

PROPOSAL FOR DRAFT AMENDMENTS TO THE GTR ON PEDESTRIAN PROTECTION
(gtr No. 9)

(Document ECE/TRANS/180/Add.9)

The modifications to the current text of the gtr on Pedestrian protection (gtr No.9) are marked in bold or strikethrough characters.

A. STATEMENT OF TECHNICAL RATIONALE AND JUSTIFICATION

Paragraph 64., amend to read:

"... TEG will also consider a transitional period during which the FlexPLI and the rigid lower legform impactor can be used as alternatives. **Several years passed after the above situation, then the TEG finalised their technical evaluation on the FlexPLI by a majority of the TEG members in [2009], therefore, this gtr also includes the FlexPLI requirements as well as the RIGID/TRL legform impactor requirements.**"

Paragraph 102., amend to read:

"... Therefore, the group recommends to use the upper legform to bumper test as an optional alternative to the lower legform to bumper test for these vehicles. **The test methods for high bumper vehicles can be applied not only to the case of using the RIGID/TRL lower legform impactor but also to the case of using the FlexPLI.**"

Paragraph 106., amend to read:

"... However, it was also recommended to consider the possible future use of the Flex-PLI, which is considered by some to be more biofidelic and expected to be highly usable and repeatable, following the evaluation to be conducted by the Technical Evaluation Group (TEG) (INF GR/PS/106) 19 /. **Several years passed, then the TEG finalised their technical evaluation on the FlexPLI by a majority of the TEG members in [2009], therefore, this gtr also includes the FlexPLI requirements as well as the RIGID/TRL legform impactor requirements.**"

Paragraph A. 110., amend to read:

"... For these reasons, a bending limit of 19° for the **RIGID/TRL 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 as [20 mm] based on the TEG discussions.**"

Paragraph 111., amend to read:

"With regard to knee shearing limits, the informal group selected a limit of 6 mm **for the RIGID/TRL lower legform impactor**, based on the analysis of PMHS by EEVC WG17 and WG10 that showed that a 6 mm shear displacement corresponds to a 4 kN shear force. The 4 kN shear force in the TRL device approximates the 3 kN average peak shearing force acting at the knee joint level that was found associated in the PMHS tests with diaphysis/metaphysis failure. **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 [12.7] mm only for monitoring purposes because ACL or PCL injury without MCL rupture is very rare in car-pedestrian accidents.**"

Paragraph 112., amend to read:

"... To protect a higher proportion of the population at risk, the informal group recommends a maximum lateral tibia acceleration limit of 170g **for the RIGID/TRL lower legform impactor**. **As for the FlexPLI, the limit of tibia bending moment is set as [312] Nm based on the TEG discussions.**"

Paragraph 113., amend to read:

"... at the following limits:

For RIGID/TRL lower legform impactor

- Maximum lateral knee bending angle $\leq 19.0^\circ$;
- Maximum lateral knee shearing displacement ≤ 6.0 mm;
- Maximum lateral tibia acceleration ≤ 170 g.

For FlexPLI

- Maximum MCL elongation $\leq [20]$ mm;**
- Maximum Tibia bending moment $\leq [312]$ Nm;**
- Maximum ACL and PCL elongation $\leq [12.7]$ mm only for monitoring purposes."**

Paragraph 115., amend to read:

"... For feasibility reasons, this gtr allows manufacturers to nominate bumper test widths up to 264 mm in total where the acceleration measured at the upper end of the tibia **of the RIGID/TRL lower legform impactor** shall not exceed 250g. The relaxation zone of 264 mm corresponds to an area that is twice the width of the legform. **[As for the FlexPLI, for feasibility reasons, TEG proposed to allow manufacturers to nominate bumper test widths up to 264 mm in total where**

the tibia bending moment of the FlexPLI shall not exceed TBD Nm and the MCL elongation of the FlexPLI shall not exceed TBD mm]."

Title of Section 10, amend to read:

" 10. METHOD OF INTRODUCING THE FLEX-PLI "

Insert a new Paragraph 133., to read:

"133. As for the new lower legform impactor, FlexPLI, introduction to the each contracting party, the TEG provided its recommendation as follows;

Effective date of the amendment 1 to the original version entry into force at each contracting party: from the date when this gtr is adopted by the [WP29].

TEG also proposed to finish the period of alternative using impactors of RIGID/TRL lower legform impactor or FlexPLI by [20XX] [[XX] months after the date of entry into force].

Section 10 (former), renumber as Section A.11 to read:

"~~40~~11. APPENDIX – REFERENCE DOCUMENTS USED BY THE WORKING GROUP"

B. TEXT OF REGULATION

Paragraph 5.1.1., amend to read:

"5.1.1. When tested in accordance with paragraph 7.1.1. (RIGID/TRL lower legform to bumper) or paragraph 7.1.2. (Flex-PLI to bumper) according to the choice of manufacturers, the results shall comply with 5.1.1.1 or 5.1.1.2 respectively.

Paragraph 5.1.1. (former), renumber as paragraph 5.1.1.1 to read:

"5.1.1.1. When tested in accordance with paragraph 7.1.1., the maximum dynamic knee bending angle shall not exceed 19°, the maximum dynamic knee shearing displacement shall not exceed 6.0 mm, and the acceleration measured at the upper end of the tibia shall not exceed 170g. In addition, the manufacturer may nominate bumper test widths up to a maximum of 264 mm in total where the acceleration measured at the upper end of the tibia shall not exceed 250g."

Insert a new Paragraph B. 5.1.1.2., to read:

"5.1.1.2. When tested in accordance with paragraph 7.1.2., the maximum dynamic medial collateral ligament elongation at knee shall not exceed [20 mm], and the dynamic bending moments at tibia shall not exceed [312 Nm]. The maximum dynamic anterior cruciate ligament and posterior cruciate ligament elongation shall be monitored with a reference value of [12,7] 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 and the MCL elongation of the FlexPLI shall not exceed TBD mm]. "

Paragraph 5.1.2., amend to read (renumbering):

"5.1.2. When tested in accordance with paragraph 7.1.23. (upper legform to bumper), the instantaneous sum of the impact forces with respect to time shall not exceed 7.5 kN and the bending moment on the test impactor shall not exceed 510 Nm."

Title of paragraph 6.3.1.1., amend to read:

"6.3.1.1. **RIGID/TRL** Lower legform impactor:"

Title of Figure 12., amend to read:

"Figure 12: **RIGID/TRL** Lower legform impactor (see paragraph 6.3.1.1.)"

Insert a new paragraphs 6.3.1.2. to 6.3.1.2.7.2., 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 $928 \pm [3]$ mm, having a required mass of $12.95 \pm [0.4]$ kg including flesh. The length of the femur, knee joint, and tibia shall be $339 \pm [2]$ mm, $185 \pm [1]$ mm, and $404 \pm [2]$ mm respectively. The knee joint centre position shall be $94 \pm [1]$ mm from the top of the knee joint.

Brackets, pulleys, protectors, etc. attached to the impactor for the purpose of launching and/or protecting may extend beyond the dimensions shown in Figure 13.

6.3.1.2.1. **The cross-sectional shape perpendicular to the Z axis of the femur and tibia main bodies shall be $90 \pm [2]$ mm in width along the Y axis, and $84 \pm [1]$ mm in width**

along the X axis as shown in Figure 14 (a). The impact face shall be $30 \pm [1]$ mm in radius, $30 \pm [1]$ mm in width along the Y axis, and $48 \pm [1]$ mm in width along the X axis as shown in Figure 14 (a).

6.3.1.2.2. The cross-sectional shape perpendicular to the Z axis of the knee joint shall be $108 \pm [2]$ mm in width along the Y axis, and $118 \pm [1]$ mm in width along the X axis as shown in Figure 14 (b). The impact face shall be $103 \pm [1]$ mm in radius, $12 \pm [1]$ mm in width along the Y axis, and $86 \pm [1]$ mm in width along the X axis as shown in Figure 14 (b).

6.3.1.2.3. The masses of the femur and tibia without flesh, including the connection part to the knee joint, shall be $2.45 \pm [0.05]$ kg and $2.63 \pm [0.05]$ kg respectively. The mass of the knee joint without flesh shall be $4.28 \pm [0.1]$ kg. The total mass of the femur, knee joint, and tibia shall be $9.36 \pm [0.2]$ kg.

The centre of gravity of the femur and tibia without flesh, including the connection part to the knee joint, shall be $167 \pm [3]$ mm and $200 \pm [3]$ 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 $93 \pm [3]$ 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 $0.0288 \pm [0.002]$ kgm² and $0.0456 \pm [0.002]$ kgm² respectively. The moment of inertia of the knee joint about the X axis through the respective centre of gravity shall be $0.018 \pm [0.0015]$ kgm².

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.

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 $20 \pm 4^\circ\text{C}$ 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.

