

This is a translation to English for reference purpose of JNCAP test method which is originally prescribed in Japanese language.

Please be sure to refer to the Japanese test method if you need to be precisely correct.

PEDESTRIAN LEG PROTECTION PERFORMANCE TEST PROCEDURE

Created: April 1, 2011

Revised: March 20, 2018

1. Dates Effective

This testing procedure was first implemented on April 1, 2011. However, the changes made on March 20, 2018 went into effect on April 1, 2018.

2. Scope of Application

This test procedure applies to the “Pedestrian Leg Protection Performance Test” of passenger vehicles with 9 occupants or less and commercial vehicles with a gross vehicle mass of 2.8 tons or less, excluding a car for which the highest Lower Bumper Reference Line (“LBRL”, see Paragraph 4.1.7.2) height measured among the bumper corners (see Paragraph 4.1.7.1) conducted by the National Agency for Automotive Safety and Victims’ Aid (NASVA) in the new car assessment program information supply project, is less than 425mm.

However, if it is confirmed that the car does not generate “Pushing Down Mode (see Attachment 1)” during the test by technical documents submitted by the vehicle manufacturer and importer, the testing protocol can be applied to a car which has a highest LBRL height of 425 mm or over.

3. Definition of Terms

The terminology in this testing procedure is defined as follows:

- (1) **Ground Reference Plane:** a horizontal plane, either real or imaginary, that passes through the lowest points of contact for all tires of a vehicle.
- (2) **A Pillars:** The foremost and outermost roof supports extending from the chassis to the roof of the vehicle.
- (3) **Legform Impactor:** A test device which simulates human leg constructions, and it has flexible long bones as well as the human ones. (more details are described in Attachment 2)
- (4) **Tibia Bending Moment:** The measured bending moment at the tibia of the legform impactor.
- (5) **MCL Elongation:** The measured elongation at the medial collateral ligament (MCL) located at the knee of the legform impactor.
- (6) **ACL Elongation:** The measured elongation at the anterior cruciate ligament (ACL) located at the knee of the legform impactor.

- (7) **PCL Elongation:** The measured elongation at the posterior cruciate ligament (PCL) located at the knee of the legform impactor.

4. Testing Requirements

4.1 Conditions of Test Vehicle

4.1.1 Data Submitted by the Vehicle Manufacturer

The vehicle manufacturer shall provide NASVA with the following data necessary for preparing the test vehicle properly.

- (1) Appendix 1
- (2) Special verification items relating to preparation of the test.

4.1.2 Mass of Test Vehicle

The mass of the test vehicle shall be adjusted between 100% and 101% of the mass at vehicle delivery* without installing the mass on the driver's seat and the front passenger's seat (seat parallel to the driver's seat and situated adjacent to the side face of the vehicle; hereinafter the same).

However, this shall not apply if the mass of the vehicle cannot be adjusted to this range after removing parts that will not affect the test. When the vehicle is equipped with a spare tire and tools, it is permissible to test the vehicle as it is.

* Mass at vehicle delivery: The test institute shall measure the mass of the vehicle received after filling with every liquid except fuel to the maximum within a specified range and filling with the fuel to 100% of the fuel tank capacity. This mass is referred to as the mass at vehicle delivery.

4.1.3 Vehicle Posture

The vehicle posture is specified as follows:

- (1) The vehicle posture of the test vehicle shall be the condition the vehicle when brought in, however, test vehicles equipped with a height adjusting device shall be adjusted to the position specified for a traveling speed of 40 km/h. And if the vehicle is equipped with a manual height adjusting device, the vehicle shall be set to the standard position.
- (2) If the vehicle is equipped with an impact force reduction device for pedestrian protection which works upon car impact with a pedestrian, the vehicle manufacturer shall provide technical documents which explain the influence of the device regarding pedestrian leg injuries. NASVA will carefully verify the technical documents, then decide whether to conduct the test "the device activated," "the device deactivated," "the system needed to activate the device activated during the test."
- (3) A mass the same as the Hybrid III dummy with the mass equivalent to 50 percentile adult male (75kg) shall be installed on the center surface of the driver's and front passenger's seats. The dummy shall comply with the stipulations provided in Title 49, Part 572, Subpart E of CFR (Code of Federal Regulations) as amended in the Federal Register No. 63 dated February 4, 1998.
- (4) Front wheels are set to the straight-traveling state. The direction of the vertical cross section of the vehicle must be within $\pm 2^\circ$ with respect to the direction of projection of the legform impactor.

- (5) Before conducting the test, the vehicle manufacturer shall provide NASVA with wheel arch design height measurements after going through steps (1) to (4) of vehicle posturing (hereinafter referred to as, "Normal Riding Posture.") If the vehicle's wheel height is $\pm 25\text{mm}$ from the design position, that design position shall be deemed the normal riding posture wheel height and the test will be conducted by either adjusting the vehicle's design position (within $\pm 2\text{mm}$) or by correcting the impact height of the legform impactor.
- (6) If the test is conducted after the side collision test, it is assumed to be impossible to conduct vehicle adjustment based on the protocol of (1) to (4). In this case, the following vehicle adjustments shall be made:
- (a) Measure the vehicle posture (fore-and-aft, and lateral directions) before the side collision test, then adjust the test vehicle posture within the tolerance $\pm 0.1^\circ$ in the fore-and-aft direction and lateral direction based on the measured values beforehand. The vehicle posture shall be adjusted by adjusting the tire pressure (standard tire pressure $+25, -50\text{kPa}$) or by using additional weights.
 - (b) The test may be evaluated by using vehicle height tolerance (vehicle height before the side collision test $\pm 5\text{mm}$; the point at which vehicle height is measured shall not be deformed by the side collision test). However, if it is difficult to adjust the car by using the vehicle height tolerance, it is permissible to adjust the vehicle height difference (before and after the side collision test) by adjusting the impact height of the legform impactor to the car.
- (7) If the seat is taken off the test vehicle to conduct the neck injury protection performance test in the rear-end collision, vehicle posture measurements taken when it was marked will be used in order to conduct the following test in the same posture. In this case, tolerance of longitudinal axis shall be within $\pm 0.1^\circ$, tolerance of lateral axis shall be within $\pm 0.1^\circ$ and tolerance of vehicle height shall be within $\pm 5\text{mm}$. However, if it is difficult to adjust the car within the tolerance, it is possible to adjust the vehicle height difference before and after removing the seat by adjusting the impact height of the legform impactor to the vehicle.

4.1.4 Test Vehicle Fluids

- (1) Every liquid except fuel shall be provided to the maximum within the specified range.
- (2) Fuel or an alternative fuel having a specific gravity similar to that of the fuel shall be provided to 100% of the fuel tank capacity.
- (3) If liquid cannot be filled as specified in (1) and (2) above for a vehicle after the side collision test, filling of (1) and (2) shall be implemented as much as possible.

4.1.5 Seat Adjustments

- (1) If the driver's seat and front passenger's seat are adjustable in the fore-aft direction, they shall be adjusted to the middle position. If adjustment to the middle position is not available, the seats shall be adjusted to a position behind the middle position but at the nearest adjustable position.
- (2) If the driver's seat and front passenger's seat are adjustable only in the vertical direction, they shall be adjusted to the lowest position.
- (3) If the driver's seat and front passenger's seat have other than the adjustable mechanisms in (1) and

(2), they shall be adjusted to the design standard positions and angles.

(4) Seats other than the driver's seat and front passenger's seat shall be adjusted to the design standard positions and angles.

4.1.6 Other Vehicle Conditions

4.1.6.1 Ignition

The engine of the test vehicle shall be stopped and the ignition switch shall be turned to the off position.

4.1.6.2 Side Doors

The doors of the test vehicle shall be closed securely. However, this shall not apply to doors of a vehicle after the side collision test that cannot be closed.

4.1.6.3 Roof

If the vehicle has a removable roof, the roof shall be installed.

If the vehicle has a sunroof, the sunroof shall be closed.

If the vehicle is convertible, the top shall be closed.

4.1.6.4 Tires

Air pressure of the tires shall be kept at the recommended level indicated in the specification table of the user's manual or label on the vehicle body. However, if the car conditions (posture, fore-aft wheel arch height, etc.) need to be adjusted by following procedures of Paragraph 4.1.3, (5) and (6), it is possible to ignore this requirement.

4.1.6.5 Securing the Vehicle

The tires of the test vehicle shall be secured by using appropriate holding means such as a parking brake or chocks.

Vehicles with automatic transmissions shall be held in place using a parking brake and keeping on P position or applying chocks.

4.1.6.6 Rearview Mirror, etc.

It is permissible to remove the rearview mirror and auxiliary mirror provided near the bonnet, wing, or A-pillar as long as this will not influence the test results.

4.1.6.7 Other

(1) If the secondary collision of the legform impactor might affect certain areas on the vehicle, it is permissible to protect such areas with a cover or other means as long as the protective measures do not affect the test results.

(2) It is permissible to protect the driver's seat and front passenger's seat from flying pieces of broken glass from the windshield.

4.1.7 Marking the Test Range, etc

After the vehicle is run for stabilization of the vehicle posture, the following markings shall be made on the vehicle.

4.1.7.1 Front Bumper Corner

(1) Mark the front bumper corner, which is the point of the vehicle where the vertical plane makes an

angle of 60deg with the vertical longitudinal plane of the car and is tangential to the outer surface of the front bumper (see Figure 3.1). Mark both sides (left and right sides) of the front bumper.

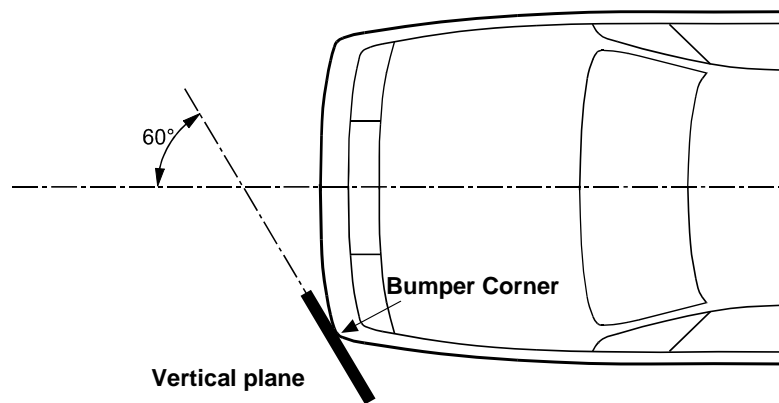


Figure 3.1: Front Bumper Corner

(2) Where multiple or continuous contacts occur, the most outboard contact shall form the bumper corner.

4.1.7.2 Lower Bumper Reference Line (LBRL)

Mark the lower bumper reference line among the bumper corners which is defined as the geometric trace of the lowermost points of contact between a straightedge 700mm long and the bumper, when the straightedge, held parallel to the vertical longitudinal plane of the car and inclined forwards by 25deg from the vertical, is traversed across the front of the surface of the bumper (see Figure 3.2).

