The Relationship Between Pedestrian Component Legform and Full Dummy Testing in Assessing Bumper Performance

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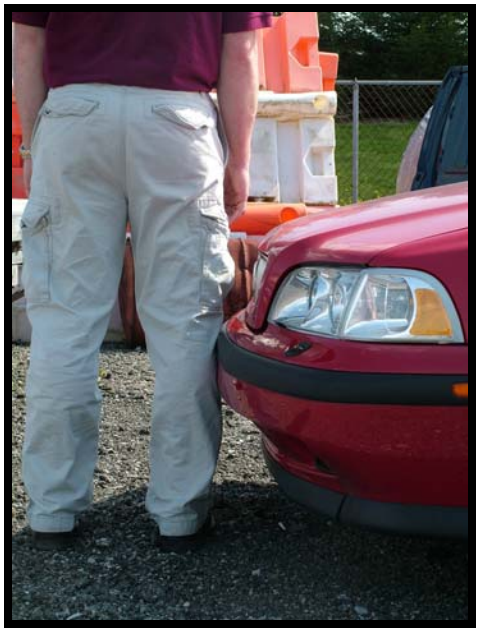
2006 Government/Industry Meeting

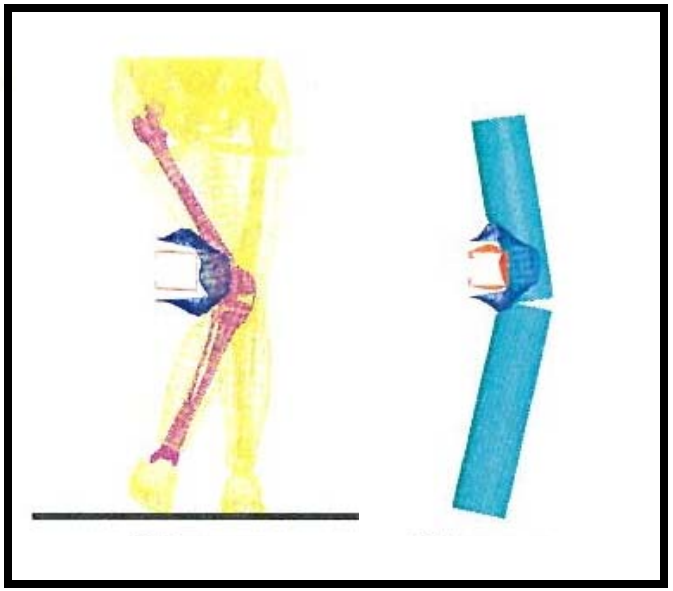
Objective

How well do projectile tests represent pedestrian lower extremity impacts?



Prior Studies

Cesari et al, ESV, 1991
Ishikawa et al, IRCOBI, 1992
Sakurai et al, ESV, 1991
Takahashi and Kikuchi, ESV, 2001
Matsui and Takabayashi,
JARI Research Journal, 2003

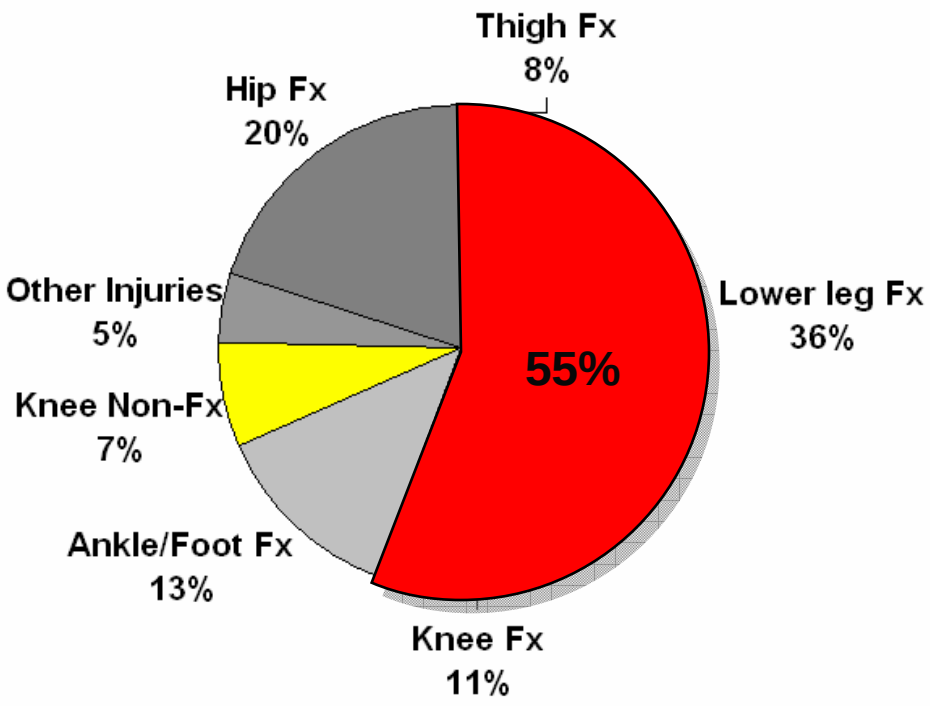


Focus on knee ligament injuries:

- Knee angle
- Knee moment
- Knee shear displacement

Focus of Current Study

PCDS
AIS 2+ Lower Extremity Injuries
1994-1998

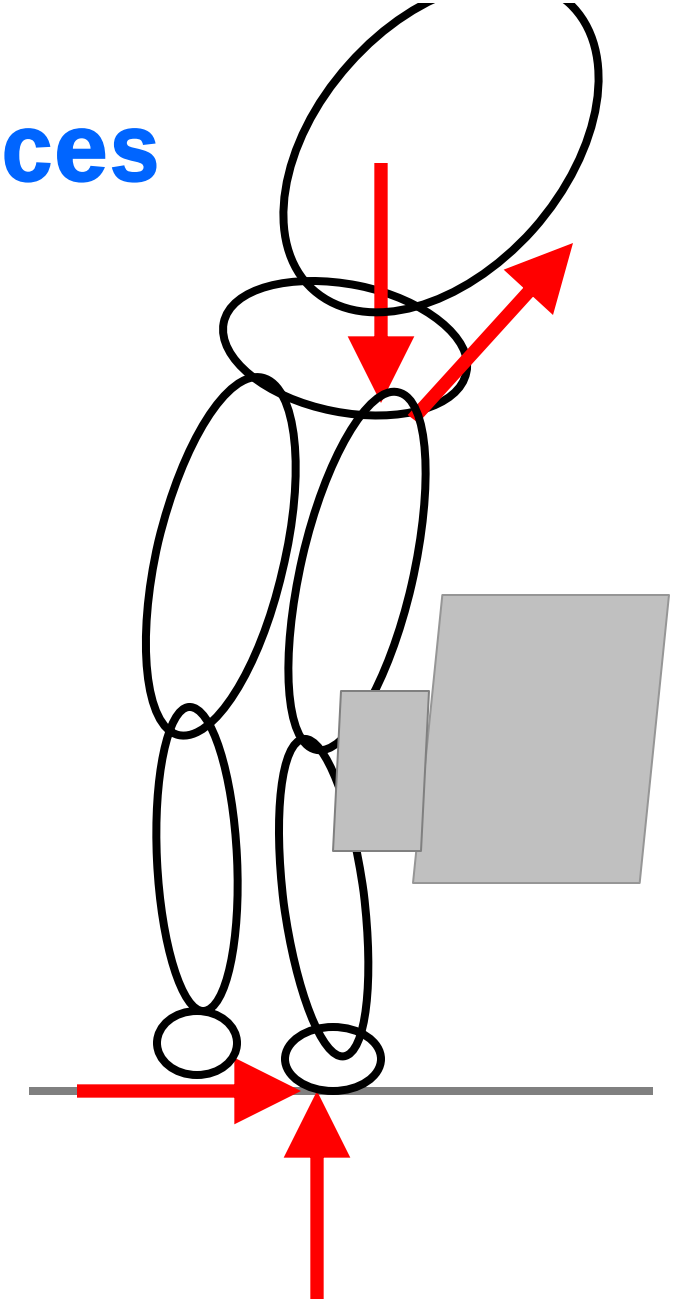


Focus on fracture measures:

- Femur moment
- Tibia moment
- Acceleration

Key Physical Differences

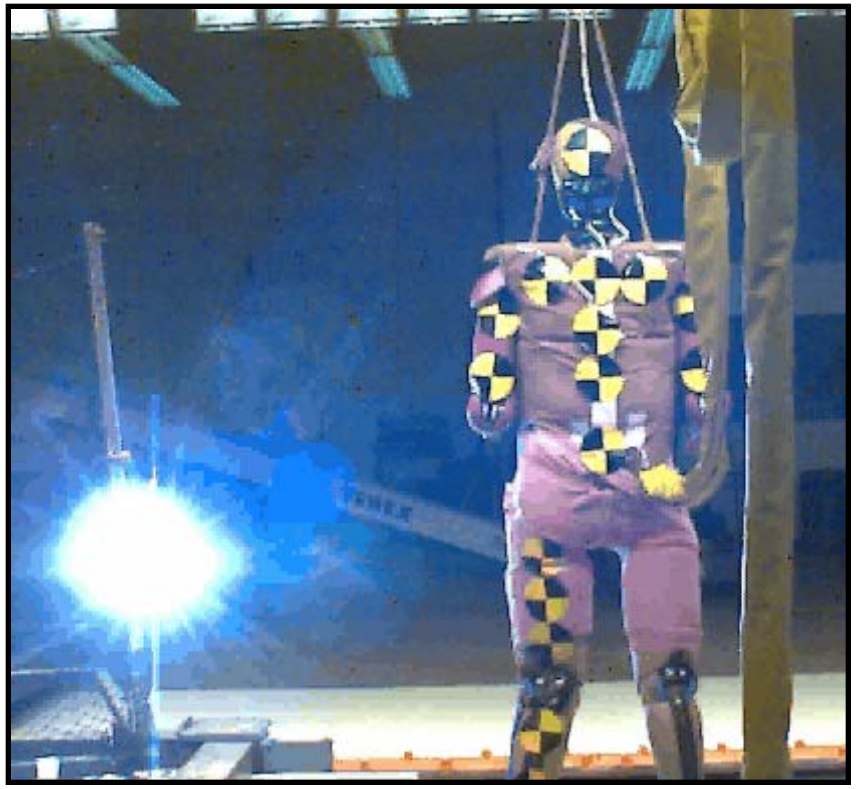
Pedestrian	Projectile
Initial axial load	No foot contact or body weight
Friction at foot	No foot contact
Upper body inertia	Thigh free to move



Key Physical Differences

Pedestrian	Projectile
Initial axial load	**No foot contact or body weight**
Friction at foot	No foot contact
Upper body inertia	Hip free to move

Polar II sled testing
48 km/h
1999 Honda Civic



Stammen and Ko "Assessment of Polar II Pedestrian Dummy for Use in Full-Scale Case Reconstructions", NHTSA report DOT HS 809 391, 2001.

