

Transmitted by the expert from Japan

***Status Report on  
Flexible Pedestrian Legform Impactor  
Technical Evaluation Group (Flex-TEG)  
Activities***

Atsuhiko Konosu  
Chairperson of Flex-TEG, Japan

# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

Participants of 6<sup>th</sup> Flex-TEG meeting (31 March 2008, BASt, Germany)

A. Konosu (Flex-TEG chairperson/J-MLIT/JARI)  
B. Been (Flex-TEG secretariat/FTSS-Europe)  
O. Zander (BASt), D.U. Gehring (BGS)  
D. Cesari (INRETS), S. Ronel (INRETS/Lyon Univ.)  
S. Meyerson (NHTSA), A. Mallory (TRC/VRTC)  
O. Ries and S. Siems (ACEA/VW)  
R. Fleischhacker and J. Walldorf (ACEA/Porsche)  
F. Matsuoka (JAMA/Toyota),  
D. Longhitano (Honda R&D Americas)  
F. Minne (UTAC)  
K. Wolff (Continental)  
G. Zenz (SABIC)  
J.C. Kolb (Berbraudt)  
M. Winkler and D. Arp (MESSRING)  
S. Pruitt (DTS)  
T. Inoue (JASTI)  
M. Burleigh (FTSS-UK)  
Total: 23 persons

# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

## Main part of Agenda of the 6th Flex-TEG meeting

### **5. Reports and Discussions: Flex-GT Technical Evaluation Results**

**5.1. NHTSA Flex-GT Test summary (TEG-063)**

**5.2. NHTSA Flex-GT Certification Tests (TEG-064)**

### **6. Finalization: Flex-GTR Designs**

#### **6.1. Mechanical Design**

**6.1.1. Flex-GTR Mechanical Design (TEG-054)**

#### **6.2. Instrumentation and Electrical Design**

**6.2.1. Flex-GTR Instrumentation Electrical Design (TEG-055)**

#### **6.3. Full Calibration Test Procedure**

**6.3.1. Flex-GTR Full Calibration Test Procedure (TEG-056)**

**6.3.2. BASt Proposal for a Full Assembly Certification Test (TEG-062)**

#### **6.4. Optional Instrumentation**

**6.4.1. Flex-GTR Optional Instrumentation (TEG-057)**

**6.4.2. Onboard DAS Information (TEG-058, TEG-059)**

#### **6.5. Others**

**6.5.1. Information: NHTSA Design of a Proposed Upper Body Mass (TEG-065)**

### **7. Future action plans**

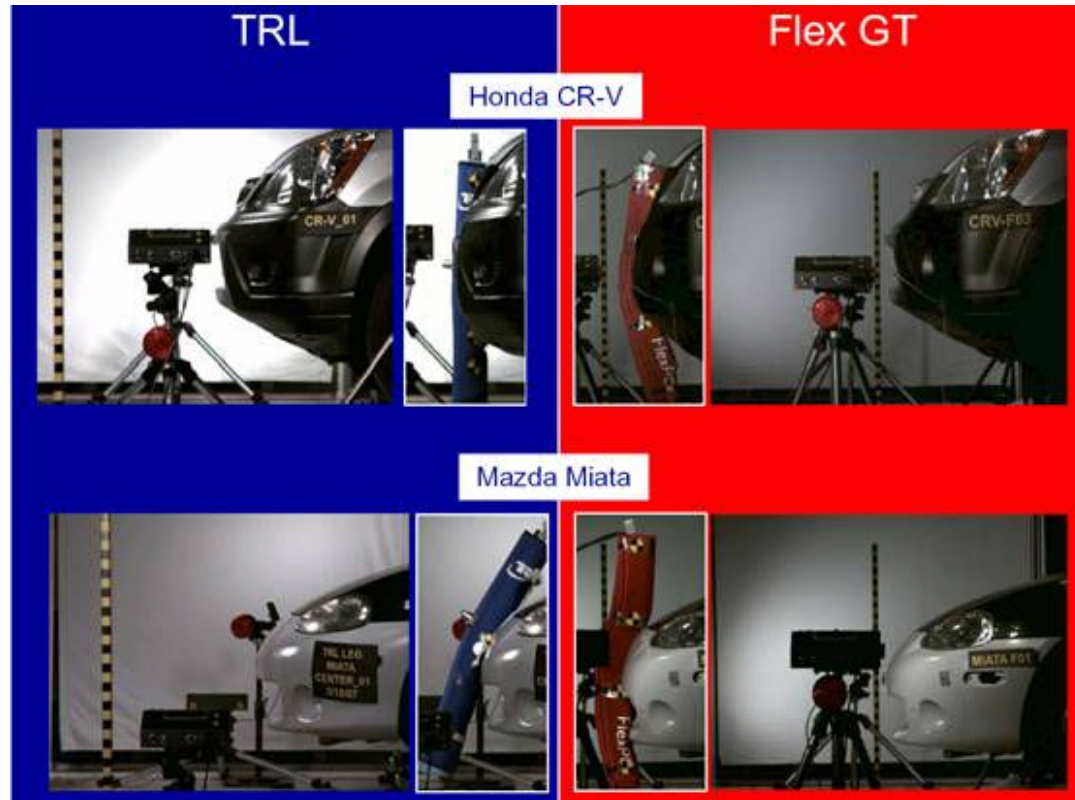
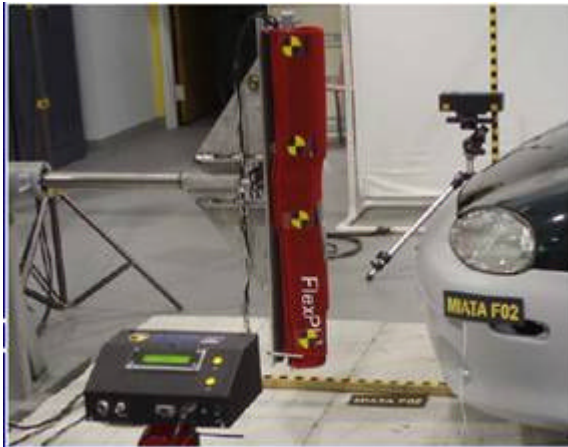
# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

## 5. Reports and Discussions: Flex-GT Technical Evaluation Results

### 5.1. NHTSA Flex-GT Test summary (TEG-063)

### 5.2. NHTSA Flex-GT Certification Tests (TEG-064)

#### NHTSA Flex-GT Evaluation Tests



- Repeatability, usability, and durability of Flex-GT are evaluated, and also comparisons between the TRL legform impactor and Flex-GT are conducted.
- These results are used for following discussions on the Flex-GTR finalization.

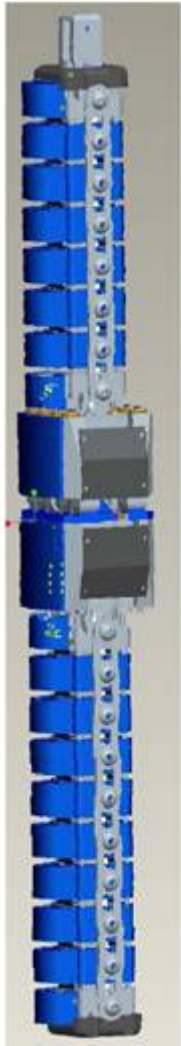
# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

## 6. Finalization: Flex-GTR Designs

### 6.1. Mechanical Design

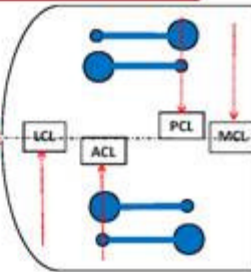
#### 6.1.1. Flex-GTR Mechanical Design (TEG-054)