6.3.1.2.6. Lower legform instrumentation

- 6.3.1.2.6.1.** Four transducers shall be installed in the tibia to measure bending moments applied to the tibia. The sensing locations of each of the transducers are as follows: tibia-1: $134 \pm [1]$ mm, tibia-2: $214 \pm [1]$ mm, tibia-3: $294 \pm [1]$ mm, and tibia-4: $374 \pm [1]$ mm below the knee joint centre respectively as shown in Figure 17. The measurement axis of each transducer shall be the X axis of the impactor.
- 6.3.1.2.6.2.** Three transducers shall be installed in the knee joint to measure elongations of the medial collateral ligament (MCL), anterior cruciate ligament (ACL), and posterior cruciate ligament (PCL). The measurement locations of each transducer are shown in Figure 17. The measurement locations shall be within $\pm [3]$ mm along the X axis from the knee joint centre.
- 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 Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate or bend until these values.
- 6.3.1.2.7.** Lower legform certification
- 6.3.1.2.7.1.** The lower legform impactor shall meet the performance requirements specified in paragraph 8.
- 6.3.1.2.7.2.** The certified impactor can be used for up to [20] impacts before requiring re-certification in dynamic certification [tests] which [are] described [in 8.1.2.2 and 8.1.2.3.] The impactor shall be re-certified by these tests if more than one year has elapsed since the previous dynamic certification tests, if any impactor transducer output has exceeded the specified CAC. If the impactor fails the tests, it shall be re-certified by using the static test described in 8.1.2.1. in order to detect which parts shall be changed to new parts. "

Insert a new Figure 13 to Figure 17., to read:

"

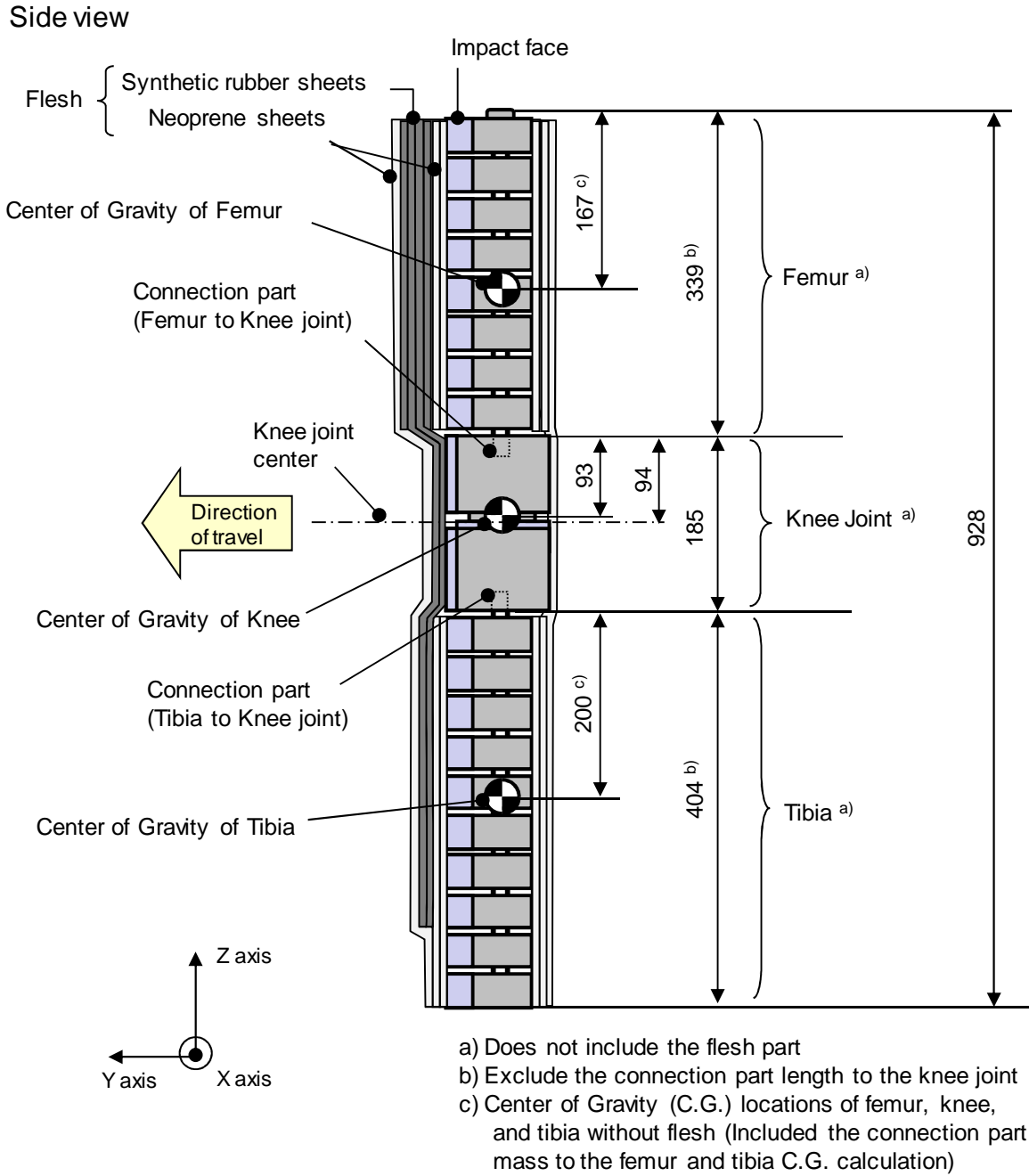


Figure 13: Flex-PLI; Dimensions and C.G. locations of femur, knee joint, and tibia (Side view)

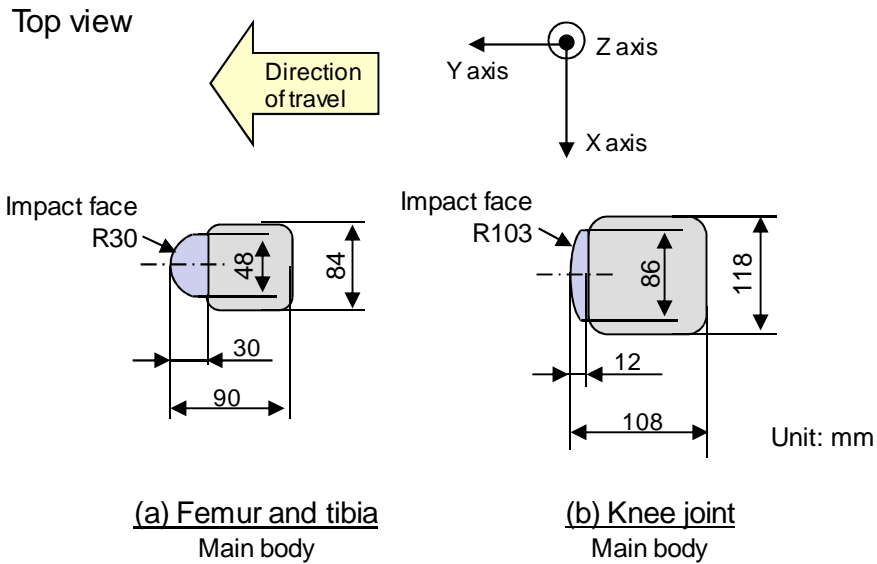


Figure 14: Flex-PLI; femur, tibia, and knee dimensions (Top view)