Key Physical Differences

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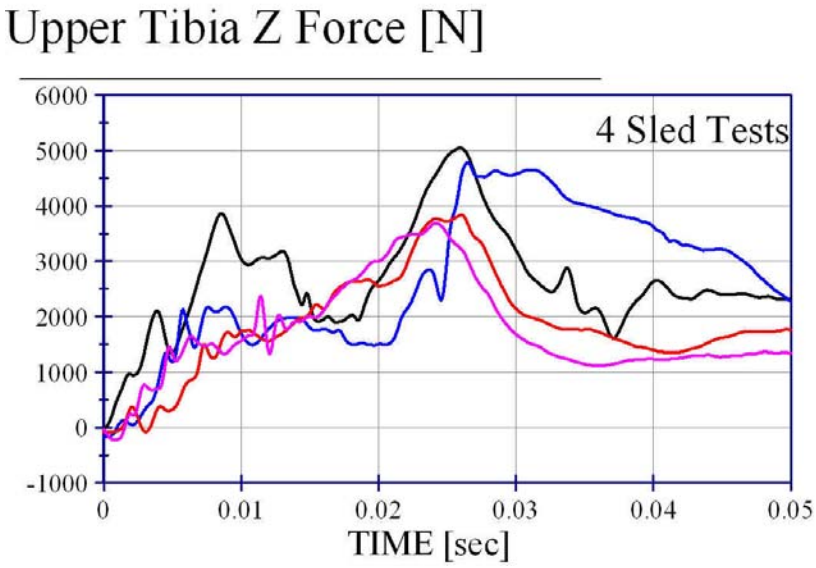
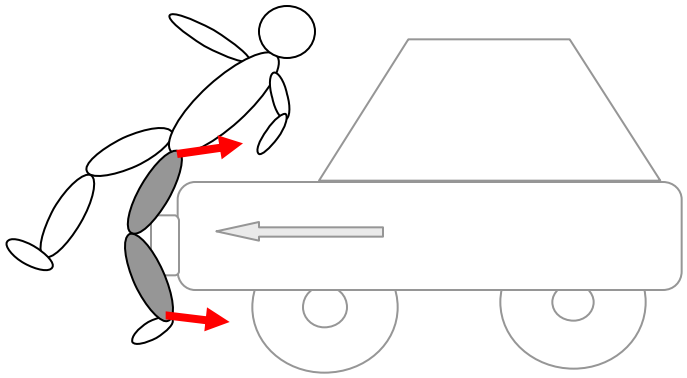




Key Physical Differences

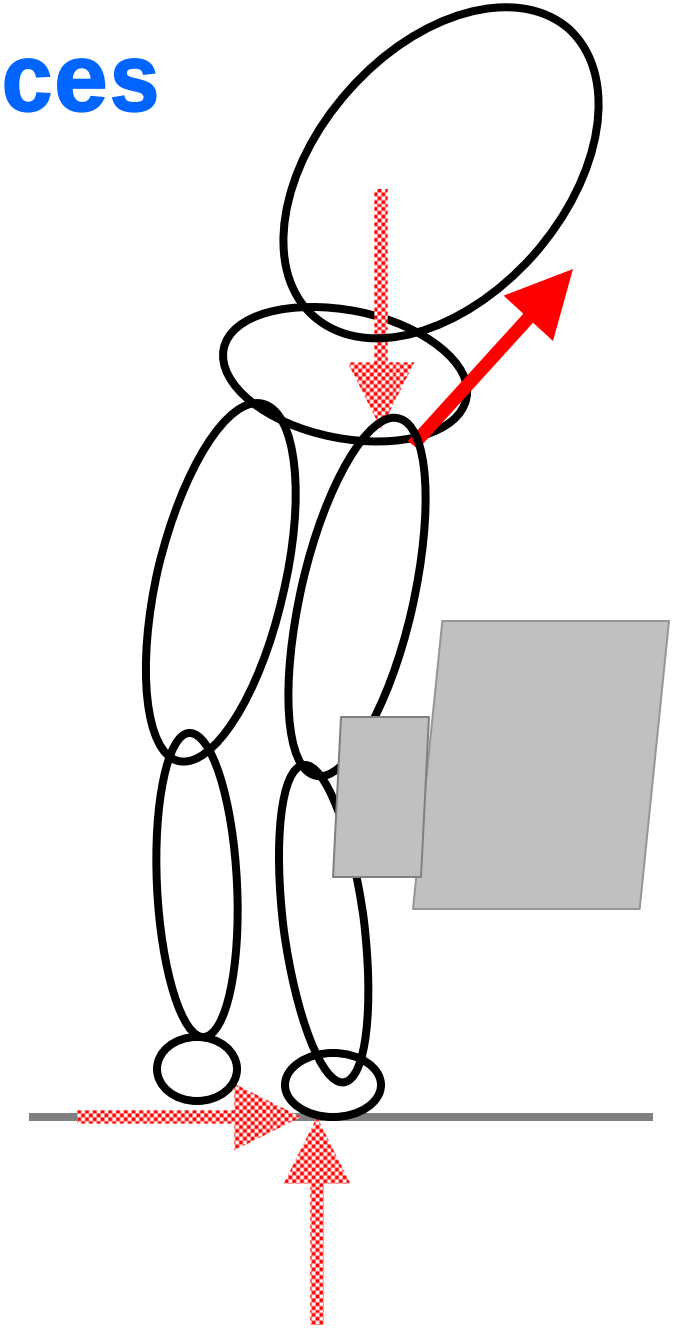
Pedestrian	Projectile
Initial axial load	No foot contact or body weight
Friction at foot	**No foot contact**
Upper body inertia	Hip free to move

