Estimation of surface traction at high creepages and its application to prediction of wear, RCF and squeal noise.

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Agenda

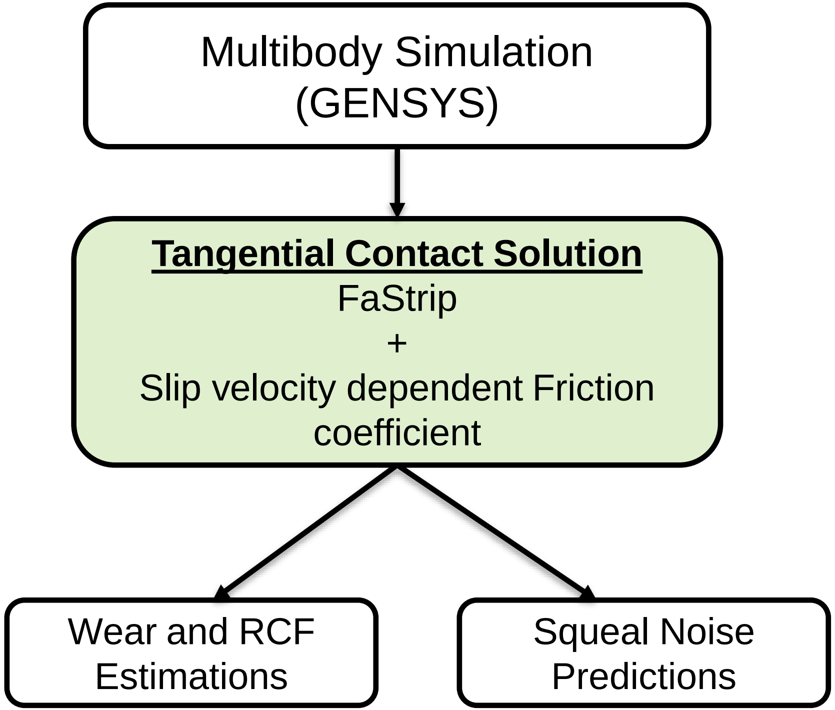
- Background
- Methodology
- Results
- Conclusions
- Discussion