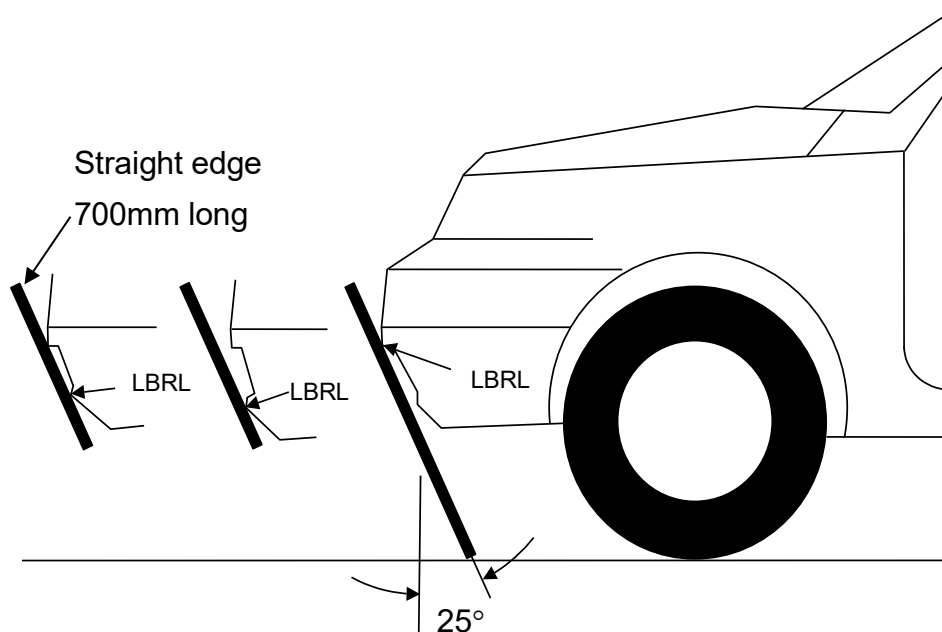


Figure 3.2: Lower Bumper Reference Line

4.1.7.3 Upper Bumper Reference Line (UBRL)

(1) Mark the upper bumper reference line among the bumper corners which is defined as the geometric

trace of the uppermost points of contact between a 700mm straightedge and the bumper, when the straightedge, held parallel to the vertical longitudinal plane of the car and inclined rearwards by 20deg to the vertical, is traversed across the front of the car among the bumper corners, while maintaining contact with the surface of the bumper (see Figure 3.3).

For vehicles with no identifiable bumper structure, it is defined as the geometric trace of the uppermost points of contact between a straight edge 700mm long and the bumper area, when the straight edge, held parallel to the vertical longitudinal plane of the car and inclined rearwards by 20deg from the vertical is traversed across the front of the car, while maintaining contact with the ground and with the surface of the bumper area.

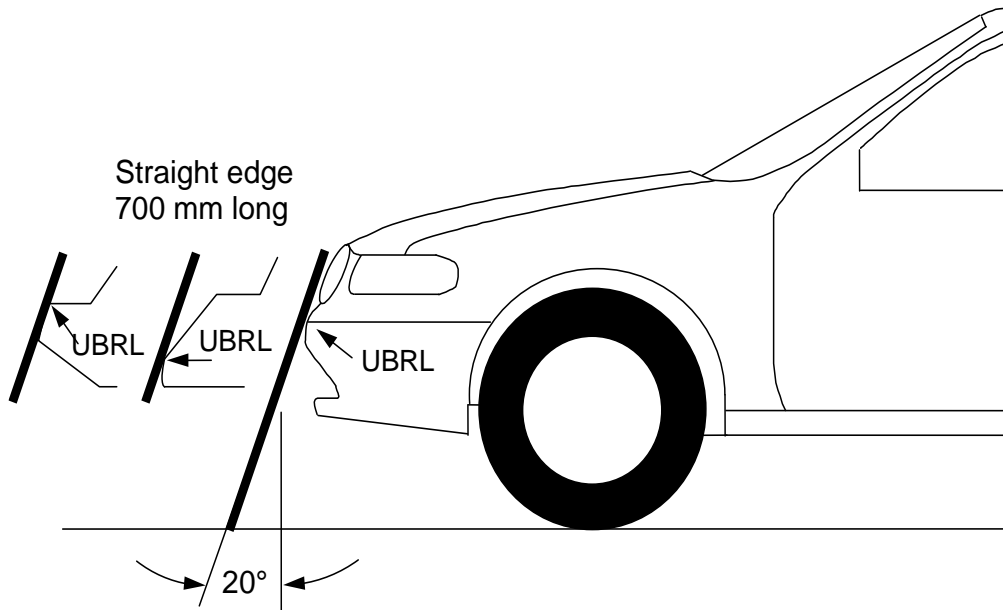


Figure 3.3: Upper Bumper Reference Line (UBRL)

- (2) During the marking process of (1), the straightedge may be shortened to avoid contact with structures above the bumper, or lengthened to reach the bumper.
- (3) During process (1) above, the tracing may be skipped over a structure of 100 mm or less. In such a case, the side ends of the structure shall be linked with straight lines.

4.1.7.4 Test Area

The test area is the frontal surface of the bumper limited by two longitudinal vertical planes intersecting the bumper corners and inboard of the bumper corners.

4.1.7.5 Partitioning the Test Area

The UBRL (upper bumper reference line) among bumper corners shall be divided into three by using the UBRL length, which is measured by flexible tape ignoring any small unevenness on the bumper. Divided points, including bumper corners, shall be marked on the UBRL, then lines shall be drawn on the front bumper in the longitudinal vertical planes intersecting the divided points. The divided test area shall be called "sub test areas", and labeled "L1", "L2" and "L3" from the right side of the car. Additionally, vertical lines shall be drawn on the points separating the UBRL. The divided test area shall

be called "sub-sub test area", and labeled "A" and "B" from the right side of the car. "A" and "B" shall be added to the label of each sub test area. (see Figure 3.4).

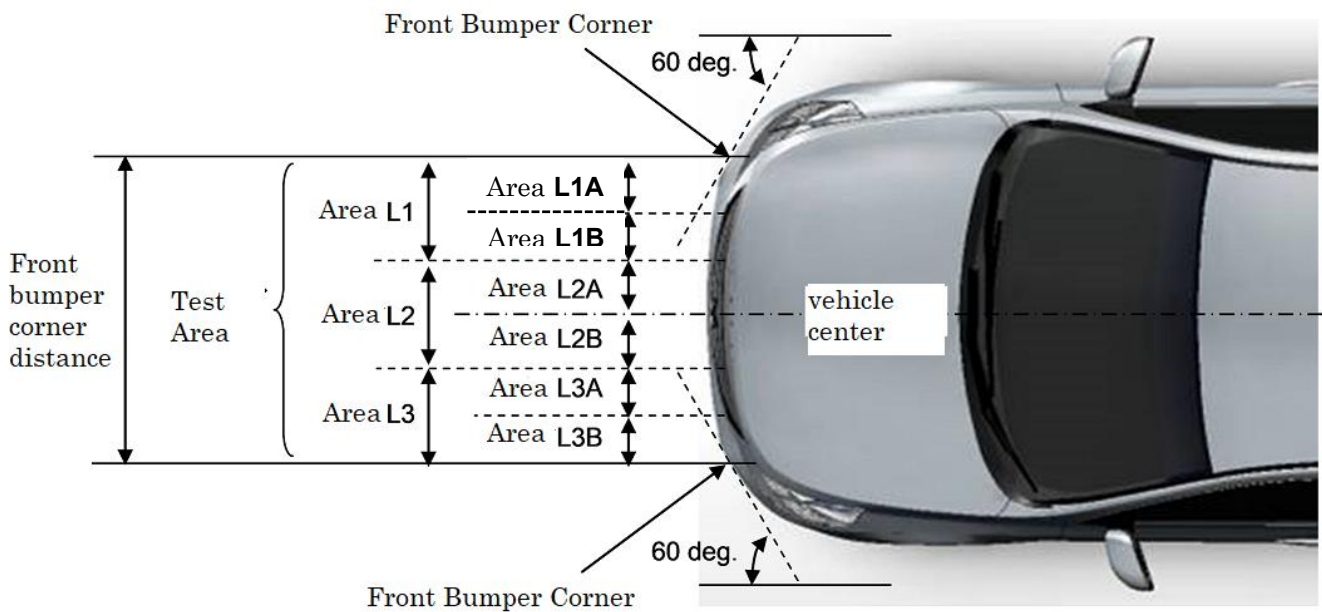


Figure 3.4: Determining and Labeling the Test Areas

4.1.8 Impact Points

4.1.8.1 Impact points for Assessment (First Candidate Impact Points)

- (1) The impact area shall be identical to the test area as determined in Paragraph 4.1.7.4. NASVA selects three impact points from the L1, L2 and L3 areas, and selects a single impact point from each sub test area. The selected impact points are assumed by NASVA to be the most dangerous impact points for a pedestrian leg in each sub test area.
- (2) If two of the selected impact points are symmetrical in the longitudinal vertical plane intersecting the vehicle center and are assumed to have the same internal structure, one side test result may be applied to the other side.
- (3) Additionally, if there are structures outboard of the bumper corners which are deemed to be clearly more injurious to a pedestrian's legs, these areas shall be struck and those test results may be used as the results for L1A or L3B. Such tests will be limited to locations between the two outermost ends of the bumper beam/lower rails/cross beam structures.
- (4) The impact points shall be laid out at least 132 mm away from each other (in straight-line distance).
If this spacing requirement prevents a test from being performed for a sub test area, the area can be assigned the score from the most appropriate adjacent sub test area located in the same sub test area or symmetrical sub test area in the longitudinal vertical planes intersecting the vehicle center.
- (5) The selected impact points shall be entered into Appendix 2-1.

4.1.8.2 Second Candidate Impact Points (Impact Points of the Target Test)

- (1) The test vehicle manufacturer can request to set second candidate impact points excluding the sub-sub test areas which include NASVA-selected impact points (first candidate impact points) as long as

NASVA is informed immediately. If NASVA selected impact points at the boundary of the sub-sub test area, i.e. boundary points "A" and "B", the vehicle manufacturer can select either sub-sub test area "A" or "B" to set the second candidate impact points as long as NASVA is informed immediately.

(2) The second candidate impact points shall be selected by NASVA as the points that are most dangerous for a pedestrian leg in the selected sub-sub test areas.

(3) The impact points shall be laid out at least 132mm away from each other (in straight-line distance). If this spacing requirement prevents a test from being performed for a sub test area, the area can be assigned the score from the most appropriate adjacent sub test area located in the same sub test area or symmetrical sub test area in the longitudinal vertical planes intersecting the vehicle center.

4.1.9 The Legform impactor

(1) The legform impactor must meet the specifications stipulated in Paragraph 1 of Attachment 2.

(2) The legform impactor shall be fitted with four transducers to measure the tibia bending moment at the tibia (one transducer at each of four locations) and three transducers to measure the elongation of MCL, ACL and PCL (one transducer for each) at the locations prescribed.

(3) The characteristics of the legform impactor must successfully pass the legform impactor certification tests specified in Paragraph 2 of Attachment 2.

(4) Wires and such may be attached to the legform impactor in order to protect it from damage as long as adverse effects to the test are minimized.

4.1.10 Temperature Conditions

Ambient temperatures of the test vehicle (exchanged parts), testing equipment, and legform impactor during the test must be kept at $20 \pm 4^{\circ}\text{C}$. And, the legform impactor used for the test must be kept in this temperature environment for four hours at least prior to the test.

5. The Testing Facility

5.1 The Impact Generator

The impact generator shall be capable of propelling the legform impactor (weighing around 13kg) in free flight to the front surface of the test vehicle at a speed of $40.0 \pm 0.7\text{km/h}$.

5.2 Speed-Measuring Device

The speed measuring device shall be capable of measuring the legform impactor speed just before impacting with the vehicle's front with an accuracy of 0.1km/h .

5.3 Angular Rate Sensor

The angular rate sensor shall be capable of measuring the angular rate with an accuracy of 0.1deg./sec .

5.4 High-Speed Photography Device

The photographing frame speed of the high-speed photographing device must be set at least 1,000 frames per second and shutter speed must be set at $1/5,000\text{ sec}$. or more.

5.5 Temperature-Measuring Device

The minimum scale values of the temperature indicator used shall be 0.1°C .

5.6 Electric Measuring Devices

5.6.1 Accuracy and Frequency Characteristics

- (1) The measuring device used must meet the ISO6487:2002*¹¹ requirements for all the equipment including its components as well as the output devices (including the computer for analysis) being connected. (The measuring device in this state is called the "measuring channel").
- (2) The channel class (an index that specifies the frequency characteristic of the measuring channel, which is the relation between the input frequency and the ratio of input to output) of the bending moments measured at the tibia and elongations measured at the knee regarding the legform impactor shall be CFC 180.
- (3) When analog-to-digital conversion is conducted on the measuring channel, the number of samples per second shall be at least 10,000.
- (4) The measurements for the legform impactor shall be taken only for the major impact with the vehicle, prior to the rebound phase. This "rebound phase" refers to the zero crossing after the maximum of the MCL elongation or of the tibia bending moments shall be considered as the end of the major impact with the vehicle.
- (5) The elimination of high frequency components (filtered) must be completed before evaluating the measured data.

