

Development of an FE Biofidelic Flexible Pedestrian Legform Impactor Model (FLEX-GT-prototype Model)

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- 2. Construction of FE Flex-GT-prototype Model**
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Background

- The flexible pedestrian legform impactor type GT prototype (Flex-GT-prototype (called as Flex-GT α in the previous report^{1), 2)) was developed in Spring 2006.}
- In this version, 1) the range of motion of the knee region, 2) the light weight of the bone parts, as well as 3) the biofidelity under assembly level (Thigh-Knee-Leg connected level) are improved.
- However, a validation study on the biofidelity of this impactor was not completely conducted, so it still needs to be validated.
- Thus, to conduct further validation study on the biofidelity of this impactor, an FE Flex-GT-prototype computer simulation model was developed.

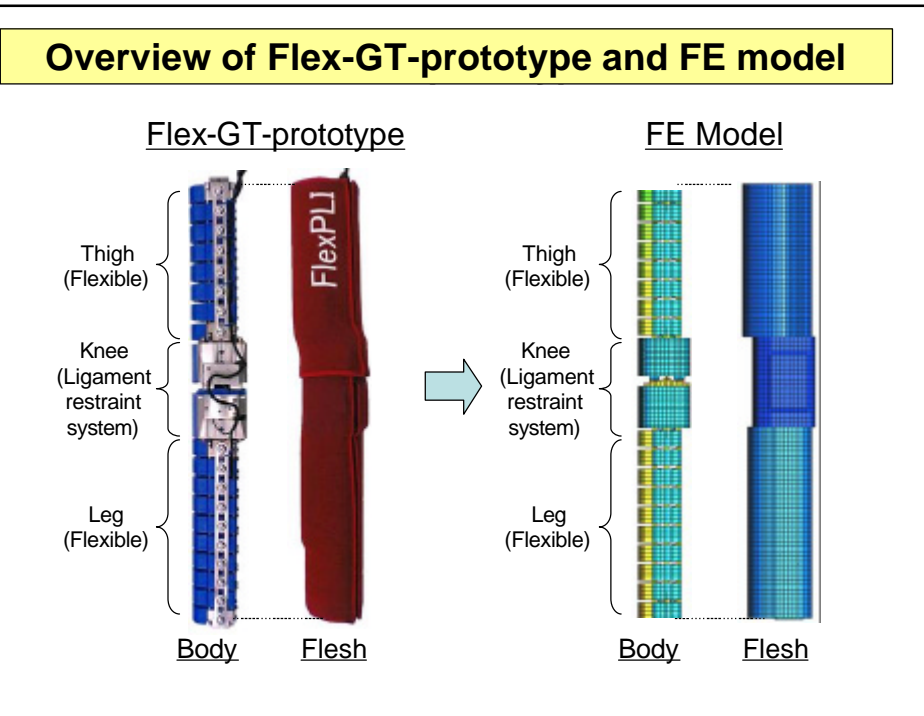
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2. Construction of FE Flex-GT-prototype Model

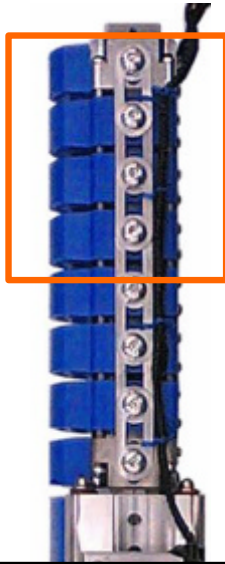
3. Evaluation of FE Flex-GT-prototype Model

4. Conclusions



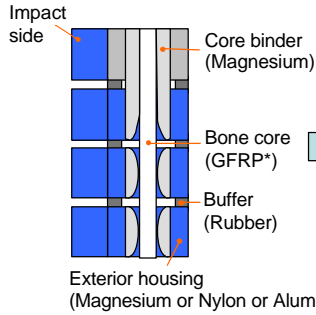
Construction of Flex-GT-prototype and FE model

