THE INFLUENCE OF FRICTION COEFFICIENT AND WHEEL/RAIL PROFILES ON ENERGY DISSIPATION IN THE WHEEL/RAIL CONTACT

M.Sc. Guillermo Idárraga
School of Materials Engineering
Tribology and Surfaces Group
gaidarra@unal.edu.co

10th International Conference on Contact Mechanics
August 30, 2015 - September 3, 2015 | Colorado Springs, Colorado, USA

The influence of friction coefficient and wheel/rail profiles on energy dissipation in the wheel/rail contact

Guillermo Idárraga Alarcón [1,2], Nico Burgelman [2], Juan Meza Meza [1], Alejandro Toro [1], Zili Li [2]

1. National University of Colombia, Tribology and Surfaces Group, Medellín, Colombia.
2. Delft University of Technology Faculty of Civil Engineering and Geosciences, Railway Engineering, the Netherlands.

**Corresponding author. Tels.: +57 4 4255339, +31 15 27 82325.*
E-mail addresses: gaidarra@unal.edu.co (G. Idarraga), N.D.M.Burgelman@tudelft.nl (N. Burgelman), jmmezam@unal.edu.co (J. Meza), aotoro@unal.edu.co (A. Toro), Z.Li@tudelft.nl (Z.Li).

INTRODUCTION

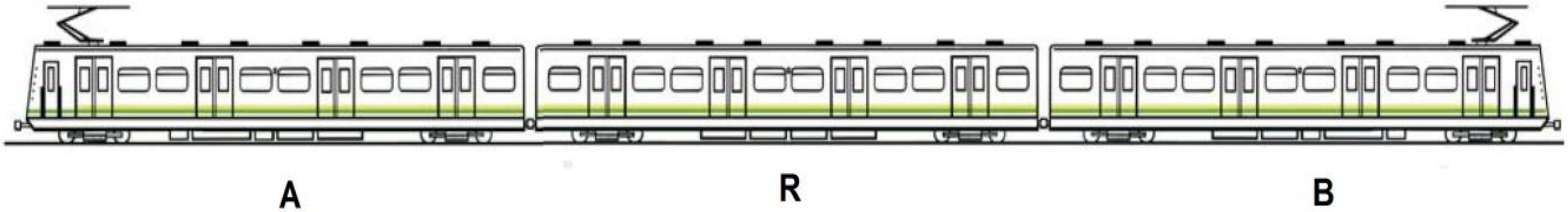
This work gives a further explanation of the effect of the friction coefficient in the energy dissipation in the wheel/rail contact. To such an end, several simulations were performed using a multibody model, including the torque of the wheels, and varying the friction coefficient from 0.2 to 0.7.

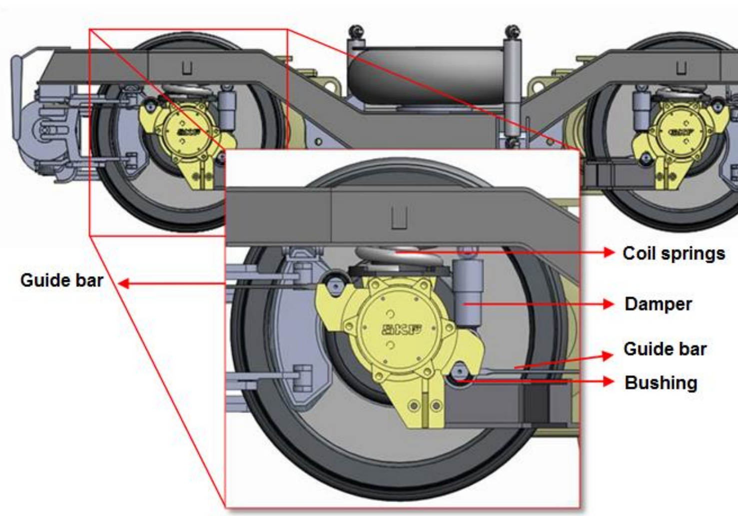
Previous work:

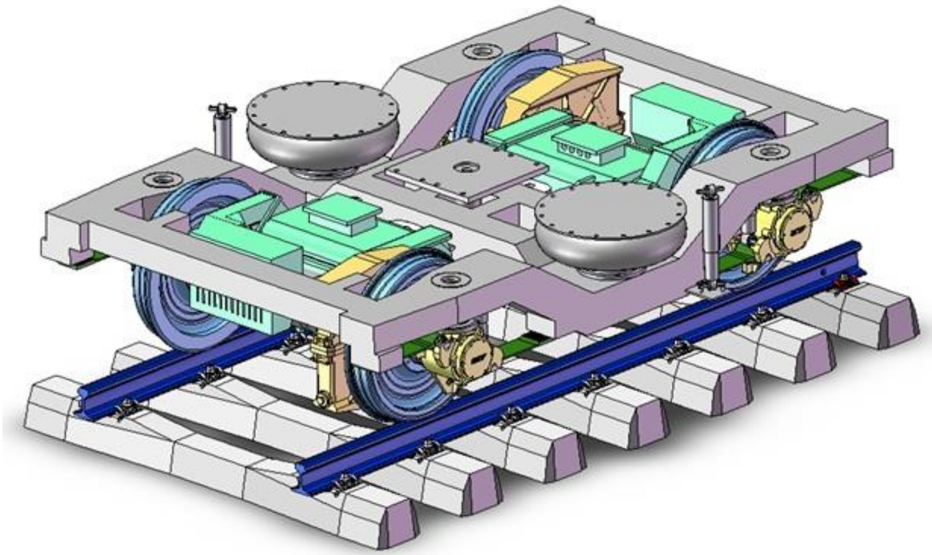
	Post – Lubricated Condition	Lubricated Condition
Power Measurements Reduction – Field [KW]	9.4%	15.3%
Power Calculations Reduction - Multibody [KW]	21.0%	35.0%
Calculated wear reduction [μg/(m mm^2)]	19.8%	36.1%

G. Idarraga et.al. 2015

THE VEHICLE MODEL:



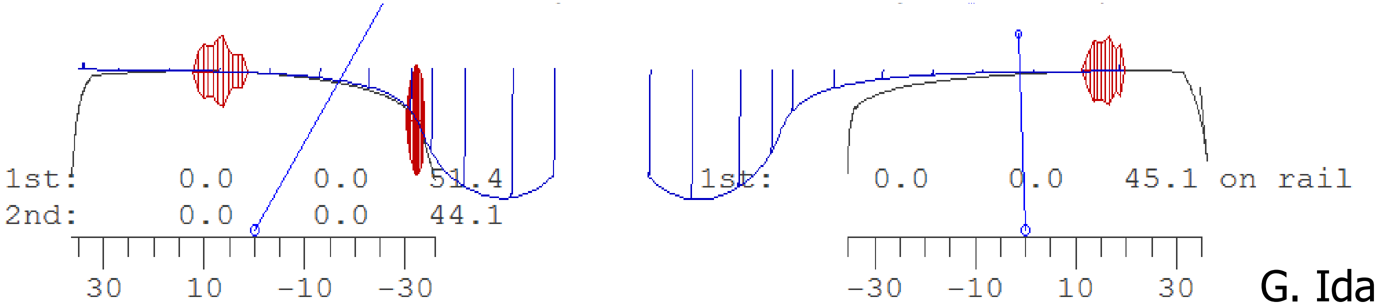




$a(t)$: vehicle acceleration

A. R. Martinez 2010; L. Castañeda et al. 2010

TRACK MODEL:



G. Idarraga et. al. 2015

ENERGY AND WEAR CALCULATIONS:

$$P_{frict} = (T_x\gamma_x + T_y\gamma_y)V$$

Where V is the velocity of the vehicle, T the tangential force, and γ the creepage (normalized slip). When the contribution of spin is included it becomes:

$$P_{frict} = (T_x\gamma_x + T_y\gamma_y + M\varphi)V$$

Where M is the spin moment and φ is the spin creepage.

$$Wear_{Rate} = KT\gamma/A$$

Where, K is a wear coefficient and A is the contact area.

