Transmitted by the expert from Japan

Informal document No. **GRSP-46-17/Rev.1**
(46th GRSP, 8 - 11 December 2009,
agenda item 4(a))

PROPOSAL FOR CORRIGENDUM TO PROPOSAL TO DEVELOP AMENDMENTS TO GLOBAL TECHNICAL REGULATION NO. 9 (PEDESTRIAN SAFETY) (ECE/TRANS/WP.29/GRSP/2009/21) BASED ON THE 10TH FLEX-TEG MEETING RESULTS

Note: The text reproduced below was prepared by the expert from Japan in order to propose a corrigendum to proposal to develop amendments to global technical regulation No. 9 (ECE/TRANS/WP.29/GRSP/2009/21) to reflect the 10th Flex-TEG meeting (1st-2nd December 2009) results. The modifications to the proposed amendments to global technical regulation No. 9 (ECE/TRANS/WP.29/GRSP/2009/21) are marked in bold or strikethrough characters.

A. PROPOSAL

Paragraph 110., amend to read:

"110… For these reasons, a bending limit of 19º for the EEVC WG17 pedestrian lower legform was selected for this gtr. As for the Flex-PLI, a limit of medial collateral ligament (MCL) elongation at the knee was set at ~~[~~22~~]~~ mm based on the agreement of the TEG from a biomechanical point of view (based on BASt correlation study and Japan Automobile Manufacturers Association (JAMA) biomechanical study)."

Paragraph 111., amend to read:

"111. With regard to knee shearing limits, …... As for the FlexPLI, a limit of anterior cruciate ligament (ACL) elongation and a limit of posterior cruciate ligament (PCL) elongation at the knee are both set as [(1) **[**13**]** mm only for monitoring purposes or nothing because the percentage of isolated ACL/PCL damage in car-pedestrian accidents is very small (3 per cent). Besides only two biomechanical data are available for the ACL/PCL threshold values (JAMA and ACEA opinion), or (2) 13 mm as mandatory threshold value because the current gtr 9 sets shearing displacement requirement for the EEVC WG17 pedestrian legform impactor and because of existing though limited biomechanical data (BASt opinion)]."

Paragraph 112., amend to read:

"112… To protect a higher proportion of the population at risk, the informal group recommends a maximum lateral tibia acceleration limit of 170g for the EEVC WG17 pedestrian lower legform impactor. As for the FlexPLI, the limit of tibia bending moment is set at ~~[~~340~~]~~ Nm based on the agreement of the TEG from a biomechanical point of view (based on BASt and JAMA biomechanical studies)."

Paragraph 113., amend to read:

"113. …at the following limits:

For EEVC WG 17 pedestrian lower legform impactor
Maximum lateral knee bending angle ≤ 19.0°;
Maximum lateral knee shearing displacement ≤ 6.0 mm;
Maximum lateral tibia acceleration ≤ 170g.

For FlexPLI
Maximum MCL elongation ≤ ~~[~~22~~]~~ mm;
Maximum Tibia bending moment ≤ ~~[~~340~~]~~ Nm;
[Maximum ACL and PCL elongation ≤ [13**]** mm only for monitoring purposes or nothing or mandatory]. "

Paragraph 113., amend to read:

"133. As for the introduction of the new lower legform impactor FlexPLI by each Contracting Party, the TEG provided the following recommendations:

(a) Some TEG members proposed that the period for using alternative impactors of EEVC WG 17 pedestrian lower legform impactor or FlexPLI should end 96 months after the date of entry into force in the respective national legislation for each contracting party.

(b) Some TEG members also propose that a vehicle model once certified using the EEVC WG 17 pedestrian legform impactor does not need to be re-certified using the FlexPLI.

~~(a) Effective date of the amendment [x] to the original version entry into force for each Contracting Party: from the date when this gtr is adopted by WP.29.~~

~~(b) The TEG also proposed that the period for using alternative impactors of EEVC WG 17 pedestrian lower legform impactor or FlexPLI should end [20XX] [[XX] months after the date of entry into force]~~

"

Section 11, amend to read:

"11. APPENDIX – REFERENCE DOCUMENTS USED BY THE WORKING GROUP
…

TEG-098	BASt_Prposale_Flex-GTR-proto_Tibia_Threshold
TEG-099	Evaluation_Test_Schedule_Flex-GTR-proto
TEG-100	DRAFT_Minutes_8th_Flex-TEG_Meeting_090812
TEG-100-Rev.1	**Final: 8th Flex-TEG Minutes**
TEG-101	**DRAFT: 9th Flex-TEG Agenda**
TEG-101-Rev.1	**Final: 9th Flex-TEG Agenda**

TEG-102	**Review of Dynamic Calibration Corridor Making Method**
TEG-103	**DRAFT: Status of Action Items**
TEG-103-Rev.1	**Final: Status of Action Items**
TEG-104	**Pushing surface Information for Flex-GTR-prototype for Flex-GTR-prototype**
TEG-105	**JAMA Round Robin Test Results Flex-GTR-prototype (SN03)**
TEG-106	**ACEA Comments, 9th TEG meeting**
TEG-107	**9th Flex-TEG Meeting** **Discussion Results of DAY 1**
TEG-108	**Refinement of (tentative) Certification Corridors for the Dynamic Full Assembly (Inverse) Certification Test Procedure**
TEG-109	**DRAFT: 9th Flex-TEG Minutes**
TEG-109-Rev.1	**Final: 9th Flex-TEG Minutes**
TEG-110	**DRAFT: 10th Flex-TEG Agenda**
TEG-110-Rev.1	**Final: 10th Flex-TEG Agenda**
TEG-111	**DRAFT: Status of Action Items**
TEG-111-Rev.1	**Final: Status of Action Items**
TEG-112	**Flex-GTR Testing, NHTSA**
TEG-113	**KATRI Round Robin Tests Using the Flex-GTR-Prototype (SN03)**
TEG-114	**ACEA Comments, 10th Flex-TEG Meeting**
TEG-115	**Influence of Test Parameter Variations on The Flex GTR Joint Project of ACEA and BASt**
TEG-116	**Impact Parameter Tolerances for Inverse Certification Test and Vehicle Testing, BASt**
TEG-117	**Minor updates and pusher plate discussion for Flex Pli GTR, FTSS**
TEG-118	**General Status from FLEX Pli GTR Model Consortium, FTSS**
TEG-119	**Finalization of Impact and Assessment Conditions for Inverse Certification Test, BASt**
TEG-120	**Requirement Corridor (BASt-Method) for Pendulum Type (Type 3) Dynamic Calibration Test Method, JAMA-JARI**
TEG-121	**Flex-GTR Flesh Dimensions and Mass Tolerance, JAMA-JARI with FTSS communications**
TEG-122	**Flex-GTR (Mass, COG, Inertia) Tolerances , JAMA-JARI with FTSS communications**
TEG-123	**SLICE Updates for FLEX-GTR, DTS**