Long bone



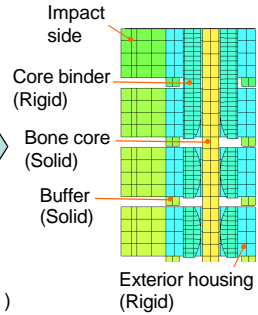
Flex-GT-prototype

(Cross sectional image)



FE Model

(Cross sectional image)



* GFRP: Glass Fiber Reinforced Plastics

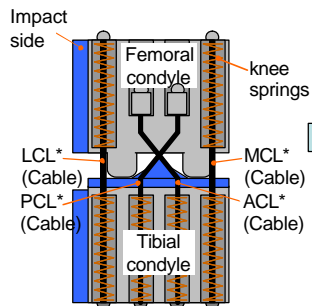
Construction of Flex-GT-prototype and FE model

Knee



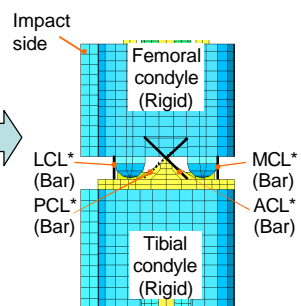
Flex-GT-prototype

(Cross sectional image)



FE Model

(Cross sectional image)



* ACL: Anterior Cruciate Ligament
 * PCL: Posterior Cruciate Ligament
 * MCL: Medial Collateral Ligament
 * LCL: Lateral Collateral Ligament

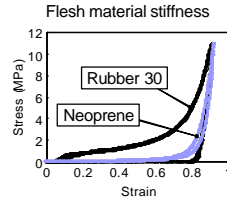
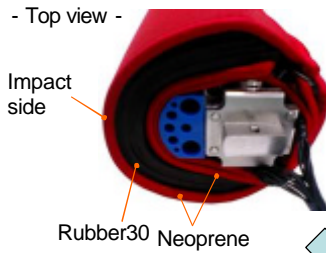
Construction of Flex-GT-prototype and FE model

Flesh



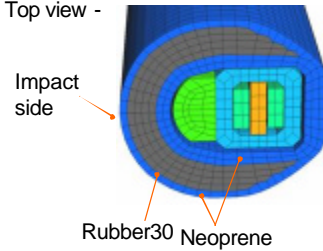
Flex-GT-prototype

- Top view -

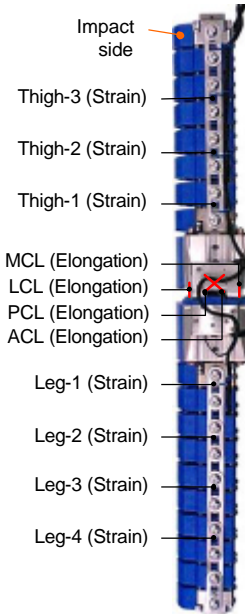


FE Model

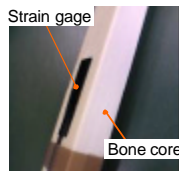
- Top view -



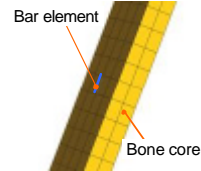
Instrumentation of Flex-GT-prototype



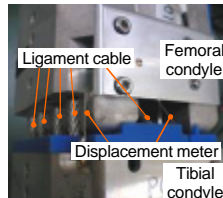
Thigh-Leg



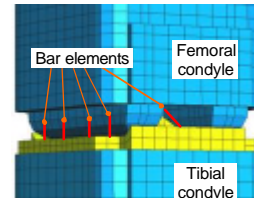
FE Model Thigh-Leg



Knee



FE Model Knee



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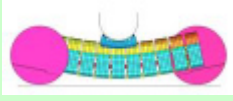
Model evaluation