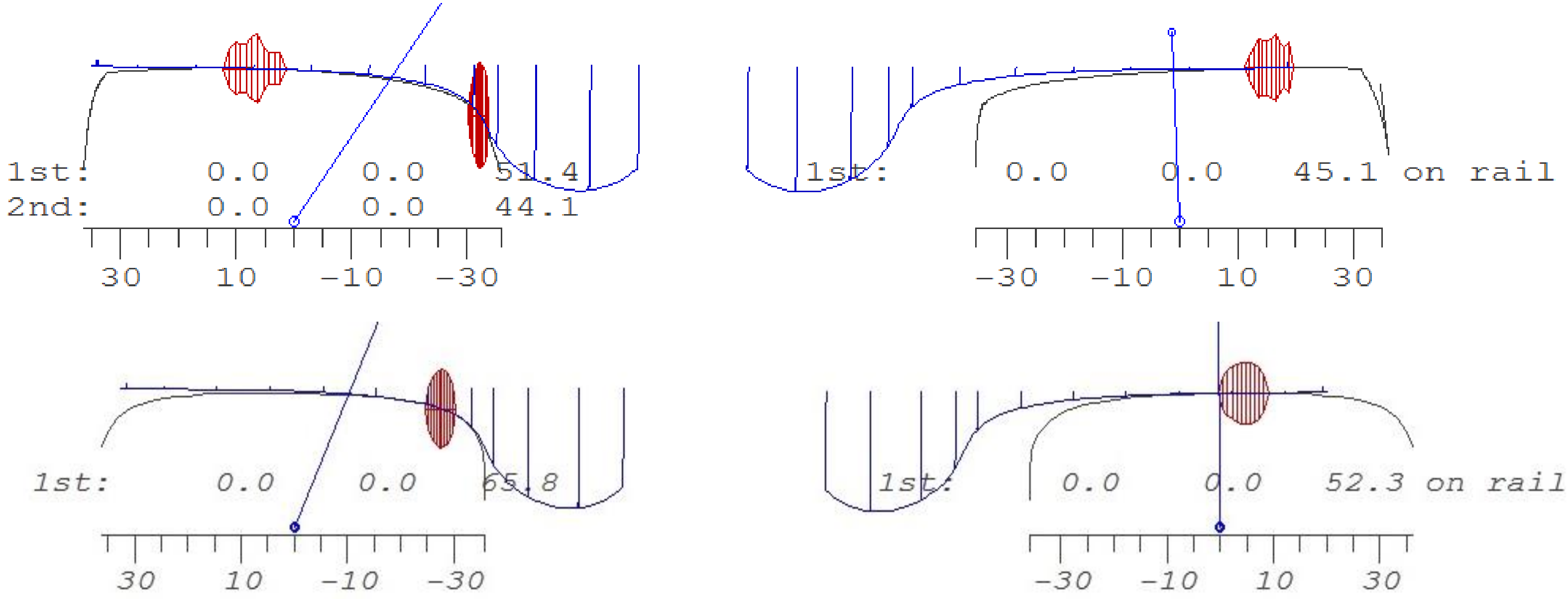
$$Wear_{Rate} = \begin{cases} 5.3I_w & I_w < 10.4 \\ 55.0 & 10.4 \leq I_w \leq 77.2 \\ 61.9I_w & I_w > 77.2 \end{cases}$$

Where I_w is the wear index.

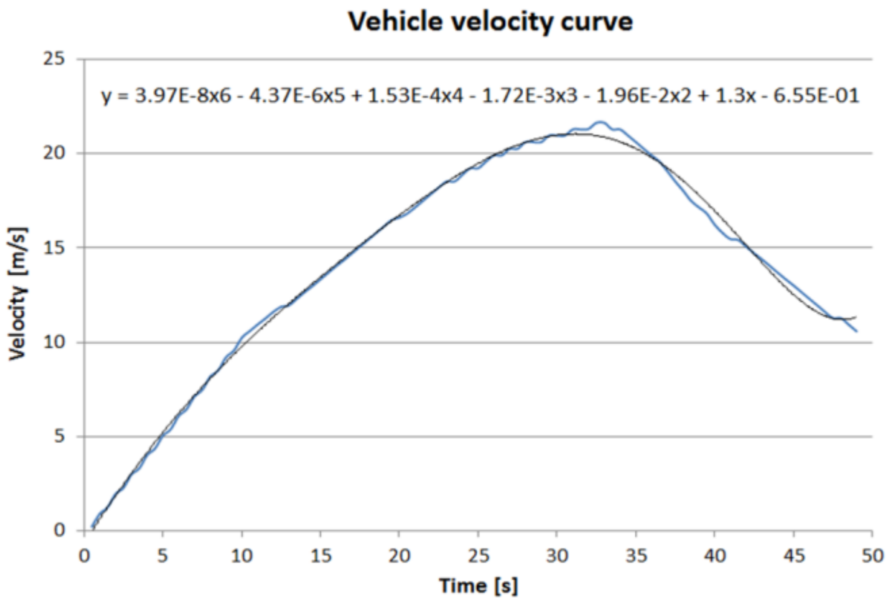
R. Lewis and R. S. Dwyer-Joyce 2004

EFFECT OF PROFILES ON THE ENERGY DISSIPATION AND WEAR RATES

Couple	Rail profiles	Wheel profiles	Designation
1	Worm CPC-HRC	New Ore S1002	Measured Profiles
2	New UIC 60	New Ore S1002	Standard Profiles



