Calibration 1

Methods

- AP, IE and VV simulation loads:
    - AP: -100 & 100 N
    - IE: -4000 & 4000 Nmm
    - VV: -5000 & 5000 Nmm
- Steps:
    - 1: Prestretch application & flexion to X degrees (full extension) → .dmp file 1
        - 0 - 0.1 Prestretch application
        - 0.1 - 0.5 Rotate knee joint to robot flexion angle
        - 0.5 - 1.0 Apply axial load (-20N only for oks models)
        - The robot flexion angle is the mean flexion angle during the AP IE and VV robot data collection.
    - 2.1: VV simulation (force-driven) Restart from .dmp file 1
        - 1.0 – 1.4 To max load value
        - 1.4 – 2.2 To min load value
    - 2.2: AP simulation (force-driven) Restart from .dmp file 1
        - 1.0 – 1.4 To max load value
        - 1.4 – 2.2 To min load value
    - 2.3: IE simulation (force - driven) Restart from .dmp file 1
        - 1.0 – 1.4 To max load value
        - 1.4 – 2.2 To min load value
- Prestretch values:
    - Start values:

	ACL	PCL	MCL	LCL
Set 1	0.95	1	1	1
Set 2	1	1.05	1	1
Set 3	1	1	1.05	1
Set 4	1	1	1	0.95
Set 5	1	1	1	1

    - Prestretch bounds large to make sure we will get the minimum:
        - ACL: 0.75 – 1.25
        - PCL: 0.75 – 1.25
        - MCL: 0.75 – 1.25
        - LCL: 0.75 -1.25
- Error values:
    - Axial load application failed = 2
    - AP, IE & VV not run at all = 1.4
    - 1. Converged 0 – 25% = 1.2

2. Converged 25 – 50% = 1.175
3. Converged 50 – 75% = 1.150
4. Converged 75 – 100 % = 1.125

- For 1, 2, 3 & 4: Not converged completely: Extra 0.1% increase in penalty per consecutive run not run.
- Fully converged = Normalized RMSE between simulated and robot kinematics (max angle/position in robot data)
- Errors normalized to maximal value in robot data
- Total error = (AP, IE & VV) /3

The Python scripts used for calibration can be found in folder: *\Python scripts - Calibration 1

Results

The calibration results can be found in: Results calibration 1.xlsx

Not all optimisations run well, a lot of them go to error = 2 and stay there. It seems like there needs to be an extra error calculation for how far the first simulation (PS, Flexion, Axial load) (before obtaining dump file 1) converges.

Found that in the models we used 0 as the no prestretch value at the start of all simulations in the loadcurves. However, this should be 1 which means there is no prestretch. This increased convergence a lot, due to restarts actually using the right values.

Looks like we need to adjust the ranges of the ligaments for some of the models to decrease the condylar lift off. E.g. ACL 1.25 pushes the knee joint apart entirely. PCL above 1 increases this effect too.

In model oks003 the MCL should not be too high. 1.25 pushes medial condyles apart. Maybe we need to recalibrate with smaller bounds of the MCL.

For model du02, the joint is way too stiff in the AP direction. We have to look at the normalization values since the AP normalized error value is larger than VV and IE.