Partial evaluation

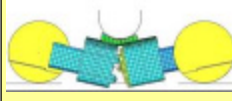
Thigh 3-point bending simulation



Leg 3-point bending simulation

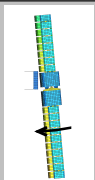


Knee 3-point bending simulation



Assembly evaluation

Assembly dynamic bending simulation



Collision simulation with simplified car model



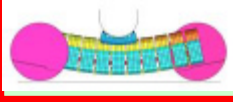
Model evaluation

Partial evaluation

Thigh 3-point bending simulation



Leg 3-point bending simulation

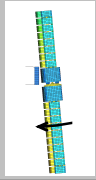


Knee 3-point bending simulation



Assembly evaluation

Assembly dynamic bending simulation

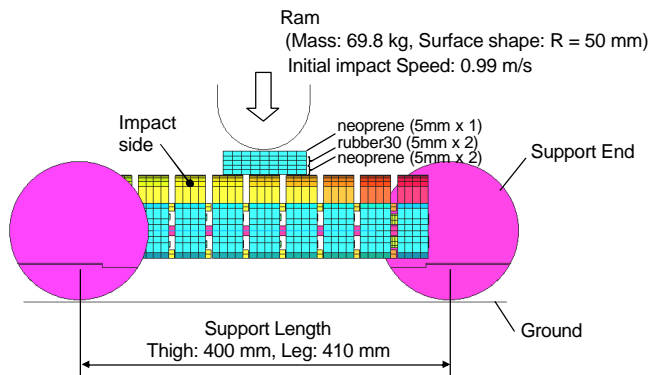


Collision simulation with simplified car model



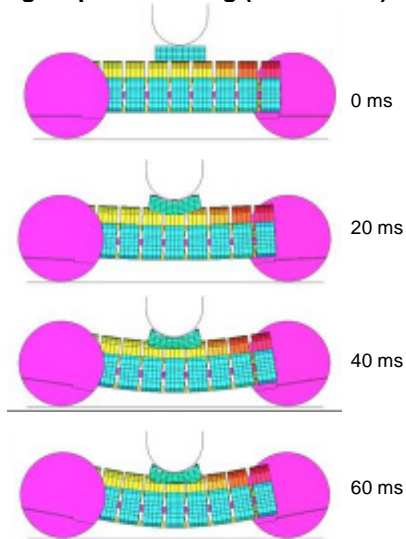
Thigh and Leg 3-point bending simulation

Model setup

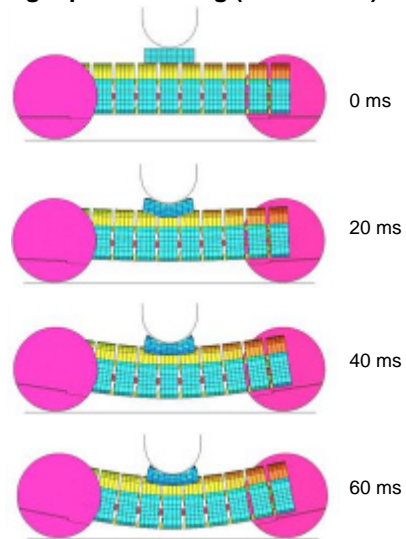


Thigh and Leg 3-point bending simulation

Thigh 3-point bending (Kinematics)

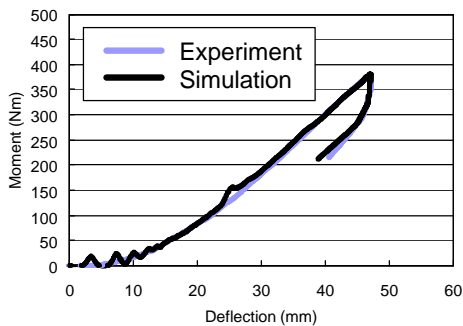


Leg 3-point bending (Kinematics)