5.6.2 Range of the Measuring Devices

5.6.2.1 Bending Moment Transducer

The measurement range of the transducers for measuring bending moment at the tibia shall be from -300 Nm to +500 Nm.

5.6.2.2 Elongation Transducer

The measurement range of the transducers for measuring elongation at the knee points shall be from -5 mm to +30 mm.

5.6.3 Recording of Electric Measuring Results to Recording Media

The measuring results of the legform impactor acceleration to the recording media shall be recorded with the channel class of 1,000 or above.

5.7 3-D Measuring Devices

The accuracy of 3-D measuring devices used in measurement of impact points on the test vehicle shall be 0.5mm/m at maximum.

6. Testing Method

6.1 Impact Conditions

The legform impactor is mounted on the impact generator, then impact is applied to the specified impact point on the test vehicle with the following impact conditions:

- (1) The permissible range of the impact velocity shall be 40.0 ± 0.7 km/h (if possible, ± 0.5 km/h is

*¹¹ ISO6487:2000 is considered as the same requirement

preferable). However, even if the impact velocity has exceeded this range, the test data is acceptable as long as the results can obtain the best performance points of this assessment.

- (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 $0 \pm 2^\circ$ at the time of first contact. The axis of the legform impactor shall be perpendicular to the horizontal plane, with a roll and pitch angle tolerance of $\pm 2^\circ$ in the lateral and longitudinal plane (if possible, $0 \pm 1^\circ$ is preferable). The horizontal, longitudinal and lateral planes are orthogonal to each other (see Figure 5.2).
- (3) The bottom of the legform impactor shall be at 75 mm above the ground reference plane at the time of first contact with the bumper (see Figure 5.1), with a $\pm 10\text{mm}$ tolerance (if possible, a $\pm 5\text{mm}$ tolerance is preferable).

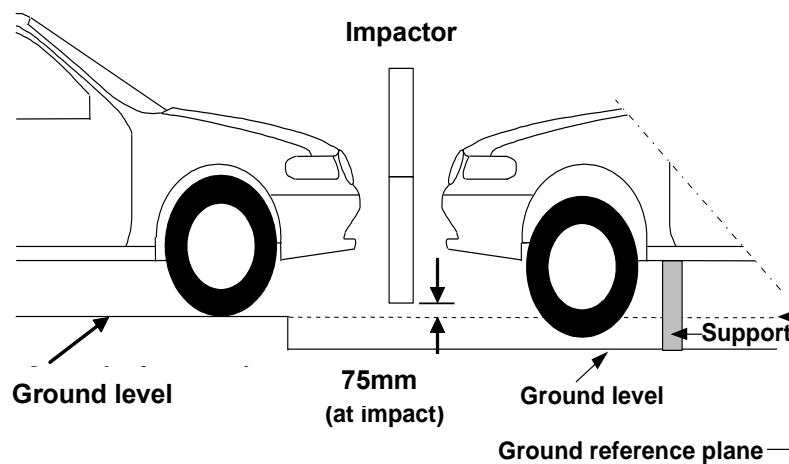


Figure 5.1: Impact Height of Legform impactor
(Complete vehicle in normal riding posture (left)
and or cut-body mounted on supports (right))

- (4) The legform impactor for the bumper tests shall be in 'free flight' at the moment of impact. The legform 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 legform impactor with the propulsion system during rebound of the legform impactor.
- (5) The legform impactor may be propelled by any means that can be shown to meet the requirements.
- (6) At the time of first contact, the legform impactor shall have the intended orientation about its vertical axis, for the correct operation of its knee joint, with a yaw angle tolerance of $\pm 5^\circ$ (see Figure 5.2).

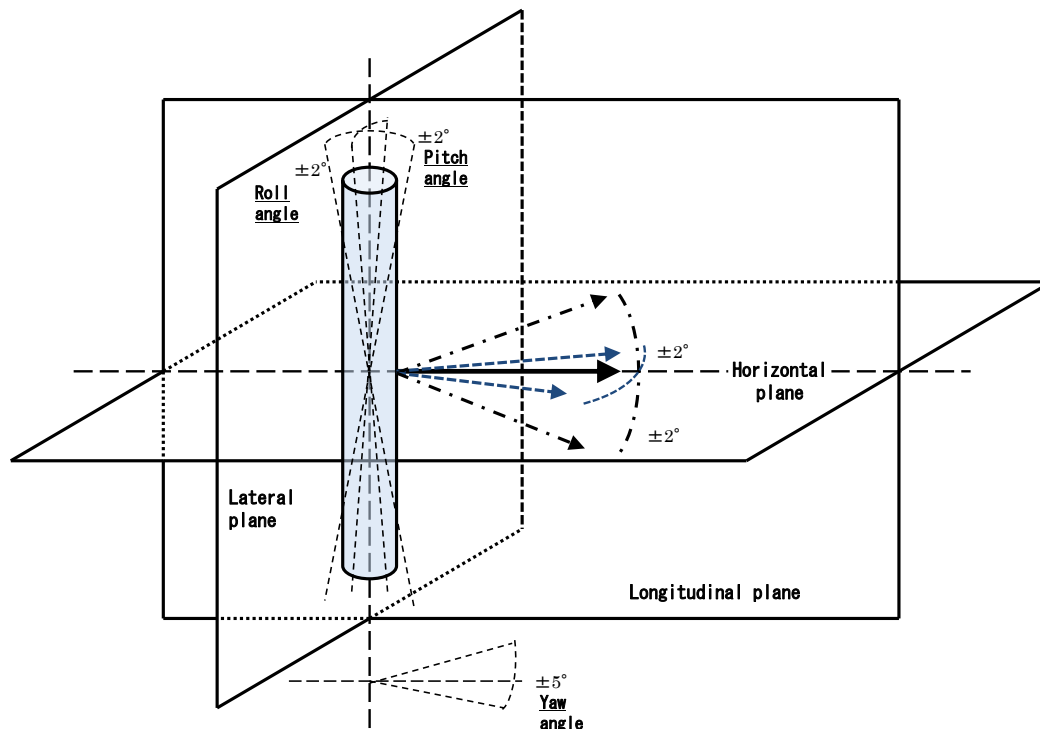


Figure 5.2: Tolerances of Angles for the Legform impactor at the time of the First Impact

- (7) At the time of first contact, the centerline of the legform impactor shall be within a $\pm 10\text{mm}$ tolerance of the selected impact location.
- (8) During contact between the legform impactor and the vehicle, the impactor shall not contact the ground or any object which is not part of the vehicle.
- (9) The effect of gravity shall be taken into account when the impact velocity is obtained from measurements taken before the time of first contact.
- (10) The bending moment generated at the tibia before the vehicle impact shall be $\pm 10\text{Nm}$ which is judged by using absolute maximum values within just before the impact with the vehicle (if possible, $0 \pm 5\text{Nm}$ is preferable). The load level of the elongation measuring devices at the knee portions shall be up to $\pm 1\text{mm}$. To determine the points for the bending moment in this case, use the maximum value (absolute value) taken before the collision, and determine the points of elongation at the moment of impact.
- (11) When the same flesh (consisting of synthetic rubber sheets and neoprene sheets) is used for the next test, approximately two hours must be allowed between tests to wait for the elasticity of the flesh to be restored. However, if the testing institute changes the flesh to another, there is no need to consider this requirement.

6.2 Test Omissions

If the selected collision points are symmetrical about the longitudinal vertical plane intersecting the vehicle center and are assumed to have the same internal structure, it is possible to apply the test

results for one side to the other side.

6.3 Testing After the Side Collision Test

Collision points that might affect the results of the side collision test may be tested after the side collision test. However, to be allowed to use this protocol, the vehicle manufacturer shall submit technical documents to NASVA to explain the collision points that affect the side collision test results if the points were tested before the side collision test.

6.4 Exchanging of Parts

A deformed or damaged part (e.g. bonnet, bumper, spoiler, headlight, etc.) must be replaced before the next test, except those conducted at the locations specified below. Additionally, for exchanging parts at the front of the vehicle, refer to Attachment 3.

- (1) The collision point of the next test is more than 400mm from the collision point of the preceding test.
- (2) The deformed or damaged parts are unlikely to affect the next test result.

7. Recording and Measuring Items

7.1 Recording Prior to the Test

7.1.1 Confirming and Recording Received Vehicle for Test

After receiving a vehicle for the test, the testing institute shall check the following items and record the results in the Appendix. At the same time, the test institute must make sure that the vehicle received complies with specifications of the vehicle provided from NASVA.

- (1) Name, model, and classification number or symbol of the vehicle
- (2) Frame number
- (3) Shape of body
- (4) Engine model
- (5) Drive system
- (6) Type of transmission
- (7) Type of tires

7.1.2 Recording the Impactor Certification Results

- (1) Characteristics of the legform impactor shall successfully pass the certification test specified in Paragraph 1.7 of Attachment 2.
- (2) The testing institute must record details of the legform impactor certification test in Appendix 5.
- (3) If the flesh or main body of the legform impactor is damaged during the test and those parts are then repaired, the repaired legform impactor must successfully pass the pendulum type dynamic certification test specified in Paragraph 2 of Attachment 2.

7.1.3 Recording of Calibration Results of Measuring Instruments

- (1) Results of the calibration conducted prior to the test, on the measuring instruments (measuring channels used by the evaluation) shall be recorded. The calibration remains effective for one year irrespective of how many times the instruments may be used during this period. However, if abnormalities are observed, they must be recalibrated.

- (2) Correctness of computation of the injury value shall be verified by using the calibration signal generator, unless the calibration described in (1) was conducted not only for each channel including transducers but also for the data acquisition system.

7.1.4 Recording of Final Vehicle Condition Prior to Test

After preparing the test vehicle according to the protocol described in Paragraph 3, the following items shall be checked and recorded:

- (1) Mass of the test vehicle
- (2) Names and masses of the parts removed, and the mass after adjustment
- (3) Heights of the vehicle (the points for measuring vehicle height shall be specified by the vehicle manufacturer)
- (4) Collision points
- (5) Reference impact-measuring points

7.1.5 Recording of Test Room Temperature, etc.

Regarding the temperature conditions specified in 4.1.10, the following shall be recorded into Appendix 6:

- (1) The test room temperature
- (2) The duration during which the legform impactor was kept at the environment specified in Paragraph 4.1.10.

7.2 Recording During the Test

7.2.1 Recording Impact Velocity, Free Flight Posture of Legform Impactor, and Deviations from the Target and Impact Points

- (1) The velocity of the legform impactor just before the impact with the test vehicle shall be measured using a velocity indicator, and the measured velocity shall be recorded.
- (2) If the velocity indicator has any trouble in (1), the time differential of the moving distance of the legform impactor just before impact in the high-speed photographing shall be adopted and recorded as an equivalent to impact velocity.
- (3) The legform impactor posture data during the free flight (from launch to the impact with the vehicle) shall be recorded.
- (4) The flight attitude in the case of angular rate indicator failure in the measurement in (3) shall be determined from the high-speed images and the crash position deviation in (5), etc., and NASVA shall consult with the vehicle manufacturer, etc., to determine whether or not to adopt the results of said test.
- (5) Collision point deviation shall be determined and recorded by checking the positions of marks such as paint left on the legform impactor prior to the test.

7.2.2 Recording of Electric Measurements

Electric measurements for injury assessment shall be recorded from -50ms to 100ms or longer. Additionally, for monitoring purpose, it is recommended to record the bending moment at the femur, elongation of the lateral collateral ligament (LCL) at the knee and acceleration at the knee (tibia side).

7.2.3 Recording the Maximum Values

By using the measured waveform data recorded as specified in Paragraph 7.2.2, the maximum values of all measurement items shall be calculated and recorded.

7.2.4 High-Speed Photography

A high-speed VTR or the like shall be used as an auxiliary recording system in order to record the free flight and impact posture of the legform impactor during the test.

