

# **Legform Tests – Results from Round 1, EEVC legform**

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Senior Researcher – 11 September 2013



### **Legform tests**

### Objectives

1

- Assess pedestrian protection levels across vehicle front
  - Could support justification for need to change bumper corner
  - Provide supporting information for the benefit estimate (i.e. predicted risk of injury around bumper corners)

2

- Determine practicality of extending bumper test area
  - Does impactor slide off vehicle giving very low values?
  - Does impactor rotate so as to invalidate measurements?



#### Legform

Purpose of tests outside of current bumper corner

1

 Show the extent of any pedestrian protection degradation outside of the current test area 2

 Determine whether an alternative corner definition and test area is likely to encapsulate any particular points with a low level of pedestrian protection 3

 Help understand if proposed changes to the corner definition angle might push the use of the legforms beyond an incident angle limit where meaningful performance criteria measurements can no longer be obtained



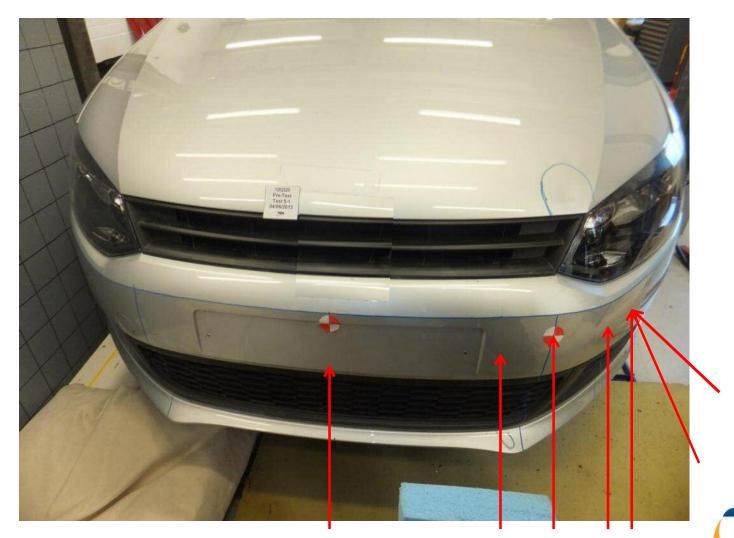
### **Legform tests – Round 1 (= EEVC legform)**

Described from middle to outside

- 1 Centre of bumper
- 2 60 degree minus legform radius (current test extreme)
- 3 60 degree, no radius allowance (30 degrees incident angle)
- 4 Edge of underlying bumper beam (Euro NCAP extreme)
- 5 45 degrees
- 6 45 degrees car rotated through 15 (30 degrees incident)
- 7 45 degrees car rotated through 30 (15 degrees incident)



