


**Flex-GTR:
Comparison of Test Results from
Prototype and Series Production Legforms
- BAST / ACEA joint project, November 2010 -**

12th Meeting of the GRSP Flex PLI Technical Evaluation Group
Bergisch Gladbach, December 2nd, 2010

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Bundesanstalt für Straßenwesen
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Background information	 	
<ul style="list-style-type: none"> • At the 10th meeting of TEG in December 2009, the inverse certification corridors developed by BAST were agreed by the members of TEG (TEG-119, TEG-124 agenda item 7) • The certification corridors were based on test results with three prototype legs at two different test labs, taking into account three alternative honeycomb materials • The first series production legs issued showed a partly significantly different performance • The first series production legs could to a high extent not fulfill either the pendulum or the inverse certification corridors that had been previously agreed by TEG and therefore submitted by the expert from Japan to GRSP for voting at its 48th session from December 7th – 10th (ECE-TRANS-WP.29-GRSP-2010-37e) • Up to now, the exact reasons for the changed impactor output are not clear • Due to the lack of sufficient available data, BAST performed in a joint project with ACEA a first comparison between the prototypes and one series production leg 		
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Test setups		
<ul style="list-style-type: none">• The comparison consists of results from in total nine (inverse) test setups• The results of the first seven test setups have been used for the definition of the inverse certification corridors as described in TEG-119• With the 8th and 9th test setup a total of additional six inverse test results have been generated within an ACEA / BAST joint project with a series production leg and two different honeycomb materials according to ECE-TRANS-WP.29-GRSP-2010-37e• The series production leg has been previously checked in detail and potential errors and defects were eliminated• The tibia bending moment and knee elongation results of these 37 tests have been checked against the defined corridors and compared in terms of repeatability and range		
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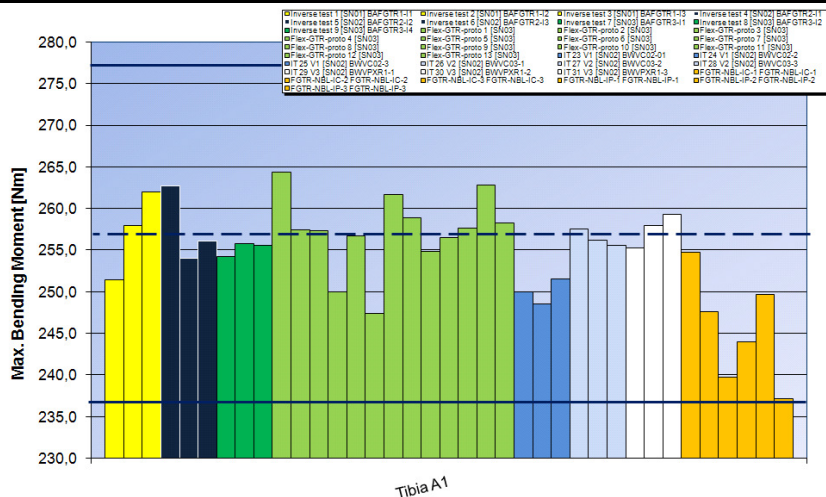
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Test results – Tibia A1 BM



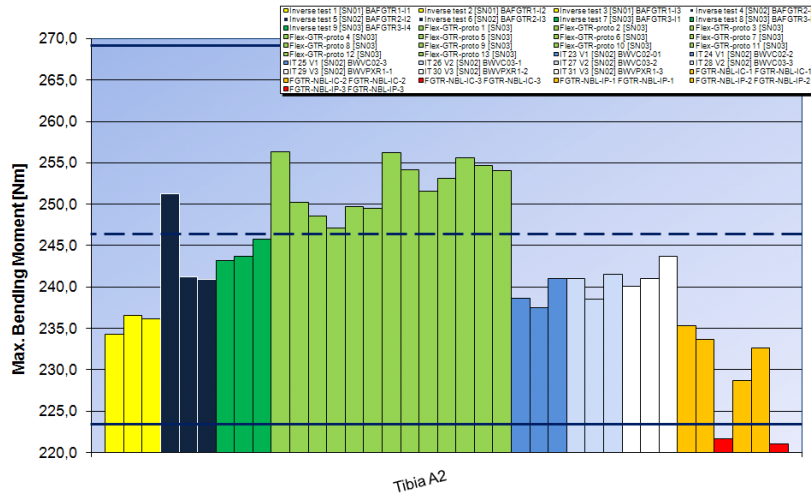
- All test results within certification corridor
- Test results of series production leg partly borderline
- Test results of series production leg with high scatter
- Tendentially lower output of the series production leg