7.3 Recording After the Test

7.3.1 Filming the Vehicle Condition Immediately After the Test

The test vehicle's following conditions shall be photographed:

- (1) Damaged locations near the collision point
- (2) Damaged internal parts within the collision point

7.3.2 Confirming and Recording the Damaged Parts

Check damages on the following parts of the test vehicle, and record the damages.

- (1) The bonnet
- (2) The front bumper (bumper face, grill, internal parts, etc.)
- (3) The front body (the radiator support, etc.)

7.4 Management of Measured Values

The following rules apply to management of measured values:

- (1) Measurement on the impact velocity (km/h) shall be recorded up to the first decimal place.
- (2) Measurement on the posture angles (deg) of the legform impactor shall be recorded up to the first decimal place.
- (3) Measurement values shall be rounded at the first decimal place and recorded up to the next whole number.
- (4) Measurement value of LBRL height (mm) from the ground level shall be rounded at the first decimal place and recorded up to the next whole number.

Definition of Pushing Down Mode

1. Definition

If the test result matches the situation described below, pushing down mode is considered to have occurred:

- ① The femur of the legform impactor leaned toward the ground hitting direction within 20ms after the impact.
- ② The femur of the legform impactor leaned toward the ground hitting direction before the maximum values of (a) bending moment of tibia, (b) elongation of MCL and (c) elongation of ACL occurred.

Specifications of Legform impactor and Requirements for Certification

1. Specifications of Legform impactor

The legform impactor shall consist of flesh, flexible long bone segments (representing femur and tibia), and a knee joint as shown in Figure 1. The overall length of the legform impactor shall be 928 ± 3 mm, and its mass including flesh shall be 13.2 ± 0.7 kg. The length of the femur, knee joint, and tibia shall be 339 ± 2 mm, 185 ± 1 mm, and 404 ± 2 mm, respectively. The center position of the knee joint shall be 94 ± 1 mm from the top of the knee joint.

Brackets, pulleys, protectors, connection parts, etc. attached to the legform impactor for the purpose of launching and/or protecting may extend beyond the dimensions shown in Figure 1.

1.1 The cross-sectional shape perpendicular to the Z-axis of the femur and tibia main bodies shall be 90 ± 2 mm in width along the Y-axis, and 84 ± 1 mm in width along the X-axis as shown in Figure 2. The impact face shall be 30 ± 1 mm in radius, 30 ± 1 mm in width along the Y-axis, and 48 ± 1 mm in width along the X-axis.

1.2 The cross-sectional shape perpendicular to the Z-axis of the knee joint shall be 108 ± 2 mm in width along the Y-axis, and 118 ± 1 mm in width along the X-axis as shown in Figure 2. The impact face shall be 103 ± 1 mm in radius, 12 ± 1 mm in width along the Y-axis, and 86 ± 1 mm in width along the X-axis.

1.3 The masses of the femur and tibia without flesh (including the connection part to the knee joint) shall be 2.46 ± 0.12 kg and 2.64 ± 0.13 kg respectively. The mass of the knee joint (without flesh) shall be 4.28 ± 0.21 kg. The total mass of the femur, knee joint, and tibia shall be 9.38 ± 0.47 kg.

The center of gravity of the femur and tibia (without flesh, including the connection part to the knee joint) shall be 159 ± 8 mm and 202 ± 10 mm respectively from the top (but not including the connection part to the knee joint) of each part as shown in Figure 1.

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 centers of gravity shall be 0.0325 ± 0.0016 kgm² and 0.0467 ± 0.0023 kgm² respectively. The moment of inertia of the knee joint about the X-axis through the respective center of gravity shall be 0.0180 ± 0.0009 kgm².

1.4 For each test, the legform 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 3. The sheets are required to have a compression characteristic as shown in Figure 4. The compression characteristic shall be checked using the same batch of sheets as those used for the legform impactor flesh. The size of the sheets shall be within the requirements described in Figure 3.

1.5 The test legform impactor or at least the flesh shall be stored for at least four hours in a controlled storage area with a stabilized temperature of $20 \pm 2^\circ\text{C}$ before removing the legform impactor for calibration. After removal from the storage, the legform impactor shall not be subjected to conditions other than those pertaining to the test area.

1.6 Legform impactor Instrumentation

1.6.1 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 ± 1 mm, tibia-2: 214 ± 1 mm, tibia-3: 294 ± 1 mm, and tibia-4: 374 ± 1 mm below the knee joint center respectively as shown in Figure 5. The measurement axis of each transducer shall be the X-axis of the legform impactor.

1.6.2 Three transducers shall be installed in the knee joint to measure elongations of the MCL, ACL, and PCL. The measurement locations of each transducer are shown in Figure 5. The measurement locations shall be within ± 4 mm along the X-axis from the knee joint center.

1.6.3 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 400 Nm for the tibia bending moments. This does not require that the legform impactor itself be able to physically elongate or bend until these values.

1.7 Legform impactor Certification

1.7.1 The legform impactor shall meet the performance requirements described in Paragraph 2. Certification of the legform impactor shall be conducted at the timing described below.

1.7.1.1 It is permissible to use the legform impactor manufacturer's test data for the static certification tests described in Paragraph 2.1 instead of the test institute conducting the test itself. However, if the legform impactor does not meet the pendulum type dynamic certification test requirement described in Paragraph 2.2 or the inverse type dynamic certification test requirement described in Paragraph 2.3, the static test described in Paragraph 2.1 shall be conducted by the test institute or by the legform impactor manufacturer.

1.7.1.2 The pendulum type dynamic certification test described in Paragraph 2.2 (and also the inverse type dynamic certification test described in Paragraph 2.3 if necessary) shall be conducted just before the series of tests of each vehicle. In addition, the pendulum type dynamic certification test (and also the inverse type dynamic certification test if necessary) shall be conducted after replacing parts of the legform impactor for repair, and when measured values exceed (a) bending moment of 380Nm for the tibia, (b) elongation of 22mm for the MCL, (c) elongation of 13mm for the ACL and/or (d) elongation of 13mm for the PCL.

Side view

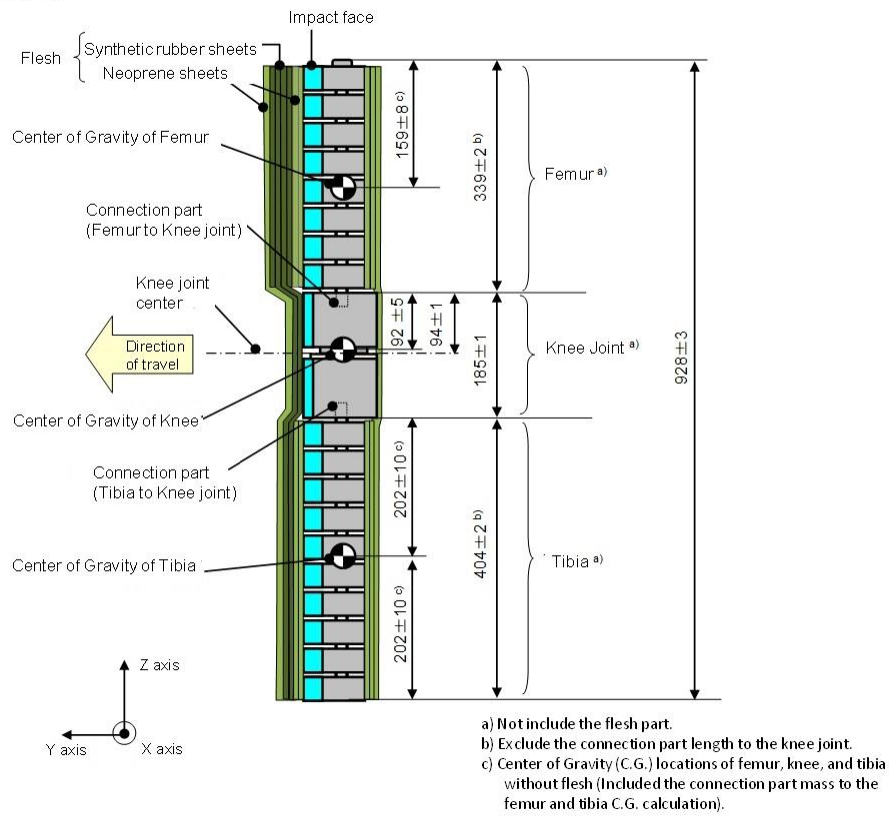


Figure 1: Legform impactor Dimensions and C.G. Locations of Femur, Knee Joint and Tibia (Side view)

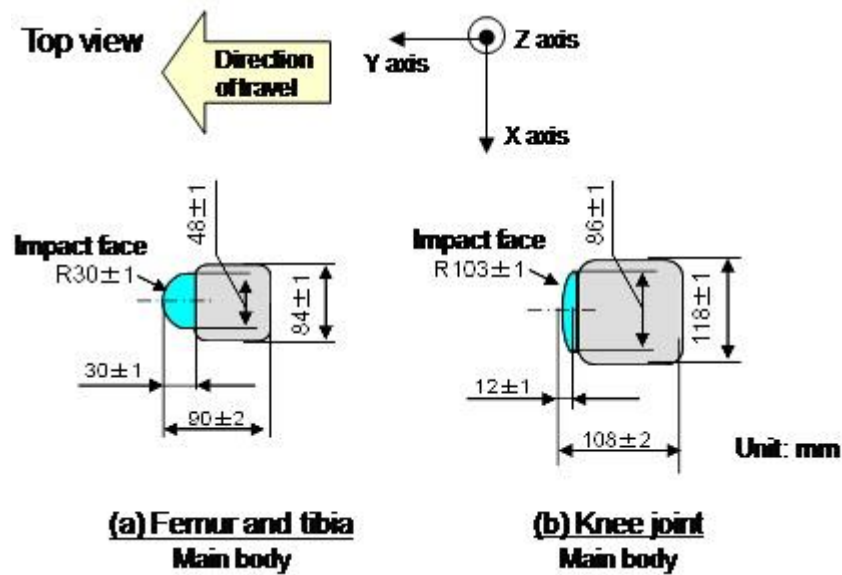


Figure 2: Legform impactor; Femur, Tibia, and Knee Dimensions (Top view)

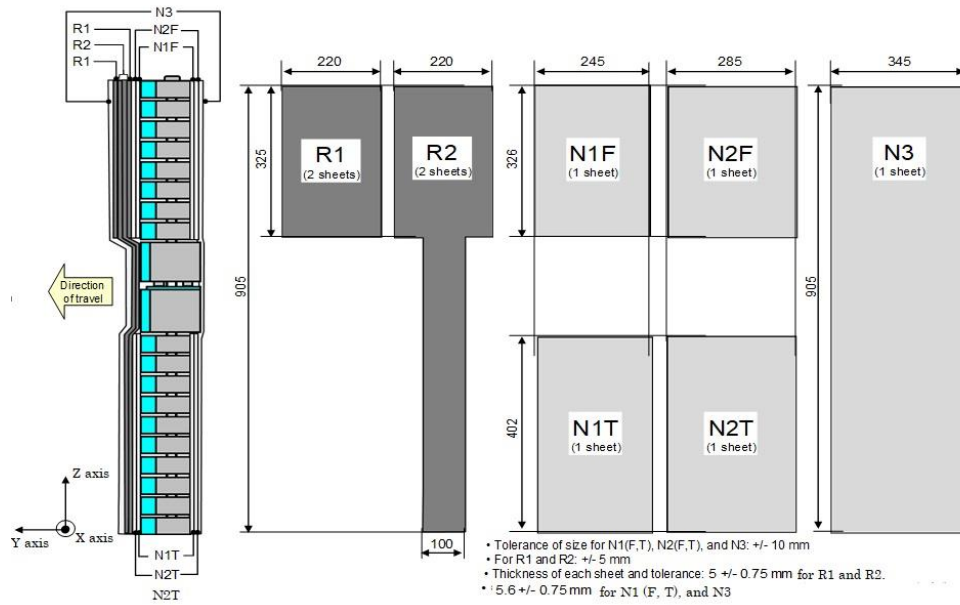
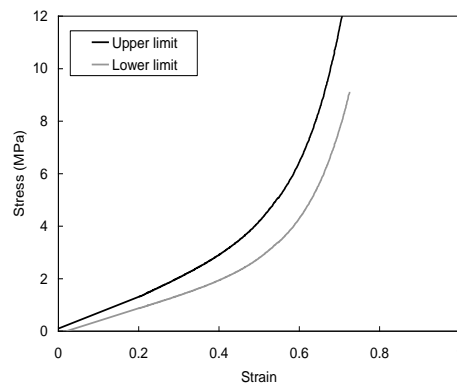
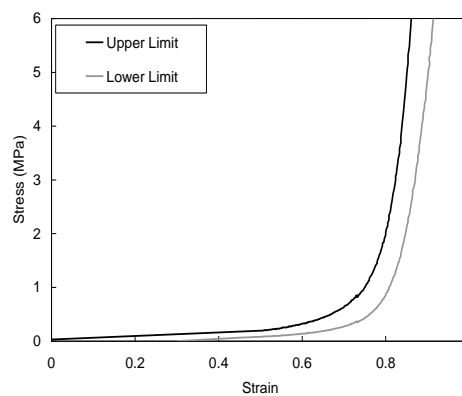