##### Flex-GTR (CAD model)

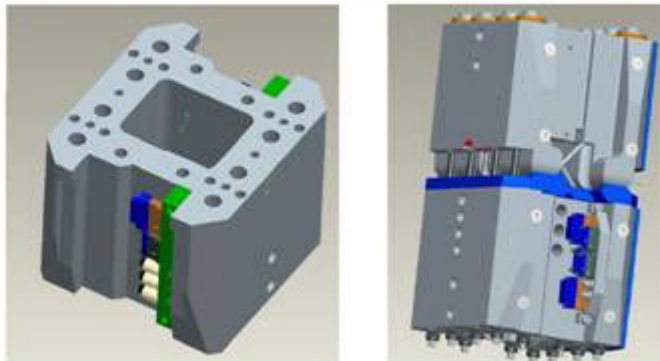


##### Conceptual Design

- To avoid A-symmetric sensitivity
  - Move MCL & LCL at centerline
  - Move ACL & PCL close to centerline
- To avoid knee twist
  - Use two sets of cruciate ligaments
  - To neutralize twist moment
- Cruciate ligaments 8 springs
  - DBØ12xØ6x40mm; 71.6N/mm
  - May need to go Ø3mm cable
  - Optimized space for DAS & connector
- Lateral ligaments 16 springs same
  - DBØ18xØ9x60mm; 76.7N/mm

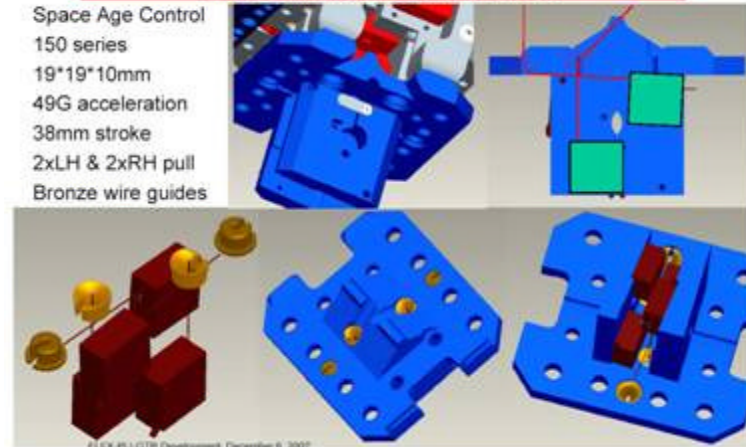


##### Integration of connector blocks and wiring

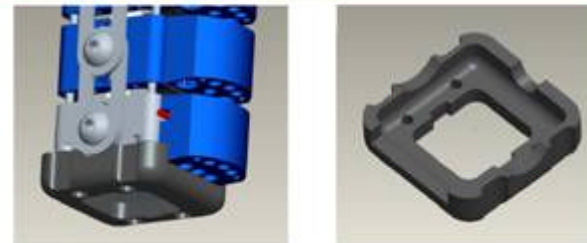


##### Packaging Ligament Elongations Sensors at Centre Line

Space Age Control  
150 series  
19\*19\*10mm  
49G acceleration  
38mm stroke  
2xLH & 2xRH pull  
Bronze wire guides



##### Protective rubber bumpers to distal and proximal ends



- Flex-GTR Mechanical Designs are frozen.