Alignment on Vehicle 1

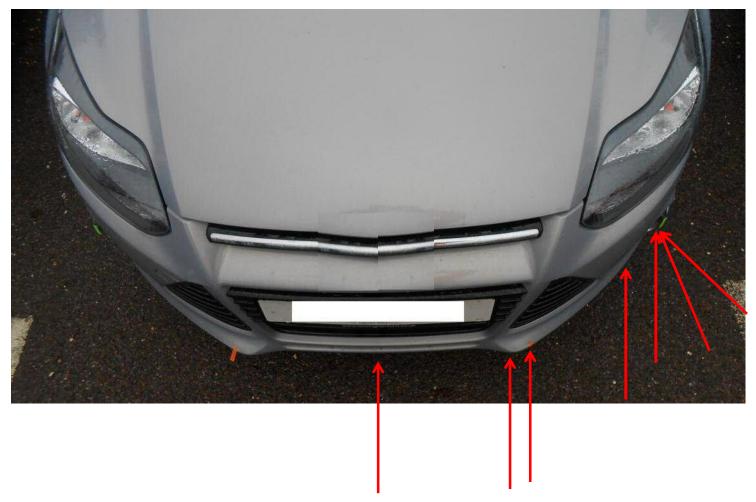


Alignment on Vehicle 2





Alignment on Vehicle 3





Need to reduce speed with rotated car

#### 45 degree point, 15 degree car

- Keep normal speed consistent with original
- V = 9.1 m/s

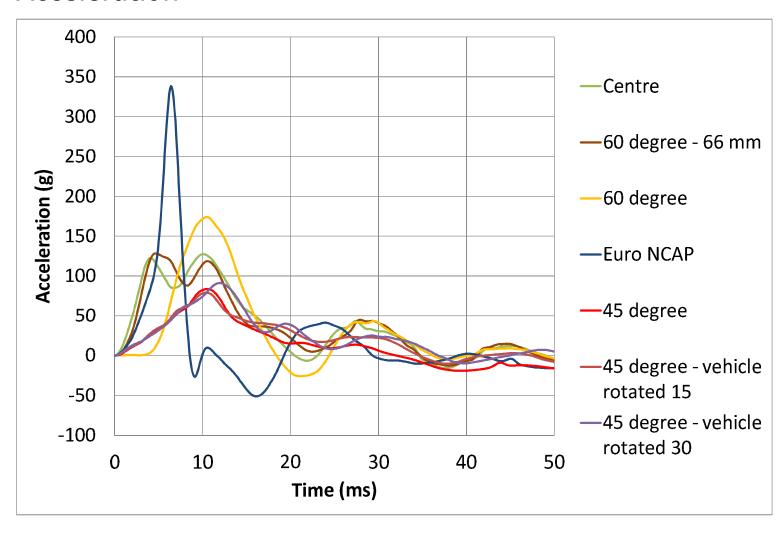