Figure 3: Legform impactor Flesh Measurements



(a) Synthetic Rubber Sheets



(b) Neoprene Sheets

Figure 4: Legform impactor; Flesh Compression Characteristics

Instruments locations

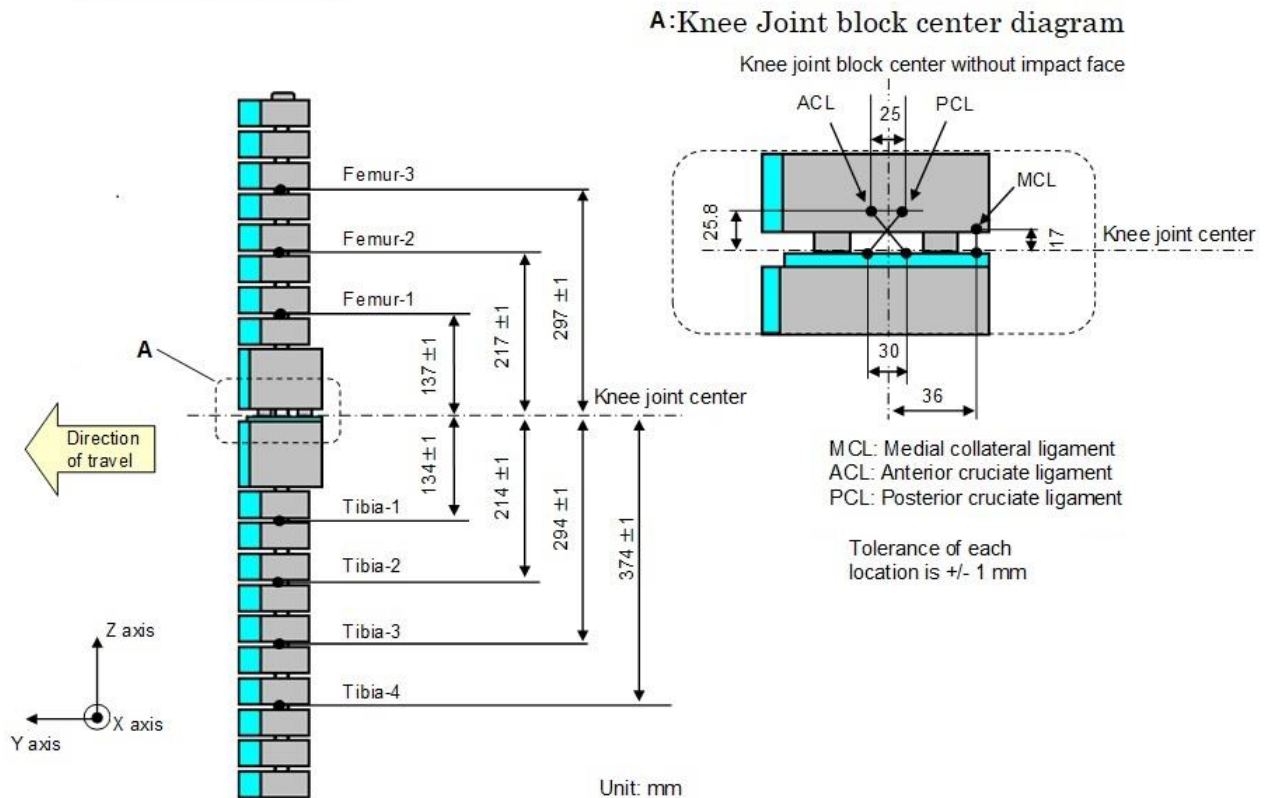


Figure 5: Legform impactor, Instrument Locations

2. Requirements for Legform impactor Certification

2.1 Static Tests

2.1.1 The femur and tibia of the legform impactor shall meet the requirements respectively specified in Paragraph 2.1.2 when tested as specified in Paragraph 2.1.4. The knee joint of the legform impactor shall meet the requirements specified in Paragraph 2.1.3 when tested as specified in Paragraph 2.1.5. The stabilized temperature of the legform 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 elongation and 4kN for the applied external load. For these tests, it is permissible to use low-pass filtering at an appropriate frequency to remove higher frequency noise without significantly affecting the measurement of the response of the legform impactor.

2.1.2 When the femur and tibia of the legform impactor are loaded in bending in accordance with Paragraph 2.1.4, the applied moment and generated deflection at the center of the femur and tibia (M_c and D_c) shall be within the corridors shown in Figure 6.

2.1.3 When the knee joint of the legform impactor is loaded in bending in accordance with Paragraph 2.1.5, the MCL, ACL and PCL elongations and applied bending moment or force at the center of the knee joint (M_c or F_c) shall be within the corridors shown in Figure 7.

2.1.4 The edges of the femur and tibia, not bending parts, shall be firmly mounted to the support rig as

shown in Figures 8 and 9. The Y-axis of the legform 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.

The center of the loading force shall be applied at the center 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 center part (Mc) of the femur or tibia reaches 400 Nm.

2.1.5 The edges of the knee joint, not bending parts, shall be mounted to the support rig firmly as shown in Figure 10. The Y-axis of the legform 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 damage to the legform impactor, a neoprene sheet shall be set underneath the loading ram, and the legform impactor face of the knee joint shown in Figure 2 shall be removed. The neoprene sheet used in this test shall have compression characteristics as shown in Figure 4.

The center of the loading force shall be applied at the center 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 center part of the knee joint (Mc) reaches 400 Nm.

2.2 Pendulum Type Dynamic Certification Tests

2.2.1 The legform impactor (with the femur, knee joint and tibia firmly connected or assembled) shall meet the requirements specified in Paragraph 2.2.3 when tested as specified in Paragraph 2.2.4.

2.2.2 General

2.2.2.1 The test facility used for the certification test shall have a stabilized temperature of $20 \pm 2^\circ\text{C}$ during certification.

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

2.2.3 Requirements

2.2.3.1 When the legform impactor is used for a test as specified in Paragraph 2.2.4, the maximum bending moment of the tibia at tibia-1 shall be 235–272 Nm, the maximum bending moment at tibia-2 shall be 187–219 Nm, the maximum bending moment at tibia-3 shall be 139–166 Nm, and the maximum bending moment at tibia-4 shall be 90–111 Nm. The maximum elongation of the MCL shall be 20.5–26 mm, the maximum elongation of the ACL shall be 8.0–10.5 mm, and the maximum elongation of the PCL shall be 3.5–5.0 mm.

For all these values, the readings used shall be from the initial impact timing to 200 ms after the impact timing.

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

2.2.4 Test Procedure Order

2.2.4.1 The legform impactor, including flesh, shall be suspended from the dynamic certification test rig

15deg \pm 1deg upward from the horizontal as shown in Figure 11. The legform impactor shall be released from the suspended position, whereupon the legform impactor falls freely against the pin joint of the test rig.

2.2.4.2 The knee joint center of the legform impactor shall be 30 ± 1 mm below the bottom line of the stopper bar, and the tibia impact face without flesh shall be 13 ± 2 mm from the front upper edge of the stopper bar when the legform impactor is hanging freely as shown in Figure 11.

2.3 Inverse Dynamic Certification Test

2.3.1 The legform impactor with flesh (femur, knee joint and tibia are connected or assembled firmly) shall meet the requirements specified in Paragraph 2.3.3 when tested as specified in Paragraph 2.3.4.

2.3.2 General

2.3.2.1 The test facility used for the certification test shall have a stabilized temperature of $20 \pm 2^\circ\text{C}$ during certification.

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

2.3.3 Requirements

2.3.3.1 When the legform impactor is used for the test specified in Paragraph 2.3.4, the maximum bending moment of the tibia at tibia-1 shall be 230–272 Nm, the maximum bending moment at tibia-2 shall be 210–252 Nm, the maximum bending moment at tibia-3 shall be 166–192 Nm, and the maximum bending moment at tibia-4 shall be 93–108 Nm. The maximum elongation of the MCL shall be 11–21 mm, that of the ACL shall be 8.0–10.0 mm, and that of the PCL shall be 4.0–6 mm.

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

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

2.3.4 Test Procedure Order

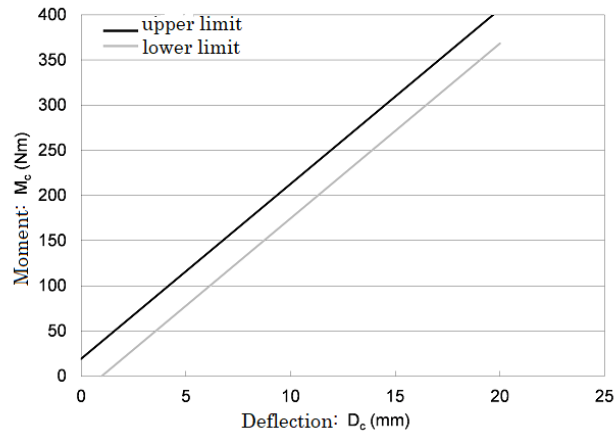
2.3.4.1 The fully assembled legform impactor (with flesh and skin) shall be stationary and suspended vertically from a test rig as shown in Figure 12. It is then impacted by the upper edge of a linearly guided aluminum honeycomb impactor, covered by a thin (less than 1 mm thickness) paper cloth, at an impact speed of 11.1 ± 0.2 m/s. The leg is to be released from the test rig within 10 ms after the time of first contact to ensure a free flight condition.

2.3.4.2 The aluminum 5052 honeycomb, which is attached in front of the moving ram, shall have a crush strength of $75 \text{ psi} \pm 10\%$ and 200 ± 5 mm in width, 160 ± 5 mm in length and 60 ± 2 mm in depth. To ensure a consistent and good level of repeatability, the aluminum honeycomb should either have a 3/16-inch cell size or a 1/4-inch cell size. The aluminum honeycomb should have a density of 2.0 pcf for a 3/16-inch cell size or a density of 2.3 pcf for a 1/4-inch cell size.

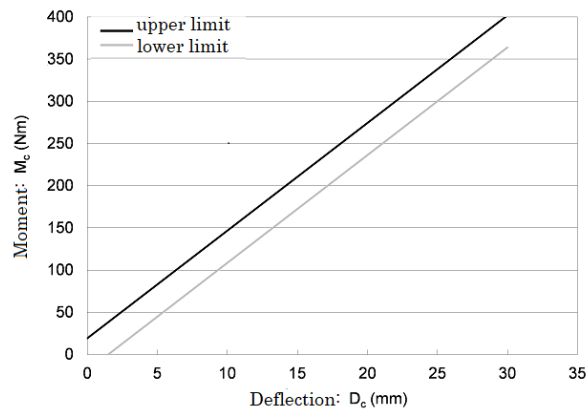
2.3.4.3 The upper edge of the aluminum honeycomb face must coincide with the line of the rigid plate of the

linearly guided impactor. At the time of first contact, the tolerance range of the upper edge of the aluminum honeycomb and the knee joint position line of the legform impactor with flesh shall be ± 2 mm. Additionally, the honeycomb shall not be deformed before the impact test.

