
	
<h2>Refinement of (tentative) Certification Corridors for the Dynamic Full Assembly (Inverse) Certification Test Procedure</h2>	
<p>9th Meeting of the GRSP Flex PLI Technical Evaluation Group Bergisch Gladbach, September 3rd - 4th, 2009</p>	
<p>Oliver Zander Bundesanstalt für Straßenwesen</p>	<p>Bundesanstalt für Straßenwesen <small>(Federal Highway Research Institute)</small></p>

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Dynamic full assembly (inverse) certification test

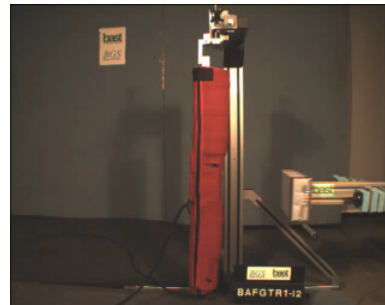
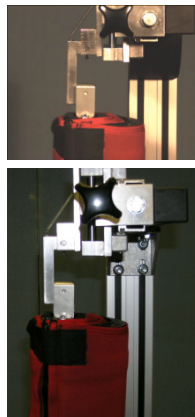
Inverse certification test results (Flex-GTR)

Development of certification corridor

Discussion / Decision

Dynamic full assembly certification test

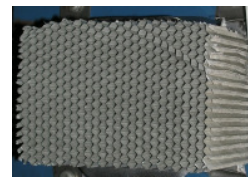
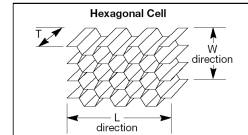
- Flex PLI (with flesh and skin) is impacted by the upper edge of a linearly guided Al honeycomb impactor at a previously defined impact speed
- Impact location: upper edge of the honeycomb in line with center of knee
- Measurement items – pass/fail parameters:
three string potentiometers (ACL, PCL, MCL), four strain gauges (tibia moments)



Dynamic full assembly certification test

- Test parameters:
 - Impact speed = 40 km/h
 - Mass of honeycomb impactor = 8,1 kg
 - Impact height: upper honeycomb edge in line with center of knee
- Test frequency: after every 20 tests or each year
- Aluminium honeycomb specifications:

Specification	Data
Cell size	3/16
Alloy	5052
Foil gauge	.001
Density	3.1
Crush strength	75 PSI
Dimensions (L*W*T)	250 (200) * 160 * 60 mm



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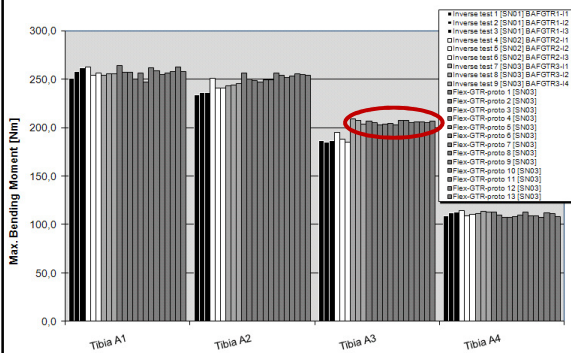
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Tibia test results (Flex-GTR)



- Dataset of TEG-094 has been amended by 13 inverse certification results with SN03 carried out by JARI in April, 2009

- It has to be kept in mind that SN03 still needs to be re-calibrated to obtain correct sensitivities on Tibia A3

Tibia mean values and coefficients of variation (22 inverse test results, thereof 3*SN01, 3*SN02 and 16*SN03):

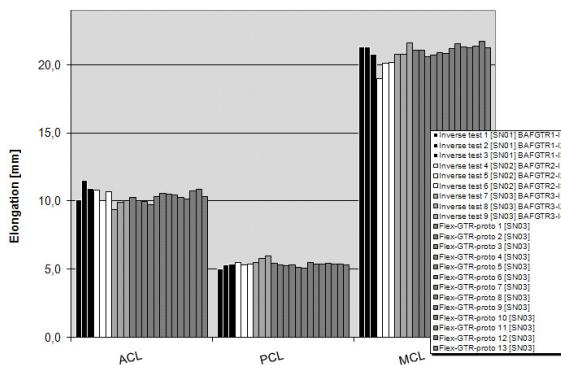
Segment	Tibia A1	Tibia A2	Tibia A3	Tibia A4
MV	256.98	247.90	200.78	110.39
CV [%]	1,64	2,75	4,25	1,99

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Ligament test results (Flex-GTR)



- Dataset of TEG-094 has been amended by 13 inverse certification results with SN03 carried out by JARI in April, 2009

Ligament mean values and coefficients of variation (22 inverse test results, thereof 3*SN01, 3*SN02 and 16*SN03):

Segment	ACL	PCL	MCL
MV	10.34	5.39	20.94
CV [%]	4,50	3,90	2,87

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Dynamic full assembly (inverse) certification test
 Inverse certification tibia test results (Flex-GTR)
Development of certification corridors
 Discussion / Decision

Development of certification corridors

Tibia sections:

Peak Bending Moments [Nm]	Tibia A1	Tibia A2	Tibia A3	Tibia A4
Max	264,3	256,4	209,0	114,5
Min	247,4	234,3	184,9	106,9
MV	257,0	247,9	200,8	110,4
max. Dev. from MV [%]	3,7	5,5	7,9	3,7
Upper Limit (Max*1,05)	277,6	269,2	219,5	120,2
Upper Limit TEG-094	276	264	220	120
Lower Limit (Min*0,95)	235,0	222,6	175,7	101,5
Lower Limit TEG-094	240	223	176	104

Corridors have been:

- widened up due to the extended test data that was taken into account
- in parts narrowed by rounding in a way such that the corridor is kept tight, as requested at the 8th TEG)

Knee elongations:

Peak Elongations [mm]	ACL	PCL	MCL
Max	11,5	6,0	21,7
Min	9,4	5,0	19,0
MV	10,3	5,4	20,9
max. Dev. from MV [%]	11,2	11,3	9,3
Upper Limit (Max*1,05)	12	6,5^{*)}	22,8
Upper Limit TEG-094	12	7	23
Lower Limit (Min*0,95)	9	4,5^{*)}	18,1
Lower Limit TEG-094	9	4	18

*1): Calculated and rounded values: 6 mm UL, 5 mm LL;
 Due to consistency with ACL range and for feasibility reasons
 corridor widened up from 1 mm to 2 mm

Dynamic full assembly (inverse) certification test
Inverse certification tibia test results (Flex-GTR)
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Discussion / Decision

- More test data leads to a refinement of certification corridors
- On the other hand, the amendment by 13 additional SN03 results signs responsible for an overweight of SN03 which does not mirror the real scatter / reproducibility of test results between the impactors
- Each impactor should preferably have the same weighting, i.e. the same number of test results of each impactor should contribute to the calculation of the certification corridors
- Therefore, the dataset should either
 - be reduced again to 3*3 tests (with impactor SN01, SN02 and SN03) as in TEG-094 (= BAST-Proposal) or
 - widened up by adding more tests with SN01 and SN02 accordingly or
 - widened up by tests with other SN
- Anyway, a re-certification of Tibia A3 of SN03 is still outstanding

Decision of the group ?

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