#### 45 degree point, 30 degree car

- Keep normal speed consistent with original
- V = 8.1 m/s

Based on geometry – not empirical data

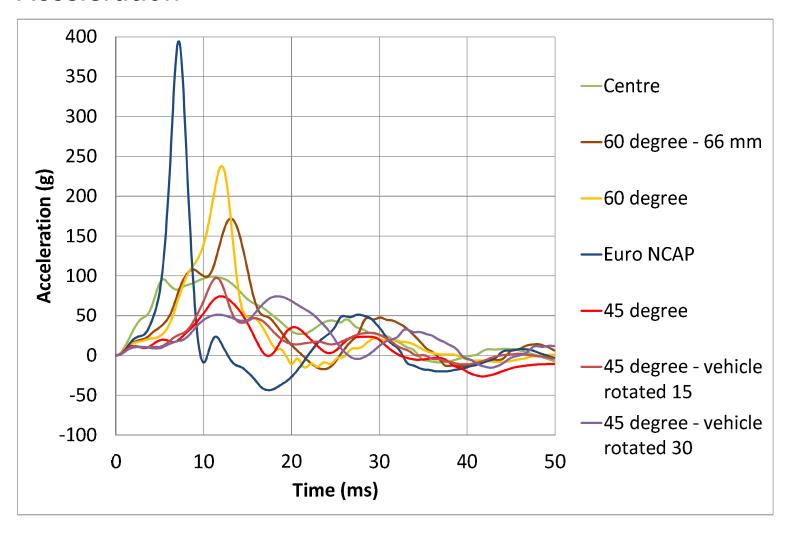


#### Acceleration



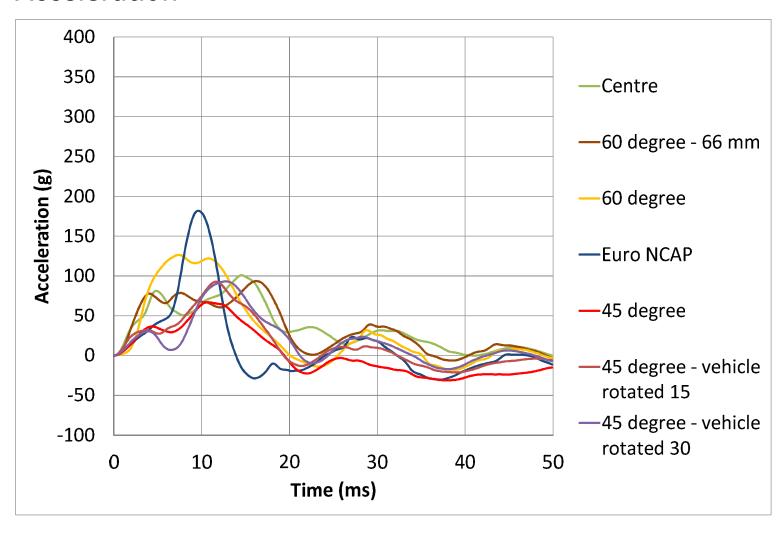


#### Acceleration



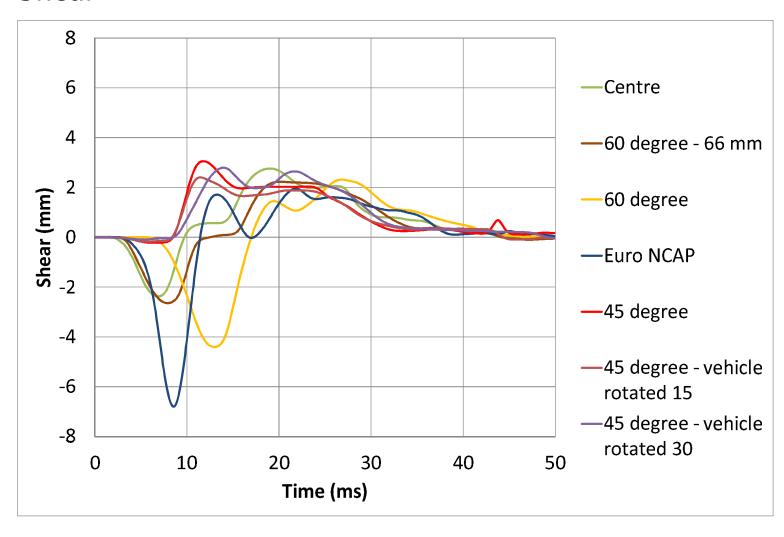


#### Acceleration



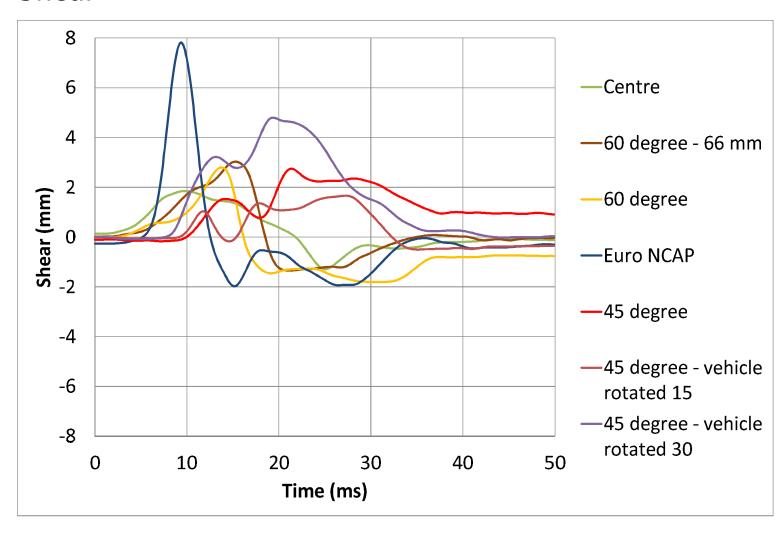


