Further studies of slip resistance measurement

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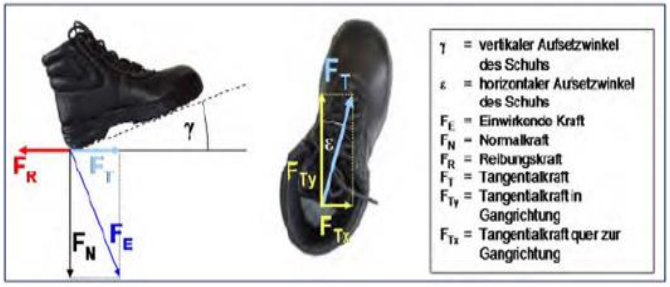
Requirements for measurement of slip resistance

- ✓ Understanding of the **Friction system,** consisting of footwear, floor covering, intermedium and enviromental conditions as a complex system
- ✓ Definition of a commonly accepted **Standardmodel of the foot movement** to define a **Requirement coefficient Qa**
- ✓ Definition of a **Validity range** for the different measurment methods
- ✓ Development of a **Concept of a holistic method** for measurement and valuation
- ✓ Reduction of error rate by **Optimisation of the useability**

Model for foot movement and definition of Qa

- **Definition of the force during walking by 2 important motions sequences**
  - Touchdown of the heel
  - The foot in roll motion and during repulsing
  - Involvement of the important forces during walking



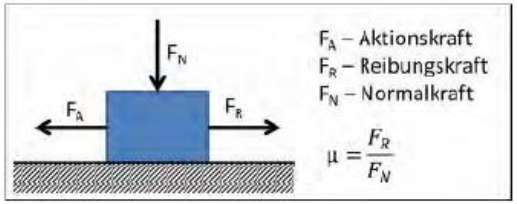
Reference:
[a}, [b]

⇨ Derivation of a **Requirement coefficient** $Q_a = \frac{F_T}{F_N}$ ⇨ **CoF > Q_a**

Parameter of Walking	**Parameter for Measurement Device**
▪ Requirement coefficient Qa	▪ Friction value
▪ Touch-down speed of the heel	▪ Fast Sliding velocity v1
▪ Rolling velocitiy of the foot	▪ Slow Sliding velocity v2
▪ Material of sole	▪ Material of slider

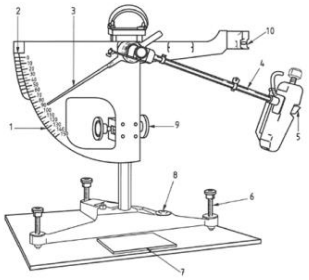
Most common Measurement methods

1) Measurement of slip resistance by sliding friction measurement (CoF method)



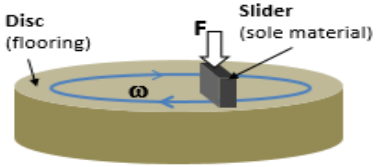
Tribometer linear :
(CoF is measured by linear drawn sliding body)

2) Measurement of slip resistance by Energy dissipation method (EDM method)



Pendulum method
(Measure of energy dissipation during short friction period)

3) As representative for labor methods Tribometer rotating



(rotary movement between friction partner)

Intended merger of the methods

Accepted measure methods	Example	Enviroment	Characteristic
Tribomter	GMG	dry / wet	Slow velocity v= 0,2 m/s
Energy dissipation	Pendulum	dry / wet	fast touch-down v = 2-3 m/s

