Flex-PLI-GTR

Technical Product Sheet

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). Humanetics is a member of this group as the dummy manufacturer. Humanetics 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 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.

Humanetics 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 gauge 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 measuring acceleration in impact direction. Mounting fixtures are available for additional accelerometer channels and rotational velocity sensors.

Simulation Models

Humanetics offers highly detailed and fully validated Finite Element (FE) models of its legforms in the codes LS-DYNA, PAM-CRASH, ABAQUS and RADIOSS, along with FE modeling consultancy services.

Dummy 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 gauges are bonded to the bones to measure bending moments, each gauge channel set is calibrated individually to establish gauge 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. On board DAS is housed in the sides of the knee and aluminum 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.

Technical Specifications

Weight Specification

Body Segment	Mass (kg)
Femur	2.45 ± 0.05
Knee	4.28* ± 0.10
Tibia	2.63 ± 0.05
Flesh System	3.59 ± 0.20
Leg Total	12.95 ± 0.40

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

Dimensions

Description	Dimension (mm)
Leg Length	928.0
Femur Length to Knee Joint	433.0
Tibia Length to Knee Joint	495.0
Knee Width	118.0
Leg Width	84.0
Knee Depth	108.5
Leg Depth	90.5
Femur Length From Top of Knee Assy	339.0
Tibia Length From Bottom of Knee Assy	404.0

Instrumentation (Standard*)

Locations	Descriptions
Femur Bone	Load Cell (Mx, 3 channels)
Tibia Bone	Load Cell (Mx, 4 channels)
Knee	Displacement (D, MCL;D ACL; D,PCL; D,LCL)
Lower Knee	Uniax Accelerometer (Ay)

* Optional instrumentation listed on www.humaneticsatd.com