"

Paragraph 5.1.1.2., amend to read:

"5.1.1.2. When tested in accordance with paragraph 7.1.2., the maximum dynamic medial collateral ligament elongation at the knee shall not exceed ~~[~~22~~]~~ mm, and the dynamic bending moments at the tibia shall not exceed ~~[~~340~~]~~ Nm. [The maximum dynamic anterior cruciate ligament and posterior cruciate ligament elongation shall be monitored with a reference value of **[**13**]** mm or nothing or mandatory with a reference value of 13 mm]. [In addition, the manufacturer may nominate bumper test widths up to a maximum of 264 mm in total where the tibia bending moment of the FlexPLI shall not exceed TBD Nm]."

Paragraph 6.3.1.2., amend to read:

"6.3.1.2. Flexible pedestrian lower legform impactor (FlexPLI):

The lower legform impactor shall consist of flesh, flexible long bone segments (representing femur and tibia), and a knee joint as shown in Figure 13.

The overall length of the impactor shall be 928 ± 3 mm, having a required mass of ~~[13.4] ± 0.4~~ **13.2 ± 0.7** kg including flesh. ……."

Paragraph 6.3.1.2.3., amend to read:

"6.3.1.2.3. The masses of the femur and tibia without flesh, including the connection part to the knee joint, shall be ~~2.47 ± 0.05~~ **2.46 ± 0.12** kg and ~~2.67 ± 0.05~~ **2.64 ± 0.13** kg respectively. The mass of the knee joint without flesh shall be ~~4.34 ± 0.1~~ **4.28 ± 0.21** kg. The total mass of the femur, knee joint, and tibia shall be ~~9.48 ± 0.2~~ **9.38 ± 0.47** kg.

The centre of gravity of the femur and tibia without flesh, including the connection part to the knee joint, shall be ~~[158] ± 3~~ **159 ± 8** mm and ~~[204] ± 3~~ **202 ± 10** mm respectively from the top, but not including the connection part to the knee joint, of each part as shown in Figure 13. The centre of gravity of the knee shall be ~~[92] ± 3~~ **92 ± 5** mm from the top of the knee joint as shown in Figure 13.

The moment of inertia of the femur and tibia without flesh, including the connection part inserted to the knee joint, about the X axis through the respective centre of gravity shall be ~~0.0331 ± 0.002~~ **0.0325 ± 0.0016** kgm² and ~~0.04685 ± 0.002~~ **0.0467 ± 0.0023** kgm² respectively. The moment of inertia of the knee joint about the X axis through the respective centre of gravity shall be ~~0.01818 ± 0.0015~~ **0.0180 ± 0.0009** kgm²."

Paragraph 6.3.1.2.4., amend to read:

"6.3.1.2.4. For each test, the impactor (femur, knee joint, and tibia) shall be covered by flesh composed of synthetic rubber sheets (R1, R2) and neoprene sheets (N1F, N2F, N1T, N2T, N3) as shown in Figure 15. The sheets are required to have a compression characteristic as shown in Figure 16. The compression characteristic shall be checked using the same batch of sheets as those used for the impactor flesh. The size ~~and weight~~ of the sheets shall be within the requirements described in Figure 16."

Paragraph 6.3.1.2.5., amend to read:

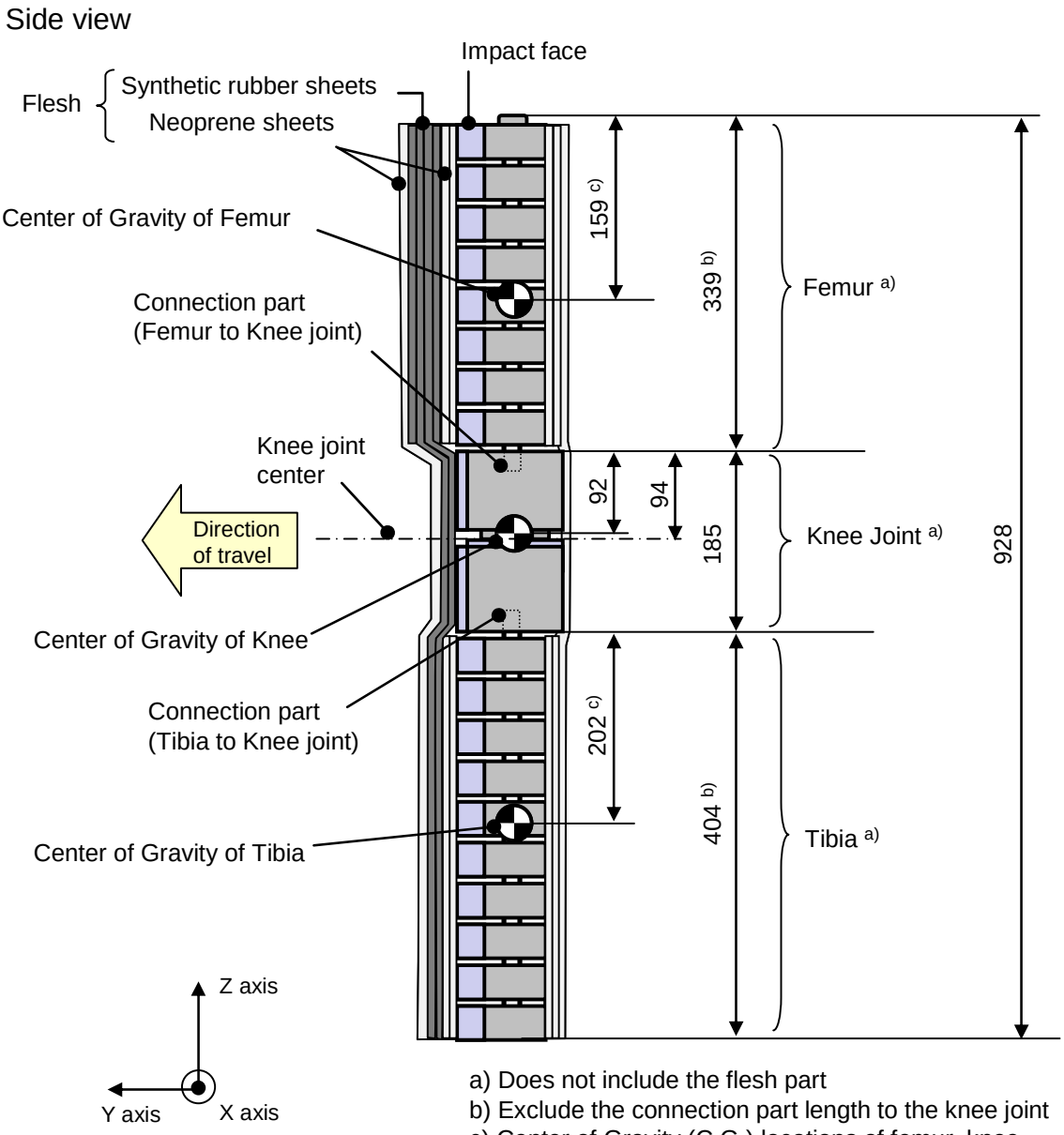
"6.3.1.2.5. The test impactor or at least the flesh shall be stored for at least four hours in a controlled storage area with a stabilised temperature of ~~20 ± 4~~ **20 ± 2**°C prior to impactor removal for calibration. After removal from the storage, the impactor shall not be subjected to conditions other than those pertaining in the test area."

