Sensitivity analyses - ACL

1. Only prestretch application

Date: 10/08/2020
Using the model parameters obtained in the sensitivity studies on model parameters 1 and 2.

1.1 Methods

Simulation with only ACL prestretch application in time steps 0 - 0.2.

Parameters of interest

ACL prestretch: 0.75 - 1.25

1.2 Results

Results in Sensitivity analyses - ACL.pptx
Some of the simulations crashed due to negative Jacobians or the maximum number of reformations reached, but most simulations converged.

1.3 Conclusion

Use the full range of ACL prestretch factors in the next sensitivity analysis.

2. Prestretch application + flexion rotation (max. reformations 25)

Date: 11/08/2020
Using the model parameters obtained in the sensitivity studies on model parameters 1 and 2.

Methods

Simulation of ACL prestretch application	time steps 0 - 0.2
Simulation of 0.6612 radians of flexion rotation	time steps 0.2 - 1.2

Parameters of interest

ACL prestretch: 0.75 - 1.25

Results

Results in Sensitivity analyses - ACL.pptx
No simulations converged completely. A lot of the simulations crashed due to negative Jacobians or the maximum number of reformations reached. The simulations converged furthest in the mid range of the ACL prestretch factors studied (around 1).

Conclusion

The convergence was low over most of the range of prestretch factors studied. An increase in maximal number of reformations might increase convergence.

3. Prestretch application + flexion rotation (max. reformations 100)

Date: 15/08/2020
Using the model parameters obtained in the sensitivity studies on model parameters 1 and 2. Set the max. reformations parameter to 100.

Methods

Simulation of prestretch application in   time steps 0 - 0.2
Simulation of 0.6612 radians of flexion rotation   time steps 0.2 - 1.2
Set the max. reformations parameter to 100.

Parameters of interest

ACL prestretch: 0.75 - 1.25

Results

Results in Sensitivity analyses - ACL.pptx
A lot of the simulations crash due to negative Jacobians or the maximum number of reformations reached. The models that did not converge with max refs 25 did not converge with 100 either.
Simulations with prestretch values around 1.0 converge furthest (0.9 – 1.01, except for 0.91 (crashed)).
Run time increased a lot compared to using max. reformations 25, some simulations did converge a bit further though.
- Mean run time 100 maxrefs: 1898 +/- 2621 seconds
- Mean run time 25 maxrefs: 752 +/- 797 seconds

Conclusion

Increasing the number of reformations did not increase convergence for most simulations but did increase run time.

4. Prestretch in a smaller range + flexion rotation to 1 radian flexion angle.

Date: Date: 17/08/2020

Methods

Parameters to try:
- Auto penalty: 0 & 1
- Gaptol   0 & 0.01
- Laugon   0 & 1
- Prestretch values: 0.92 – 1.02 (Not pushing the joint apart)
Total of 88 simulations.
max. reformations set to 25

Simulation: Prestretch application + flexion rotation to 1 radian flexion angle.

Results

Results in Sensitivity analyses - ACL.pptx
Autopenalty 0   Improves convergence
Laugon 0   Improves convergence

A combination of autopenalty 0 and laugon 0 showed best convergence.
Gaptol had no influence on convergence time.

Conclusion

Use Autopenalty 0 and Laugon 0 in all contacts.