Flex-GT Full Calibration Test Procedures
**Long Bones**

- **Step 1(a): Bone Core**
  - Quasi-static 3-Point Bending Test
  - (Femur bone core, Tibia bone core)
  - ✓ Evaluate Long Bone Cores Bending Characteristic
  - ✓ Obtain Strain to Moment Conversion values

- **Step 1(b): Long Bone**
  - Quasi-static 3-Point Bending Test
  - (Femur, Tibia)
  - ✓ Evaluate Long Bone Bending Characteristics

**Knee**

- **Step 2: Knee**
  - Quasi-static 3-Point Bending Test
  - ✓ Evaluate Knee Bending Characteristics
  - ✓ Evaluate Knee Ligament Elongation Values

**Step 3: Assembled (Femur-Knee-Tibia)**

**Step 4: Assembly (Femur-Knee-Tibia)**
- Dynamic Calibration Test
  - ✓ Evaluate measured values
**Step 1(a): Bone Core**
**Quasi-static 3-Point Bending Test**
(Femur bone core)

\[ F_c \]: Force Center, \( D_c \): Deflection Center

\[ M_c \]: Moment Center (Nm) = \( F_c / 2 \) (N) x 0.165 (m)

\[ M_{F1} \]: Moment Femur-1 (Nm) = \( F_c / 2 \) (N) x 0.065 (m)

\[ M_{F2} \]: Moment Femur-2 (Nm) = \( F_c / 2 \) (N) x 0.145 (m)

\[ M_{F3} \]: Moment Femur-3 (Nm) = \( F_c / 2 \) (N) x 0.105 (m)
Step 1(a): Bone Core
Quasi-static 3-Point Bending Test
(Femur bone core)

- Evaluate Long Bone Cores Bending Characteristic

![Graph showing deflection vs. moment for bone core test results and tentative corridor.](attachment:image.png)
Step 1(a): Bone Core
Quasi-static 3-Point Bending Test
(Femur bone core)

✓ Obtain Strain to Moment Conversion values

example

a) Strain gages (side A: opposite side of loading)

b) Strain gages (side B: loading side, spear gages for side A)
Step 1(a): Bone Core
Quasi-static 3-Point Bending Test
(Tibia bone core)

Load transducer

Ram (r = 25 mm)

Knee side of tibia bone core

Support (Fixed)

Support Length: 410 mm

F_c: Force Center, D_c: Deflection Center
M_c: Moment Center (Nm) = \( F_c / 2 \) (N) × 0.205 (m)
M_{T1}: Moment Tibia-1 (Nm) = \( F_c / 2 \) (N) × 0.065 (m)
M_{T2}: Moment Tibia-2 (Nm) = \( F_c / 2 \) (N) × 0.145 (m)
M_{T3}: Moment Tibia-3 (Nm) = \( F_c / 2 \) (N) × 0.185 (m)
M_{T4}: Moment Tibia-4 (Nm) = \( F_c / 2 \) (N) × 0.105 (m)
Step 1(a): Bone Core
Quasi-static 3-Point Bending Test (Tibia bone core)

- Evaluate Long Bone Cores Bending Characteristic

![Graph showing the relationship between deflection and moment for tentatively corridor and test results.](image-url)
Step 1(a): Bone Core
Quasi-static 3-Point Bending Test
(Tibia bone core)

✓ Obtain Strain to Moment Conversion values

**example**

![Graph 1](image1.png)

- a) Strain gages (side A: opposite side of loading)

![Graph 2](image2.png)

- b) Strain gages (side B: loading side, spear gages for side A)
Step 1(b): Long Bone
Quasi-static 3-Point Bending Test (Femur)

Load transducer

F<sub>c</sub>: Force Center, D<sub>c</sub>: Deflection Center
M<sub>c</sub>: Moment Center (Nm) = F<sub>c</sub>/2 (N) x 0.165 (m)
Step 1(b): Long Bone
Quasi-static 3-Point Bending Test
(Femur)

✓ Evaluate Long Bone Bending Characteristics
Step 1(b): Long Bone
Quasi-static 3-Point Bending Test
(Tibia)

Load transducer

Ram (flat surface)

Neoprene

Knee side of tibia bone core

Support (rotate)

Support (rotate)

Sectional image

Load transducer

F_c: Force Center, D_c: Deflection Center
M_c: Moment Center (Nm) = F_c/2 (N) x 0.205 (m)
Step 1(b): Long Bone
Quasi-static 3-Point Bending Test
(Tibia)

- Evaluate Long Bone Bending Characteristics

![Graph showing a comparison between tentative corridor and test data for moment vs. deflection.](image-url)
Step 2: Knee
Quasi-static 3-Point Bending Test

Femur side of knee
Neoprene
Support (rotate)
Load transducer (fixed)
Load transducer (fixed)
F_{1}: Support force of Femur side of knee
M_{c}: Moment Center - at Knee joint surface (Nm) = F_{1} (N) \times 0.2 (m)
Step 2: Knee
Quasi-static 3-Point Bending Test

- Evaluate Knee Bending Characteristics
- Evaluate Knee Ligament Elongation Values
Step 4: Assembly (Femur-Knee-Tibia)  
Dynamic Calibration Test

Angular measurement tool

Leg suspension angle 15 deg.

Supporting rig

Pin joint

Knee joint surface level

Without flesh

Free fall

Put neoprene and rubber sheets (5 sheets in total) on the impact face.

Rubber 30 (5mm x3)
Neoprene (5mm x2)
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

✓ Evaluate measured values
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

☑ Evaluate measured values
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

✓ Evaluate measured values

- Femur 3
- Tentative Corridor_U (GT_SN01-03)
- Tentative Corridor_L (GT_SN01_03)
- Average (GT_SN01-03)
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

- Evaluate measured values

Tibia 1
Tentative Corridor_U (GT_SN01-03)
Tentative Corridor_L (GT_SN01-03)
Tentative Average (GT_SN01-03)
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

✓ Evaluate measured values
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

✓ Evaluate measured values
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

✓ Evaluate measured values
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

- Evaluate measured values

![Graph showing elongation values with different corridors and a tentative average.](chart.png)
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

✓ Evaluate measured values
Step 4: Assembly (Femur-Knee-Tibia)
Dynamic Calibration Test

✓ Evaluate measured values