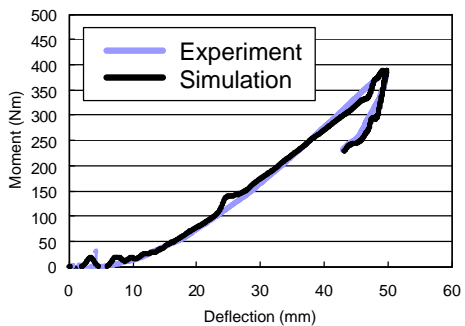


Thigh and Leg 3-point bending simulation

Thigh 3-point bending
(moment-deflection response)



Leg 3-point bending
(moment-deflection response)



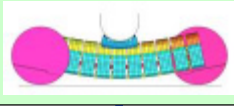
Model evaluation

Partial evaluation

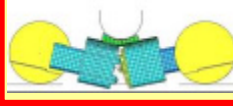
Thigh 3-point bending simulation



Leg 3-point bending simulation

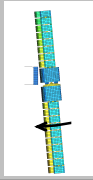


Knee 3-point bending simulation



Assembly evaluation

Assembly dynamic bending simulation

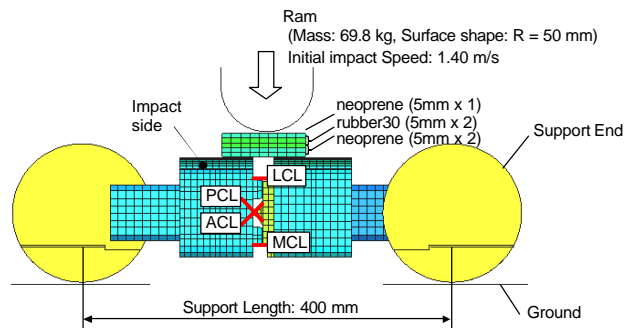


Collision simulation with simplified car model



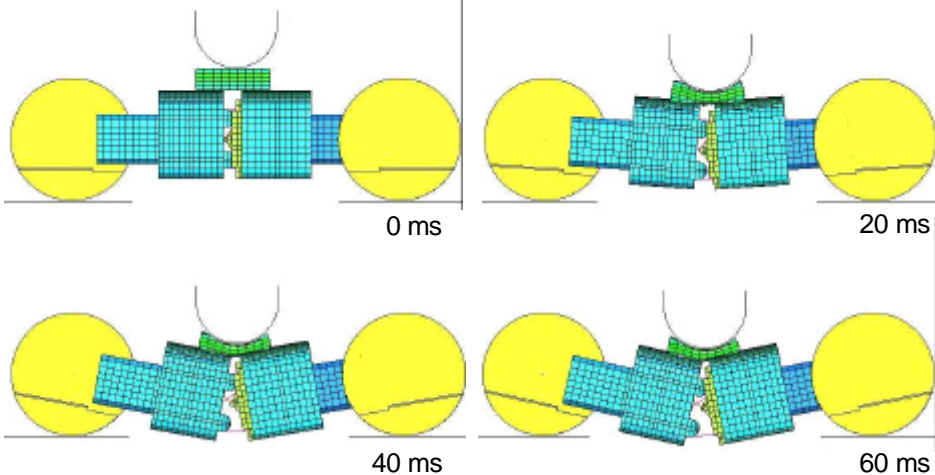
Knee 3-point bending simulation

Model setup

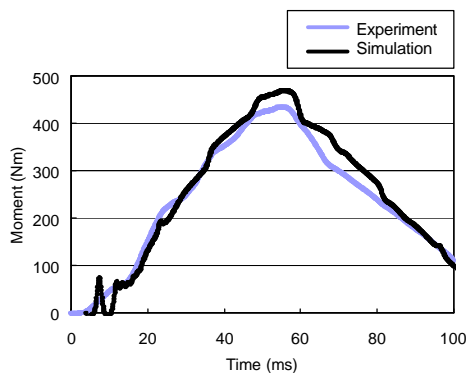


Knee 3-point bending simulation

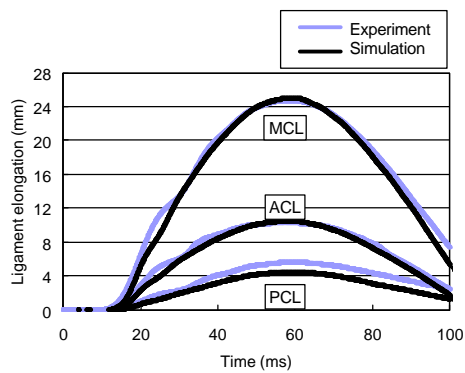
Knee 3-point bending (Kinematics)