Paragraph 6.3.1.2.6.3., amend to read:

"6.3.1.2.6.3. The instrumentation response value channel frequency class (CFC), as defined in ISO 6487:2002, shall be 180 for all transducers. The CAC response values, as defined in ISO 6487:2002, shall be 30 mm for the knee ligament elongations and ~~350~~ **400** Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate or bend until these values."

Figures 13., amend to read:

"



a) Does not include the flesh part
b) Exclude the connection part length to the knee joint
c) Center of Gravity (C.G.) locations of femur, knee, and tibia without flesh (Included the connection part mass to the femur and tibia C.G. calculation)

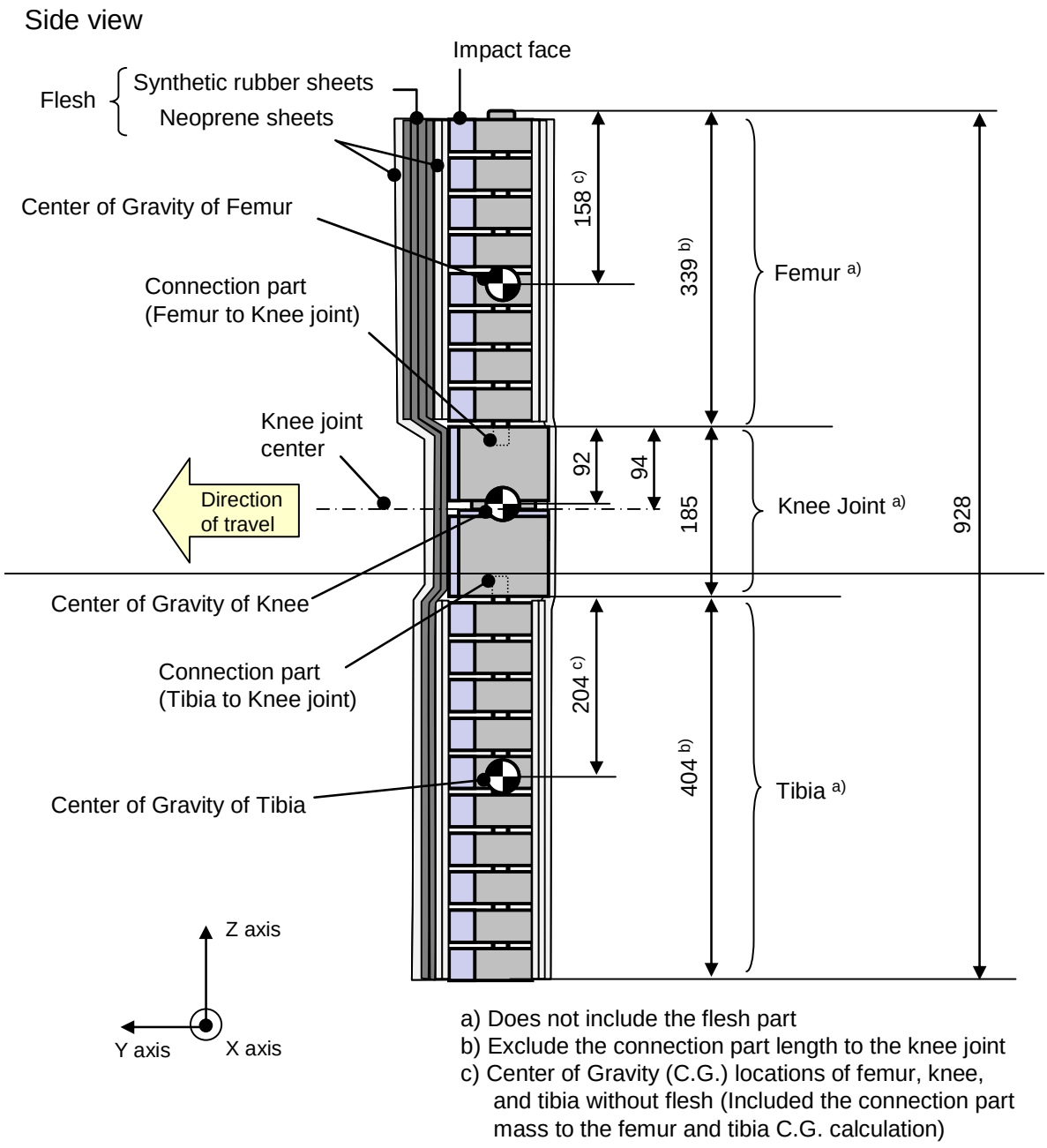


Figure 13: Flex-PLI; Dimensions and C.G. locations of femur, knee joint, and tibia (Side view)