Main difference: different velocities and path length

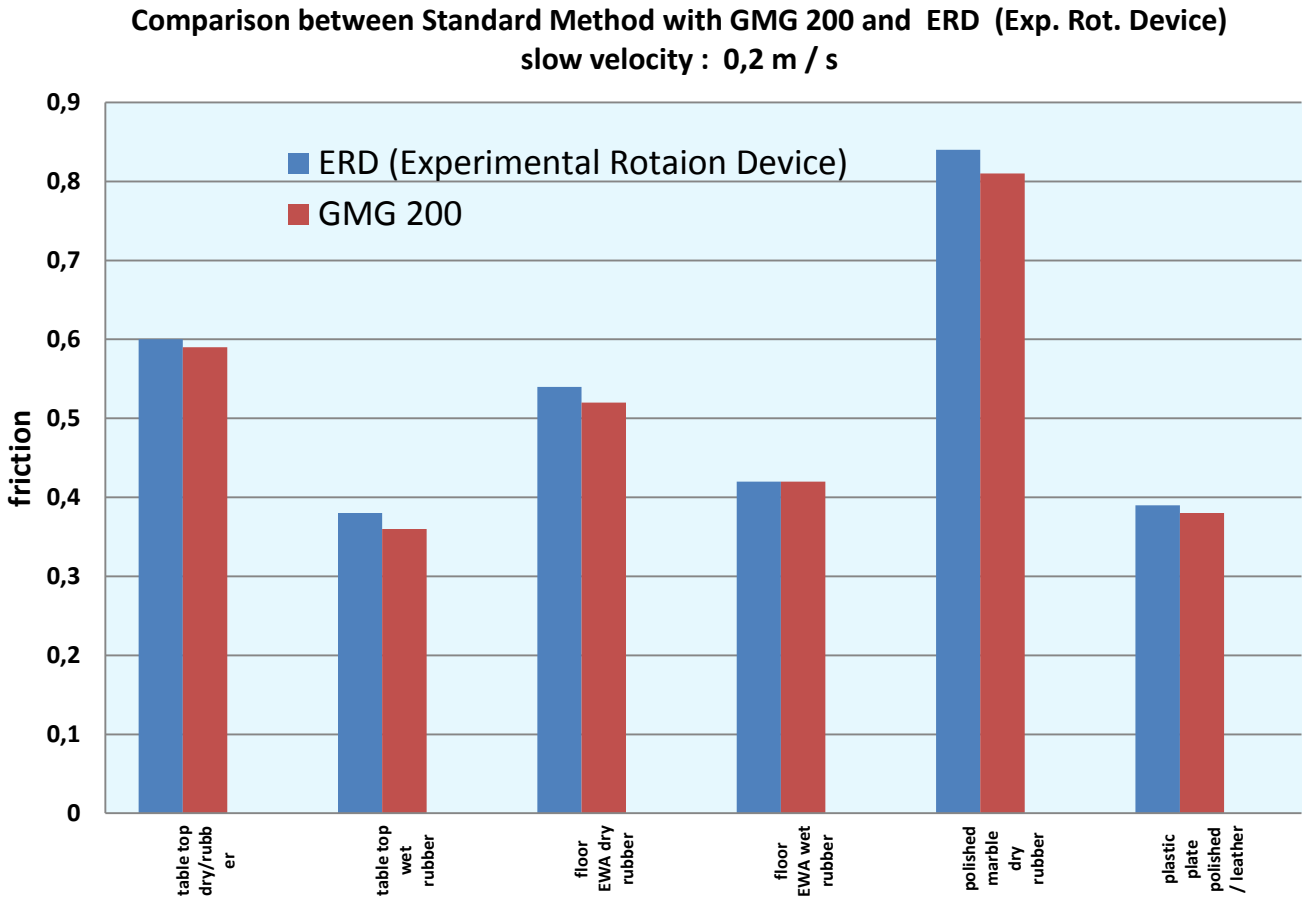
⇨ **Considerations to merge both methods in an outdoor experiment arrangement with the collaboration of Institut** IK4 TEKNIKER

Requirements of the Outdoor Experimental Rotary Device ERD

1) **Construction of an experimental test device following the rotation labor principle**
2) **Involvement of the measurement of the transition from Static – to Sliding friction**
3) **Experiments to involve some new aspects of friction beside the standard measurements**

Outdoor Experimental Device Result 01
Slow velocity

Experimental device as Rotary Tribometer with slow velocity as mentioned in Standard DIN 51131, DIN EN 13893 and CEN TS 16165



Good correlation between linear and rotary tribometer for slow velocity

Outdoor Experimental Device Result 02
High velocity

First Results with Experimental Rotary device

Non matching values with other methods like

Pendulum

because of

- Slip-Stop effect
- Hydroplaning
- Several other difficult technical and physical conditions

These findings are well known, therefore the velocity is standardized
with v = 0,2 m/s

Outdoor Experimental Device Result 3
Energy Dissipation

Energy dissipation measurements with high velocity with the ERD experimental device comparable with the pendulum method

First results with an early version of the ERD device by measuring the energy dissipation with high velocity has shown:

- **Uncertainty of measurement**
- **heavy dependence from the intermediate medium**
- **Depending of velocity**
- **Depending from kind of touch down**
- **Depending of path length**

Result:

- **Difficult to adjust**
- **Difficult to receive reproducible measurement**
- **Difficult handling**