Background

Why do we need a more accurate tangential contact problem solution

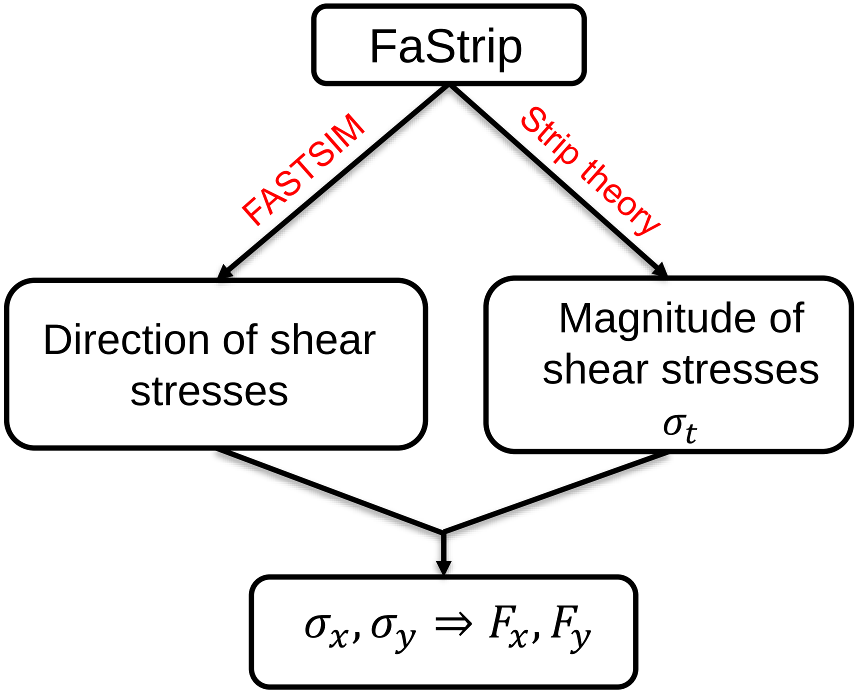
- Wear
- RCF
- Squeal noise prediction

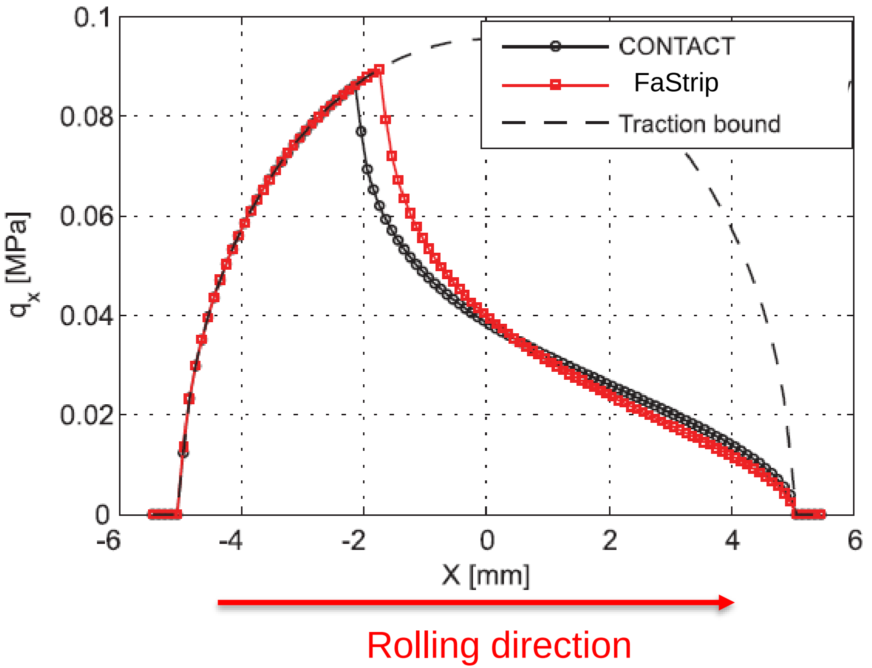
Methodology



http://www.gensys.se – Re.1911

FaStrip





Sichani MSh., Enblom R., Berg M., (2016). "An alternative to FASTSIM for tangential solution of the wheel-rail contact". *Journal of Vehicle System Dynamics*. 54. p. 748–764

Kalker, J.J., 2013. *Three-dimensional elastic bodies in rolling contact* (Vol. 2). Springer Science & Business Media.

Slip velocity dependent friction coefficient

- Adjusting μ gradualy instead of instantaneously
- μ_ν is distinguished from actual coefficient of friction μ
- Tendency of μ to μ_ν is made proportional to slip velocity and $\mu - \mu_\nu$
- It is described by differential equation