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Figures 15., amend to read:

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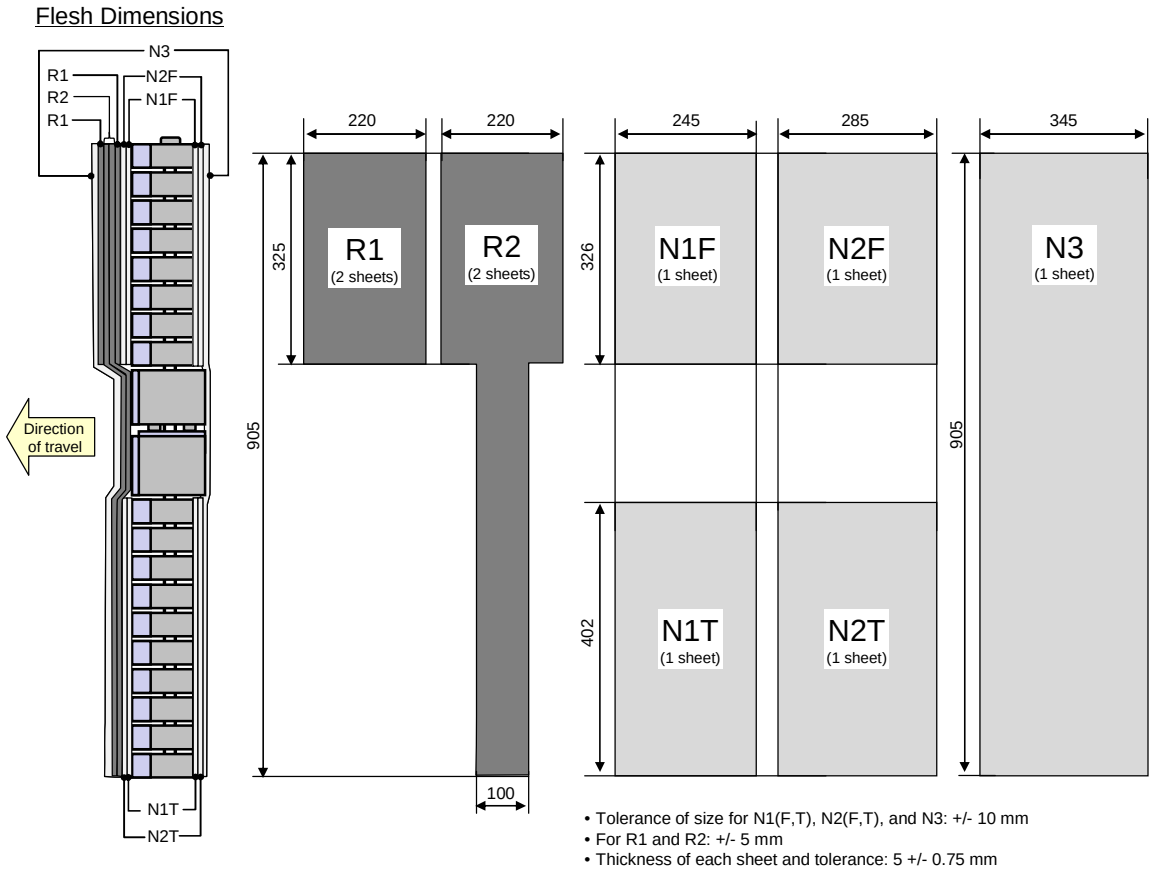