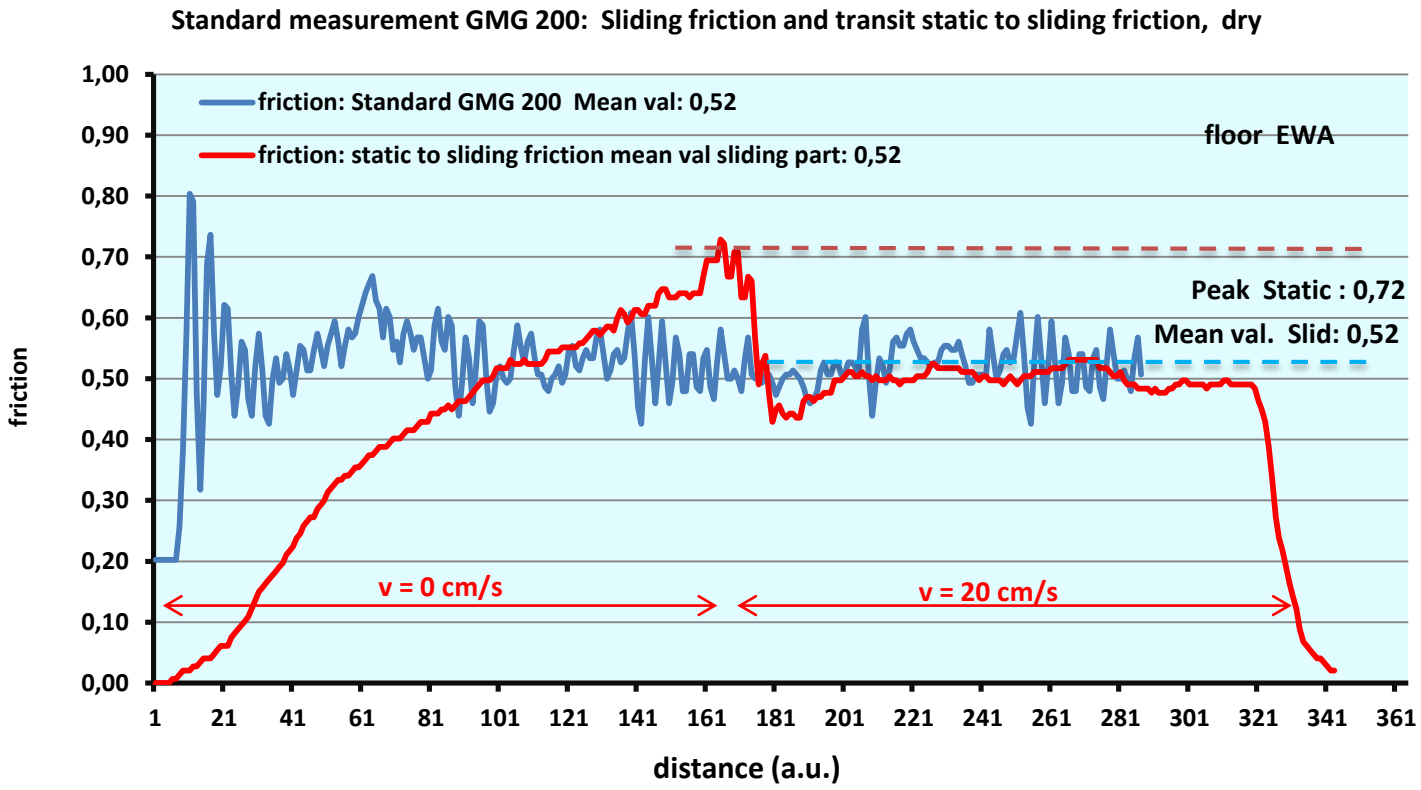
Outdoor Experimental Device Result 4
Transition from STATIC- to SLIDING Friction

Motivation:

Experiments have shown, that the transition from static friction to sliding friction can gain additional data and knowledge for characterisation of slippery effects

Measure method:

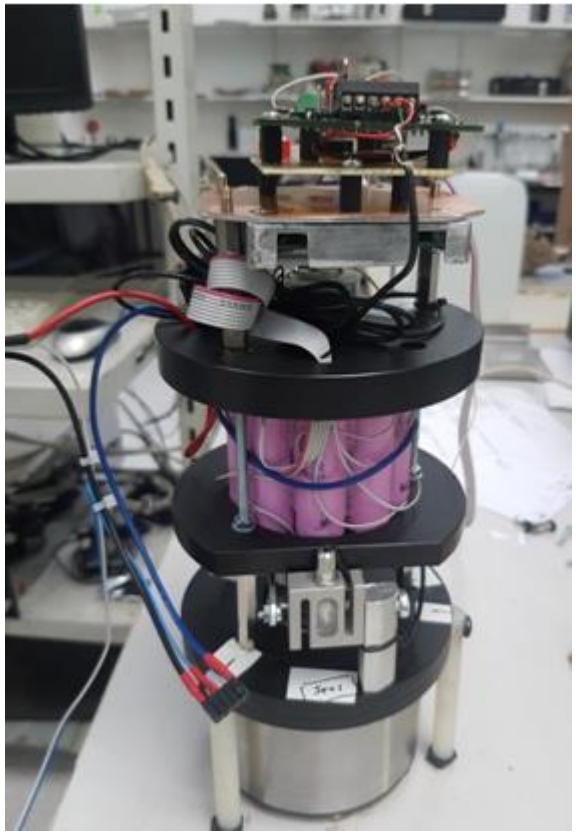
Slowly increasing the pulling force or the rotation torque and recording the maximum forces at the moving starting point



Experimental Rotary Outdoor Device

Device with useful objects

Open device with rotary lifting disc, torque sensor, battery, hardware



Summary

- **There are two well known and valid measurement procedures: COF and EDM**
- **An ERD (experimental rotation device) was built on basis of Slipsafe‘s research results**
- **The ERD was used to validate some reseacher`s results**

[a] Rutschgefahren erkennen und vermeiden
C, Wetzel, U.Windhövel, D.Mewes, T. Götte
Lit.: Techn. Sicherheit BD.3 (2013) Nr.4

[b] Assessment of safety of floors against slip
H. Fischer
Sonderschrift baua S84