #2	51	50,00	9,51
BFA-350-1	Flex G	A-Class	Modification #2	350	50,00	8,32
BFA-350-2	Flex G	A-Class	Modification #2	350	50,00	10,80
BFA-350-3	Flex G	A-Class	Modification #2	350	50,00	10,88
BFA-350-4	Flex G	A-Class	Modification #2	350	50,00	10,88

Modification #1: bumper padding removed

Modification #2: bumper padding removed,
padding (100 mm Golf, 150 mm A-Class) at lower outer contour
of bumper

Impact height 50 mm for reasons of compatibility with structure of the car

 : tests at 40 km/h

Test programme TRL PLI (performed)

**Mercedes A-Class
(series-production)**



likely to be softest impact point

$v = 40 \text{ km/h}$

**VW Golf V
(series-production)**



manufacturer's emblem

$v = 40 \text{ km/h}$

Test programme TRL PLI (performed)

**Mercedes A-Class
(modified)**



likely to be softest impact point

$v = 40 \text{ km/h}$

**VW Golf V
(modified)**



manufacturer's emblem

$v = 40 \text{ km/h}$

Dynamic certification test

Visual check of impactor before and after each test

Mercedes A-Class

2 tests

(likely to be softest impact point)

VW Golf V

2 tests

(manufacturer's emblem)

Test	Impactor	Vehicle	Vehicle front assembly	Impact location y [mm]	Impact height [mm]	v [m/s]
BFA-350-5	TRL	A-Class	Modification #2	350	50,00	11,05
BFA-350-6	TRL	A-Class	Series-production	350	0,00	11,12
BFG-L2B-7	TRL	VW Golf	Modification #2	51	50,00	11,07
BFG-L2B-8	TRL	VW Golf	Series-production	51	0,00	11,04

Modification #2: bumper padding removed,
padding (100 mm Golf, 150 mm A-Class) at lower outer
contour of bumper

Impact height 50 mm due to comparability with previous tests (Flex-G)

Comparison Flex-G - TRL PLI



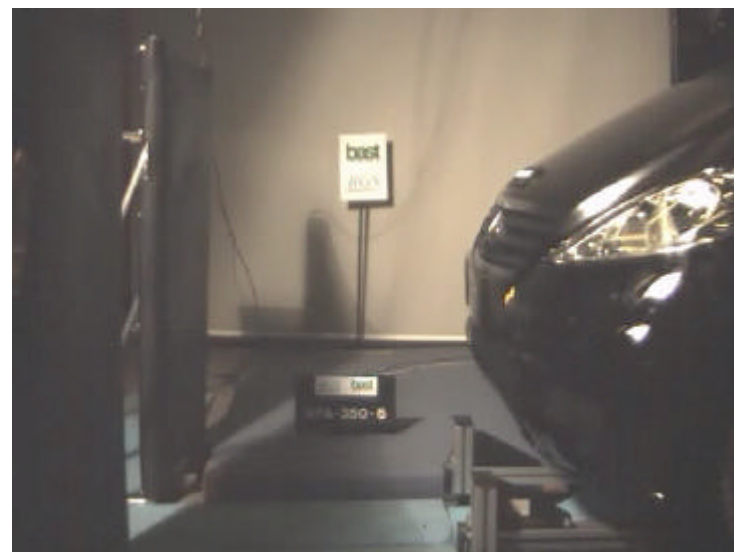
Flex-G

(A-Class series-production, 24 km/h)

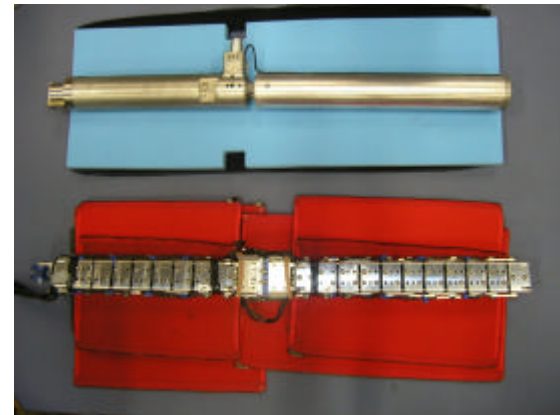
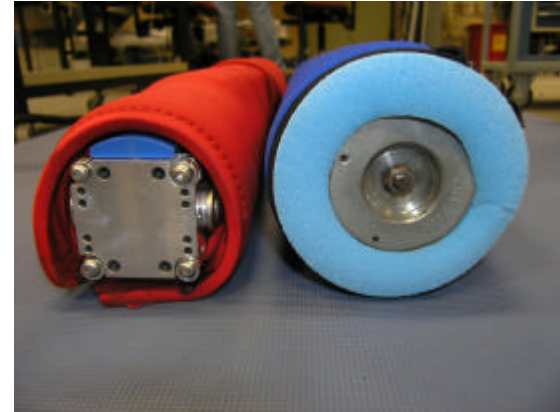


TRL

(A-Class series-production, 40 km/h)



Comparison Flex-G - TRL PLI



A-Class

- impact point **L2a** not performed (likely to be too hard)
- therefore, **y = 350** tested with modifications (40 km/h)
- repeatability (**y = 350**) seems to be acceptable (tests with 40 km/h, modifications)
- impact point **L3b** tested only with reduced impact speed (24 km/h, series-production)

VW Golf

- impact point **L1b** not performed (likely to be too hard)
- impact point **L2b** tested in different variations
(different impact speeds, with / without modifications)
- repeatability (**L2b**) seems to be acceptable (tests with 35 km/h, modifications)

- ⇒ Good handling
- ⇒ Easy certification procedure of Flex-G
- ⇒ No certification of skin (Neopren)
- ⇒ Usability of certification procedure requires revision
- ⇒ Current/proposed calibration procedure for strain gauges influenced by mechanical aspects ==> needs to be re-defined
- ⇒ Calibration of sensors and bones currently not adressed
- ⇒ No torque moment defined for the screws at the bars at the side of the impactor
- ⇒ No expendables (ligaments, foam) necessary
- ⇒ Mechanical wear (knee pads)
- ⇒ Durability ? (knee bands etc.)

- ⇒ Flex-G seems to be less sensitive for environmental influence (no Confor-foam necessary) ==> further research needed
- ⇒ The tested “pedestrian friendly” cars (according to Euro-NCAP, TRL-PLI) can marginally meet the Flex-G proposed protection criteria at a speed of 25 km/h
- ⇒ Modified cars allowed first information about the repeatability of test results
- ⇒ Good test results with Flex-G on modified cars were confirmed by tests with the TRL PLI (impact height 50 mm)
- ⇒ Pedestrian friendly bumper according to Euro NCAP / EEVC WG 17 could be too hard to be tested with Flex-G without modifications at an impact speed of 40 km/h

Further research / additional tests needed

Tests on other (pedestrian-friendly) vehicles with different front shapes and structures (SUV, Roadster)

Further tests needed to determine durability of the Flex-G and the repeatability of test results

Tests with additional Flex-G impactors in order to examine the reproducibility of test results