2.3.4.4 The legform impactor pitch angle (angle of rotation around the y-axis), i.e., the impact velocity vector pitch angle, shall be within a margin of error of $0 \pm 2^\circ$ at the time of the initial collision. Similarly, the legform impactor roll angle (angle of rotation around the z-axis), i.e., the impact velocity vector roll angle, shall be within a margin of error of $0 \pm 2^\circ$ at the time of the initial collision. Additionally, the legform impactor yaw angle (angle of rotation around the x-axis), i.e., the impact velocity vector yaw angle, shall be within a margin of error of $0 \pm 2^\circ$ at the time of the initial collision.

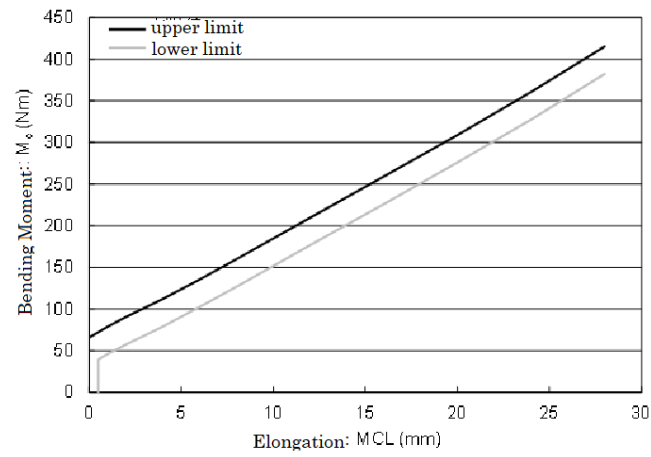


(a) Femur bending corridor

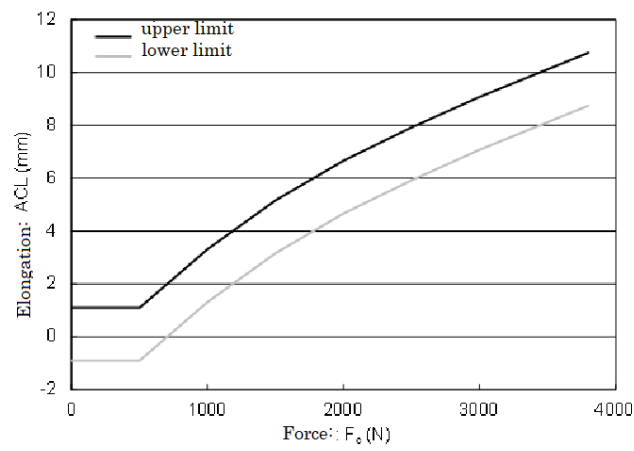


(b) Tibia bending corridor

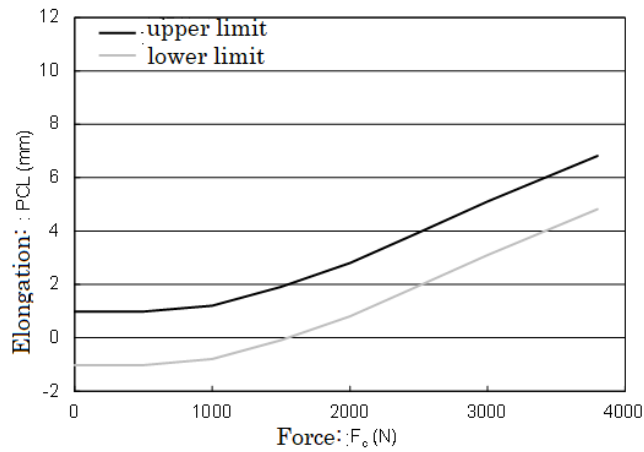
Figure 6: Legform impactor Requirement Corridor of Femur and Tibia in Static Certification Test



(a) for MCL

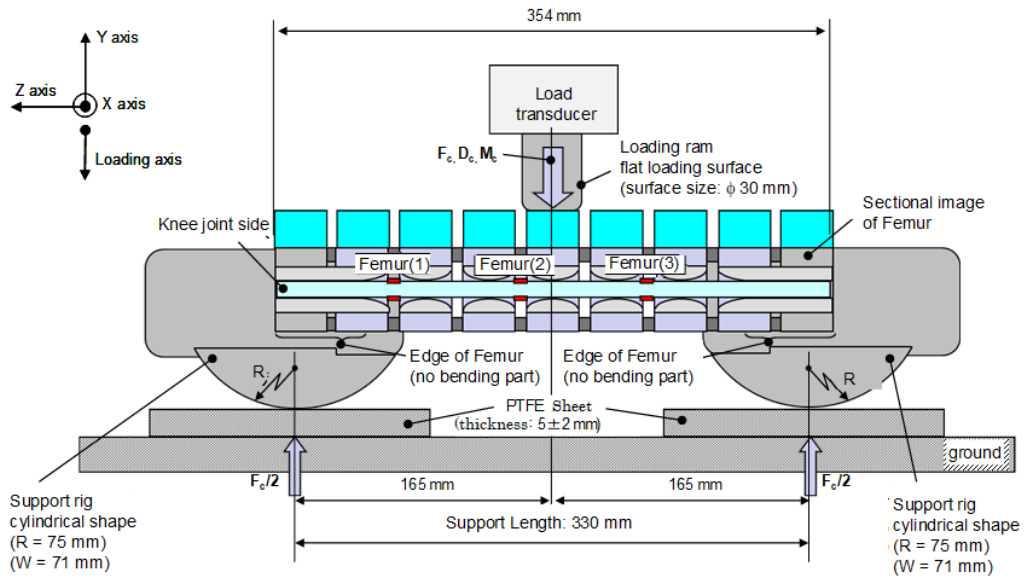


(b) for ACL



(c) for PCL

Figure 7: Legform impactor Requirement Corridors for Knee Joint in Static Certification Test



F_c : Extremal loading force at center of the femur
 D_c : Deflection at center of the femur
 M_c : Moment Center (Nm) = $F_c/2$ (N) \times 0.165 (m)
 Tolerance range for the above measurements: ± 2 mm

Figure 8: Legform impactor Test Set-up for Femur in Static Certification Test

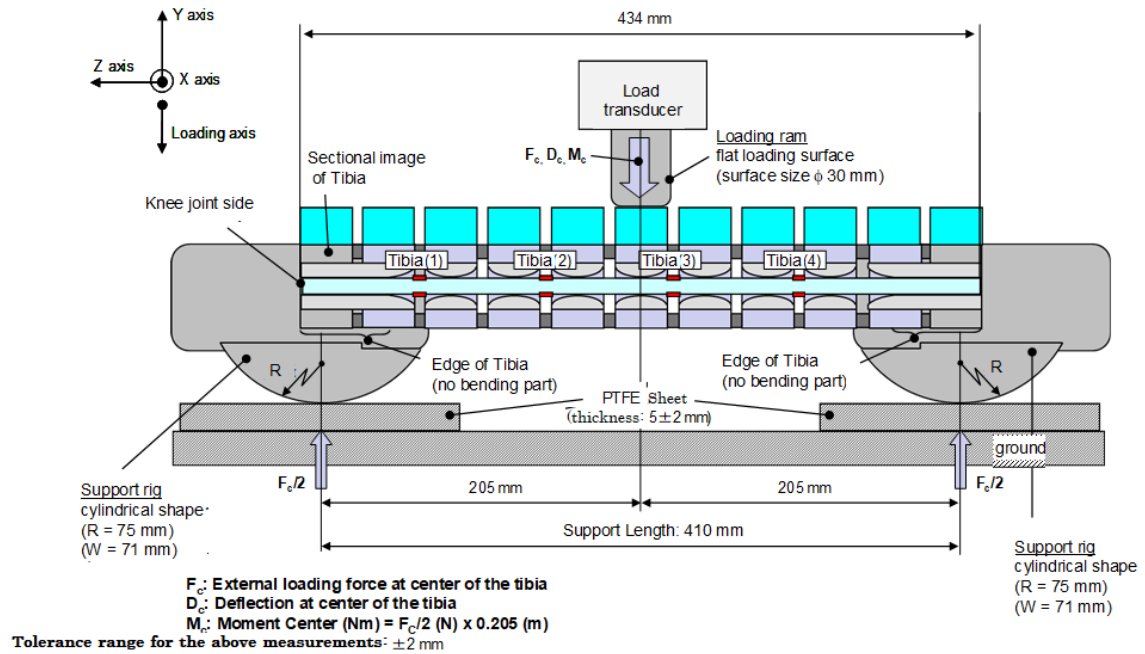


Figure 9: Legform impactor Test Setup for Tibia in Static Certification Test

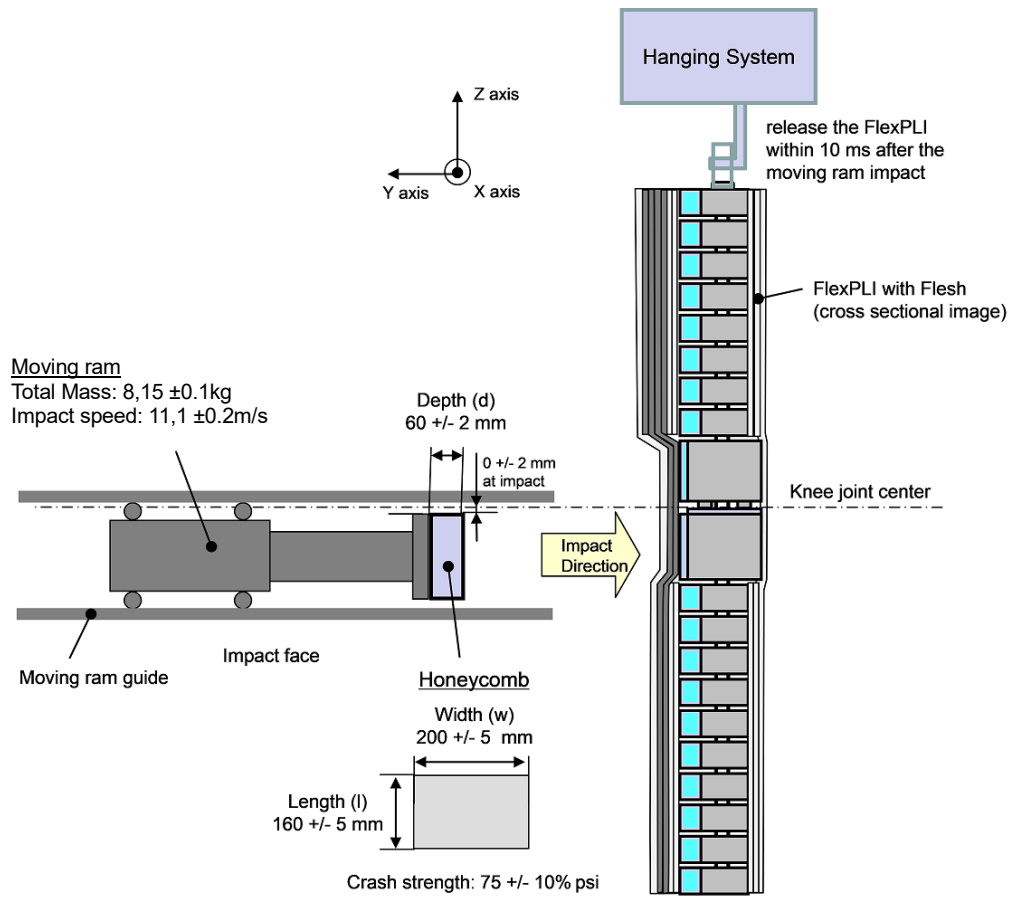


Figure 12: Legform impactor Test Set-up for Inverse Type Dynamic Legform impactor Certification Test

Detailed Protocols for Replacing Vehicle Parts

1. Repair of vehicle parts

Part	Repair
Frame/Body	These parts cannot be replaced even if they are deformed by the impact test. Therefore, deformed parts shall be repaired to the original shape by using several repair tools where possible.
Fender Bonnet hinge	These parts take too long to replace. Therefore, deformed parts shall be repaired to the original shape by using several repair tools where possible.
Other parts	If other deformed parts would affect the subsequent test results, they shall be repaired to the original shape by using several repair tools where possible.