#### Shear



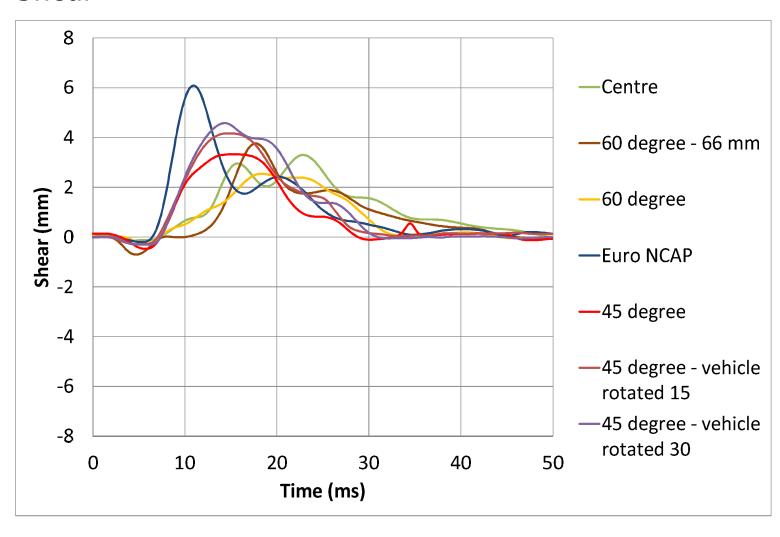


#### Shear



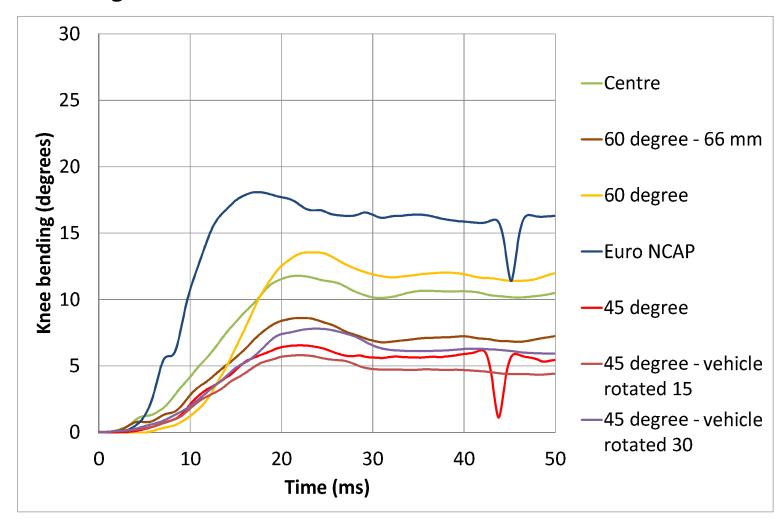


#### Shear



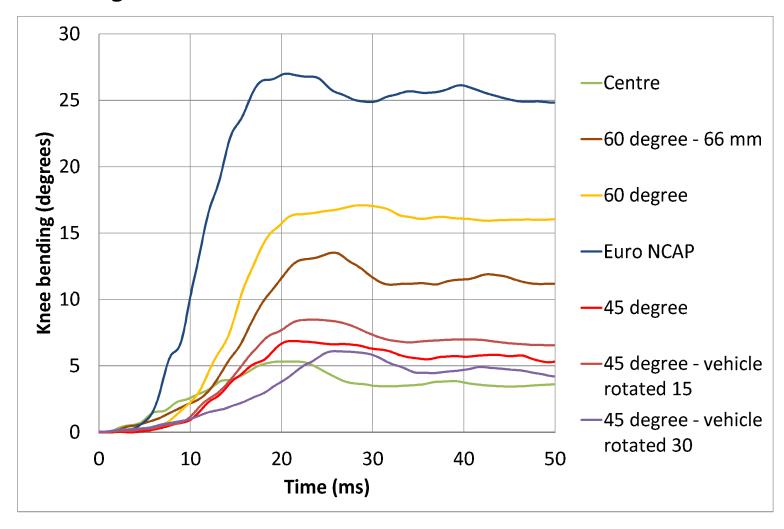


### Bending



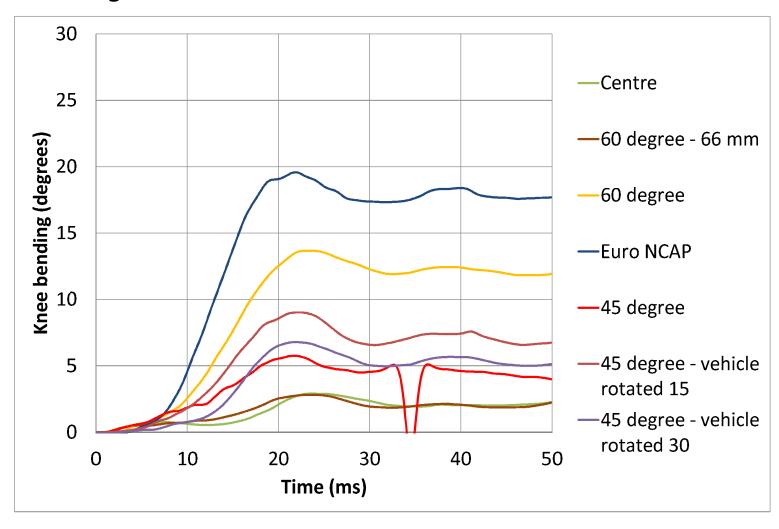


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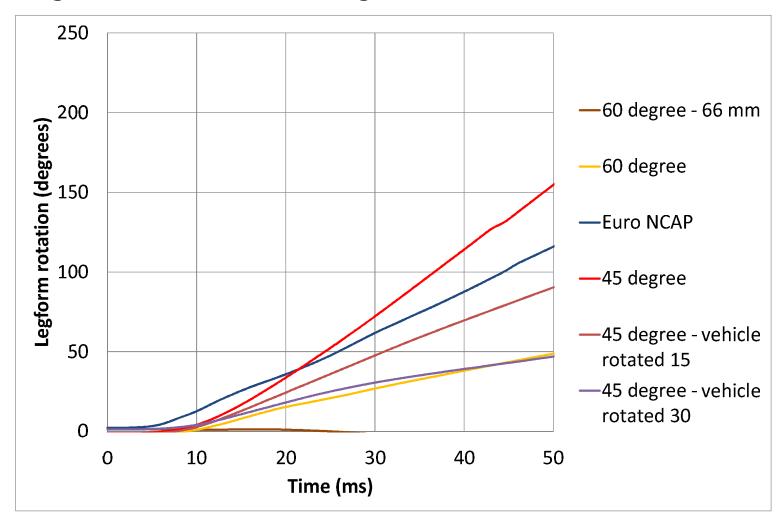