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Test results – Tibia A2 BM



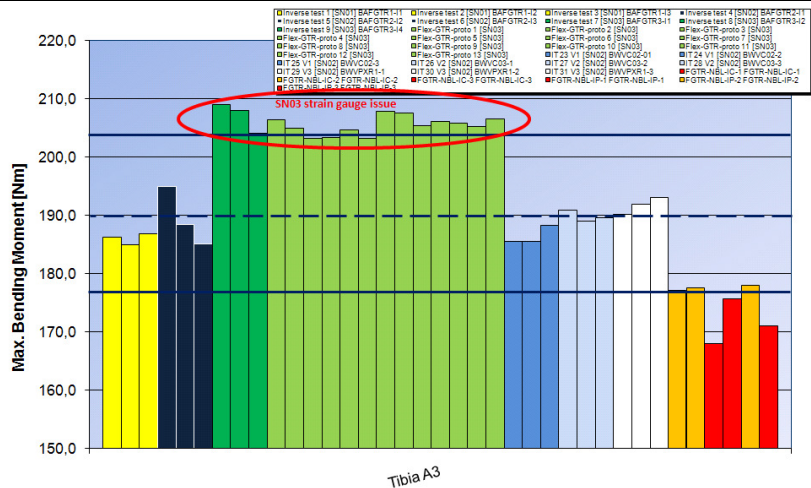
- Two test results of series production leg don't meet certification corridor
- Test results of series production leg with high scatter
- Lower output of the series production leg

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Test results – Tibia A3 BM



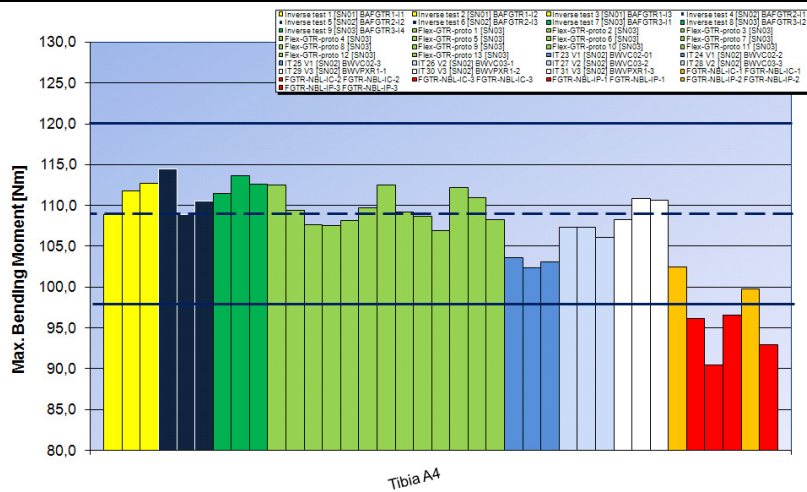
- Three test results of series production leg don't meet certification corridor
- Remaining three test results of series production leg borderline
- Significantly lower output of series production leg

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Test results – Tibia A4 BM



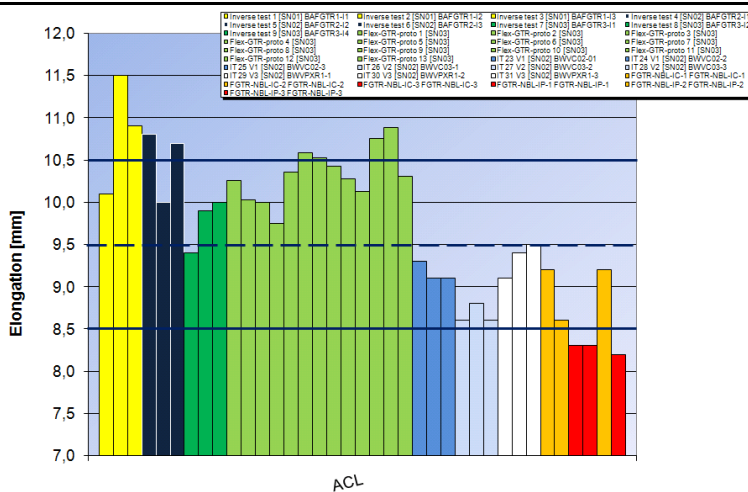
- Four test results of series production leg don't meet certification corridor
- Test results of series production leg with high scatter
- Significantly lower output of series production leg

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Test results – ACL EL



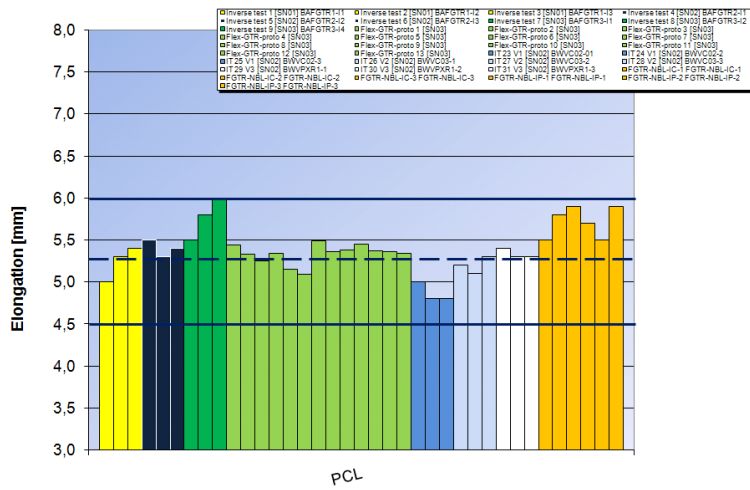
- Three test results of series production leg don't meet the corridor (50 %)
- From the prototype legs, the fail rate was 26 % only
- Test results of series production leg with high scatter
- Tendentially lower output of series production leg