Knee 3-point bending simulation



(a) Moment

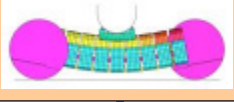


(b) Ligament elongation

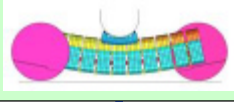
Model evaluation

Partial evaluation

Thigh 3-point bending simulation



Leg 3-point bending simulation

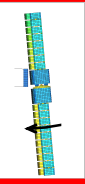


Knee 3-point bending simulation



Assembly evaluation

Assembly dynamic bending simulation

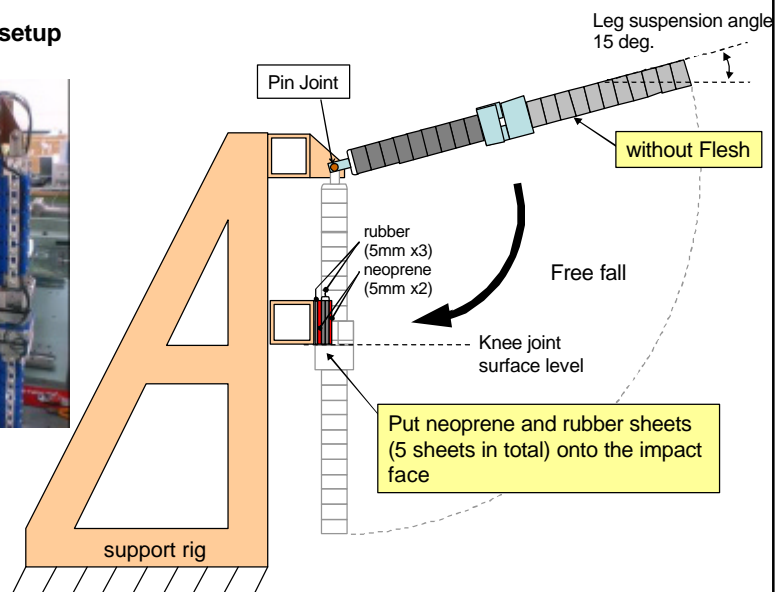
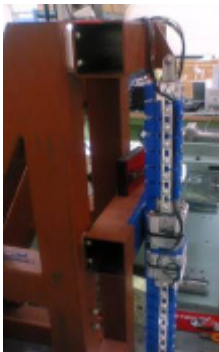