μ = 0.15

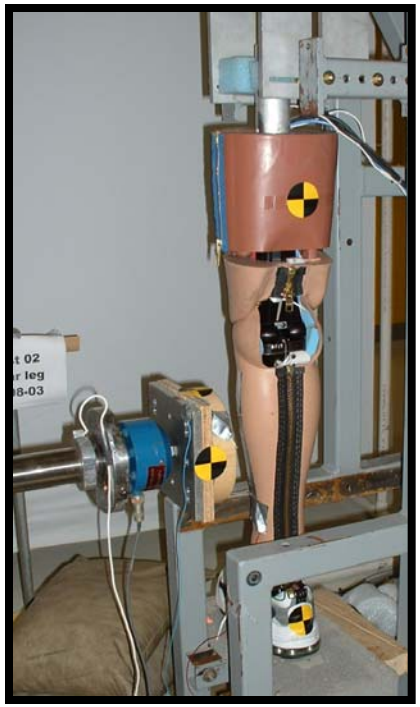
μ = 0.80

Key Physical Differences

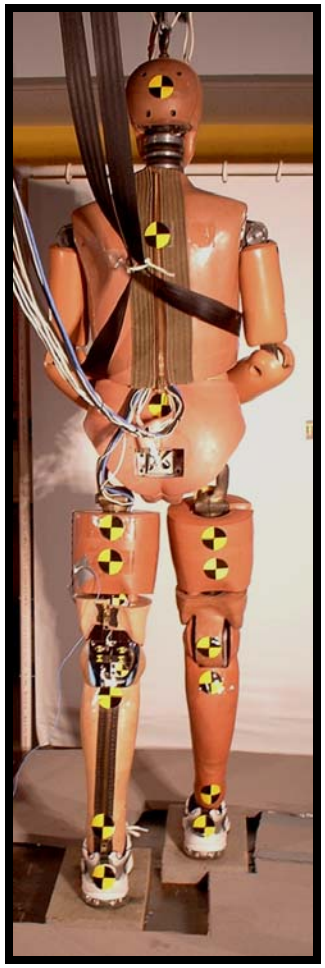
Pedestrian	Projectile
Initial axial load	No foot contact or body weight
Friction at foot	No foot contact
Upper body inertia	**Hip free to move**



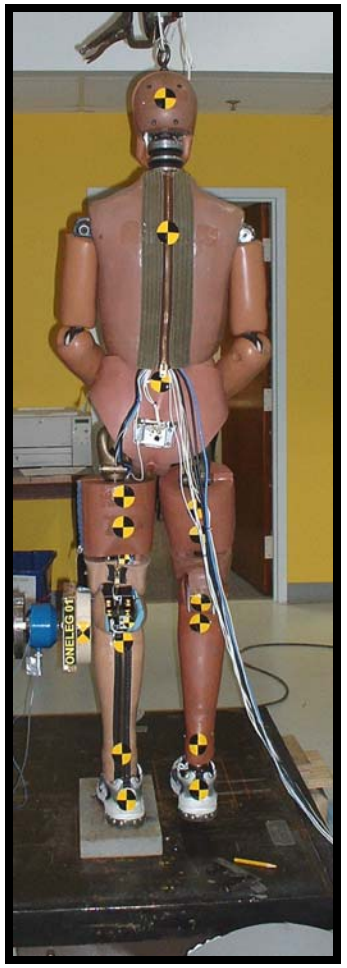
Weight Conditions (3)



Leg only
(no weight)



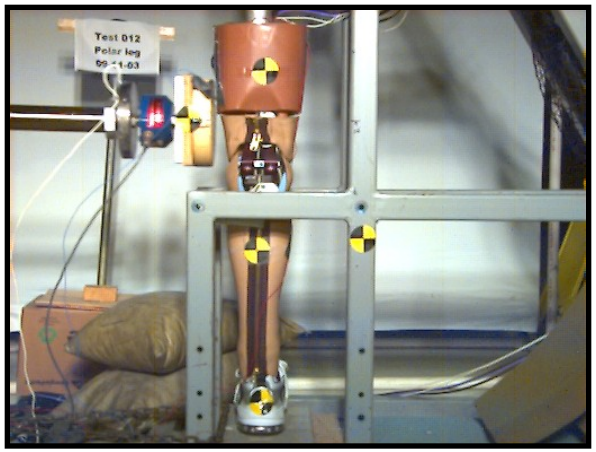
Two-leg stance
(mid weight)



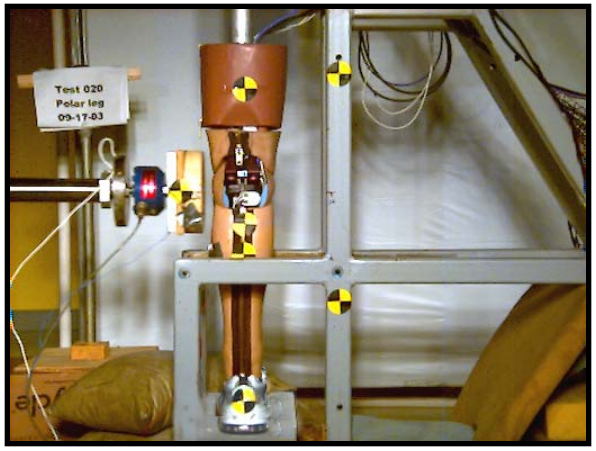
One-leg stance
(high weight)

Impact Locations (3)