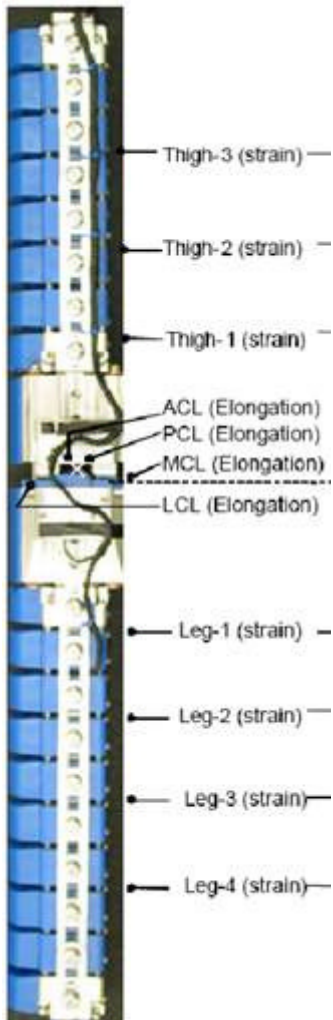
# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

## 6. Finalization: Flex-GTR Designs

### 6.2. Instrumentation and Electrical Design

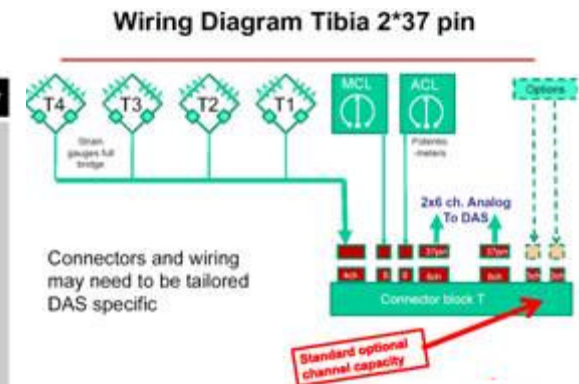
#### 6.2.1. Flex-GTR Instrumentation Electrical Design (TEG-055)

#### Flex-GTR (Electrical design)

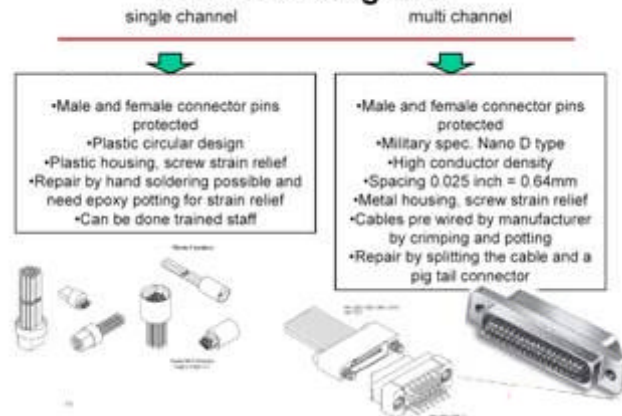


Measurement Items (Standard)

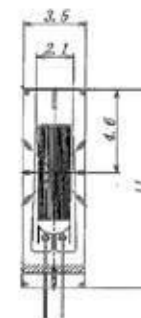
Channel	Purpose	Standard	Option	DAS	Priority
Femur moment 1, 2 and 3	Calibration	3	0	Standard option On board DAS	
Tibia moment 1, 2, 3 and 4	Injury	4	0		
Tibia top acceln ax	Calibration	1	-1		
MCL elongation	Injury	1	0		
ACL elongation	Calibration	1	0		
PCL elongation	Calibration	1	0		
LCL elongation	Calibration	1	0		



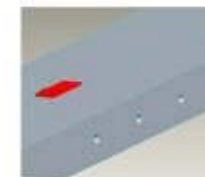
#### Connectors agreed



#### Strain Gauges



- FLEX-GT specs and adhesive are going to be used
- Uni-axial, 5mm length, 350 Ohm



- Flex-GTR electrical designs are frozen, except ACL and PCL measurement purpose, injury assessment purpose and/or calibration purpose.

# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

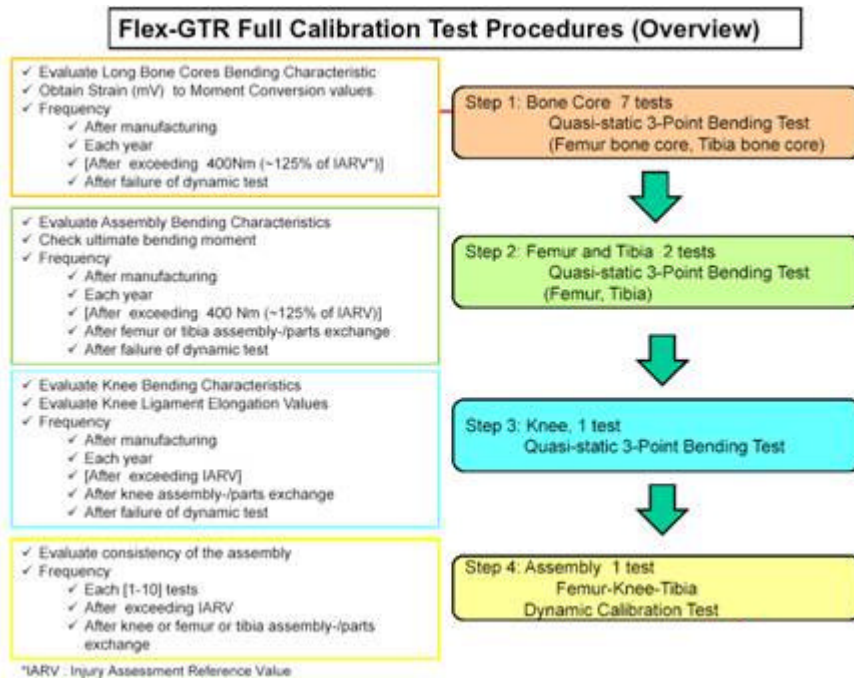
## 6. Finalization: Flex-GTR Designs

### 6.3. Full Calibration Test Procedure

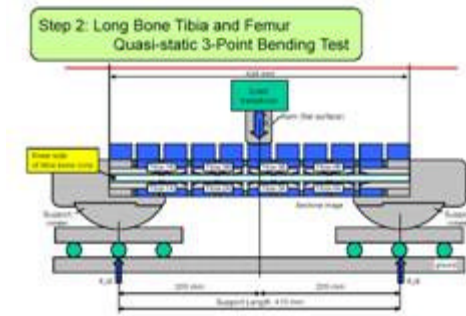
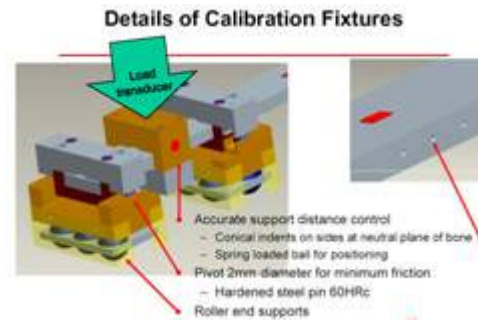
#### 6.3.1. Flex-GTR Full Calibration Test Procedure (TEG-056)

#### 6.3.2. BAsT Proposal for a Full Assembly Certification Test (TEG-062)

### Flex-GTR (Full Calibration Test Procedure)



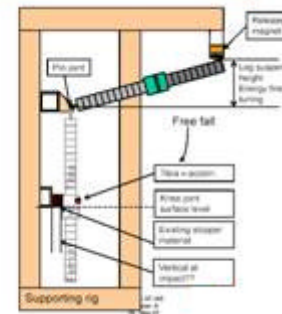
### Component Level



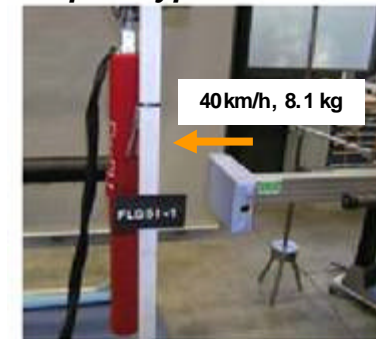
### Assembly Level

#### Pendulum type

- Calibration rig with support arm and release magnet
- Control input pulse with tibia x-acceleration
- Control parameters
  - Drop height
  - As tibia proximal
  - MCL, ACL, PCL (and LCL)
  - Tibia bending moments
  - No pass/fail parameter femur bending moments
  - Target corridor ±10% from average



#### or Impact type



• Flex-GTR full calibration test procedures are frozen, except type of assembly level calibration test method, pendulum type or impact type.

# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

## 6. Finalization: Flex-GTR Designs

### 6.4. Optional Instrumentation

#### 6.4.1. Flex-GTR Optional Instrumentation (TEG-057)

#### 6.4.2. Onboard DAS Information (TEG-058, TEG-059)

### Flex-GTR (Optional Instrumentation)

#### Summary

##### On board pending feasibility

- 3 axis damped accelerometer ●
- 3 axis angular velocity sensor ●

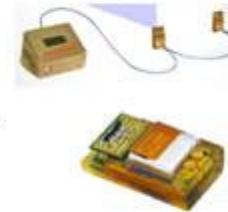
##### Off board

- Attachment place for 3 axis damped accelerometer ■
- Attachment place for 1 axis damped accelerometer ■

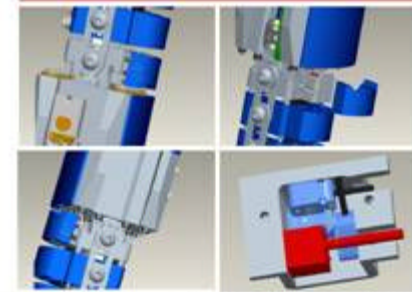


#### On Board Data Acquisition Systems

- High priority
- 'Standard' option
- Improve free flight motion control
- Packaging space is optimized, though still limited
  - Potential solutions meet packaging space

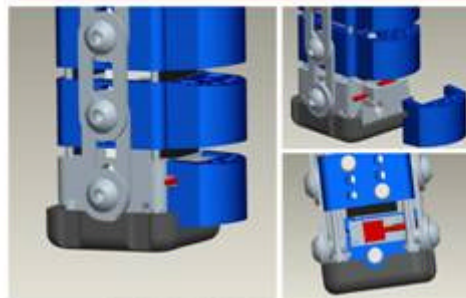


#### Tibia and Femur Knee Part

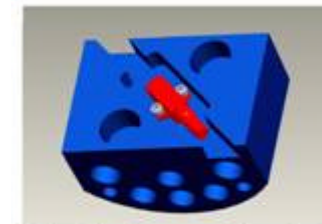


Triax accelerometer  
Three angular velocity sensors

#### Triax accelerometer Distal Tibia (shown) and Proximal Femur



#### Single axis accelerometer x-direction each segment



- Dedicated nylon segment for optional accelerometer
- Threaded metal insert

<sup>5</sup>  
FLEX-PLI-GTR Development, January 22, 2008

• Flex-GTR Optional Instrumentation designs are frozen.