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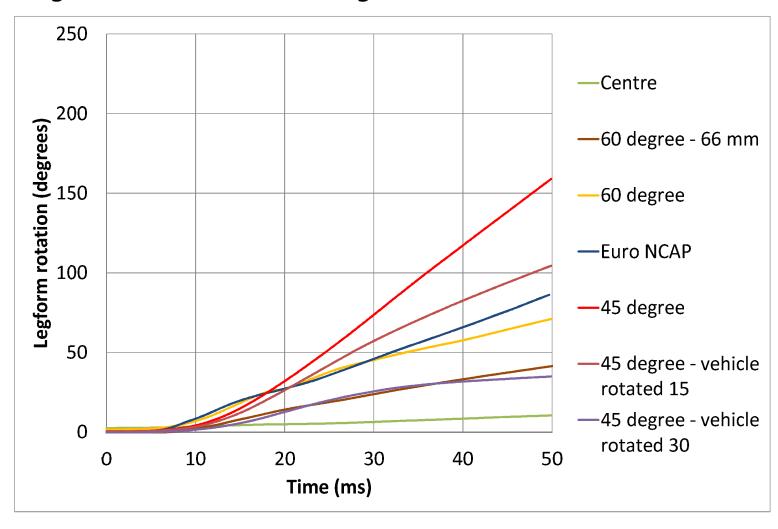


#### Angle of rotation – via angular rate sensor



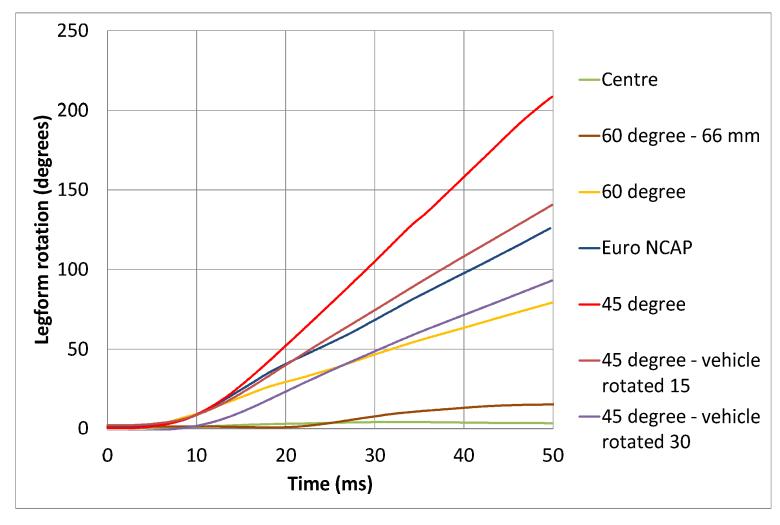


#### Angle of rotation – via angular rate sensor



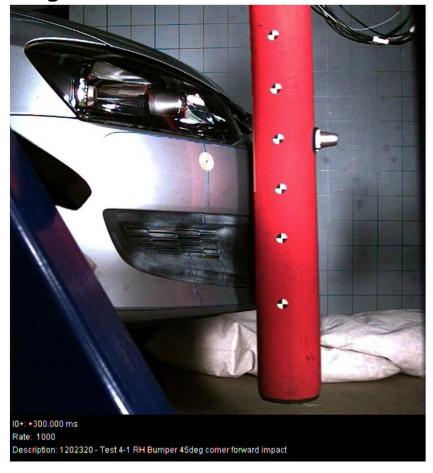


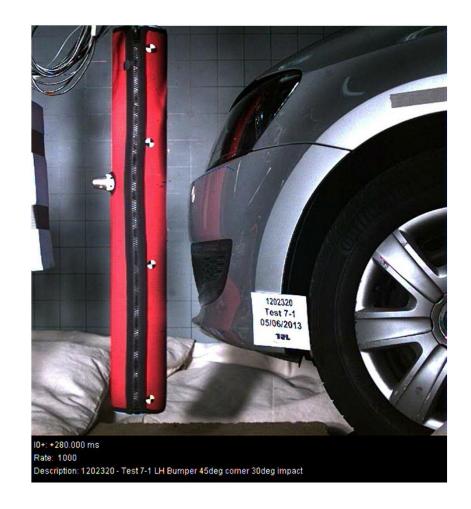
Angle of rotation – via angular rate sensor





