First Technology
Safety & Analysis

Flex-PLI-GTR
(133-5000)

*Technical Product Sheet*

## Flex-PLI-GTR, 133-5000
### (Flexible Pedestrian Legform Impactor Global Technical Regulation)

In the year 2000, the Japan Automobile Manufacturers Association, Inc. (JAMA) and the Japan Automobile Research Institute (JARI) initiated development of the "Flexible Pedestrian Legform Impactor (Flex-PLI)". In 2002, an initial design was made available, followed by the Flex-GT version in 2006. A Technical Evaluation Group (Flex-TEG), consisting of governmental and industrial parties, is evaluating the possibility to use the legform impactor for Global Regulation on Pedestrian Safety (PS-GTR). FTSS is a member of this group as the dummy manufacturer. FTSS was asked to review the GT design and manufacture the leg. This review highlighted a number of improvements and the proposed GTR design was accepted. The performance of the leg was to be unchanged to ensure existing test data remained valid.

The impactor represents a 50th percentile male leg which is struck from the right side. The Flex PLI (Flexible Pedestrian Legform Impactor) simulates the flexible nature of the human bone. It is fired from a linear guide into the bumper of a static vehicle at 40 km/hr for the assessment of pedestrian lower leg and knee injuries.

The main improvements were centralizing the deflection sensors to avoid impact direction sensitivity, balancing the spring force load in the knee joint to prevent knee joint twist, various improvements related to handling, introduction of full bridge strain gauge configuration, adding additional optional sensors and incorporating onboard Data Acquisition Systems (DAS) to improve free flight motion.

FTSS also reviewed and updated the numerous quasi static calibration procedures for internal bones, thigh, knee and lower leg assemblies. The dynamic calibration rig and procedure were also updated to provide more realistic loading and to improve the reproducibility.

The standard leg instrumentation has 12 channels; this includes 3 full bridge strain gage sensors in the thigh and 4 in the lower leg all measuring bone bending moment. In the knee are 4 string potentiometers measuring ligament elongation and an accelerometer measures acceleration in impact direction. Mounting fixtures are available for additional accelerometer channels and rotational velocity sensors.

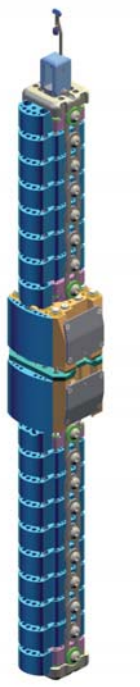
## Features

### *Leg Bones*

The tibia and femur are designed as a segmented assembly mainly made from a high strength plastic with a fiber reinforced bone on the inside. Strain gages are bonded to the bones to measure bending moments, each gage channel set is calibrated individually to establish gage sensitivity. Stainless steel wires limit bone bending at the injury threshold to prevent bones being over stressed. Links connect the segments maintaining even spacing between them and rubber buffers prevent segment contact. The bone assemblies are also certified as sub assemblies to biomechanical corridors. If required optional accelerometers can be mounted in any segment of the leg.

### *Knee*

The knee is a two part design flexible at the knee joint which uses springs and stainless steel wires to simulate ligaments. The springs are designed to meet the required ligament resistive forces and range of motion. The knee is certified to biomechanical corridors. Optional accelerometers and angular rate sensors can be placed on either side of the knee to observe differential movement of the knee components. Onboard DAS is housed in either side of the upper section and connector bocks are housed in the lower section, side covers protect the wiring and electronics.



### *Flesh*

The flesh comprises of a combination of rubber and Neoprene foam sheets. The bulk of the rubber is in the upper part of the leg to help provide humanlike flesh and maintain mass distribution.

### *Standard 12 Channel Instrumentation*

| Location | Sensor Description | Channels |
|---|---|---|
| Upper Leg Bone | Load Cell | My, 3 Channels |
| Lower Leg Bone | Load Cell | My, 4 Channels |
| Knee | Displacement | D, MCL Ligament |
| Knee | Displacement | D, ACL Ligament |
| Knee | Displacement | D, PCL Ligament |
| Knee | Displacement | D, LCL Ligament |
| Lower Knee | Uniax Accelerometer | Ay |

### *Optional Instrumentation*

| Location | Sensor Description | Channels |
|---|---|---|
| Upper Leg | Triax Accelerometer | Top of Leg Ax, Ay, Ax |
| | Uniax Accelerometer | Each Segment Ax (6 positions) |
| Upper Knee | Triax Accelerometer | Ax, Ay, Az |
| | 3 ARS Sensor | ωx, ωy, ωz |
| Lower Knee | Triax Accelerometer | Ax, Ay, Az |
| | 3 ARS Sensor | ωx, ωy, ωz |
| Lower Leg | Uniax Accelerometer | Each Segment Ax (8 positions) |
| | Triax Accelerometer | Bottom of Leg Ax, Ay, Ax |

*The high use of optional sensors if using off board DAS may affect free flight stability.*

### *Weight Specification*

| Leg Part | Weight (kg) | Weight Tol (kg) |
|---|---|---|
| Femur (133-5100) | 2.45 | ±0.05 |
| Knee (133-5300) | *4.28 | ±0.1 |
| Tibia (133-5500) | 2.63 | ±0.05 |
| Flesh System | 3.59 | ±0.2 |
| Leg Total | 12.95 | ±0.4 |

** If off board DAS is used knee has 0.1kg allocated for cables*

### *Test Equipment*

| Description | Part No. |
|---|---|
| Bone Fixture | 133-8000 |
| Leg & Knee Assembly Fixtures | 133-8120 & 133-8100 |
| Stopper Block Fixture, for pendulum | 133-8300 |
| Dynamic Pendulum | 133-8400 |

### *External Dimensions*

| Dimension Descriptions | Specifications (mm) |
|---|---|
| Leg Length | 928 |
| Femur Length to Knee Joint | 433 |
| Tibia Length to Knee Joint | 495 |
| Knee Width | 118 |
| Leg Width | 84 |
| Knee Depth | 108.5 |
| Leg Depth | 90.5 |
| Femur Length From Top of Knee Assy | 339 |
| Tibia Length From Bottom of Knee Assy | 404 |

*Dimensions do not include flesh system, end buffers and top launch guide.*