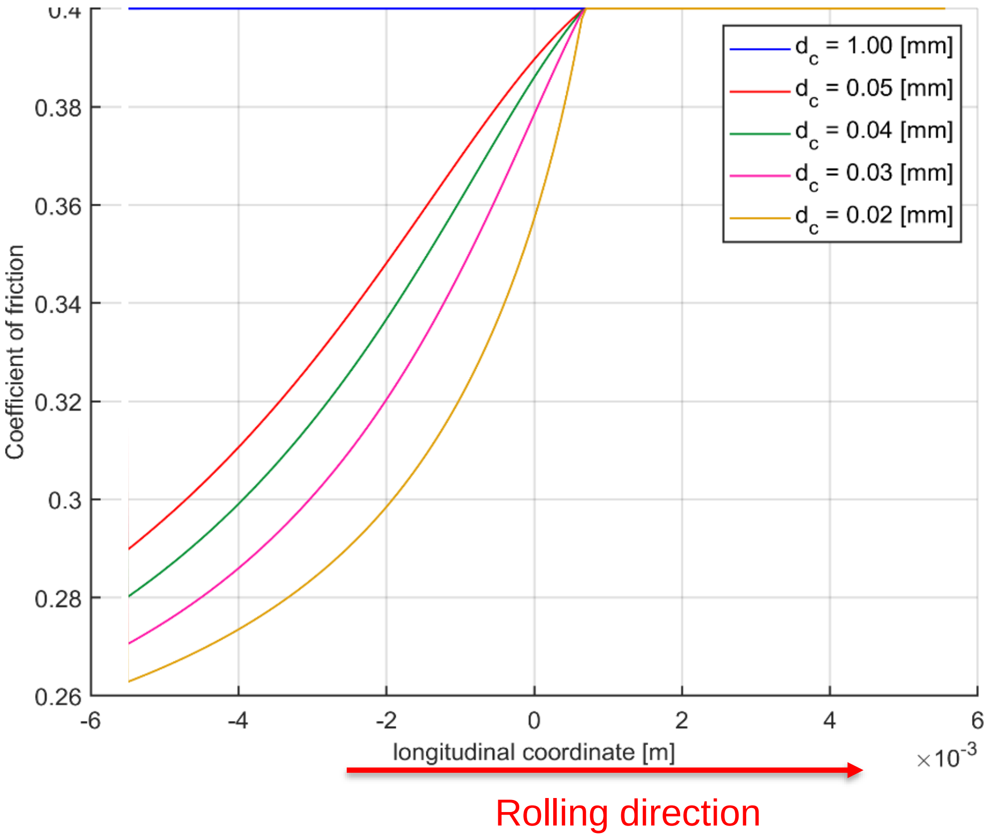
$$\boxed{\frac{d\mu}{dx} = -\frac{\nu(x,t)}{d_c}\left(\mu(x,t) - \mu_\nu(\nu(x,t))\right)}$$

Vollebregt, E.A.H. and Schuttelaars, H.M., 2012. Quasi-static analysis of two-dimensional rolling contact with slip-velocity dependent friction. *Journal of Sound and Vibration*, *331*(9), pp.2141-2155.