## Angle of rotation – visual

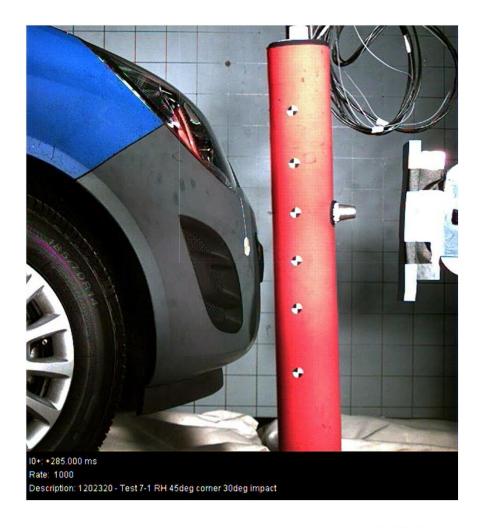






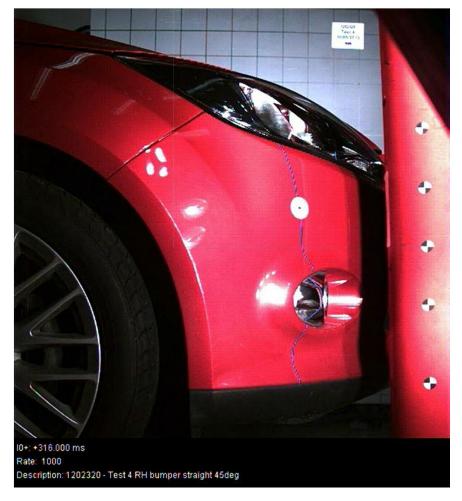
### Angle of rotation – visual

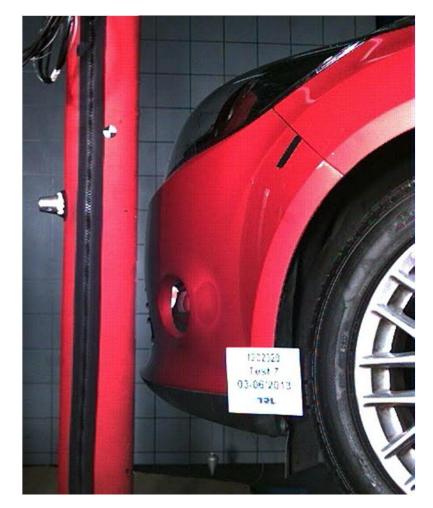






### Angle of rotation – visual







## **Legform measurement results**

Tables to follow...

Impact position	Acceleration	Shear	Bending
	Peak value		
	Rotation at peak		
	Peak value		
	Rotation at peak		
Moving from the centre out to 45 degrees			

**Vehicle 1** 

Description		Acceleration	Shear	Bending
Centre	Value	127.3 <i>g</i>	2.8 mm	11.8°
	Angle			
60 degrees – 66 mm	Value	128.3 <i>g</i>	-2.6 mm	8.6°
	Anlge	1.30	1.10	0.60
60 degrees	Value	174.1 <i>g</i>	-4.4 mm	13.6°
	Angle	1.50	4.80	18.80
Euro NCAP	Value	338.3 <i>g</i>	-6.8 mm	18.1°
	Angle	5.00	9.60	30.30
45 degrees - straight car	Value	83.7 <i>g</i>	3.1 mm	6.6°
	Angle	5.0°	7.80	41.00
45 degrees – 15 deg car	Value	79.1 <i>g</i>	2.4 mm	5.80
	Angle	3.30	5.10	29.00
45 degrees - 30 deg car	Value	91.1 <i>g</i>	2.8 mm	7.8°
	Angle	6.30	9.20	23.40

**Vehicle 1**Peak values and legform angle

Description		Acceleration	Shear	Bending
Centre	Value	127.3 <i>g</i>	2.8 mm	11.8°
	Angle			
Exceeding lower three	ochold i	aranasad for C	-2.6 mm	8.6°
exceeding lower time	esilolu į	Ji oposed for G	1.10	0.60
60 degrees	Value	174.1 <i>g</i>	-4.4 mm	13.6°
	Angle	1.50	4.80	18.8º
Euro NCAP	Value	338.3 <i>g</i>	-6.8 mm	18.1°
Exceeding th	reshold	S 5.0°	9.60	30.30
45 degrees - straight car	Value	83.7 <i>g</i>	3.1 mm	6.6°
	Angle	5.00	7.80	41.00
45 degrees – 15 deg car	Value	79.1 <i>g</i>	2.4 mm	5.8°
	Angle	3.30	5.10	29.00
45 degrees – 30 deg car	Value	91.1 <i>g</i>	2.8 mm	7.8°
	Angle	6.3°	9.20	23.40