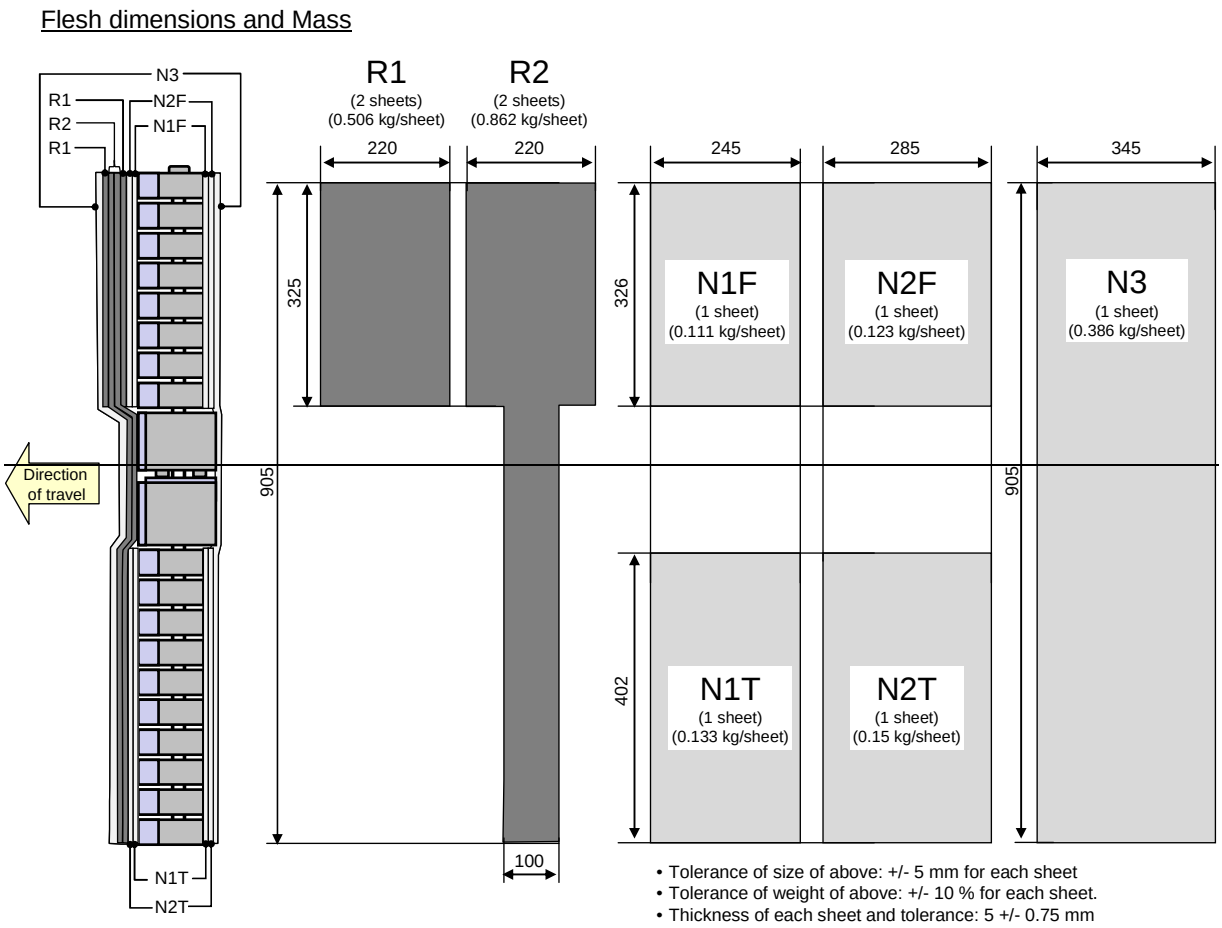


Figure 15: Flex-PLI; flesh dimensions ~~and mass~~

"

Paragraph 7.1.2.2., amend to read:

"7.1.2.2. The direction of the impact velocity vector shall be in the horizontal plane and parallel to the longitudinal vertical plane of the vehicle. The tolerance for the direction of the velocity vector in the horizontal plane and in the longitudinal plane shall be ± ~~[2]~~° at the time of first contact. The axis of the impactor shall be perpendicular to the horizontal plane**,** with a **roll and pitch angle** tolerance of ± ~~[2]~~° in the lateral and longitudinal plane. The horizontal, longitudinal and lateral planes are orthogonal to each other (see Figure 23). "

Paragraph 7.1.2.3., amend to read:

"7.1.2.3. The bottom of the impactor shall be at 75 mm above ground reference plane at the time of first contact with the bumper (see Figure 24), with a ± ~~[10]~~ mm tolerance. When setting the height of the propulsion system, an allowance must be made for the influence of gravity during the period of free flight of the impactor. "

Paragraph 7.1.2.3.2., amend to read:

"7.1.2.3.2. 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 **yaw angle** tolerance of ± 5° (see Figure 23)."

Paragraph 8.2.2.2.1., amend to read:

"8.2.2.2.1. The test facility used for the certification test shall have a stabilised temperature of ~~20 ± 4~~ **20 ± 2** °C during certification."

Paragraph 8.2.2.3.1., amend to read:

"8.2.2.3.1. When the lower legform impactor is used for a test as specified in paragraph 8.2.2.4., the maximum bending moment of the tibia at tibia-1 shall be not more than ~~[267]~~ **272** Nm and not less than ~~[240]~~ **235** Nm, the maximum bending moment at tibia-2 shall be not more than ~~[220]~~ **211** Nm and not less than ~~[197]~~ **185** Nm, the maximum bending moment at tibia-3 shall be not more than ~~[173]~~ **160** Nm and not less than ~~[153]~~ **135** Nm, and the maximum bending moment at tibia-4 shall be not more than ~~[~~108~~]~~ Nm and not less than ~~[95]~~ **94** Nm. The maximum elongation of MCL shall be not more than ~~[25]~~ **26** mm and not less than ~~[~~23~~]~~ mm, the maximum elongation of ACL shall be not more than ~~[~~11~~]~~ mm and not less than ~~[9.7]~~ **9.0** mm, and the maximum elongation of PCL shall be not more than ~~[5.6]~~ **5.4** mm and not less than ~~[3]~~ **4.0** mm. ……. "

Paragraph 8.2.2.3.2., amend to read:

"8.2.2.3.2. The instrumentation response value CFC, as defined in ISO 6487:2002, shall be 180 for all transducers. The CAC response values, as defined in ISO 6487:2002, shall be 30 mm for the knee ligament elongations and ~~350~~ **400** Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate and bend to these values. "

Paragraph 8.2.2.4.1., amend to read:

"8.2.2.4.1. The impactor, ~~excluding~~ **including** flesh, shall be suspended from the dynamic certification test rig 15 ± 1° upward from the horizontal as shown in Figure 36. The impactor shall be released from the suspended position, whereupon the impactor falls freely against the pin joint of the test rig as shown in Figure 36. "

Paragraph 8.2.3.2.1., amend to read:

"8.2.3.2.1. The test facility used for the certification test shall have a stabilised temperature of ~~20 ± 4~~ **20 ± 2** °C during certification."

Paragraph 8.2.3.3.1., amend to read:

"8.2.3.3.1. When the lower legform impactor is used for the test specified in paragraph 8.2.3.4., the maximum bending moment of the tibia at tibia-1 shall be not more than ~~[278]~~ **277** Nm and not less than ~~[235]~~ **237** Nm, the maximum bending moment at tibia-2 shall be not more than ~~[269]~~ Nm and not less than ~~[223]~~ Nm, the maximum bending moment at tibia-3 shall be not more than ~~[220]~~ **204** Nm and not less than ~~[176]~~ Nm, and the maximum bending moment at tibia-4 shall be not more than ~~[120]~~ Nm and not less than ~~[102]~~ **98** Nm. The maximum elongation of the MCL shall be not more than ~~[22.8]~~ **23** mm and not less than ~~[18.1]~~ **18** mm, that of the ACL shall be not more than ~~[12]~~ **10.5** mm and not less than ~~[9]~~ **8.5** mm, and that of the PCL shall be not more than ~~[6.5]~~ **6** mm and not less than ~~[4.5]~~ mm. ……"

Paragraph 8.2.3.3.2., amend to read:

"8.2.3.3.2. The instrumentation response value CFC, as defined in ISO 6487:2002, shall be 180 for all transducers. The CAC response values, as defined in ISO 6487:2002, shall be 30 mm for the knee ligament elongations and ~~350~~ **400** Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate and bend to these values. "

Paragraph 8.2.3.4.1., amend to read:

"8.2.3.4.1. **The fully assembled FlexPLI (with flesh and skin) shall be stationary suspended vertically from a test rig as shown in Figure 37. It is then impacted by the upper edge of a linearly guided Al honeycomb impactor , covered by a thin (less than 1 mm thickness) paper cloth, at an impact speed of 11,1±0,2 m/s. The legform is to be released from the test rig within 5 ms after the time of first contact to ensure a free flight condition.**

~~The impactor covered by flesh shall be hung vertically as shown in Figure 37. The impactor shall be impacted by a moving ram of 8.1 ± 0.1 kg mass, at an impact speed of 11.1 ± 0.2 m/s. The impactor shall be released from the hanging system within 5 ms after the moving ram impacts the impactor.~~ "

Paragraph 8.2.3.4.2., amend to read:

"8.2.3.4.2. **The honeycomb of 5052 alloy, which is attached in front of the moving ram, shall have a crash strength of 75 ± 10 % psi and dimensions of l=200±2 mm, w=160±2 mm and d=60±5 mm. To ensure a consistent and good level of repeatability, the honeycomb should either have a 3/16 inches cell size in combination with a density of 3.1 pcf or a 1/4 inches cell size in combination with a density of 2.3 pcf or a 3/16 inches cell size in combination with a density of 2.0 pcf.**

~~The honeycomb, which is attached in front of the moving ram, shall have a crash strength of [75 (-0/+10per cent)] psi, and it shall have the dimensions shown in Figure 38.~~ "

Paragraph 8.2.3.4.3., amend to read:

"8.2.3.4.3. **The upper edge of the honeycomb face is to be in line with the rigid plate of the linearly guided impactor. At time of first contact, the upper edge of the honeycomb is to be in line with the knee joint centre line within a vertical tolerance of 0±2 mm.**

~~The honeycomb, to be covered by a thin paper cloth, shall be set in front of the moving ram with its top line matching the knee joint centre line within a tolerance of 0 [± 3] mm along the vertical axis at the impact timing. The top line of the impact face of the moving ram also shall match the knee joint centre line within a tolerance of 0 [± 3] mm along the vertical axis at the impact timing.~~

The honeycomb shall not be excessively handled or deformed before the impact test"

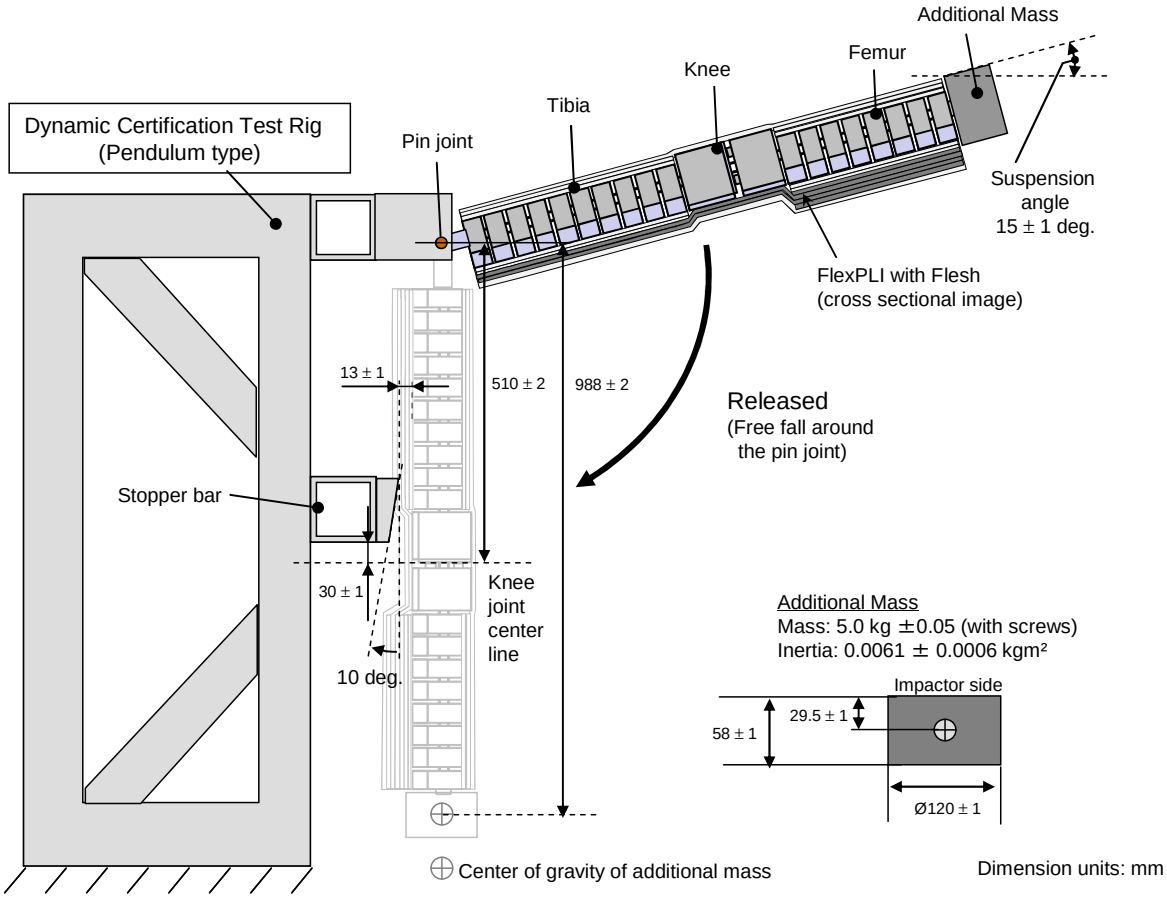
Paragraph 8.2.3.4.4., amend to read:

"8.2.3.4.4. **The FlexPLI pitch angle and therefore the pitch angle of the velocity vector of the honeycomb impactor (rotation around y-axis) at the time of first contact shall be within a tolerance of 0±2° in relation to the lateral vertical plane. The FlexPLI roll angle and therefore the roll angle of the honeycomb impactor (rotation around x-axis) at the time of first contact shall be within a tolerance of 0±2°in relation to the longitudinal vertical plane. The FlexPLI yaw angle and therefore the yaw angle of the velocity vector of the honeycomb impactor (rotation around z-axis) at the time of first contact shall be within a tolerance of 0±2°, to ensure a correct operation of the knee joint.**