2. Replacement of vehicle parts

Part	Change	Do Not Change
1. Bumper 2. Bonnet 3. Energy Absorber	If these parts were deformed or broken by the preceding test, they shall be changed to new parts before the next test.	If the collision point of the next test is located 400 mm or more from the collision point of the preceding test.
1. Headlights	If these parts were deformed or broken by the preceding test, they shall be changed to new parts before the next test.	If the collision point of the next test is located in a symmetrical sub test area (e.g. L1 → L3, L3 → L1) and the collision point of the next test is located 400 mm or more from the collision point of the preceding test.
1. Bumper Beam 2. Striker 3. Grill 4. Radiator Support	If these parts were deformed or broken by the preceding test, they shall be changed to new parts before the next test.	If the collision point of the next test is located 400 mm or more from the collision point of the preceding test.
Other parts	If the damaged or deformed parts would affect the results of the next test.	

APPENDIX 1: SPECIFICATION DATA SHEET OF TEST VEHICLE

[For entry by the vehicle manufacturer and importer]

1. Specifications of test vehicle

Name, model, classification number or symbol of the vehicle	
Frame number	
Body shape	
Engine model	
Drive system	
Type of transmission	
Type of tire	
Tire air pressure	Front: kPa, Rear: kPa
Fuel tank capacity	L

2. Seat Adjustments

			Driver	Front Passenger	Other	
Fore-aft adjustment of seat (by seat-rail)	Adjustment distance per stage		mm	mm	mm	
	Total adjusted distance		mm	mm	mm	
	Mid position	from the front	mm (stages)	mm (stages)	Design Standard Position	mm (stages)
		from the rear	mm (stages)	mm (stages)		mm (stages)
Fore-aft seat adjustment (other)	Name of device Mid-position					
Height adjustment device (only can adjust vertically)			Provided / Not provided	Provided / Not provided	Provided / Not provided	
Adjustment of seatback angle	Design standard angle		deg (stages)	deg (stages)	deg (stages)	
Other adjustment device	Name,Design standard position					

Note) Enter the number of position adjusting stages counting the first locking position as 0

3. Reference Measuring Points of Vehicle Posture

(Enter the vehicle height after installing a mass of 75 kg to the driver and front passenger seat, respectively, in addition to the mass of the test vehicle when brought in.)

(1) Height of front side : Reference point (*) : Left Right

(2) Height of rear side : Reference point (*) : Left Right

* Describe name of reference point. Submit drawings, if necessary to understand the point.

4. Reference: LBRL height (highest value) of vehicle scheduled for test

(1) LBRL height : mm

APPENDIX 2: SPECIFICATION OF TEST VEHICLE

[For entry by the test institute]

1. Specifications of Test Vehicle

Vehicle name	
Model name	
Grade	
Model type	
Classification	
Key optional equipment	
Brand name and size of tire	
Mass at vehicle delivery	kg

2. Seat Adjustments

		Driver	Front Passenger	Other	
Fore-aft adjustment of seat (by seat-rail)	Adjustment distance per stage	mm	mm	mm	
	Total adjusted distance	mm	mm	mm	
	Mid position	mm (stages)	mm (stages)	Design Standard position	mm (stages)
		mm (stages)	mm (stages)		mm (stages)
Fore-aft seat adjustment (other)	Name of device Mid-position				
Height adjustment device (only can adjust vertically)		Provided / Not provided	Provided / Not provided	Provided / Not provided	
Adjustment of seatback angle	Design standard angle	deg (stages)	deg (stages)	deg (stages)	
Other adjustment device	Name, Design standard position				

3. Other

Reference Measuring Points of Vehicle Posture

(1) Height of front side: Reference point (*) : Left Right

(2) Height of rear side: Reference point (*) : Left Right

* Describe name of reference point.

Appendix 2-1: Collision Points for Assessment (vehicle name:)

First candidate of collision point [NASVA]

Area		Distinction between 1st and 2nd candidates		Impact point			Impact order	Remarks	
		Request		x	y	z		Impact parts and other	Replacement of bumper and other
L1	L1A								
	L1B								
L2	L2A								
	L2B								
L3	L3A								
	L3B								

Note 1. "O" in the Area Classification column indicates the second candidate area. Those without "O" indicate the first candidate area.

2. Reference impact point (x=0, y=0, z=0) : Bonnet rear end on the vehicles centerline.

Appendix 2-2: Bird's Eye Photo of Test Vehicle

Reference

- Test vehicle attached with marking
- Angle: 30 degrees in front of the test vehicle
- Photo taken using a digital camera
(use this photo for lower leg impactor test as well as for head impactor test)

Appendix 2-3: Collision Points for Assessment (vehicle name:)
Second Candidate of Collision Point

Area		Distinction between 1st and 2nd candidates		Impact point			Impact order	Remarks	
		Request		x	y	z		Impact parts and other	Replacement of bumper and other
L1	L1A								
	L1B								
L2	L2A								
	L2B								
L3	L3A								
	L3B								

Note 1. "O" in the Area Classification column indicates the second candidate area. Those without "O" indicate the first candidate area.

2. Reference impact point (x=0, y=0, z=0) : Bonnet rear end on the vehicles centerline.

Appendix 2-4: Test Implementation Plan (vehicle name:)

Area		Distinction between 1st and 2nd candidates		Impact point			Impact order	Remarks		Planned test date Replacement parts
		Request		x	y	z		Impact parts and other	Replacement of bumper and other	
L1	L1A									
	L1B									
L2	L2A									
	L2B									
L3	L3A									
	L3B									

Note 1. "O" in the Area Classification column indicates the second candidate area. Those without "O" indicate the first candidate area.

2. Reference impact point (x=0, y=0, z=0) : Bonnet rear end on the vehicles centerline.

Appendix 3-1: Specification Data Sheet of Test Vehicle

[For entry by the test institute]

1. Specifications of Test vehicle

Name, Model, Classification number			
Frame number			
Body shape			
Engine model			
Drive system			
Type of transmission			
Tire type			
Tire air pressure		Front wheel	Right: Left:
		Rear wheel	Right: Left:
Steering device	Shape of steering wheel		
	Air bag	Not provided / Provided	
	Vertical adjustment	Not provided / Provided (Electric, Manual)	
	Fore-aft adjustment	Not Provided / Provided (Electric, Manual)	
Seat	Fore-aft adjustment (seat-rail)	Dr. seat	Not provided / Provided (Electric, Manual)
		Fr. P. seat	Not provided / Provided (Electric, Manual)
		Other seat	Not provided / Provided (Electric, Manual)
	Fore-aft adjustment (other mechanism)	Dr. seat	Device name : _____, Not provided / Provided (Electric, Manual)
		Fr. P. seat	Device name : _____, Not provided / Provided (Electric, Manual)
		Other seat	Device name : _____, Not provided / Provided (Electric, Manual)
	Height adjustment (only adjusted vertically)	Fr. P. seat	Not provided / Provided (Electric, Manual)
		Other seat	Not provided / Provided (Electric, Manual)
		Other seat	Not provided / Provided (Electric, Manual)
	Seatback adjustment	Dr. seat	Not provided / Provided (Electric, Manual)
		Fr. P. seat	Not provided / Provided (Electric, Manual)
		Other seat	Not provided / Provided (Electric, Manual)
	Other adjustment devices	Dr. seat	Device name: _____ (Electric, Manual)
		Fr. P. seat	Device name: _____ (Electric, Manual)
		Other seat	Device name: _____ (Electric, Manual)
Fuel tank Capacity		L	

Reference Measuring Points of Vehicle Posture

(1) Height of front side Reference point (*) : Left Right

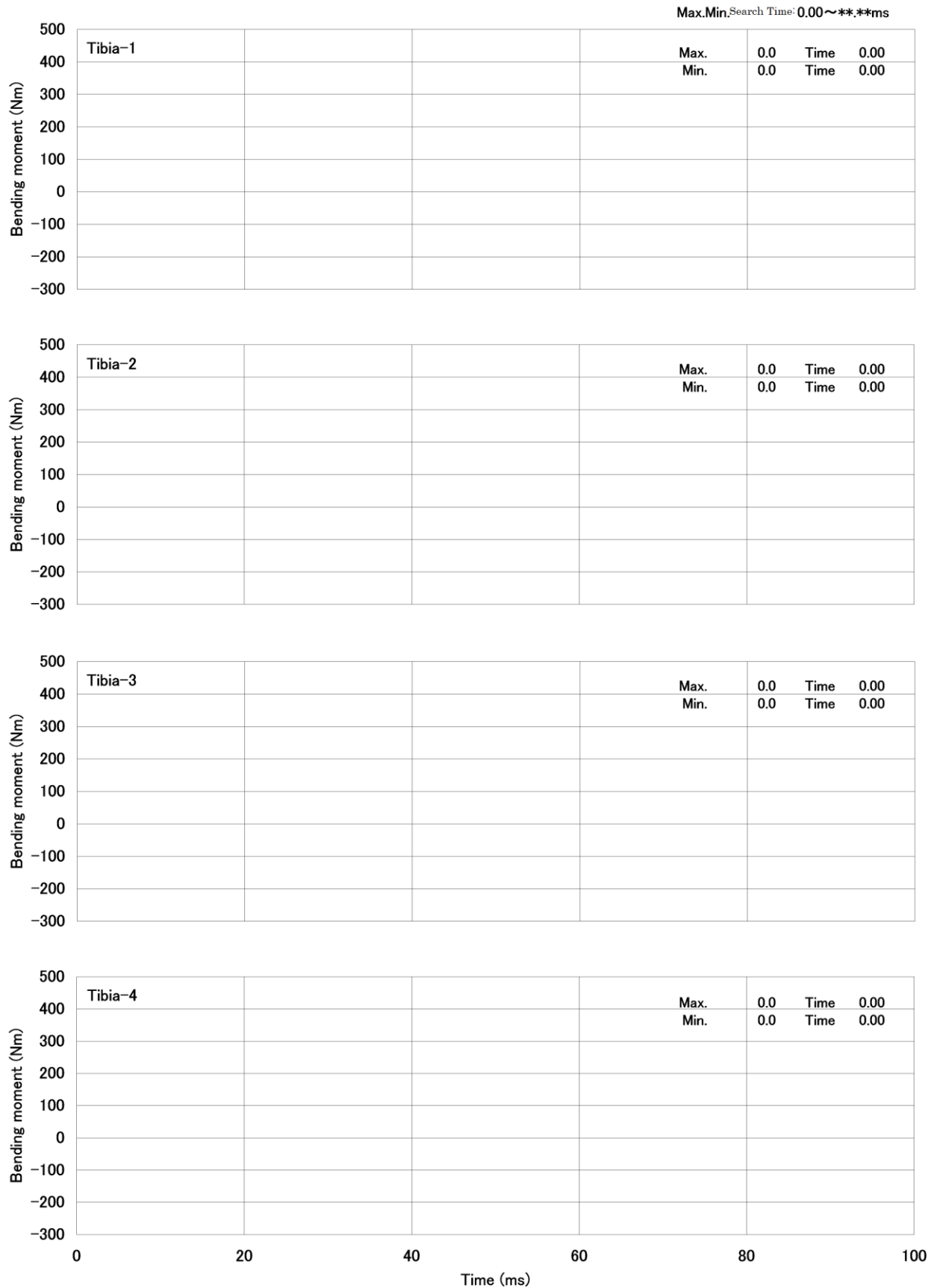
(2) Height of rear side Reference point (*) : Left Right

* Describe name of reference point.

