Piezoelectric Force Plates
Piezoelectric Force Plates

Piezoelectric force transducers mounted in the corners of the plate measure:

- the 3 components $F_x$, $F_y$, and $F_z$ of a force $F$ acting on the platform
- the 3 components $M_x$, $M_y$, and $M_z$ of the resulting moment vector $M$
Piezoelectric Sensors

- In piezoelectric force sensors, synthetic quartz is used.
- When mechanically loaded, the quartz produces an electrical charge proportional in magnitude to that of the applied force.
Two Terminal, Series Resonant

Equivalent Circuit of a Quartz Crystal
Piezoelectric Sensors

Two rings are sensitive to shear and measure $F_x$ and $F_y$

One ring is sensitive to pressure and measures the component $F_z$
Amplification

- Output charge is amplified and converted to an analog DC voltage
- 8 channel charge amplifier is an integrator with a large time constant (>100 000 s)
BioWare Software

Collects data and converts to useful plots

- Ground Reaction Forces
- Center of Pressure
- Frictional Torque Tz
- Force Vector
## Technical Data for Kistler Piezoelectric Force Plates

<table>
<thead>
<tr>
<th></th>
<th>9281C</th>
<th>9286A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range</strong></td>
<td>Fx, Fy</td>
<td>-10…10 kN</td>
</tr>
<tr>
<td></td>
<td>Fz</td>
<td>-10…20 kN</td>
</tr>
<tr>
<td><strong>Overload</strong></td>
<td>Fx, Fy</td>
<td>-15/15 kN</td>
</tr>
<tr>
<td></td>
<td>Fz</td>
<td>-15/25 kN</td>
</tr>
<tr>
<td><strong>Natural Frequency</strong></td>
<td>Fo (x,y)</td>
<td>1000 Hz</td>
</tr>
<tr>
<td></td>
<td>Fo (z)</td>
<td>1000 Hz</td>
</tr>
<tr>
<td><strong>Op. Temp. Range</strong></td>
<td></td>
<td>0…60 °C</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td></td>
<td>16 kg</td>
</tr>
<tr>
<td><strong>Threshold</strong></td>
<td></td>
<td>&lt;250 mN</td>
</tr>
<tr>
<td><strong>Drift</strong></td>
<td></td>
<td>&lt;10 mN/s</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>Fx, Fy</td>
<td>-7.5 pC/N</td>
</tr>
<tr>
<td></td>
<td>Fz</td>
<td>-3.8 pC/N</td>
</tr>
</tbody>
</table>
Limitations

- Not suitable for static long time measurements
- Overloading
- Cost
Advantages

- Extremely sensitive
- Wide measuring range
- Fast response time
- Very stable, long life
- Recalibrations are unnecessary
Applications in Biomechanics

- Balance studies
- Gait analysis
- Measurement of high impact forces
- Underwater testing
- Orthopaedic assessment
- Sports training applications