Flesh dimensions and Mass

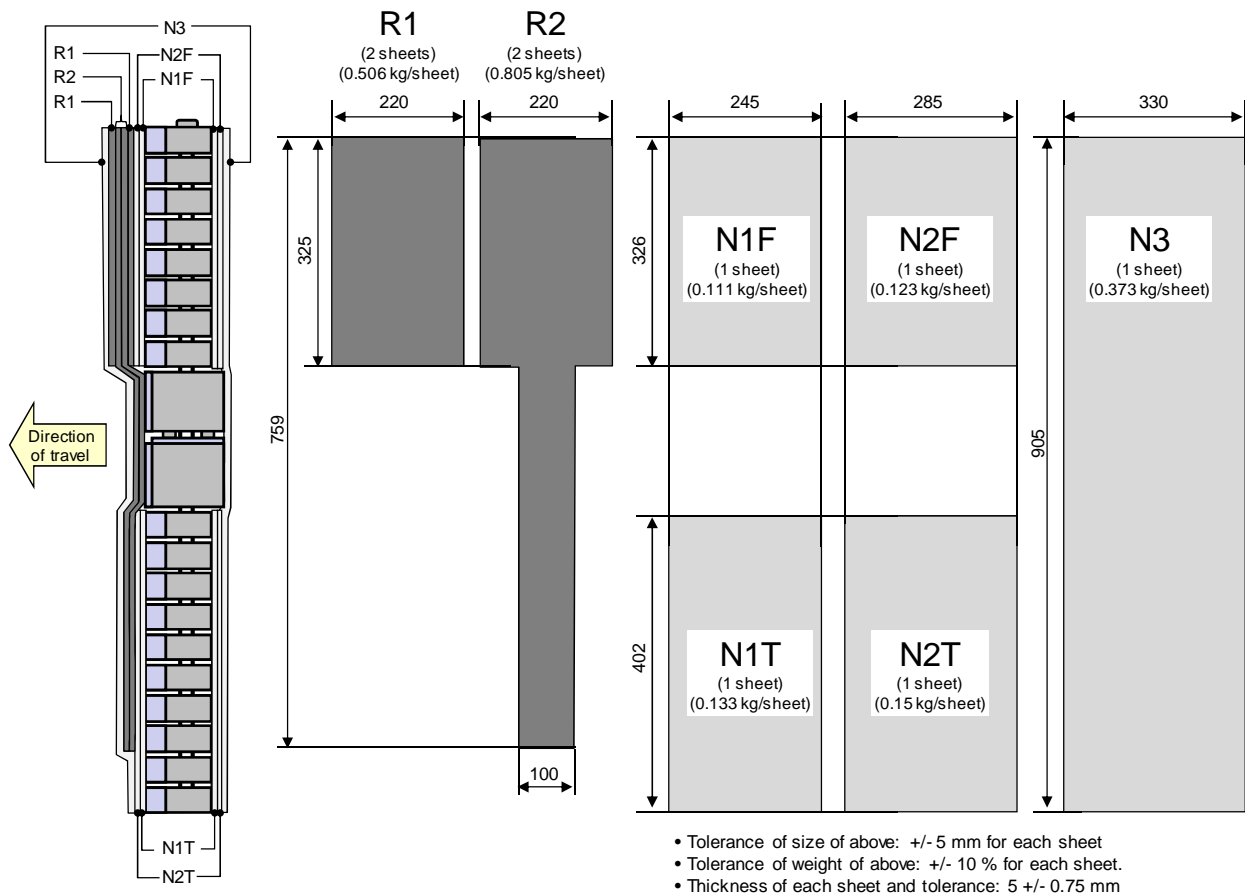
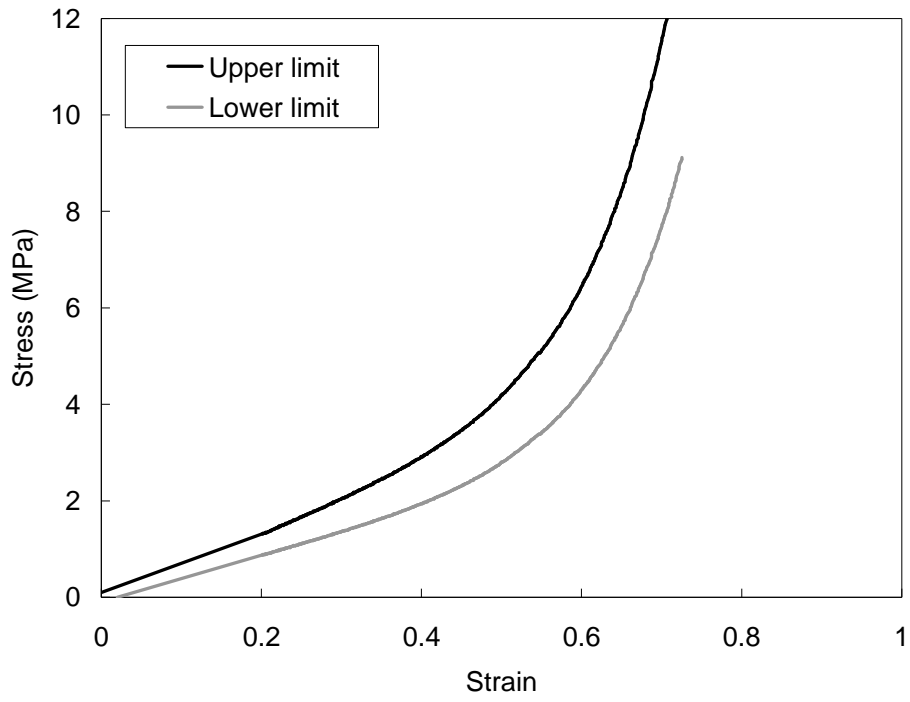
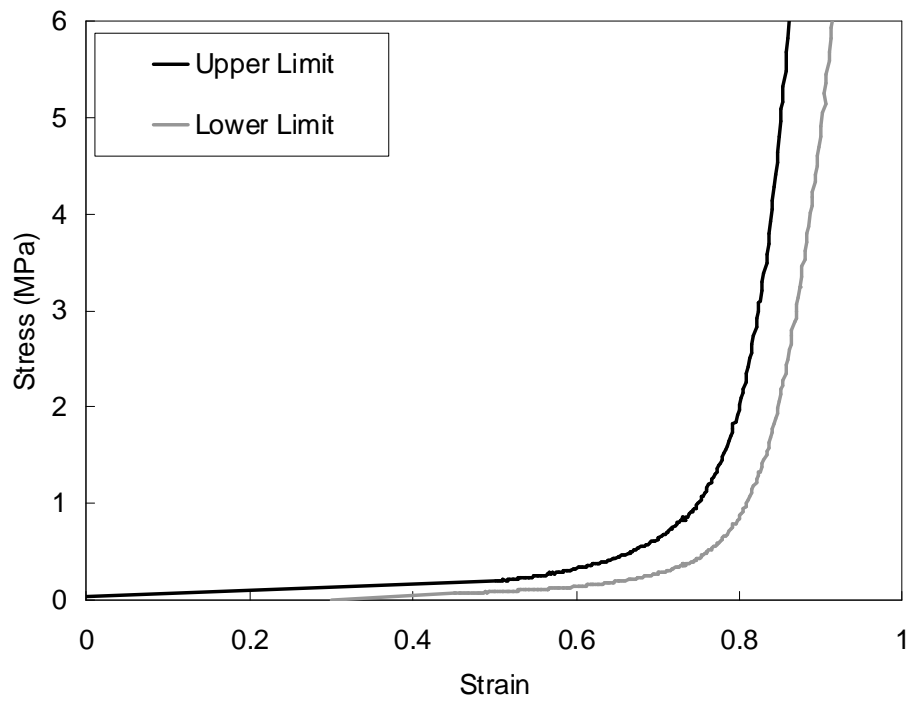


Figure 15: Flex-PLI; flesh dimensions and mass



(a) Synthetic rubber sheets



(b) Neoprene sheets

Figure 16: Flex-PLI; flesh compression characteristics

Instruments locations

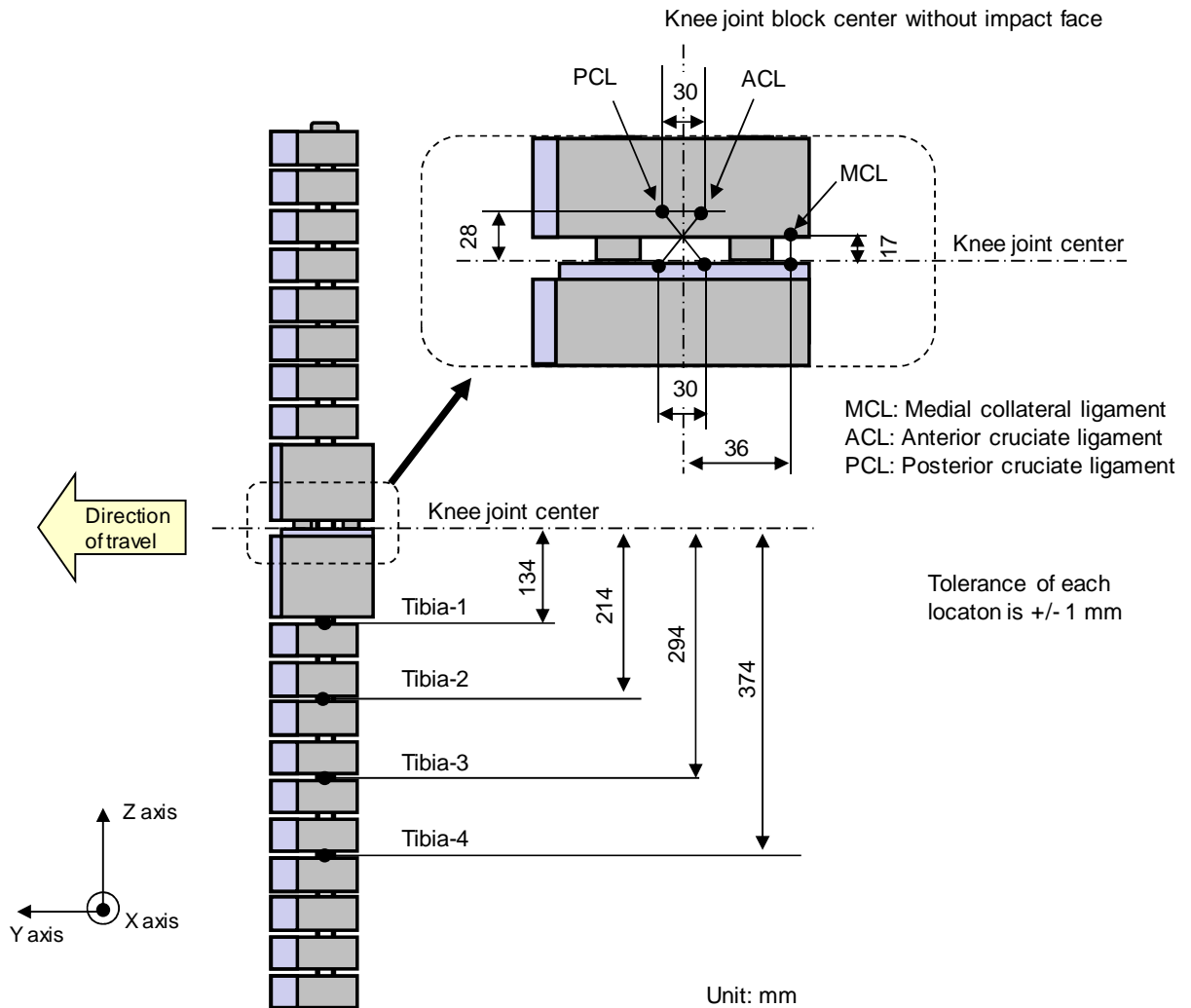


Figure 17: Flex-PLI; instrument locations "

Paragraph B. 6.3.1.2.(former) to Paragraph B. 6.3.1.2.10.2. (former), renumber as paragraph B. 6.3.1.3. to paragraph B. 6.3.1.3.10.2.

Paragraph B. 6.3.1.2. (former), amend (renumber) to read:

"..., foam covered at the impact side, and 350 ± 5 mm long (see Figure 138)."