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Test results – PCL EL



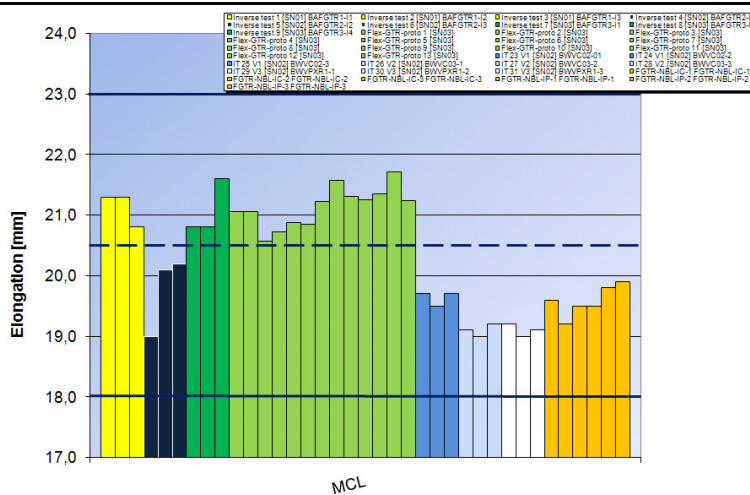
- All test results within certification corridor
- Test results of series production leg partly borderline
- Tendentially higher output of series production leg

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Test results – MCL EL



- All test results within certification corridor
- Test results of series production leg in line with previously observed results

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Coefficients of variation



Setup	Leg	Honeycomb material	TA1	TA2	TA3	TA4
1	SN01	1	2,08	0,51	0,52	1,79
2	SN02	1	1,76	2,42	2,63	2,59
3	SN03	1	0,34	0,56	1,27	0,93
4	SN03 (Lab 2)	1	1,81	1,24	0,75	1,79
5	SN02	1	0,60	0,75	0,87	0,59
6	SN02	2	0,38	0,67	0,52	0,65
7	SN02	3	0,79	0,78	0,74	1,29
8	Customer	1	3,03	3,23	3,08	6,23
9	Customer	3	2,59	2,60	2,04	3,58

Setup	Leg	Honeycomb material	ACL	PCL	MCL
1	SN01	1	6,48	3,98	1,37
2	SN02	1	4,15	1,85	3,37
3	SN03	1	3,29	4,36	2,19
4	SN03 (Lab 2)	1	3,05	2,13	1,55
5	SN02	1	1,26	2,37	0,59
6	SN02	2	1,33	1,92	0,52
7	SN02	3	2,23	1,08	0,52
8	Customer	1	5,27	3,63	1,07
9	Customer	3	6,43	3,51	1,05

- Repeatability of tibia segments within series production legs lower, but still acceptable
- Repeatability of ACL/PCL still acceptable

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Range [Nm], [mm]



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Setup	Leg	Honeycomb material	TA1	TA2	TA3	TA4
1	SN01	1	10,60	2,30	1,90	3,80
2	SN02	1	8,70	10,40	9,80	5,60
3	SN03	1	1,60	2,60	5,00	2,10
4 ^{*1)}	SN03 (Lab 2)	1	15,84	18,87	22,37	10,15
5	SN02	1	3,00	3,50	2,80	1,20
6	SN02	2	1,90	3,00	1,90	1,20
7	SN02	3	4,00	3,60	2,80	2,60
8	Customer	1	15,00	13,60	9,50	12,00
9	Customer	3	12,60	11,60	7,00	6,90

Setup	Leg	Honeycomb material	ACL	PCL	MCL
1	SN01	1	1,40	0,40	0,50
2	SN02	1	0,80	0,20	1,20
3	SN03	1	0,60	0,50	0,80
4 ^{*1)}	SN03 (Lab 2)	1	2,28	0,69	2,71
5	SN02	1	0,20	0,20	0,20
6	SN02	2	0,20	0,20	0,20
7	SN02	3	0,40	0,10	0,20
8	Customer	1	0,90	0,40	0,40
9	Customer	3	1,00	0,40	0,40

*1): 13 Tests

- Higher range of tibia results in series production legs
- High range of Test setup #4 presumably due to the higher number of tests
- ACL with the highest range in both, prototype and series production legs

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Conclusions



- A comparison between prototype and series production legs showed
 - a) a partly significantly different impactor output of the series production leg
 - b) a lower output for many segments of the series production leg
 - c) a partly higher scatter and range in test results generated by the series production leg
 - d) that the inverse certification corridors could not be met in many times
- Slight shifting of the corridors cannot be the solution. If at all, the corridors need to be modified/widened.
- The impactor should preferably be trimmed back to the old performance On which also the threshold values for type approval tests are based on.
- Anyway, if the changed impactor performance is accepted by the group, then the limits for type approval testing have to be re-discussed and modified as well
- However, for a final decision more test results are needed, if possible eliminating any lab-to-lab variability at that stage

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Thank you!

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