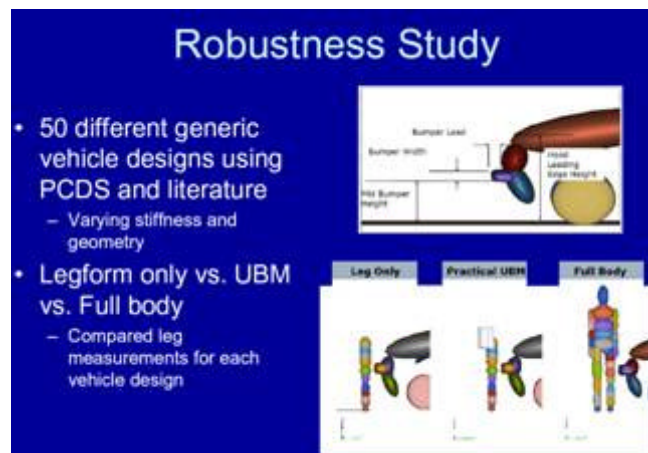
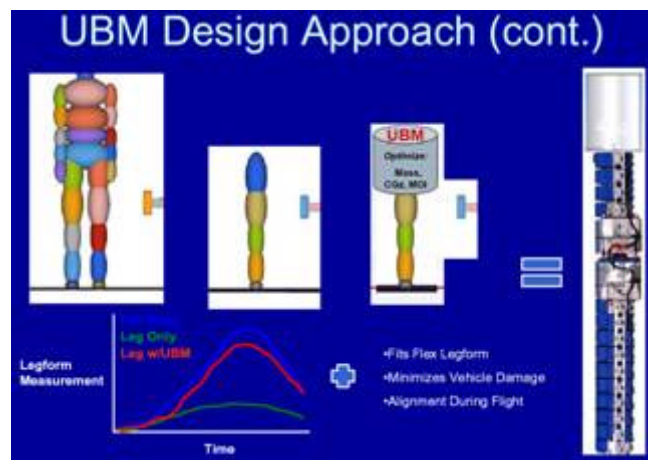
# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

## 6. Finalization: Flex-GTR Designs

### 6.5. Others

#### 6.5.1. Information: NHTSA Design of a Proposed Upper Body Mass (TEG-065)

#### Information: NHTSA Design of a Proposed Upper Body Mass



## Discussion Points

- Addition of UBM improves similarity to our full-body model
  - Most improvement above/at knee
  - Important for high-bumper vehicles (femur fracture)
- Proposed UBM design seems practical
  - Need to conduct physical tests to be certain
- Flex GT more flexible than our MADYMO model
  - UBM optimized for rigid femur and tibia
  - Unclear if optimized UBM works for Flex
- Could upper body mass:
  - Produce vertical knee displacements similar to full-body displacements *for individual vehicles (rather than universal 75 mm)?*
  - Improve correlation with full-body measures for femur moments and ACL as well as tibia moments and MCL/bending angle ?

- As information, NHTSA upper body mass study is informed.
- Status of the research is an initial stage, e.g. rigid femur and rigid tibia is used in their study, therefore, Flex-TEG does not treat this topic in the Flex-TEG activities (future work for another group).

# Latest Flex-TEG Activities (6<sup>th</sup> Flex-TEG meeting)

## 7. Future action plans

By the end of September 2008

- Flex-GTR developer group will product Flex-GTR, and conduct Flex-GTR evaluations by them.
- Flex-TEG members will discuss and decide the ACL and PCL measurement purpose, Injury assessment and/or Calibration.
- Flex-TEG members will discuss and decide the type of assembly level calibration test method for Flex-GTR, pendulum type or impact type

☆ 7<sup>th</sup> Flex-TEG meeting

From October 2008 to the end of April 2009

- Initial technical evaluation of the Flex-GTR will be conducted by main Flex-TEG members.

☆ 8<sup>th</sup> Flex-TEG meeting

\* 1) Review of Injury Risk Functions, 2) Evaluations of Technical Feasibilities, 3) Evaluation of Lower Limb Protection Level of Flex-GTR, and 4) Documentation Activities, will be conducted in parallel on above activities.

Flex-GTR



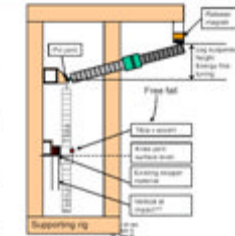
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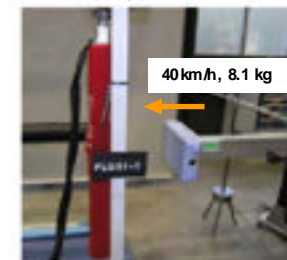
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OR Impact type



**Thank you for your attentions!**