Paragraph B. 6.3.1.2.9.1. (former), amend (renumber) to read:

"...in three positions, as shown in Figure 138, each using a separate channel."

Paragraph B. 6.3.1.2.9.2. (former), amend (renumber) to read:

"...at positions 50 mm either side of the centre line (see Figure 138)."

Title of Figure 13, amend (renumber) to read:

"Figure 13: Upper legform impactor (see paragraph 6.3.1.-~~23~~.)"

Title of Paragraph B. 6.3.2.1., amend (renumber) to read:

"6.3.2.1. Child headform impactor (see Figure ~~1419~~)"

Paragraph B. 6.3.2.1.1., amend (renumber) to read:

"... axis perpendicular to the mounting face A (see Figure ~~1419~~) and ..."

Figure 14 (former), renumber as Figure 19.

Title of Paragraph B. 6.3.2.2., amend (renumber) to read:

"6.3.2.2. Adult headform impactor (see Figure ~~1520~~)"

Figure 15 (former), renumber as Figure 20.

Paragraph B. 6.3.2.2.1., amend (renumber) to read:

"... axis perpendicular to the mounting face A (see Figure ~~1520~~) and ..."

Title of Paragraph B. 7.1.1., amend to read:

"7.1.1. **RIGID/TRL** ~~L~~lower legform to bumper test procedure:"

Paragraph B. 7.1.1.2., amend (renumber) to read:

"... and lateral planes are orthogonal to each other (see Figure ~~1621~~)."

Paragraph B. 7.1.1.3., amend (renumber) to read:

"... at the time of first contact with the bumper (see Figure ~~1722~~), ..."

Paragraph B. 7.1.1.3.2., amend (renumber) to read:

"...its knee joint, with a tolerance of $\pm 5^\circ$ (see Figure ~~1621~~)."

Figure 16 (former) to Figure 17 (former), renumber as Figure 21 to Figure 22.

Insert new paragraphs 7.1.2. to paragraph 7.1.2.4., to read:

"7.1.2. FlexPLI to bumper test procedure

Each test shall be completed within two hours of when the impactor to be used is removed from the controlled storage area.

7.1.2.1. The selected target points shall be in the bumper test area.

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 $\pm 2^\circ$ at the time of first contact. The axis of the impactor shall be perpendicular to the horizontal plane with a tolerance of $\pm 2^\circ$ in the lateral and longitudinal plane. The horizontal, longitudinal and lateral planes are orthogonal to each other (see Figure 23).

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.

7.1.2.3.1. The lower legform impactor for the bumper tests shall be in 'free flight' at the moment of impact. The impactor shall be released to free flight at such a distance from the vehicle that the test results are not influenced by contact of the impactor with the propulsion system during rebound of the impactor.

The impactor may be propelled by an air, spring or hydraulic gun, or by other means that can be shown to give the same result.

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 tolerance of $\pm 5^\circ$ (see Figure 23).

7.1.2.3.3. At the time of first contact the centre line of the impactor shall be within a ± 10 mm tolerance to the selected impact location.

7.1.2.3.4. During contact between the impactor and the vehicle, the impactor shall not contact the ground or any object which is not part of the vehicle.

7.1.2.4. The impact velocity of the impactor when striking the bumper shall be 11.1 ± 0.2 m/s. The effect of gravity shall be taken into account when the impact velocity is obtained from measurements taken before the time of first contact. "

Insert new Figures 23 and 24., to read:

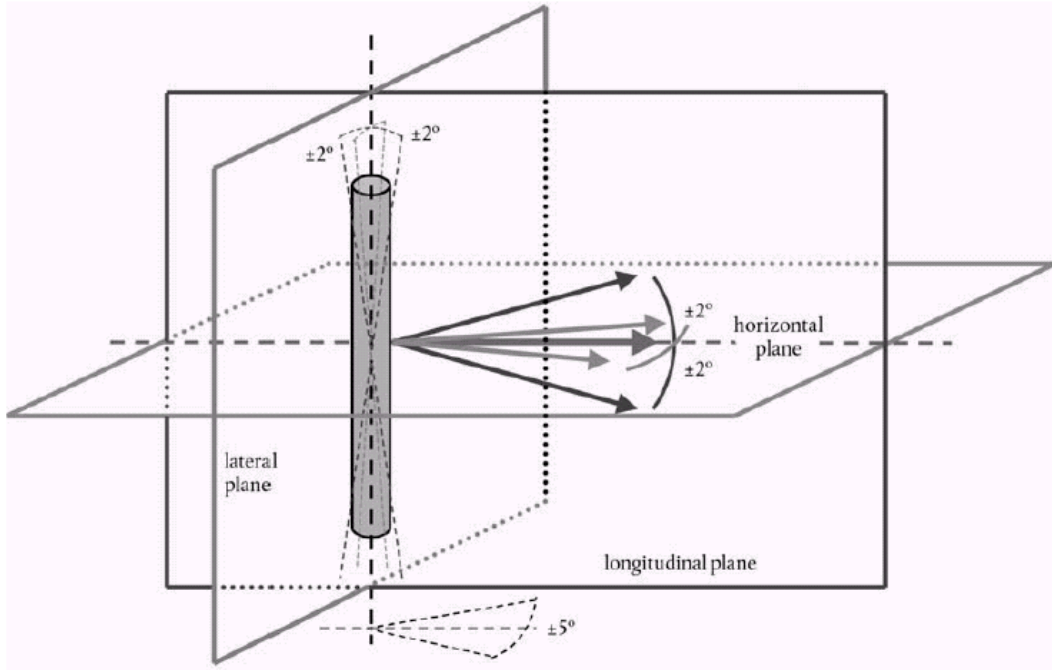


Figure 23: Tolerances of angles for the lower legform impactor at the time of the first impact (see paragraphs 7.1.2.2. and 7.1.2.3.2.)

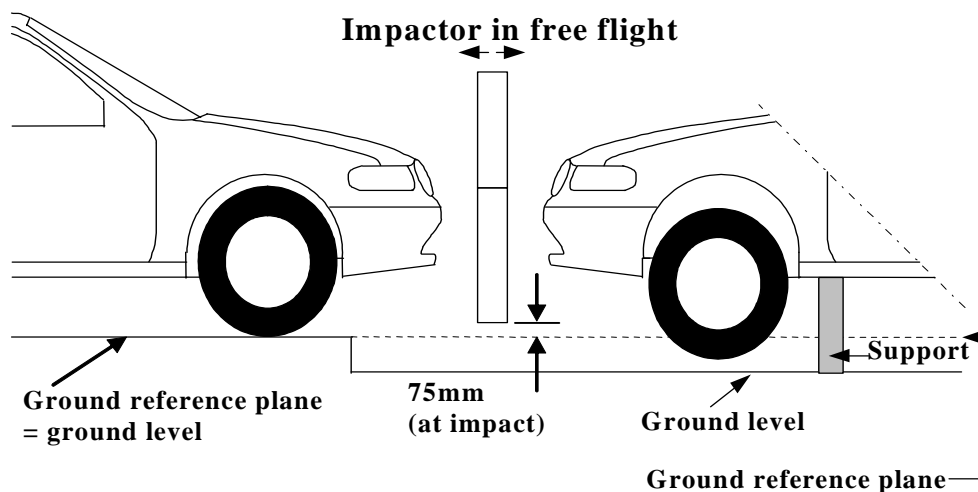


Figure 24: Flex-PLI to bumper tests for complete vehicle in normal ride attitude (left) and for cut-body mounted on supports (right) (see paragraph 7.1.2.3.) "

Paragraphs 7.1.2. (former) to 7.1.2.3. (former), renumber as paragraphs 7.1.3. to paragraph 7.1.3.3.
Paragraph 8., amend to read:

"8. ...
 The requirements for the lower legform impactor are specified in paragraph 8.1. **or 8.2.**,
 the upper legform impactor requirements are specified in paragraph ~~8.28.3.~~ and the adult
 and child headform impactors requirements are specified in paragraph ~~8.38.4.~~"

Title of paragraph 8.1., amend to read:

"8.1. **RIGID/TRL Lower legform to bumper certification**"

Paragraph 8.1.1.2., amend to read:

"8.1.1.2. ... shall be within the limits shown in Figure ~~4825.~~ Also, the energy ..."

Paragraph 8.1.1.3., amend to read:

"8.1.1.3. ...shall be within the limits shown in Figure ~~4926.~~"

Paragraph 8.1.1.4., amend to read:

"8.1.1.4 ... firmly to the femur, as shown in Figure ~~2027.~~ The rotational axis ..."

Paragraph 8.1.1.5., amend to read:

"8.1.1.5. ... from the centre of the knee joint, as shown in Figure ~~2128.~~ ..."

Paragraph 8.1.2.4.1., amend to read:

"8.1.2.4.1. ...of 2000 mm minimum length, as shown in Figure ~~2229.~~ It shall be ..."

Paragraph 8.1.2.4.2., amend to read:

"8.1.2.4.2. ...the certification impactor shall be as specified in Figure ~~2330.~~ The face of ..."

Paragraph 8.1.2.4.5., amend (renumber) to read:

"8.1.2.4.5 ...the stationary impactor as shown in Figure ~~2330.~~ The certification impactor ..."

Insert new paragraphs 8.2. to 8.2.3.4.4., to read:

"8.2. **Flex-PLI certification**

8.2.1. Static certification tests

8.2.1.1. The femur and tibia of the lower legform impactor shall meet the requirements respectively specified in paragraph 8.2.1.2. when tested as specified in paragraph 8.2.1.4. The knee joint of the lower legform impactor shall meet the requirements specified in paragraph 8.2.1.3. when tested as specified in paragraph 8.2.1.5. The stabilised temperature of the impactor during the certification tests shall be $20^{\circ} \pm 2^{\circ}\text{C}$.