Collision simulation with simplified car model



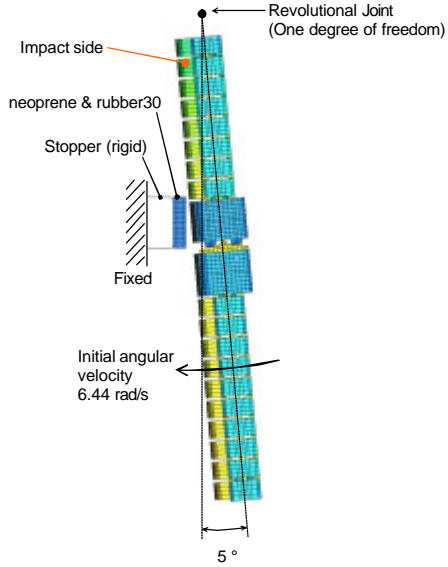
Assembly dynamic bending simulation

Experiment setup

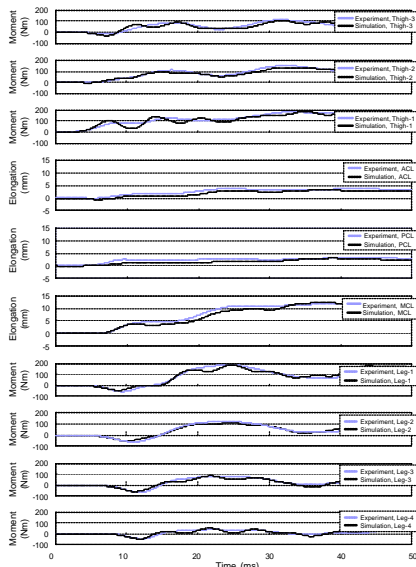


Assembly dynamic bending simulation

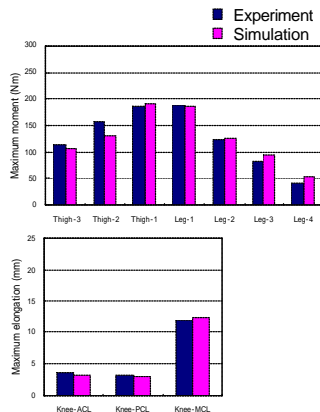
Model setup



Assembly dynamic bending simulation



(a) Wave forms

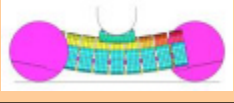


(b) Maximum values

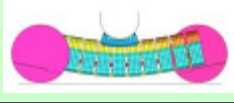
Model evaluation

Partial evaluation

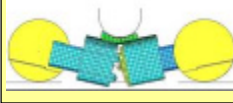
Thigh 3-point bending simulation



Leg 3-point bending simulation

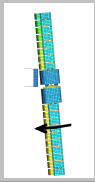


Knee 3-point bending simulation



Assembly evaluation

Assembly dynamic bending simulation

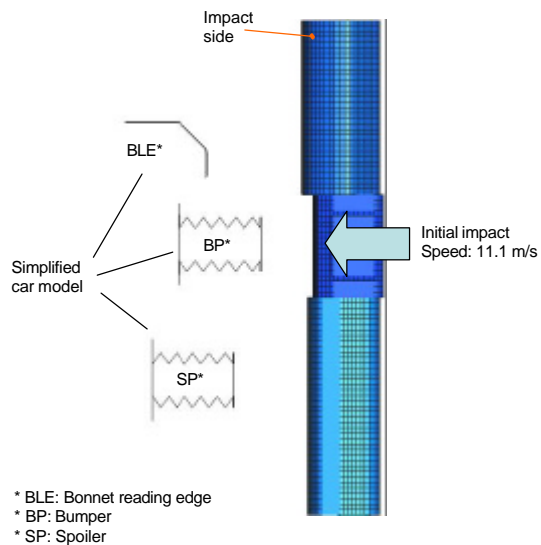


Collision simulation with simplified car model



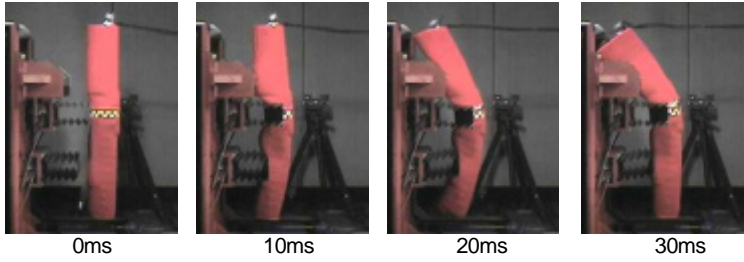
Collision simulation with simplified car model