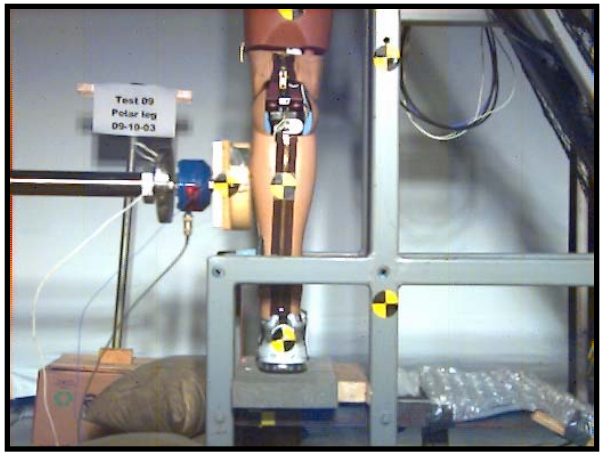
Femur impact



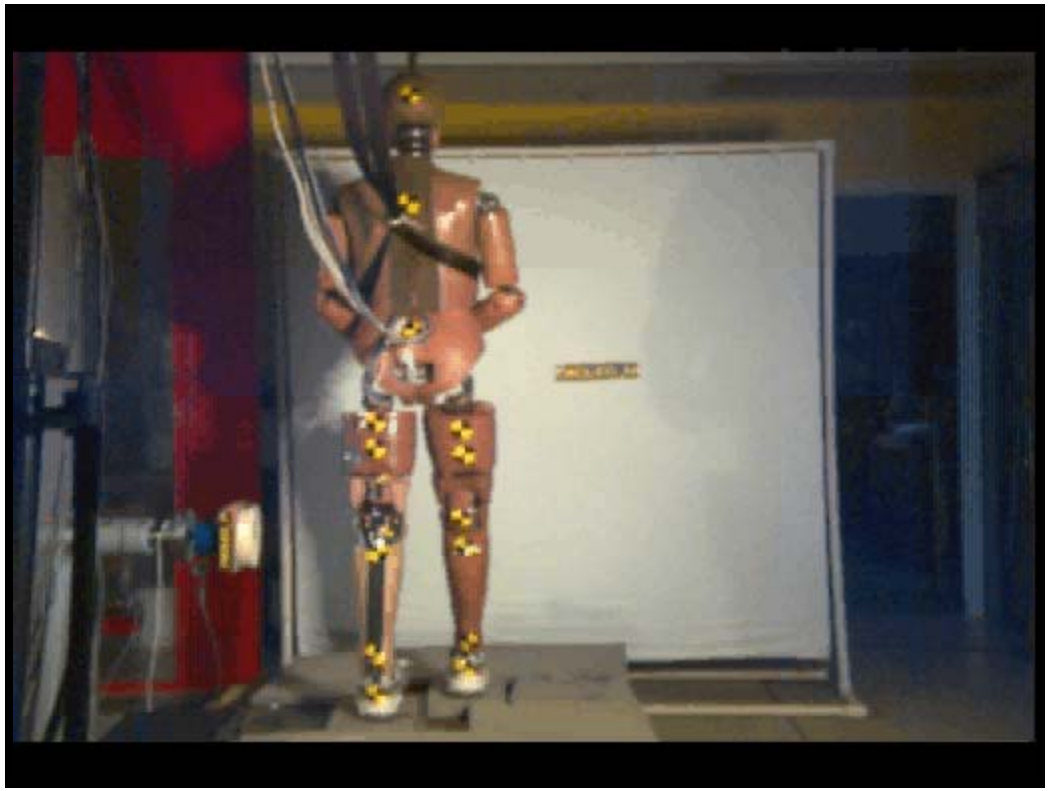
Knee impact



Tibia impact



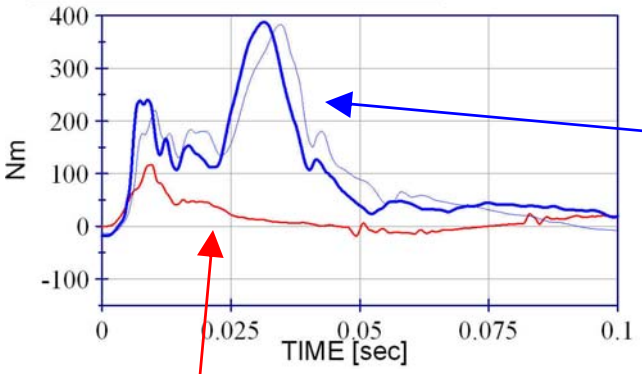
Polar II Legform with Hybrid III Body

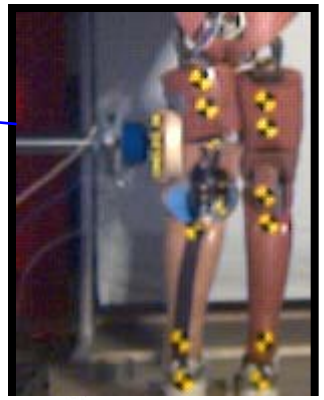


Two-leg stance, Knee impact

Inertial effects of upper body: Preliminary Results

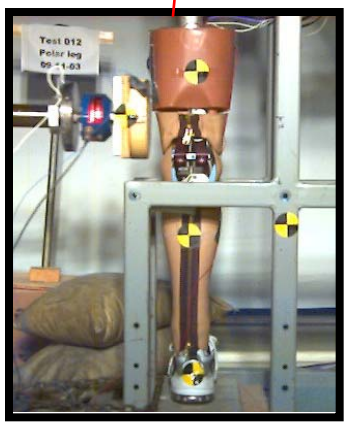
Femur Level Impact:



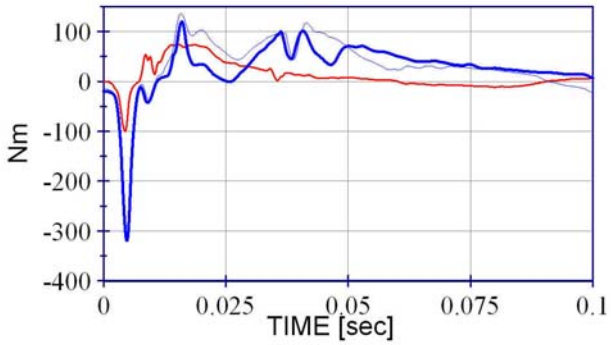


Femur X Moment

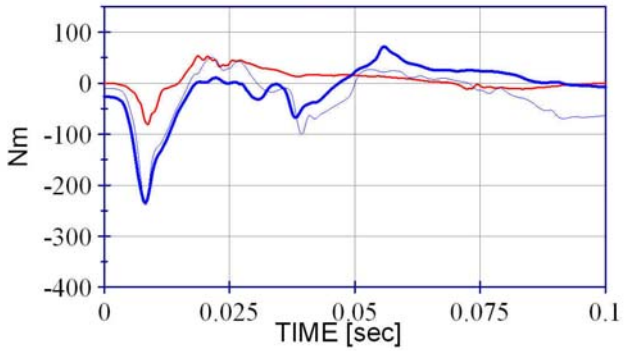
No Weight
Mid Weight
High Weight



Knee Level Impact:

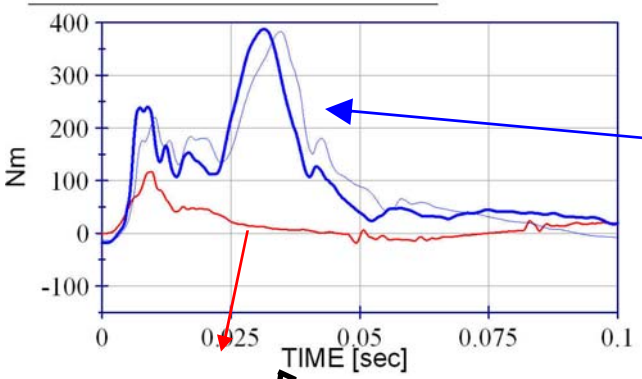


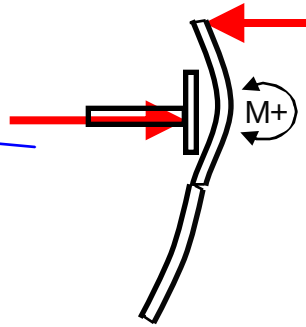
Tibia Level Impact:



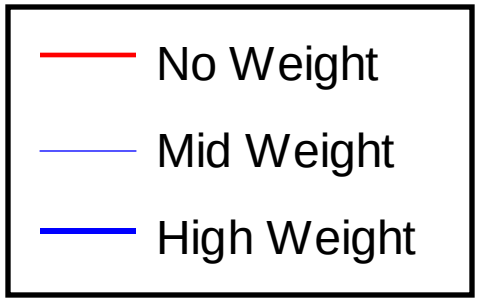
Inertial effects of upper body: Preliminary Results

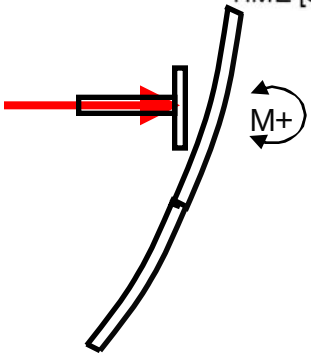
Femur Level Impact:



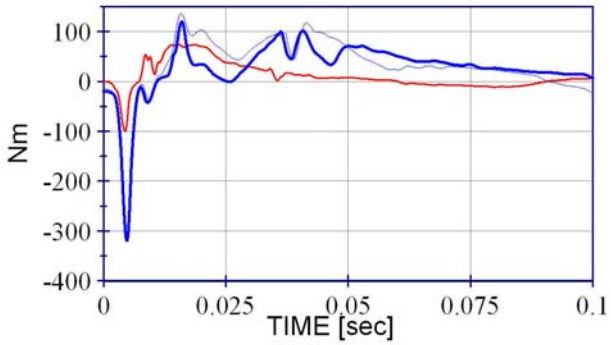


Femur X Moment

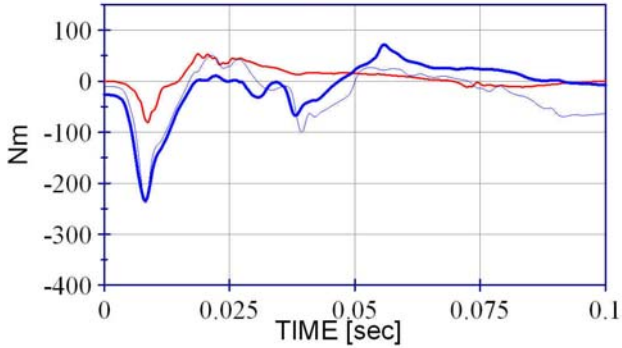




Knee Level Impact:

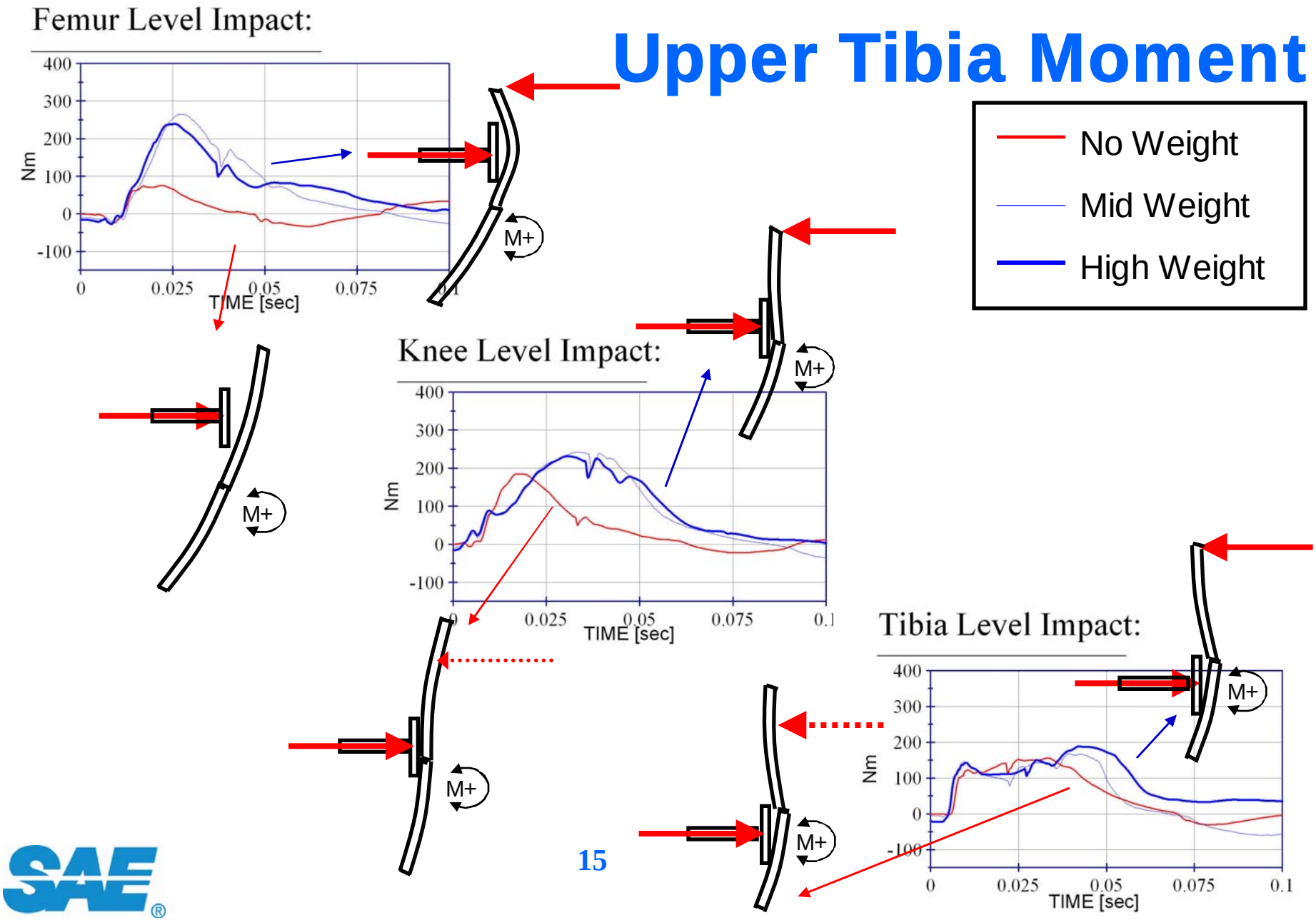


Tibia Level Impact:



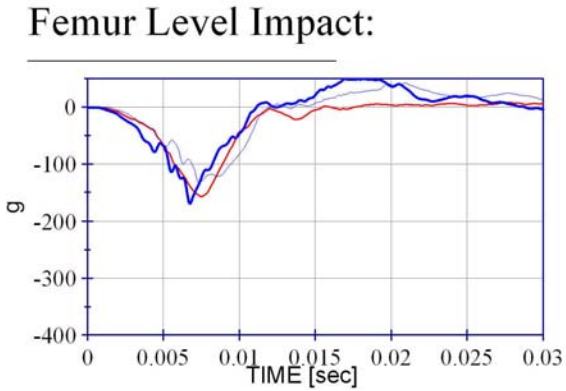
Inertial effects of upper body: Preliminary Results

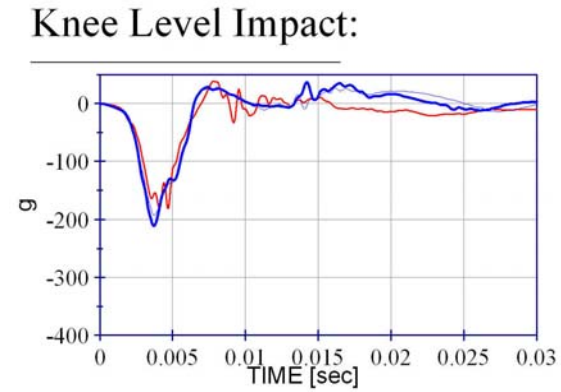
Upper Tibia Moment

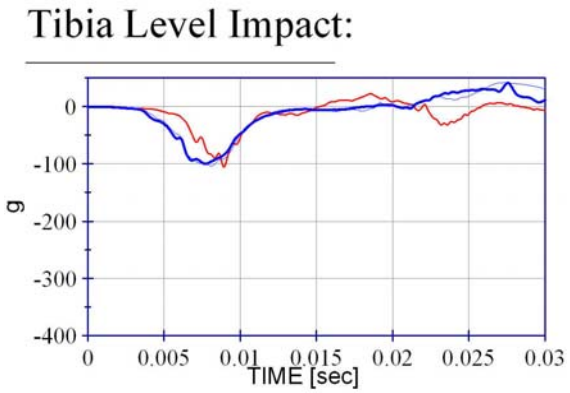


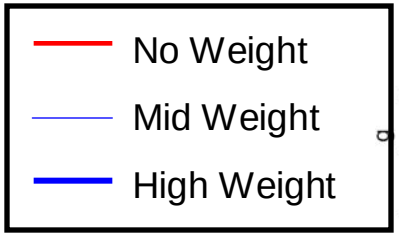
Inertial effects of upper body: Preliminary Results