**Vehicle 2** 

Description		Acceleration	Shear	Bending
Centre	Value	99.1 <i>g</i>	-1.8 mm	5.3°
	Angle	3.70	3.40	5.00
60 degrees – 66 mm	Value	172.0 <i>g</i>	-3.0 mm	13.5°
	Anlge	4.40	5.7°	10.10
60 degrees	Value	237 <b>.</b> 9 <i>g</i>	-2.8 mm	17.1°
	Angle	10.80	15.3°	43.70
Euro NCAP	Value	394.4 <i>g</i>	-7.8 mm	27.0°
	Angle	2.50	6.90	27.9°
45 degrees - straight car	Value	74.3 <i>g</i>	2.7 mm	6.9°
	Angle	7 <b>.</b> 5º	37.4°	36.6°
45 degrees – 15 deg car	Value	97.6 <i>g</i>	1.7 mm	8.5°
	Angle	5.20	49.30	37.0°
45 degrees - 30 deg car	Value	74.3 <i>g</i>	4.8 mm	6.1°
	Angle	10.20	11.70	21.10

Vehicle 2
Peak values and legform angle

Description		Acceleration	Shear	Bending
Centre	Value	99.1 a	-1.8 mm	5.3°
Exceeding lower thre	eshold p	proposed for GT	TR 3.4º	5.0°
60 degrees – 66 mm	Value	172.0 g	-3.0 mm	13.5°
	Anlge	4.40	5.70	10.10
60 degrees	Value	237.9 <i>g</i>	-2.8 mm	17.1°
	Angle	10.00	15.3	43.70
Euro NCAP	Value	394.4 <i>g</i>	-7.8 mm	27.09
Exceeding th	recholds	2.50	6.90	27.90
45 degree LXCEEding th		74.3 <i>g</i>	2.7 mm	6.9°
	Angle	7.50	37.40	36.6°
45 degrees – 15 deg car	Value	97.6 <i>g</i>	<b>1.7</b> mm	8.5°
	Angle	5.20	49.30	37.00
45 degrees – 30 deg car	Value	74.3 <i>g</i>	4.8 mm	6.1°
	Angle	10.20	11.70	21.10

Vehicle 3

Description		Acceleration	Shear	Bending
Centre	Value	100.8 <i>g</i>	3.3 mm	2.90
	Angle	2.30	3.40	3.50
60 degrees – 66 mm	Value	93.5 <i>g</i>	3.8 mm	2.80
	Anlge	4.40	5.70	10.10
60 degrees	Value	126.4 <i>g</i>	2.5 mm	13.70
	Angle	5.10	26.70	34.40
Euro NCAP	Value	181.8 <i>g</i>	6.1 mm	19.60
	Angle	7.40	10.80	45.20
45 degrees - straight car	Value	67.0 <i>g</i>	3.3 mm	5.70
	Angle	11.00	28.70	61.50
45 degrees – 15 deg car	Value	92.8 <i>g</i>	4.2 mm	9.00
	Angle	12.30	21.30	48.20
45 degrees - 30 deg car	Value	93.0 <i>g</i>	4.6 mm	6.80
	Angle	5.90	8.90	28.10

**Vehicle 3**Peak values and legform angle

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Centre	Value	100.8 <i>g</i>	3.3 mm	2.90
	Angle	2.30	3.40	3.50
60 degrees – 66 mm	Value	93.5 <i>g</i>	3.8 mm	2.80
	Anlge	4.40	5.70	10.10
60 degrees	Value	126.4 <i>g</i>	2.5 mm	13.70
	Angle	5.10	26.70	34.40
Euro NCAP	Value	181.8 g	6.1 mm	19.6°
Exceeding threshold	s propo	osed for GTR	10.80	45.20
45 degrees - straight car	Value	67.0 <i>g</i>	3.3 mm	5.7°
	Angle	11.00	28.7º	61.5°
45 degrees – 15 deg car	Value	92.8 <i>g</i>	4.2 mm	9.00
	Angle	12.30	21.30	48.20
45 degrees - 30 deg car	Value	93.0 <i>g</i>	4.6 mm	6.8°
	Angle	5.9°	8.90	28.10

### Angle at peak value

#### **Tolerance**

- "At the time of first contact the impactor shall have the intended orientation about its vertical axis, for the correct operation of its knee joint, with a tolerance of ± 5°."
- 5° is unlikely to cause substantial error in linear measurements...