Model setup

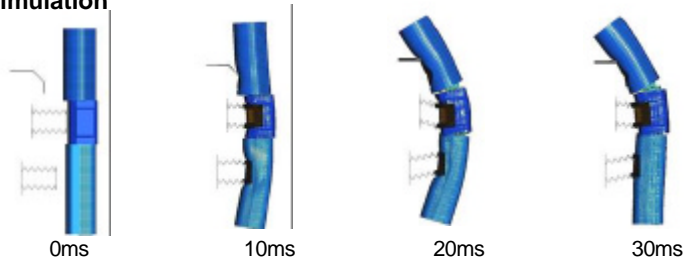


Collision simulation with simplified car model

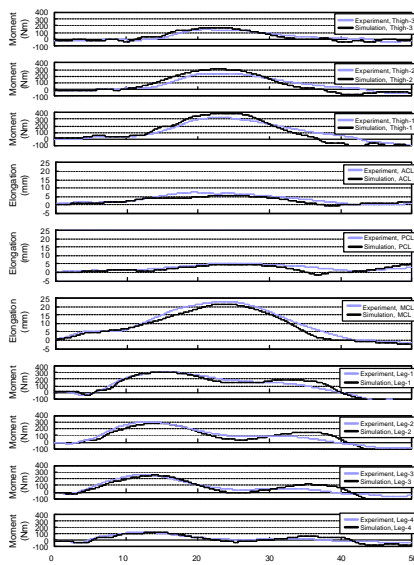
Experiment



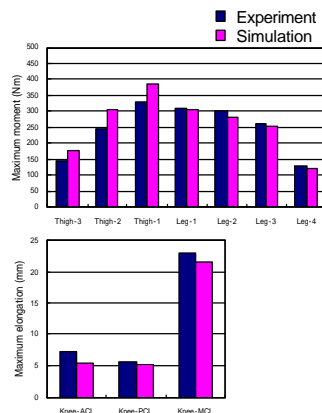
Simulation



Collision simulation with simplified car model



(a) Wave forms



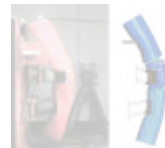
(b) Maximum values

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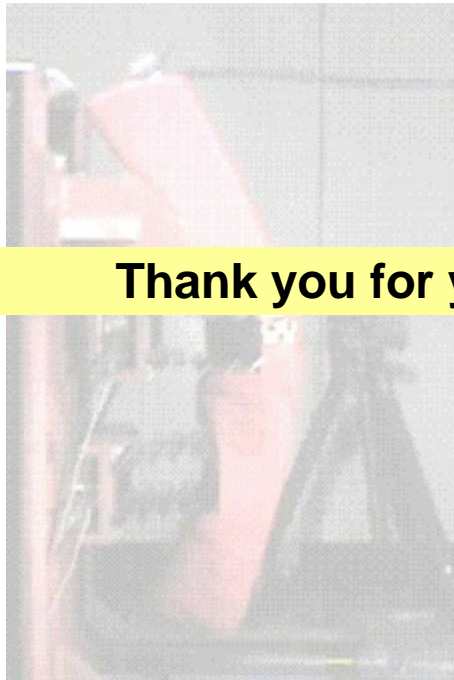
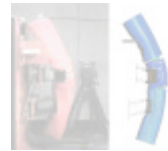
Conclusions

- In this study, a computer simulation model of FE Flex-GT-prototype was developed, and its fidelity to an actual Flex-GT-prototype was evaluated.
- Based on the evaluation study results, under the segmental level (thigh, leg, and knee parts) and assembly level loading conditions, it was verified the equivalence of the FE Flex-GT-prototype model to an actual one.
- In our further study, this model is utilized in evaluation of its biofidelity to finalize the Flex-GT specifications.



References

- 1) UN/ECE/WP29/GRSP/INF-GR-PS/Flex-TEG: Information on the Flexible Pedestrian Legform Impactor GT Alpha (Flex-GT-alpha), TEG-021 (2006)
- 2) UN/ECE/WP29/GRSP/INF-GR-PS/Flex-TEG: Evaluation Activities on Injury Assessment Ability of the Flexible Pedestrian Legform Impactor GT Alpha (Flex-GT-alpha), TEG-022 (2006)



Thank you for your attentions!