~~The impact direction of the moving ram shall be parallel to the horizontal axis with a tolerance of ± [2]°.~~"

Figure 36., amend to read:

"



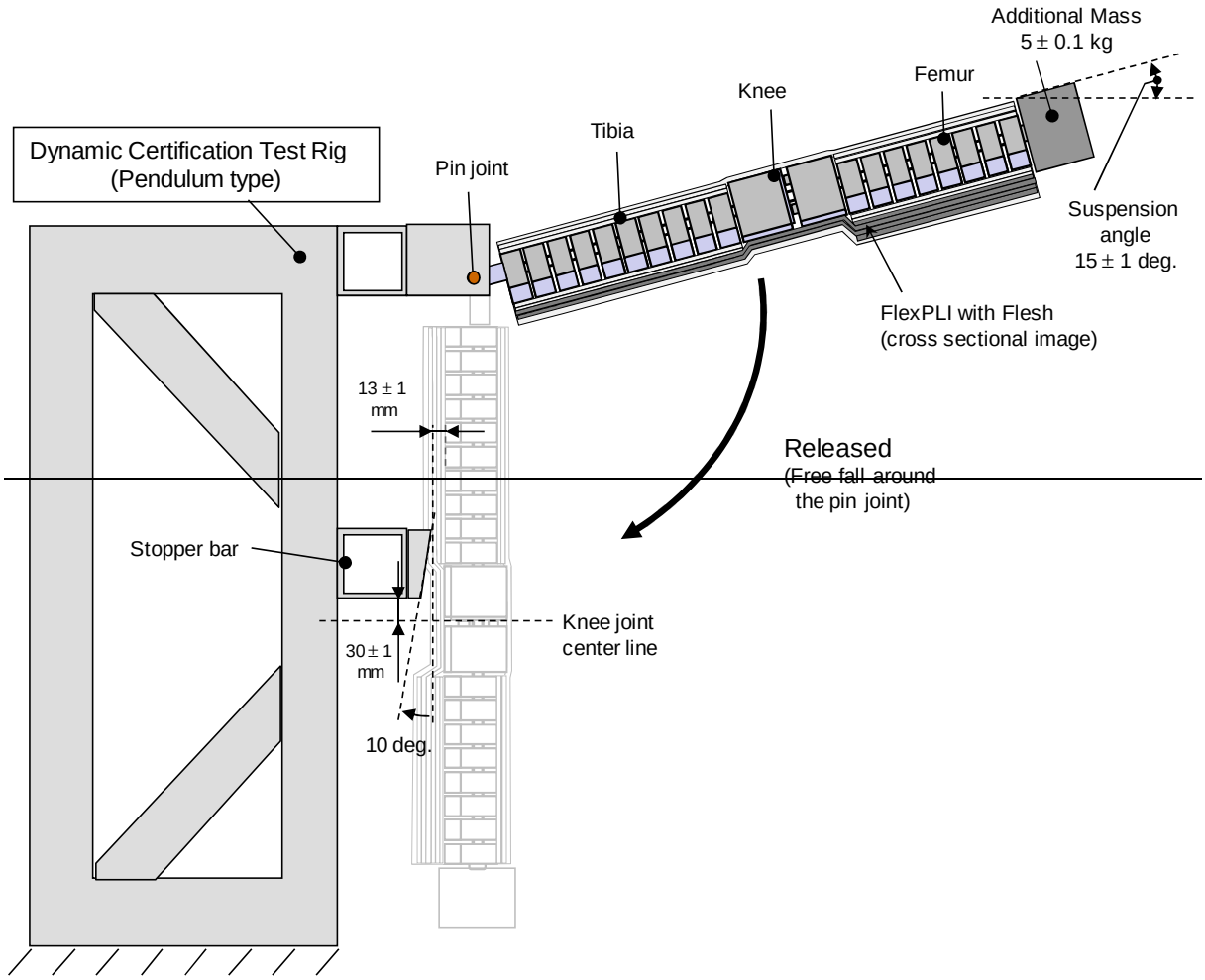


Figure 36: Test set-up for dynamic lower legform impactor certification test, Pendulum type (see paragraph 8.2.2.4.) "

Figure 37., amend to read:

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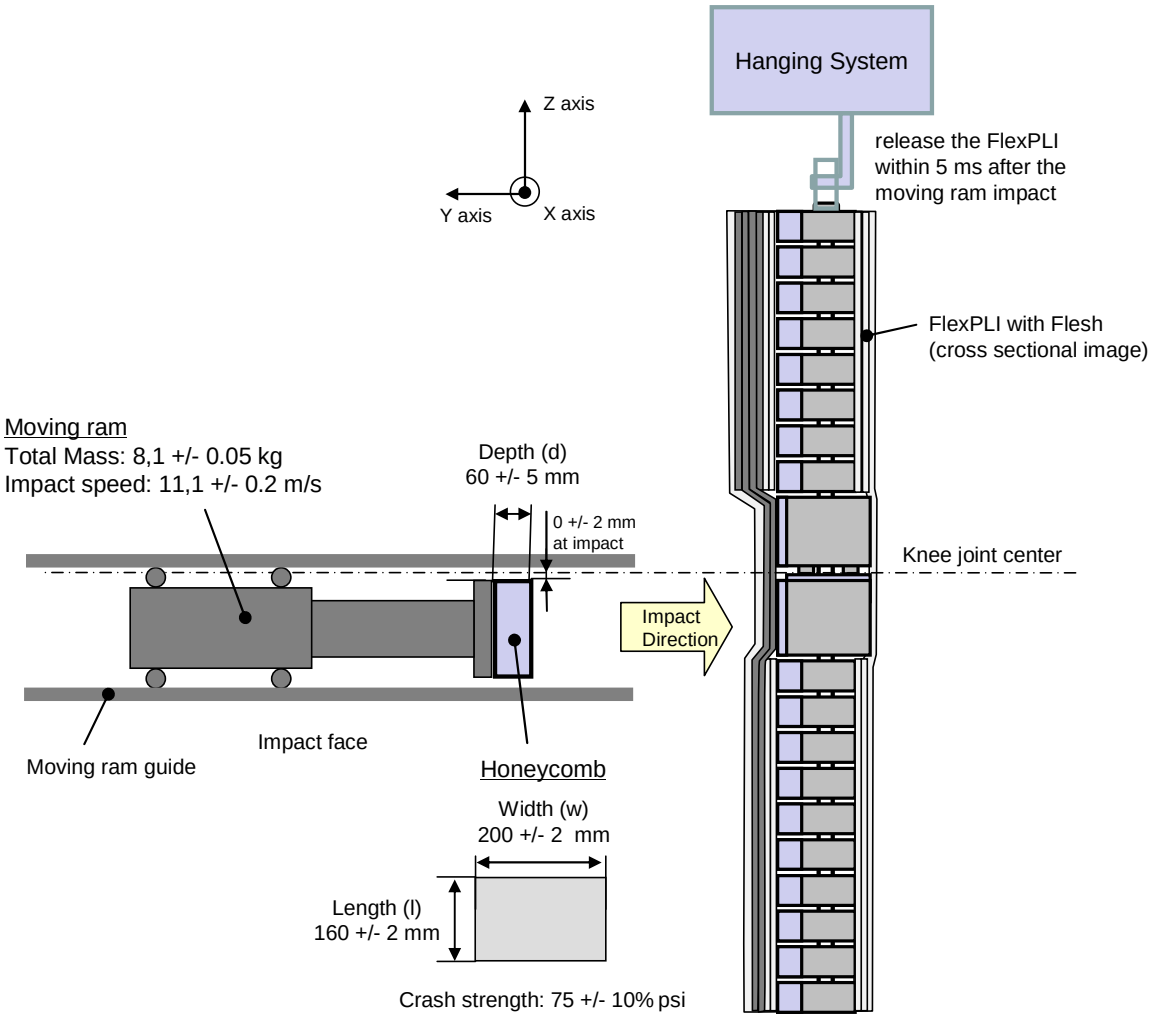