#### **Geometry**

- Cos 5 = 0.996
- Cos 10 = 0.985
- Cos 15 = 0.966
- Cos 20 = 0.940



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**Vehicle 2** 

Description		Acceleration	Shear	Bending
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	Angle	3.70	3.40	5.00
60 degrees – 66 mm	Value	172.0 <i>g</i>	-3.0 mm	13.5°
	Anlge	4.40	5.7°	10.10
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	Angle	5.1°	26.7°	34.4°
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	Angle	11.0°	28.7°	61.5°
45 degrees – 15 deg car	Value	92.8 <i>g</i>	4.2 mm	9.00
	Angle	12.3°	21.3°	48.2°
45 degrees – 30 deg car	Value	93.0 <i>q</i>	4.6 mm	6.8°
	Angle	<b>(5.9°)</b>	8.90	28.1°

**Vehicle 3** 

Description		Acceleration	Shear	Bending
Centre	Value	100.8 <i>g</i>	3.3 mm	2.90
	Angle	2.30	3.40	3.50
60 degrees – 66 mm	Value	93.5 <i>g</i>	3.8 mm	2.80
	Anlge	4.40	5.70	10.10
60 degrees	Value	126.4 <i>g</i>	2.5 mm	13.70
	Angle	5.10	26.7°	34.40
Euro NCAP	Value	181.8 <i>q</i>	6.1 mm	19.6°
	Angle	7.40	10.80	45.2°
45 degrees – straight car	Value	67.0 <i>g</i>	3.3 mm	5.70
	Angle	11.00	28.7°	61.5°
45 degrees – 15 deg car	Value	92.8 <i>q</i>	4.2 mm	9.00
	Angle	12.3°	21.3°	48.2°
45 degrees - 30 deg car	Value	93.0 <i>q</i>	4.6 mm	6.80
	Angle	5.90	8.90	28.1°

**Vehicle 3** 

Description		Acceleration	Shear	Bending
Centre	Value	100.8 <i>g</i>	3.3 mm	2.90
	Angle	2.30	3.40	3.50
60 degrees – 66 mm	Value	93.5 <i>g</i>	3.8 mm	2.80
	Anlge	4.40	5.70	10.10
60 degrees	Value	126.4 <i>g</i>	2.5 mm	13,70
	Angle	5.10	26.70	34.49
Euro NCAP	Value	181.8 <i>q</i>	6.1 mm	19.60
	Angle	7.40	10.80	45.20
45 degrees – straight car	Value	67.0 <i>g</i>	3.3 mm	5.70
	Angle	11.00	28.70	61.50
45 degrees – 15 deg car	Value	92.8 <i>q</i>	4.2 mm	9.00
	Angle	12.3°	21.30	48.2°
45 degrees - 30 deg car	Value	93.0 <i>q</i>	4.6 mm	6.80
	Angle	5.9°	8.90	28.10

### **Legform tests – Round 1**

Initial thoughts

# Some injurious points

 At the extreme of the Euro NCAP range



#### **Legform tests - Round 1**

#### Initial thoughts

#### Timing of peak

- The timing of peak values varies between the criteria
- Acceleration less susceptible to angular effects than bending

#### Value of peak

- Large incident angles creat large legform rotations at time of peak values in criteria
- When moving to the edges, a limit of incident angle (and test speed) may be necessary to generate measurements equivalent to centre of bumper tests



#### **Legform tests – Round 2**

#### Plan for forward tests

#### Investigating options

 Need to decide on tests for next phase

#### **Availability of legform**

- Humanetics have offered to provide a Flex-PLI
  - Other offers from test labs.
- Thank you!

#### **Next phase**

- Weeks 38 and 39
- Suggestions welcome!



#### **Legform tests – Round 2**

Scheme for tests with Flex-PLI

- Position along bumper to give 15 degree incident angle
- 2 Euro NCAP extreme position no vehicle rotation
- Euro NCAP extreme position vehicle rotated to remove oblique component
- 4 45 degree position with car rotated 15 degrees
- 5 45 degree position with car rotated 30 degrees



# Thank you... Questions?

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