Appendix 3-2: List of Test Results

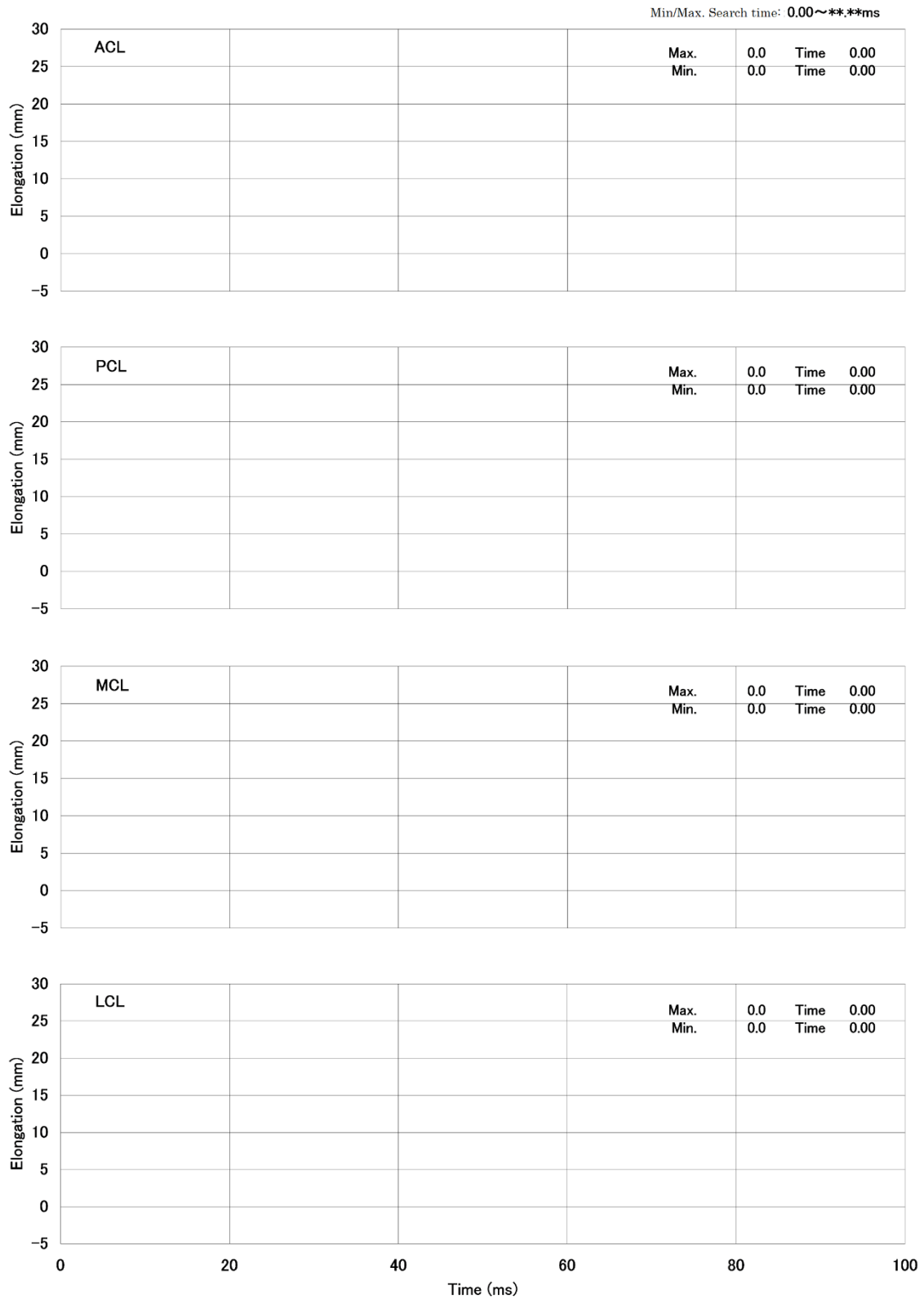
Area		Distinction between 1st and 2nd candidates	Impact order	Tibia-1 (Nm)	Tibia-2 (Nm)	Tibia-3 (Nm)	Tibia-4 (Nm)	MCL (mm)	ACL (mm)	PCL (mm)	Impact speed (km/h)	Impactor posture	Deviation from the targeted impact point	Remarks
L1	L1A													
	L1B													
L2	L2A													
	L2B													
L3	L3A													
	L3B													

Appendix 4: Results of Electric Measurements (area: sub area, sub-sub area)



TestNo. NASVA20**-****-***

Leg Impactor Measurement Items: (Tibia-1, Tibia-2, Tibia-3, Tibia-4)

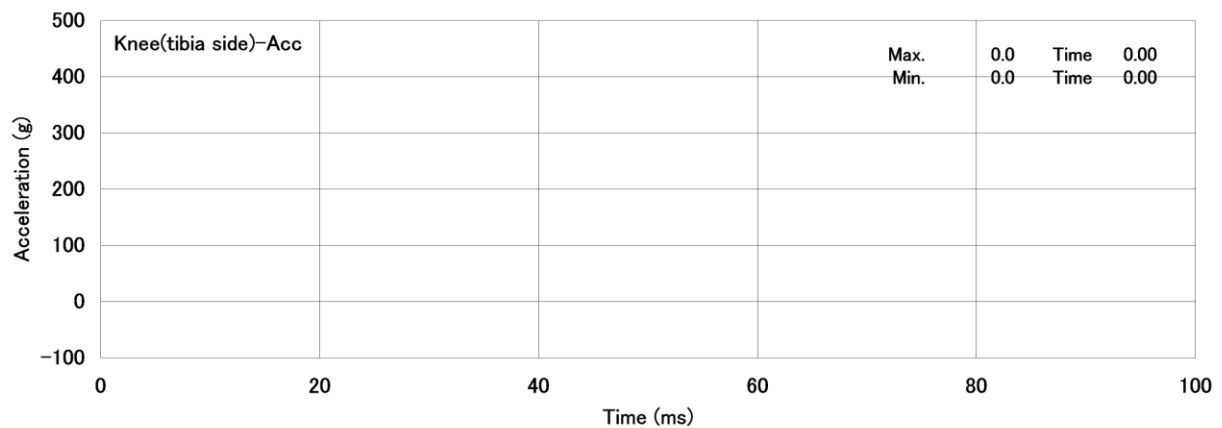
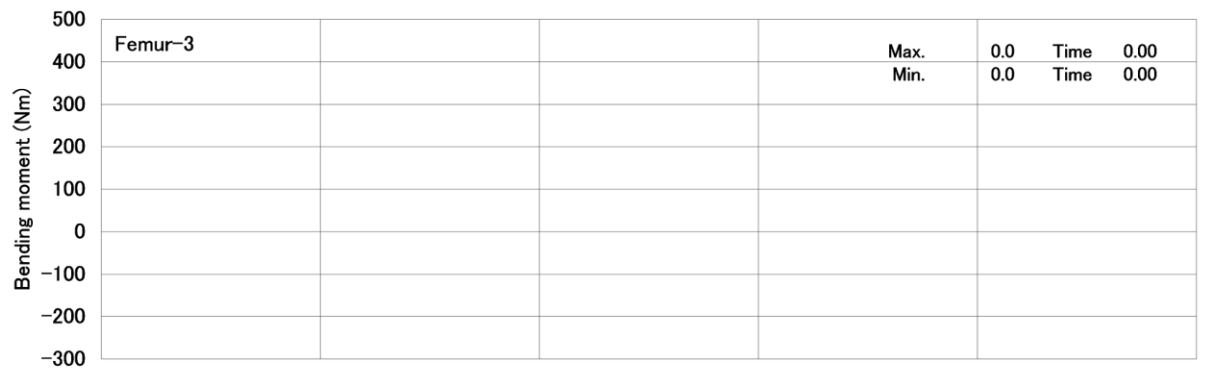
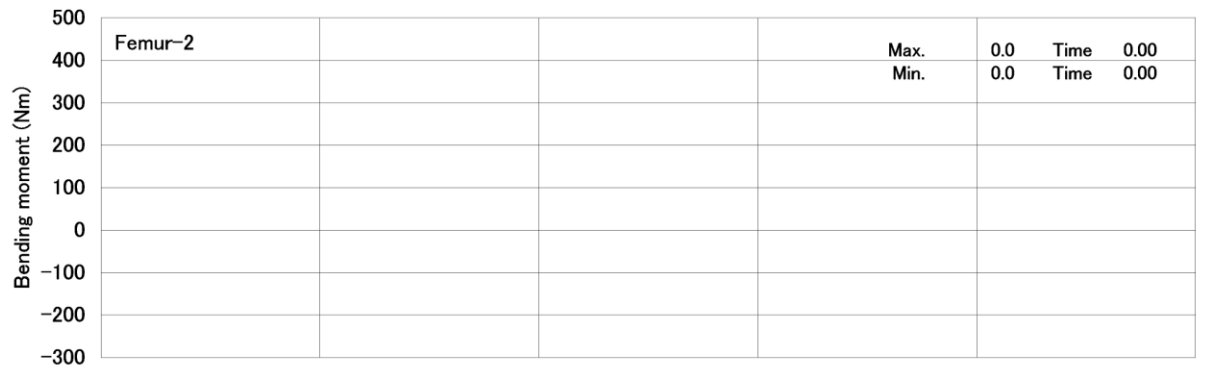
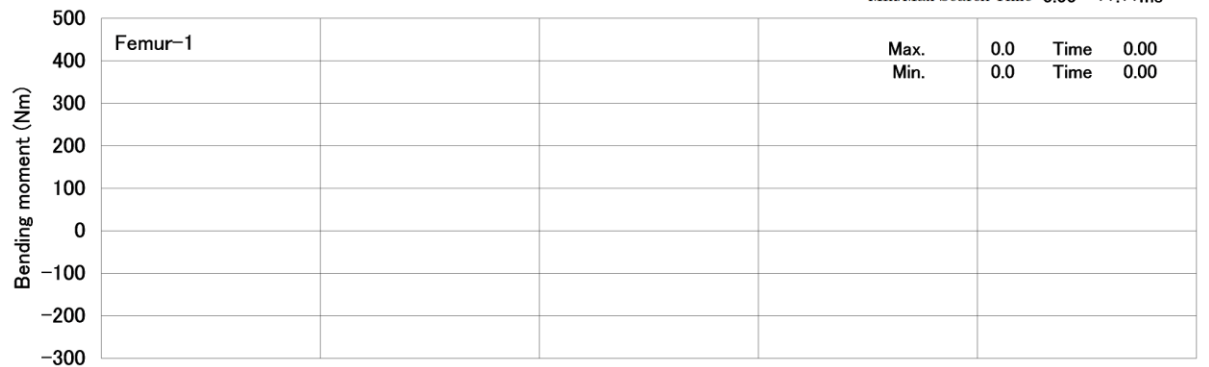


TestNo. NASVA20**-****-***

Leg Impactor Measurement Items: (ACL, PCL, MCL, LCL*)

*Reference Measurements

Min/Max Search Time: 0.00~**.**ms



TestNo. NASVA20**-****-***

Leg Impactor Measurement Items: (Femur-3*, Femur-2*, Femur-1*, Knee(tibia side)-Acc*)

*Reference Measurements

Appendix 5: Results of Leg Impactor Certification Test

Test Number	Date/ Temperature	Calibration Methods	Leg Impactor No.	Measurement Items	Maximum Value		
***		Pendulum or Inverse		Tibia-1	Nm		
				Tibia-2	Nm		
				Tibia-3	Nm		
				Tibia-4	Nm		
				ACL	mm		
				PCL	mm		
				MCL	mm		
	Test Result					Pass	Fail
		Pendulum or Inverse			Tibia-1	Nm	
					Tibia-2	Nm	
					Tibia-3	Nm	
					Tibia-4	Nm	
					ACL	mm	
					PCL	mm	
					MCL	mm	
	Test Result					Pass	Fail
		Pendulum or Inverse			Tibia-1	Nm	
					Tibia-2	Nm	
					Tibia-3	Nm	
					Tibia-4	Nm	
					ACL	mm	
					PCL	mm	
					MCL	mm	
	Test Result					Pass	Fail

Note: Attach wave forms during the calibration test.

Appendix 6: Temperature Records

Leg impactors soak start date and time: ___day___month___year ___hr. ___min.

Temperature at the start of soak: Temperature: °C

Temperature when using leg impactor

Test No.	Temperature (°C)	Test Date/Time