Bionix® 12-Station Hip Wear Simulator

Accurate, repeatable replication of hip forces and motions

Specifications

- Maximum loading capacity: 5 kN
- Maximum stroke capacity: 100 mm
- Frequency: 1 Hz (60 rpm) nominal rotation
- Load waveform: programmable function generation
- Hydraulic power requirement: 40 l/min at 21 MPa
- 4 axial stations per crosshead assembly
- Individual attachment of alignment fixtures per station

MTS has developed a Multistation Hip Wear Testing System designed to simulate the motions, loads and environment experienced by the hip joint during the walking process.

Its function is to aid researchers in developing better prosthetic-hip designs through component optimization and material properties characterization. It also provides a realistic and practical compromise between general-wear screening devices (such as pin-on-disk systems) and the intensive research accomplished through full-scale simulation and modeling using a multichannel MTS Mini Bionix® Testing System.

The Hip Wear Simulator features a multistation configuration that allows up to twelve hip prostheses to be tested at a time. It is designed for nominal operation at the approximate walking cycle speed of 1 Hz. Programmable servohydraulic actuators provide an axial loading on each joint of 5000 Newtons per actuator. Each actuator is attached to a specimen/component mounting block which is inclined at 23 degrees from vertical. This is the approximate anatomical position of the hip joint. The inclined block and actuators, while axially loaded, are rotated to provide an exaggerated biaxial rocking motion that simulates walking kinematics. Special, corrosion-resistant fluid chambers house the acetabulum cup or femoral ball. These chambers are designed to be filled with blood serum or saline solution. Fluid temperature inside the chambers reach and stabilize at 37°C ± 2°C. A special alignment fixture is used to assure proper positioning of the femoral ball and acetabulum cup during setup and throughout the test.

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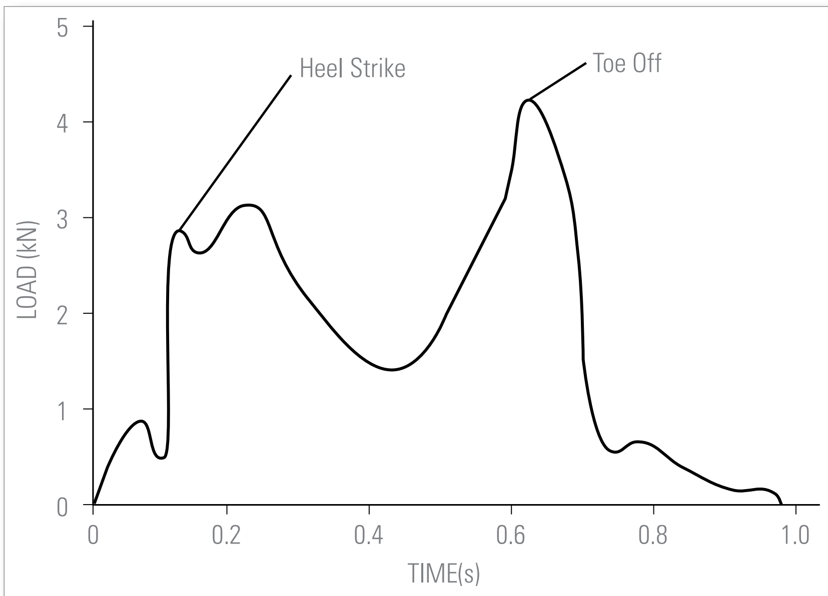
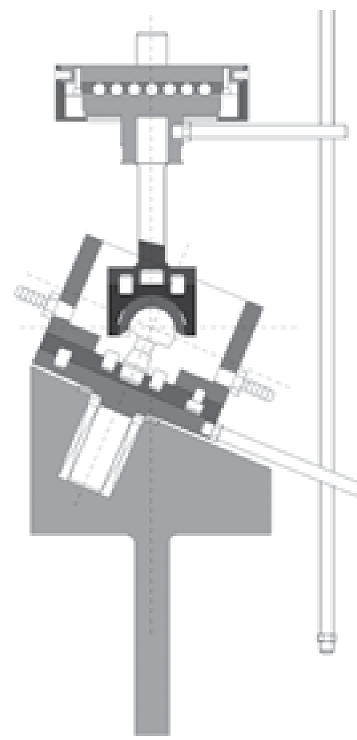
All actuators share a common hydraulic manifold, servovalve and pressure-sensing transducer to provide uniform, controlled, axial loading characteristics to each station. Tight machining tolerances and a close-coupled manifold are used to minimize station-to-station variability. A belt and pulley design, coupled to each vertical actuator, provides for rotary motion of the actuator pistons while allowing vertical movement. An electric rotary motor coupled to the pulley provides the required torque. An evaluation of system performance indicates that control of axial rotation to 60 revolutions per minute (1 Hz) is within ±1 revolution per minute for axial loads of 4500 Newtons per actuator. Although the maximum observed load-following error was 2 percent at a peak load of 3000 N, station-to-station load control variability was less than 0.6 percent. Initial wear studies with this simulator, using ultra-high molecular weight polyethylene and cobalt-chromium heads, indicate a specimen-to-specimen wear variability in the 5 percent range after millions of test cycles.



Closed-loop control capabilities make it possible for this system to precisely simulate the loading forces seen at the hip joint during the walking cycle. (Reference: J.Paul)

Simulator Dimensions

LENGTH (NO ENCLOSURE)	LENGTH (WITH ENCLOSURE)	DEPTH	HEIGHT (COVER CLOSED)	HEIGHT (COVER OPEN)	WEIGHT
1854 mm	2159 mm	877 mm	1700 mm	2157 mm	1821 kg
(73 in)	(85 in)	(35 in)	(67 in)	(85 in)	(4015 lb)



Cross-section schematic showing the pin bearing assembly housed within the inclined mounting block, which rotates to provide the biaxial walking motion. Alternate specimen mounting where the ball is attached to the top fixturing can be provided.

MTS Systems
14000 Technology Drive
Eden Prairie, MN 55344-2290 USA

Telephone: 1.952.937.4000
Toll Free: 1.800.328.2255

E-mail: info@mts.com
www.mts.com

ISO 9001 Certified QMS

100-068-763b BionixHipWear Printed in U.S.A. 9/21