The CAC response values, as defined in ISO 6487:2002, shall be 30 mm for the knee ligament elongations and 5 kN for the applied external load. For these tests low-pass filtering at an appropriate frequency is permitted, to remove higher frequency noise without significantly affecting the measurement of the response of the impactor.

8.2.1.2. When the femur and tibia of the impactor are loaded in bending in accordance with paragraph 8.2.1.4., the applied moment and generated deflection at the centre of the femur and tibia (M_c and D_c) shall be within the corridors shown in Figure 31.

8.2.1.3. When the knee joint of the impactor is loaded in bending in accordance with paragraph 8.2.1.5., the MCL, ACL, and PCL elongations and applied bending moment or force at the centre of the knee joint (M_c or F_c) shall be within the corridors shown in Figure 32.

8.2.1.4. The edges, of the femur and tibia, not bending parts, shall be mounted to the support rig firmly as shown in Figure 33. The Y axis of the impactor shall be parallel to the loading axis within $180 \pm 2^{\circ}$ tolerance. In order to avoid friction errors, roller plates shall be set underneath the support rigs. To avoid impactor damage, a neoprene sheet shall be set underneath the loading ram. The neoprene sheet used in this test shall have compression characteristics as shown in Figure 16.

The centre of the loading force shall be applied at the centre of the femur and tibia within $\pm [2^{\circ}]$ tolerance along the Z axis. The force shall be increased at a rate between 10 and 100 mm/minute until the bending moment at the centre part (M_c) of the femur or tibia reaches 312 Nm.

8.2.1.5. The edges of the knee joint, not bending parts, shall be mounted to the support rig firmly as shown in Figure 35. The Y axis of the impactor shall be parallel to the loading axis within $180 \pm 2^{\circ}$. In order to avoid friction errors, roller plates shall be set underneath the support rigs. To avoid impactor damage, a neoprene sheet shall

be set underneath the loading ram and shall be removed the impactor face of the knee joint which is described in the Figure 14. The neoprene sheet used in this test shall have compression characteristics as shown in Figure 16.

The centre of the loading force shall be applied at the centre of the Knee joint within $\pm [2]^\circ$ tolerance along the Z axis. The external load shall be increased at a rate between 10 and 100 mm/minute until the bending moment at the centre part of the knee joint (M_c) reaches 300 Nm.

8.2.2. Dynamic certification tests (Pendulum Type)

8.2.2.1. The lower legform impactor (femur, knee joint, and tibia are connected/assembled firmly) shall meet the requirements specified in paragraph 8.2.2.3. when tested as specified in paragraph 8.2.2.4.

8.2.2.2. Calibration

8.2.2.2.1. The test facility used for the calibration test shall have a stabilised temperature of $20 \pm 4^\circ\text{C}$ during calibration.

8.2.2.2.2. The temperature of the calibration area shall be measured at the time of calibration and recorded in a calibration report.

8.2.2.3. Requirements

8.2.2.3.1. When the lower legform impactor is used for a test as specified in paragraph 8.1.2.2.4., the maximum bending moment of the tibia at tibia-1 shall be not less than [267] Nm and not more than [218] Nm, the maximum bending moment at tibia-2 shall be not less than [221] Nm and not more than [181] Nm, the maximum bending moment at tibia-3 shall be not less than [172] Nm and not more than [141] Nm, and the maximum bending moment at tibia-4 shall be not less than [119] Nm and not more than [97] Nm. The maximum elongation of MCL shall be not less than [24.6] mm and not more than [20.0] mm, the maximum elongation of ACL shall be not less than [9.0] mm and not more than [7.4] mm, and the maximum elongation of PCL shall be not less than [5.4] mm and not more than [4.4] mm.

For all these values, the readings used shall be from the initial impact timing to 250 ms after the impact timing.

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 Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate and bend to these values.

8.2.2.4. Test procedure

8.2.2.4.1. The impactor, excluding flesh, shall be suspended from the dynamic certification test rig $15 \pm 1^\circ$ 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.

8.2.2.4.2. The stopper block, attached to the front of the stopper bar, shall have compression characteristics as shown in Figure 16 or shall generate maximum compression force from 3.5 to 4 kN when it is subjected to the drop test shown in Figure 37.

8.2.2.4.3. The knee joint centre of the impactor shall be $30 \pm [1]$ mm below the bottom line of the stopper bar, and the tibia impact face shall be located $13 \pm [1]$ mm from the front upper edge of the stopper bar when the stopper block is removed from the stopper bar and then hung from the impactor without any contact (see Figure 36).

8.2.3. Dynamic certification tests (Inverse Type)

8.2.3.1. The lower legform impactor with flesh (femur, knee joint, and tibia are connected/assembled firmly) shall meet the requirements specified in paragraph 8.2.3.3. when tested as specified in paragraph 8.2.3.4.

8.2.3.2. Calibration

8.2.3.2.1. The test facility used for the calibration test shall have a stabilised temperature of $20 \pm 4^\circ\text{C}$ during calibration.

8.2.3.2.3. The temperature of the calibration area shall be measured at the time of calibration and recorded in a calibration report.

8.2.3.3. Requirements

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 less than [270] Nm and not more than [230] Nm, the maximum bending moment at tibia-2 shall be not less than [230] Nm and not more than [200] Nm, the maximum bending moment at tibia-3 shall be not less than [170] Nm and not more than [150] Nm, and the

maximum bending moment at tibia-4 shall be not less than [110] Nm and not more than [80] Nm. The maximum elongation of the MCL shall be not less than [20] mm and not more than [18] mm, that of the ACL shall be not less than [12.5] mm and not more than [8] mm, and that of the PCL shall be not less than [5] mm and not more than [3] mm.

For all these values, the readings used shall be from the initial impact timing to 50 ms after the impact timing.

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 Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate and bend to these values.

8.2.3.4. Test procedure

8.2.3.4.1. The impactor covered by flesh shall be hung vertically as shown in Figure 38. 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.

8.2.3.4.2. The honeycomb, which is attached in front of the moving ram, shall have a crash strength of 75 ± 7.5 psi, and it shall have the dimensions shown in Figure 38.

8.2.3.4.3. The honeycomb 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.

8.2.3.4.4. The impact direction of the moving ram shall be parallel to the horizontal axis with a tolerance of $\pm 2^\circ$.

Paragraphs 8.2. to 8.2.4.7. (former), renumber as paragraph 8.3. to 8.3.4.7.

Paragraph 8.2.1. (former), amend (renumber) to read:

"8.2.1 ... specified in paragraph 8.-23.3. when tested as specified in paragraph 8.-23.4."

Paragraph 8.2.4.6. (former), amend (renumber) to read:

"8.2.4.6. ... at a velocity of 7.1 ± 0.1 m/s into the stationary pendulum as shown in Figure ~~24~~**37**."

Paragraph 8.3. (former) to paragraph 8.3.3.4. (former), renumber as paragraph 8.4. to paragraph 8.4.3.4.

Paragraph 8.3.1.1. (former), amend (renumber) to read:

"8.3.1.1. ... specified in paragraph 8.~~34~~.2. when tested as specified in paragraph 8.~~34~~.3."

Paragraph 8.3.3.1. (former), amend (renumber) to read:

"8.3.3.1. ...impactor shall be suspended from a drop rig as shown in Figure ~~25~~**38**."

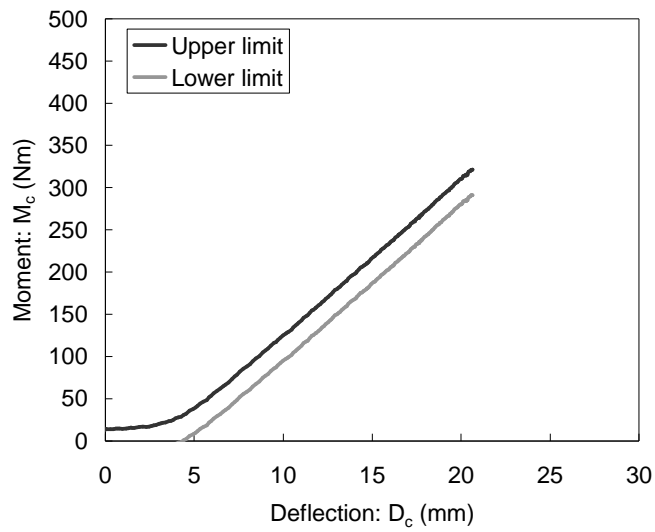
Paragraph 8.3.3.3. (former), amend to read:

"8.3.3.3. ... impactor with respect to the vertical as shown in Figure ~~25~~**37**. The suspension of ..."

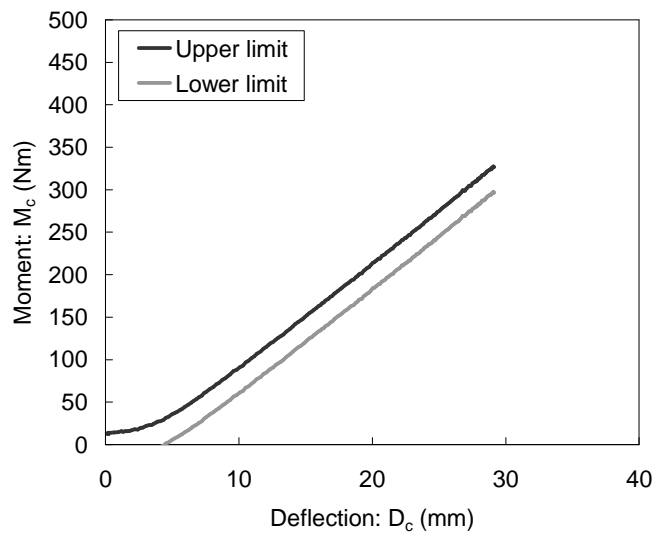
Figure 18 (former) to Figure 23 (former), renumber as Figure 25. to Figure 30.