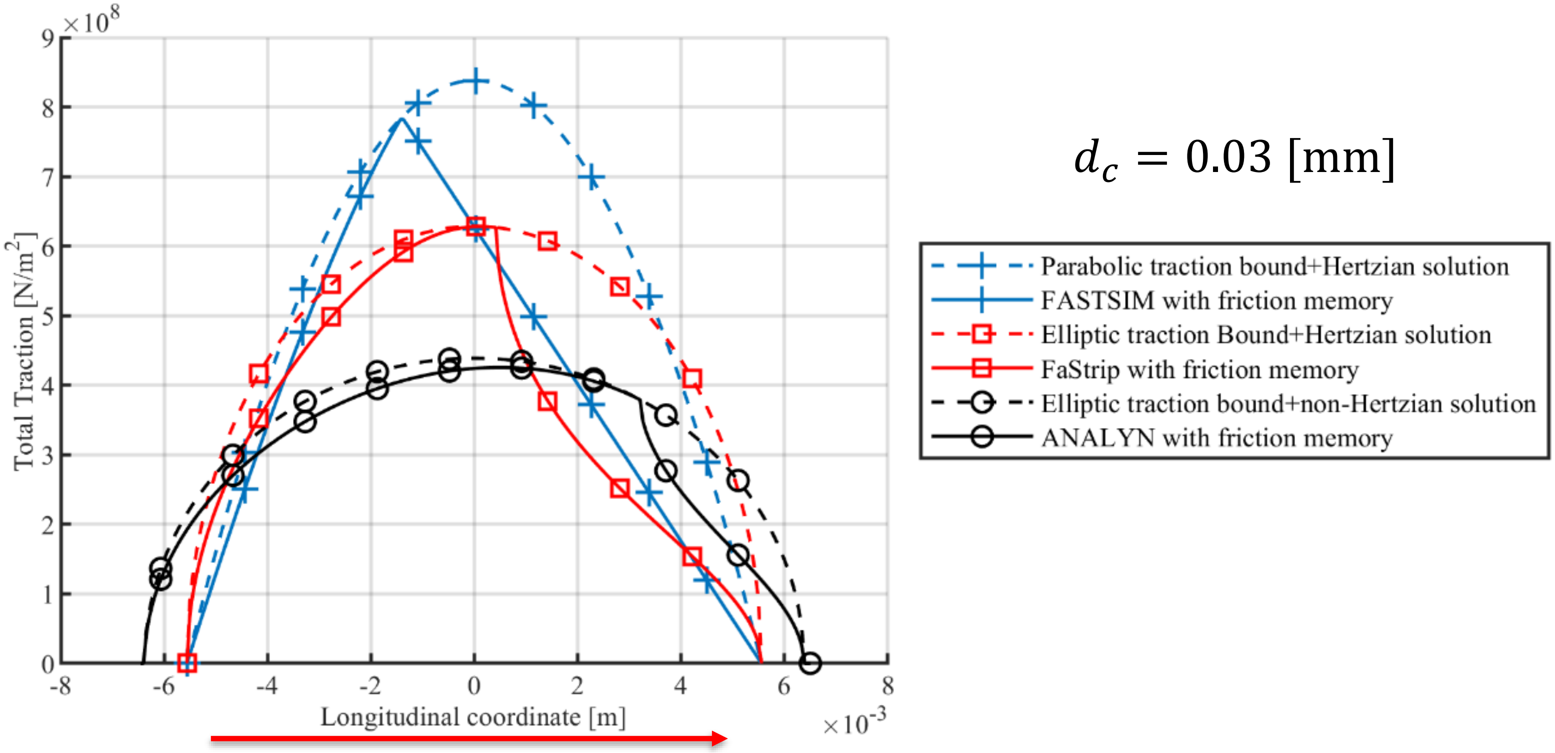
Actual coefficient of friction

$$if\ d_c \to \infty:\ \mu(x) \to \mu_s$$

$$if\ d_c \to 0:\ \mu(x) \to \mu_v$$



Shear Stress Distribution



$$d_c = 0.03 \text{ [mm]}$$

Rolling direction

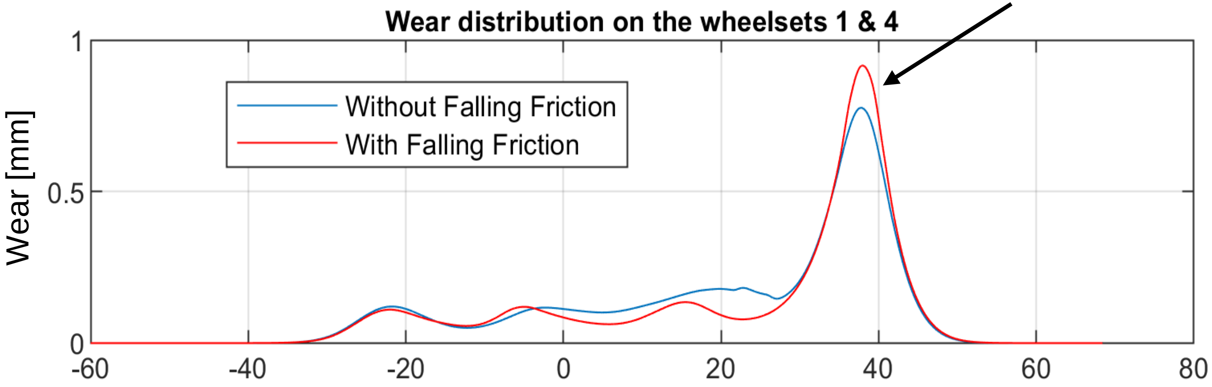
Wear

- Archard method:

$$V_{wear} = k_i \left(\frac{S.N}{H} \right)$$

- Passenger coach (X2000)
- 10000 km

Flange wear



Archard, J., 1953. Contact and rubbing of flat surfaces. *Journal of applied physics*, *24*(8), pp.981-988.