Femur acceleration

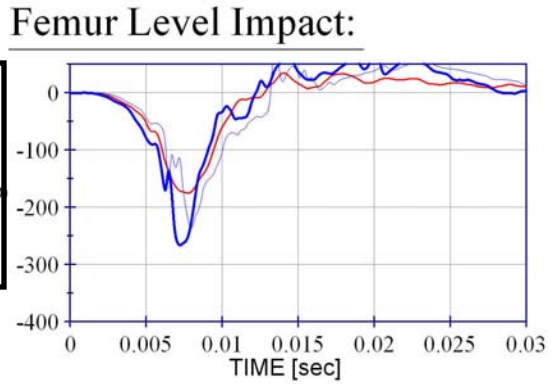


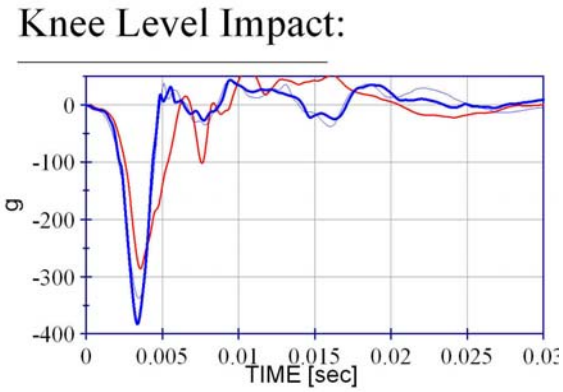


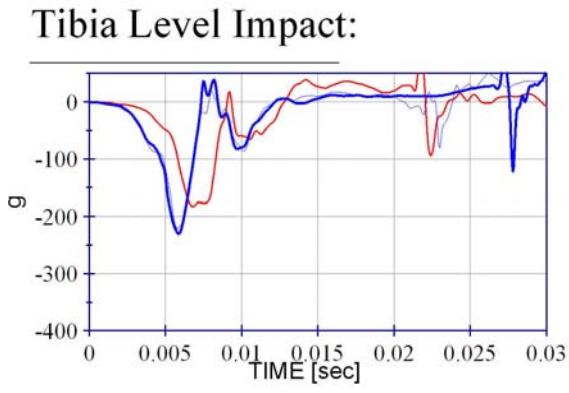




Tibia acceleration







Preliminary Observations

1) Ground contact effects appear minimal.
2) Presence of body mass does have effect on bending moment.
   - Femur moment - all impact heights
   - Tibia moment - high-bumper impacts
3) Presence of body mass has less effect on acceleration.

Implications for Test Procedure

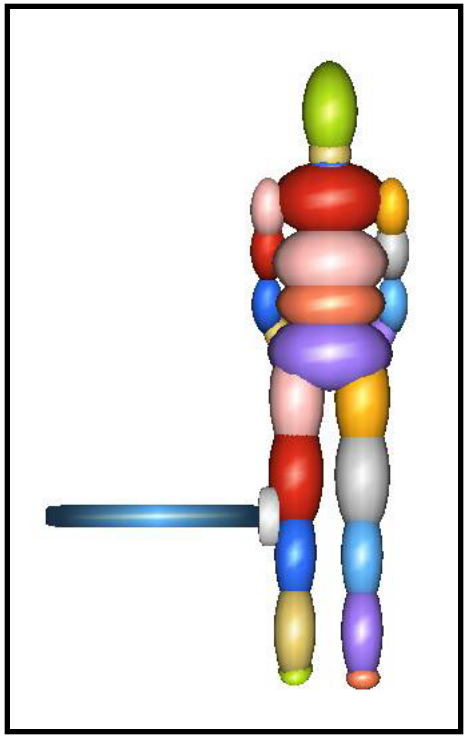
- Projectile test has potential to evaluate fracture measures
- Body weight effects on bending moment:
  - Limitations for unweighted projectile legform
- Future evaluation of bending moment should:
  - Be limited to impacts in certain height range

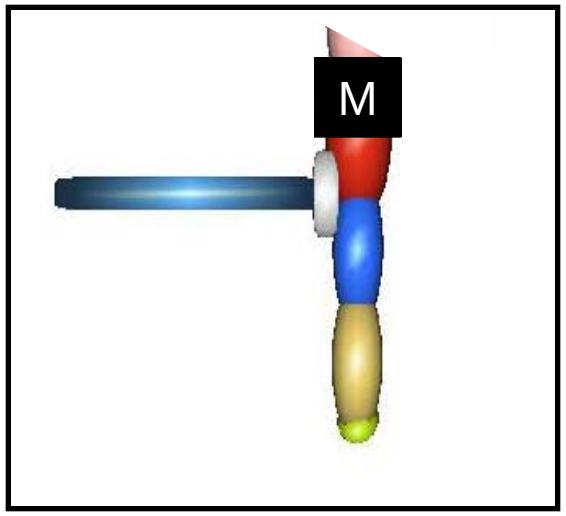
or

  - Simulate the inertia of the upper body

Future work

- Modeling
  - Determine added mass required to simulate whole body impact
  - Begin with mass recommended for knee injury measures.
- Testing
  - Modify legform with mass
  - Compare weighted leg with full-body tests





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