Insert a new Figure 31 to Figure 38., to read:

"

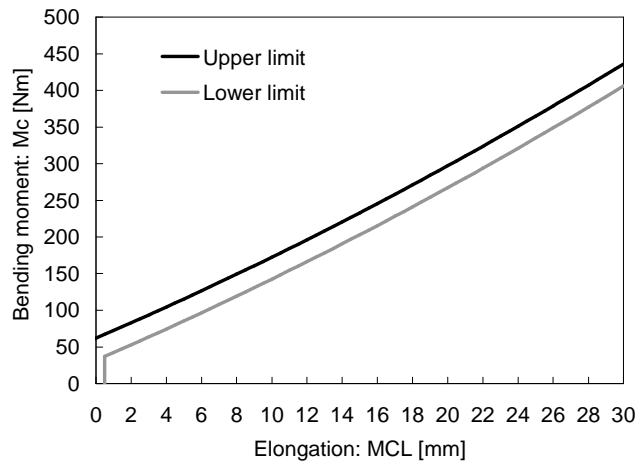


(a) Femur bending corridor

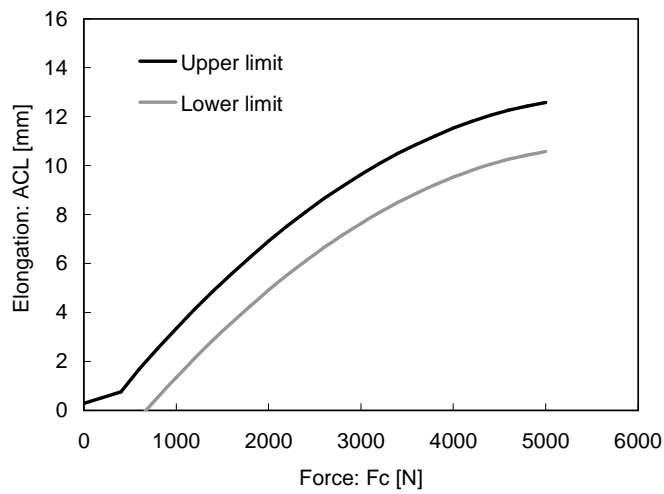


(b) Tibia bending corridor

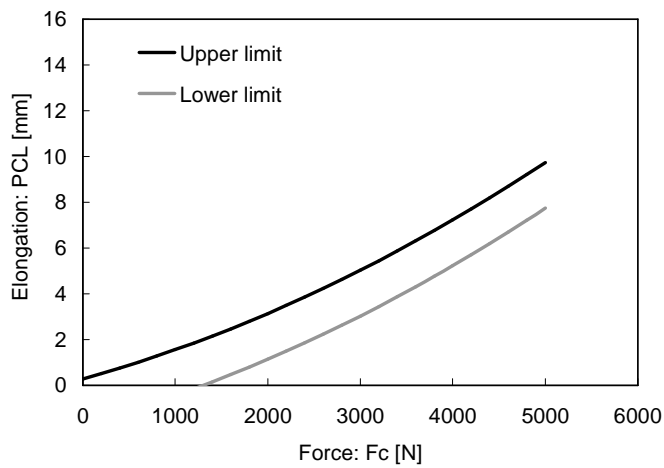
Figure 31: Requirement corridor of femur and tibia in static certification test (see paragraph 8.2.1.2.)



(a) for MCL



(b) for ACL



(c) for PCL

Figure 32: Requirement corridors for knee joint in static certification test (see paragraph 8.2.1.3.)

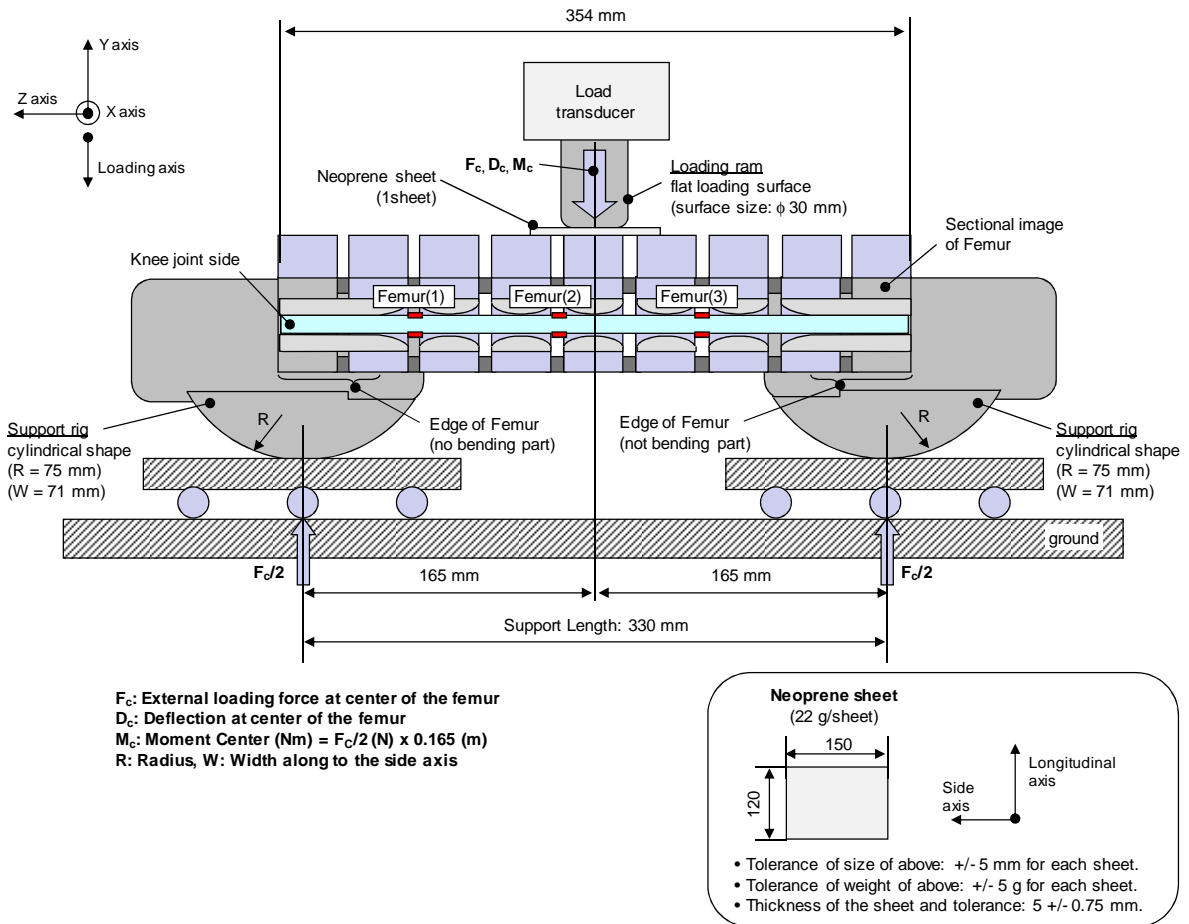


Figure 33: Test set-up for femur in static certification tests
(see paragraph 8.2.1.4.)