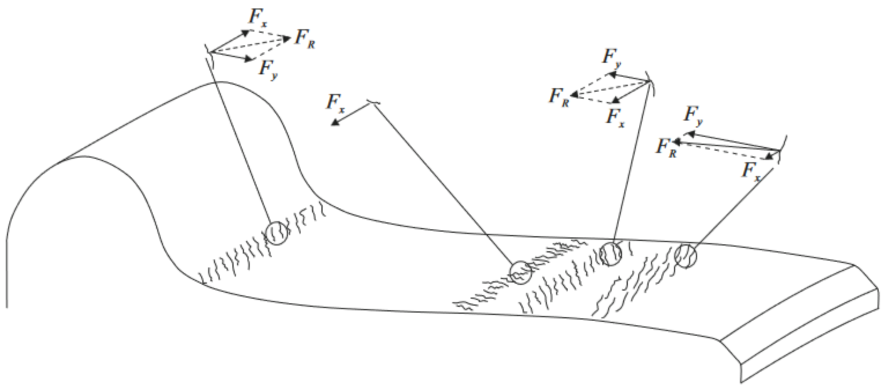
RCF

- RCF happens if shear stress exceeds shear stress yield limit

- Effect of wear on RCF

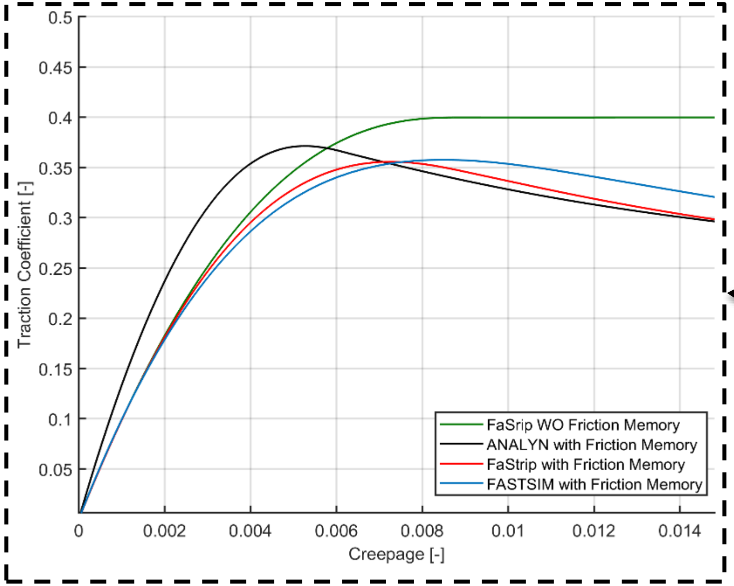
- Crack size:

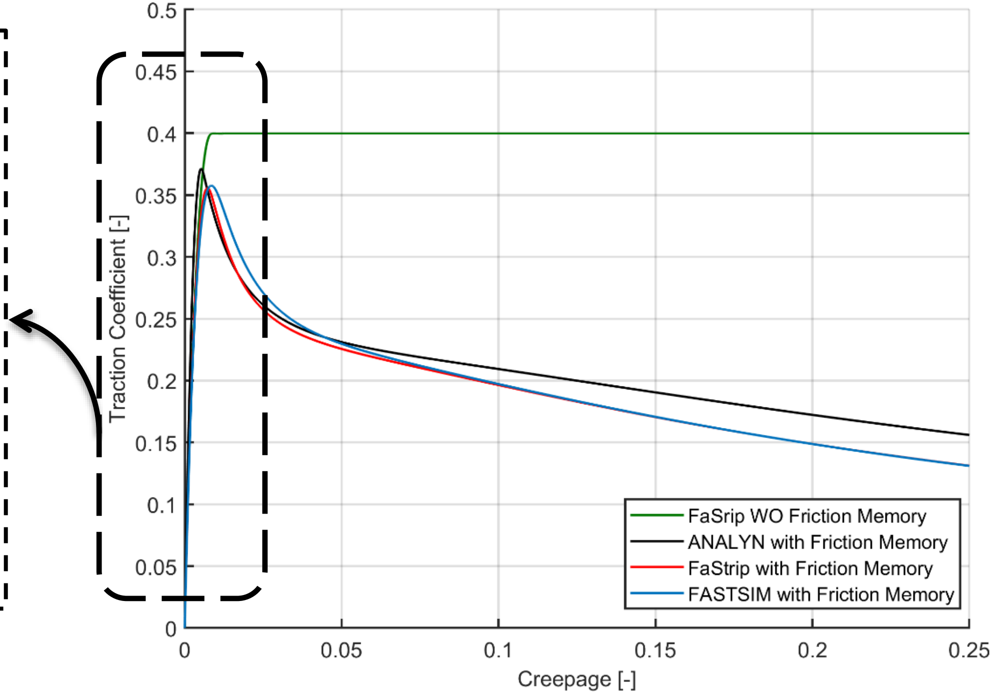
$$c_{p_i} = \sum_{i=1}^{N} \left(\frac{1}{\alpha(\sigma_a)^{\beta}} \right) - wear\ depth$$



Dirks, B., Enblom, R., Ekberg, A. and Berg, M., 2015. The development of a crack propagation model for railway wheels and rails. *Fatigue & Fracture of Engineering Materials & Structures*, *38*(12), pp.1478-1491.

Squeal Noise Prediction





$$d_c = 0.03 \text{ [mm]}$$

Conclusions

- Proposed method can be implemented in MBS for a more accurate estimation of shear stresses over the contact patch.
- Using a tangential contact model with a non-constant friction coefficient, changes the wear depth on the parts of the wheel where we have the high creepages.
- The proposed method can be used to estimate the generation of the squeal noise in different curve radius, different wheel and rail profiles combinations.

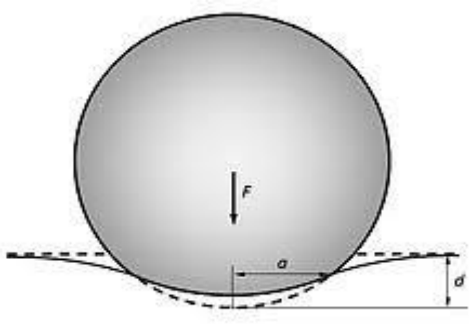
Thank you for your attention

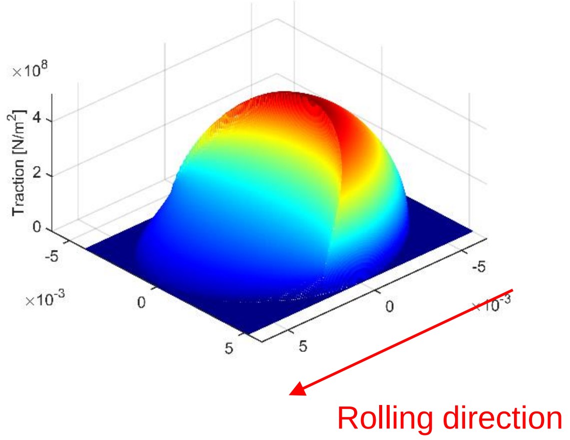
Background

Contact Problem

- Normal contact problem
  - Shape and size of contact area
  - Normal stress distribution

- Tangential contact problem
  - Shear stress distribution
  - Creep forces





Squeal Noise Prediction (Example)