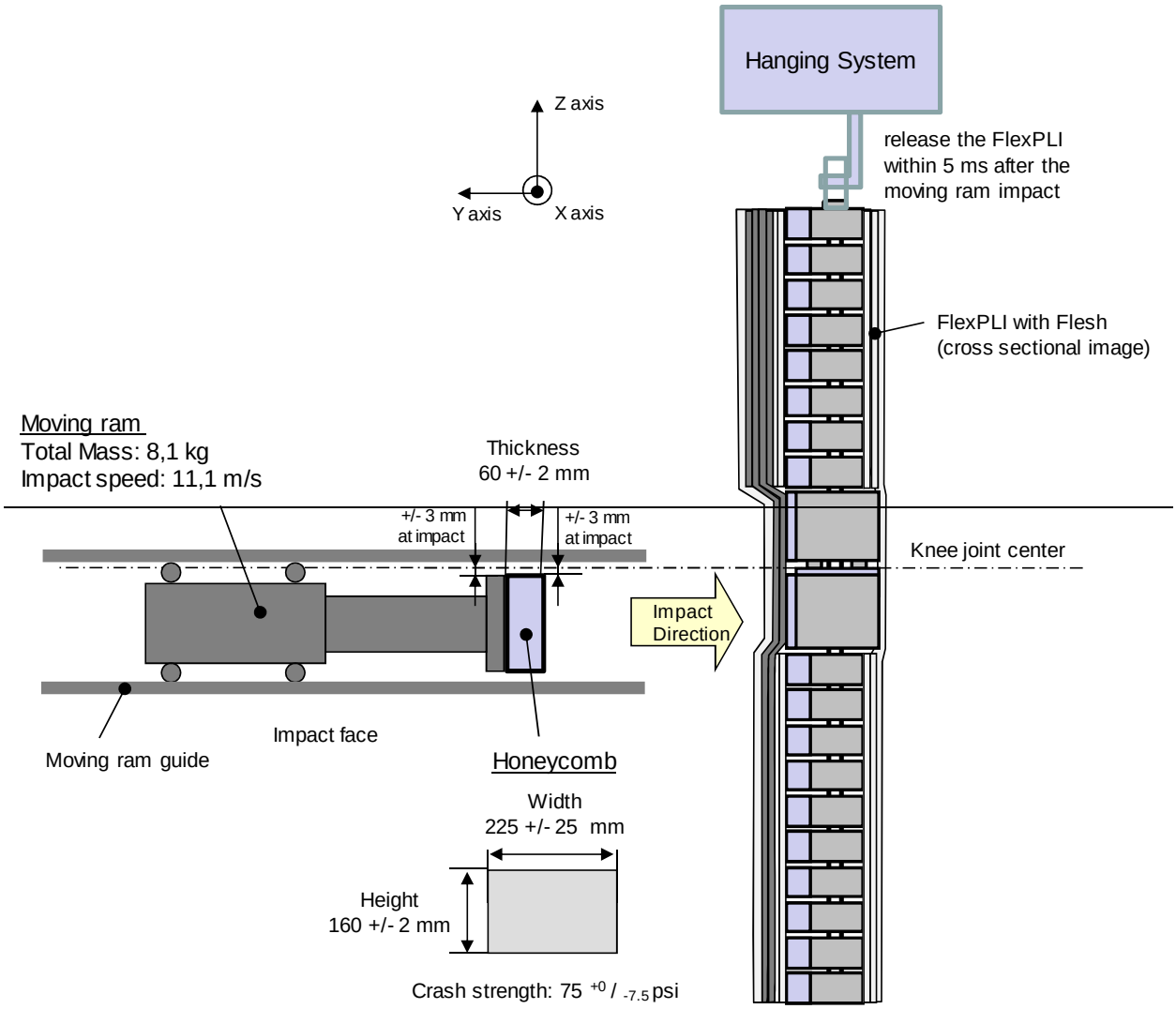

Figure 37: Test set-up for dynamic lower legform impactor certification test, Inverse type (see paragraph 8.2.3.4.) "

B. JUSTIFICATION

Based on the results of the 10th Flex-TEG (1st-2nd December 2009), the expert from Japan updated the above mentioned draft amendments to the gtr on pedestrian protection (gtr No. 9) (ECE/TRANS/WP.29/GRSP/2009/21) following the responsibility of the TEG chairmanship.

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