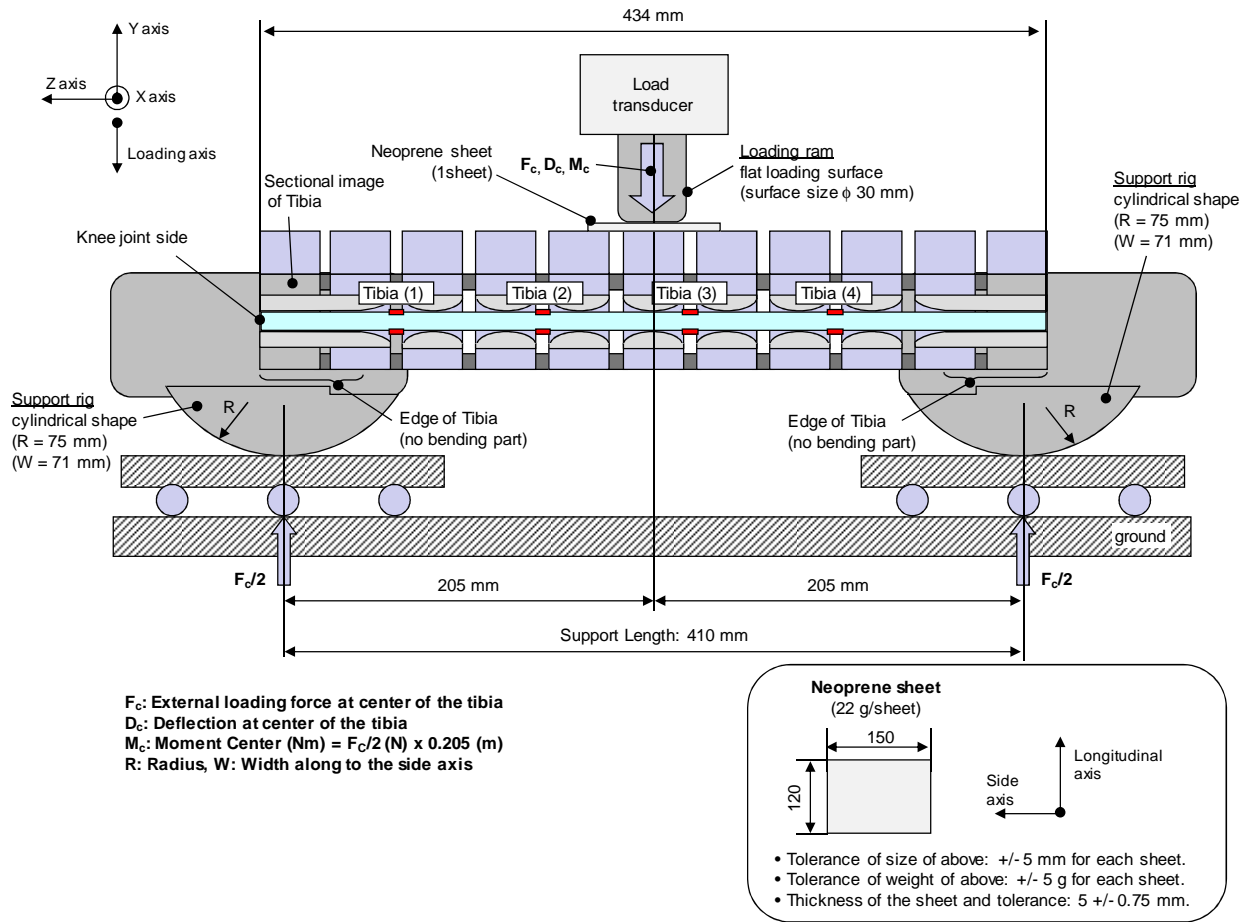
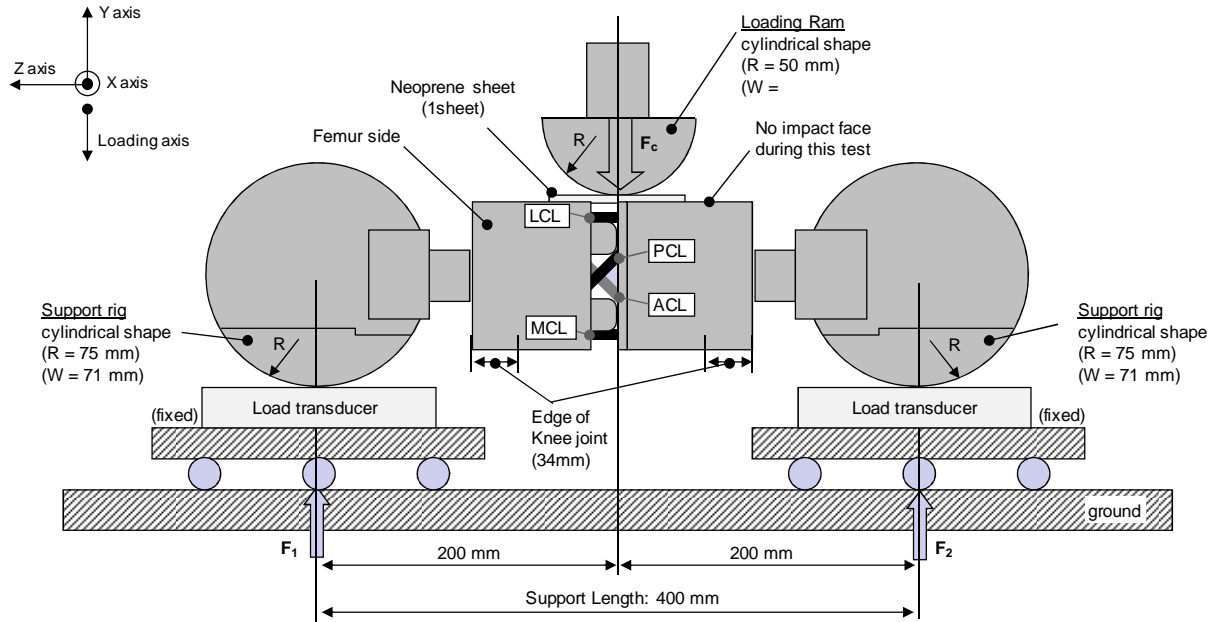


Figure 34: Test set-up for tibia in static certification tests
(see paragraph 8.2.1.4.)

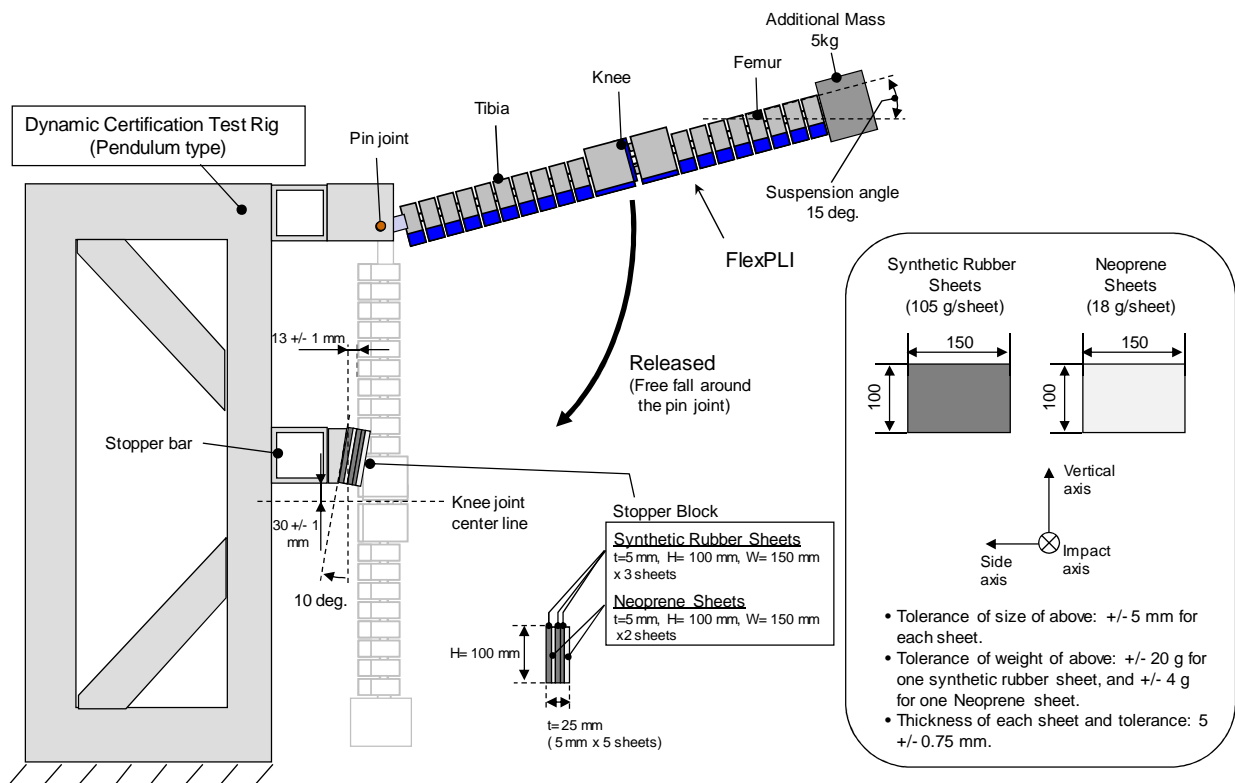


F_0 : External loading force at center of knee joint
 F_1 : Support force of Femur side of knee
 M_c : Bending moment at Knee joint center (Nm) = F_1 (N) x 0.2 (m)
 R : Radius, W : Width along to the side axis

Neoprene sheet
(22 g/sheet)

- Tolerance of size of above: +/- 5 mm for each sheet.
- Tolerance of weight of above: +/- 5 g for each sheet.
- Thickness of the sheet and tolerance: 5 +/- 0.75 mm.

Figure 35: Test set-up for knee joint in static certification test (see paragraph 8.2.1.5.)



Synthetic Rubber Sheets (105 g/sheet)	Neoprene Sheets (18 g/sheet)
<ul style="list-style-type: none"> • Tolerance of size of above: +/- 5 mm for each sheet. • Tolerance of weight of above: +/- 20 g for one synthetic rubber sheet, and +/- 4 g for one Neoprene sheet. • Thickness of each sheet and tolerance: 5 +/- 0.75 mm. 	

Vertical axis
Side axis
Impact axis

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

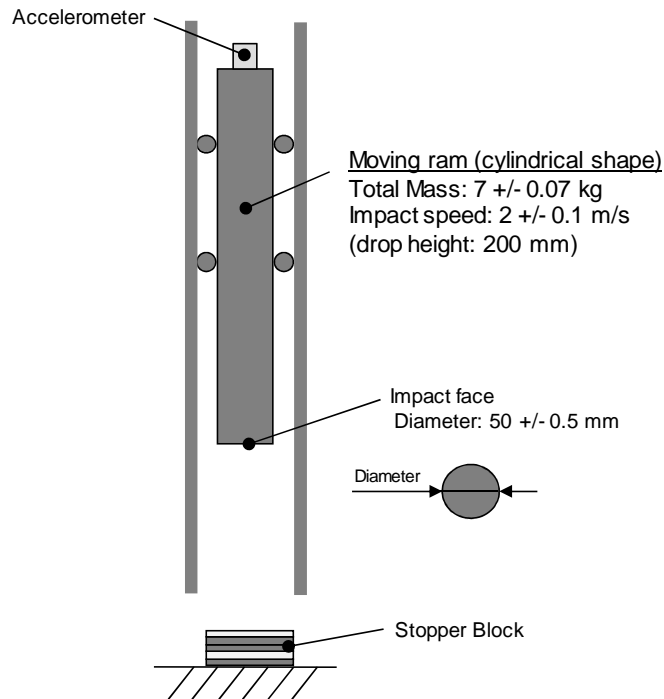


Figure 37: Test set-up for stopper block certification test
 (see paragraph 8.2.2.4.)

