### Servohydraulic Nechanical Testing Nachines: Uses for Biomechanical Analysis



### Heather Raiston 51:158 Biomechanics of Orthopaedic Implants



### Mechanical testing apparatus used primarily to simulate reallife loading conditions

Applicable for:

- Tension
  - Compression
    - •Bending

Loading Conditions:

- •Static
  - Dynamic



# Components

- •Load Frame
  - •Hydraulic Pump
    - Axial Motion:
      - •LVDT
      - •Load Cell
    - **Torsional Motion:** 
      - RVDT
      - •Torque Cell



Has a pressure gage and controls to

damp and unclamp grips.

Crosshead Moves up and down the colums to accommodate specimens of varying lengths.

Hydraulic Crosshead Lifts Raise and lower the crosshead.

### Grips

Grasp and hold the specimen in place durint testing. Hydraulic trips are shown, but there are many different kinds of devices available to hold specimens.

### **Control Module (optional)**

Controls raising and lowering the crosshead on units with hydraulic crosshead lifts. Also has locking/unlocking control for units with hydrauli locks.

An Emergency stop button allows the operator to immediately remove hydraulic power.

Isolation Pads Dampen the natural frequency to about 20 Hz. Hydraulic Crosshead Locks (optional) Clamp the crosshead to the columns.

> Force Sensor (Load Cell) Measures the compressive and tensile forces applied to the specimen.

### Actuator

Applies forces to the specimen. A linear actuator is shown. It applies compressive and tensile forces. Other types of actuators, such as rotarty actuators, are also available.

### Servovalve

Controls the rate and direction of hydraulic fluid entering the actuator

### Hydraulic Service Manifold

Controls the application and removal of hydraulic pressure to this load unit.

### Accumulators

Improve the actuator's response and reduce hydraulic line fluctuations. One accumulator connects to the pressure line, the other to the return line.



## Hydraulic Nechanism

- Electrical current to torque motor
- Flapper moves and diverts flow to the spool
- Spool moves, opening holes to supply pressure and return
- Spool pushes on the feedback wire,
  - restoring torque
- Comparison between torques
- Spool stops where feedback equals input



Flow is proportional to spool position





### Capabilities

Forces

•10 Newtons to 100 mega Newtons

Cycles

•Static to 200 Hz

Displacement

•Micrometers to 250 mm

Velocity

•Static to 30 m/s

### Instron & MTS





# Applications

- Test types:
  - Fatigue
  - Impact
  - •Bend
  - Compression
  - •Tension
- Other Uses:
- Nitinol wire
- Athletic shoes



### Bone Testing

Ex vivo bone characteristics

- •Anisotropic properties analyzed at varied axis loading
- Variation in loading rate
- •Fracture line dependent on force applied

Bone surrogate model

- Axial-Torsional Loading
- •Cantilever Bend Testing
- Four-point Bend Testing



# Knee Wear Simulator

Multi-axis physiologic motion •Four degrees of freedom 172000 test cycles per day (at 2 Hz) Loads up to 1000 lb can be applied Design Validation

- Volumetric wear
- •Wear patterns
- Polyethylene fatigue damage







## Hip Wear Simulation

**AMTI-Boston Simulator** Reproducible physiologic environment Rotation about three axes Temperature-controlled fluid bath •Flexible plastic bag enclosure 172000 test cycles per day (at 2 Hz) Loads up to 1000 lb can be applied



Wear Test on Acetabular Liner of Hip Implant

### References

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