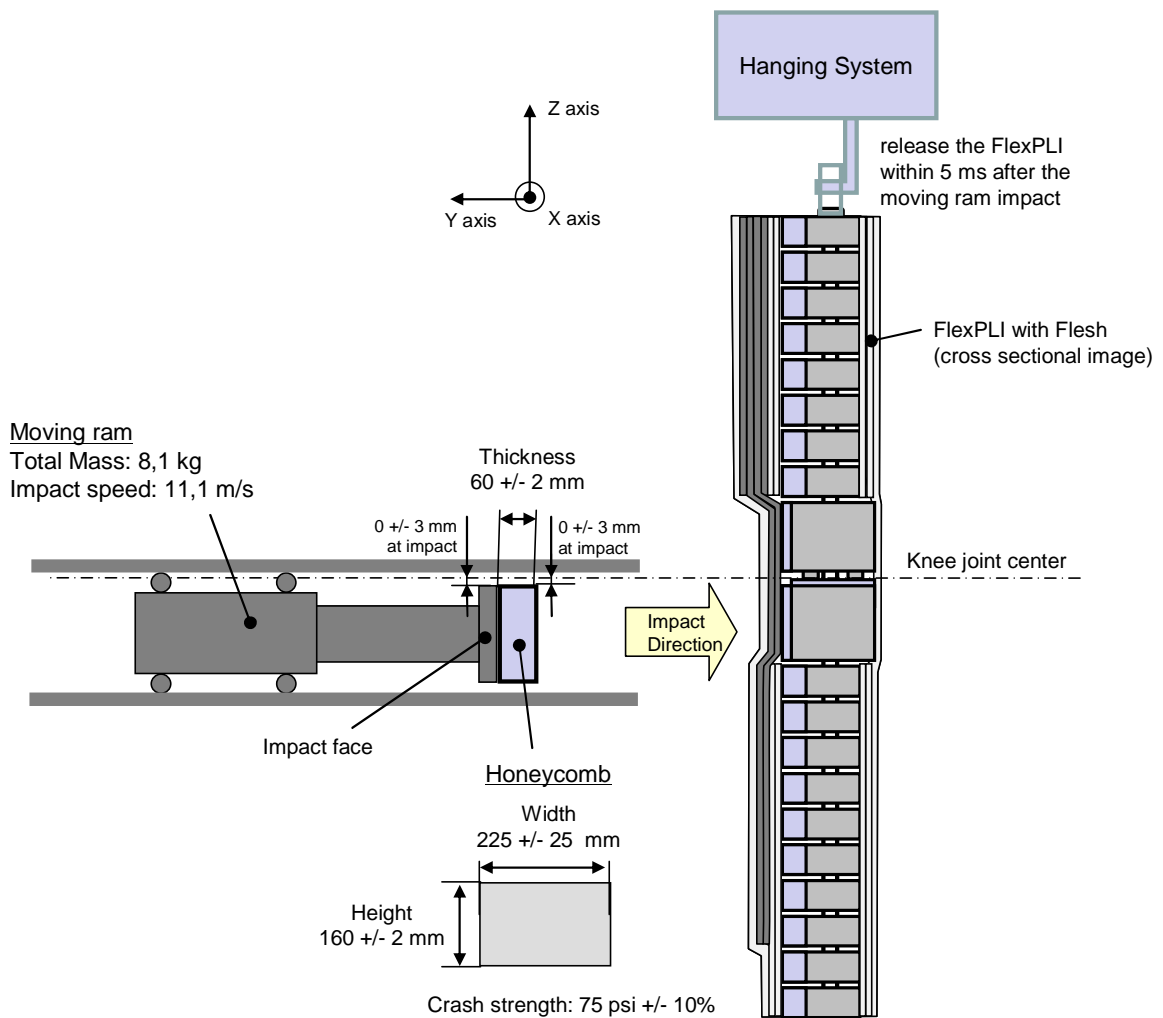


Figure 38: Test set-up for dynamic lower legform impactor certification test,

Inverse type (see paragraph 8.2.3.4.)

Figure 24 (former) to Figure 25 (former), renumber as Figure 39. to Figure 40.

B. JUSTIFICATION

Based on the results of the TEG activities up to now, Japan made a proposal for draft amendments to the gtr on pedestrian protection (gtr9) as a responsibility of the TEG chair country.

Paragraph A. 64: Inserted the sentences based on the TEG activities so far.

Paragraph A. 102: Inserted the sentences regards to the Flexible Pedestrian Legform Impactor (FlexPLI).

Paragraph A. 106: Inserted the sentences based on the TEG activities so far.

Paragraph A. 110: Inserted the sentences regards to the FlexPLI.

Paragraph A. 111: Inserted the sentences regards to the FlexPLI

Paragraph A. 112: Inserted the sentences regards to the FlexPLI

Paragraph A. 113: Inserted the sentences regards to the FlexPLI

Paragraph A. 115: Inserted the sentences regards to the FlexPLI

Title of Section A.10: Inserted the sentences regards to the FlexPLI.

Insert a new Paragraph A. 133.: Inserted the sentences how to introduce the FlexPLI to the each contracting party smoothly.

Section A.10 (former): Renumbering (Editorial).

Paragraph B. 5.1.1: Guidance for the alternative use of the RIGID/TRL lower legform and FlexPLI during an alternative period.

Insert a new Paragraph B. 5.1.1.2.: Inserted the sentences regards to the FlexPLI.

Title of Paragraph B. 6.3.1.1.: Clarification (Editorial).

Title of Figure 12: Clarification (Editorial).

Insert a new Paragraph B. 6.3.1.2. to Paragraph B. 6.3.1.2.7.2: Inserted the new Paragraphs regards to the FlexPLI

Insert a new Figure 13 to Figure 17: Inserted the figures regards to the Flex-PLI.

Paragraph B. 6.3.1.2. (former): Renumbering (Editorial).

Paragraph B. 6.3.1.2.9.1. (former): Renumbering (Editorial).

Paragraph B. 6.3.1.2.9.2. (former): Renumbering (Editorial).

Title of Figure 13: Renumbering (Editorial).

Title of Paragraph B. 6.3.2.1.: Renumbering (Editorial).

Paragraph B. 6.3.2.1.1.: Renumbering (Editorial).

Figure 14 (former): Renumbering (Editorial).

Title of Paragraph B. 6.3.2.2.: Renumbering (Editorial).

Figure 15 (former): Renumbering (Editorial).

Paragraph B. 6.3.2.2.1.: Renumbering (Editorial).

Title of Paragraph B. 7.1.1.: Clarification (Editorial).

Paragraph B. 7.1.1.2.: Renumbering (Editorial).

Paragraph B. 7.1.1.3.: Renumbering (Editorial).

Paragraph B. 7.1.1.3.2.: Renumbering (Editorial).

Figure 16 (former) to Figure 17 (former): Renumbering (Editorial).

Insert a new Paragraph B. 7.1.2. to Paragraph B. 7.1.2.4: Inserted the new paragraphs regards to the Flex-PLI.

Insert a new Figure 23 to Figure 24: Inserted the figures regards to the Flex-PLI.

Paragraph B. 7.1.2. (former) to Paragraph B. 7.1.2.3. (former): Renumbering (Editorial).

Paragraph B. 8.: Renumbering (Editorial) and alternative use of the RIGID/TRL legform impactor and FlexPLI during an alternative period.

Title of Paragraph B. 8.1: Clarification (Editorial).

Paragraph B. 8.1.1.2.: Renumbering (Editorial).

Paragraph B. 8.1.1.3.: Renumbering (Editorial).

Paragraph B. 8.1.1.4.: Renumbering (Editorial).

Paragraph B. 8.1.1.5.: Renumbering (Editorial).

Paragraph B. 8.1.2.4.1.: Renumbering (Editorial).

Paragraph B. 8.1.2.4.2.: Renumbering (Editorial).

Paragraph B. 8.1.2.4.5.: Renumbering (Editorial).

Insert a new Paragraph B. 8.2. to Paragraph B. 8.2.3.4.4: Inserted the new paragraphs regards to the FlexPLI.

Paragraph B. 8.2. (former) to Paragraph B. 8.2.4.7. (former): Renumbering (Editorial).

Paragraph B. 8.2.1 (former): Renumbering (Editorial).

Paragraph B. 8.2.4.6. (former): Renumbering (Editorial).

Paragraph B. 8.3. (former) to Paragraph B. 8.3.3.4. (former): Renumbering (Editorial).

Paragraph B. 8.3.1.1. (former): Renumbering (Editorial).

Paragraph B. 8.3.3.1. (former): Renumbering (Editorial).

Paragraph B. 8.3.3.3. (former): Renumbering (Editorial).

Figure 18 (former) to Figure 23 (former): Inserted the figures regards to the FlexPLI.