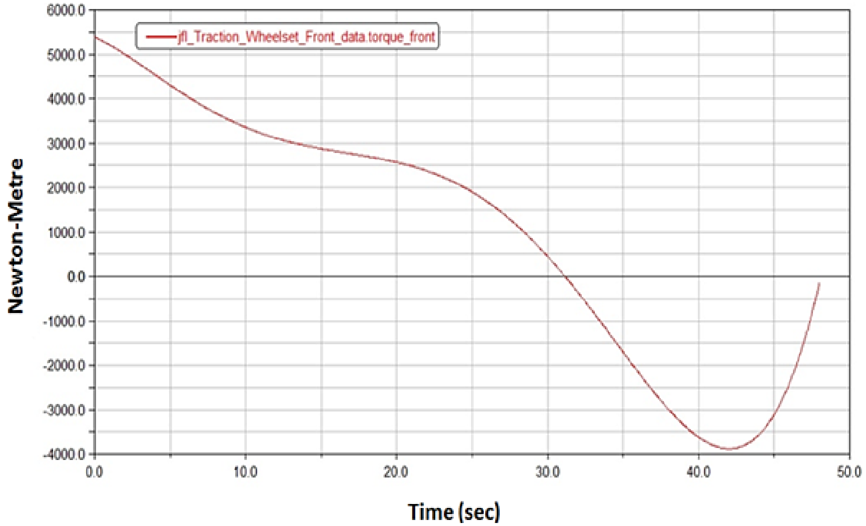
TRACTION MOMENT ON THE WHEELS

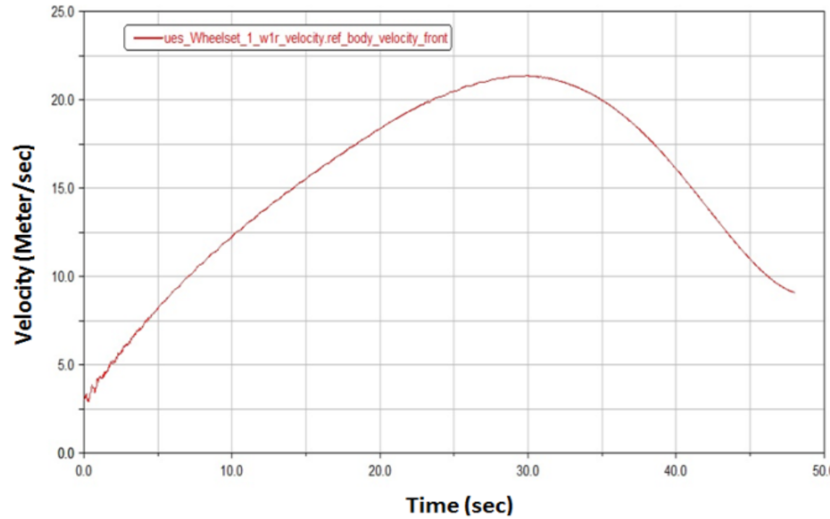


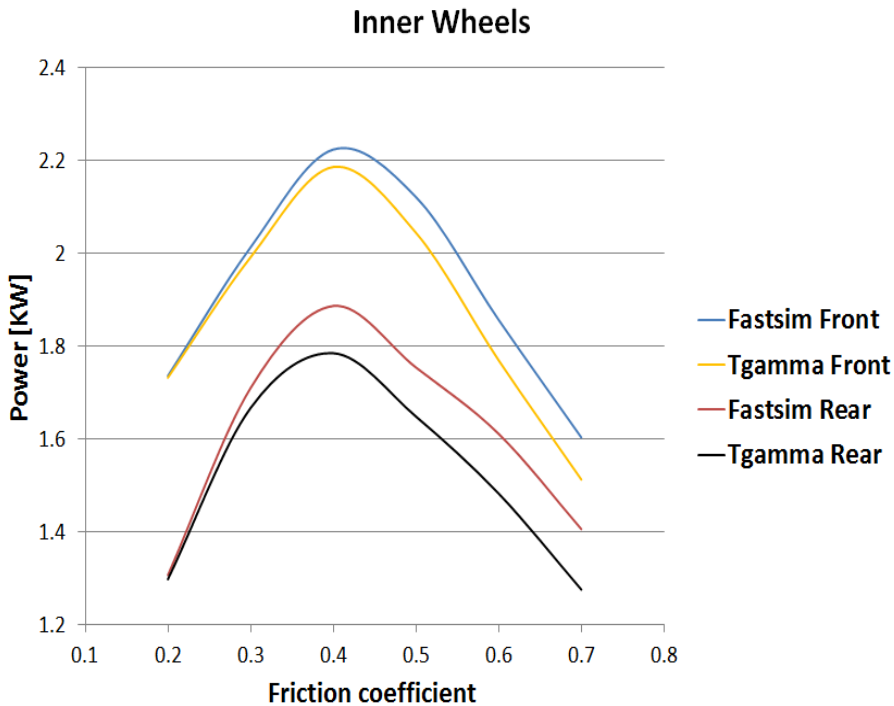
$$M = \frac{ma(t)R}{16}$$

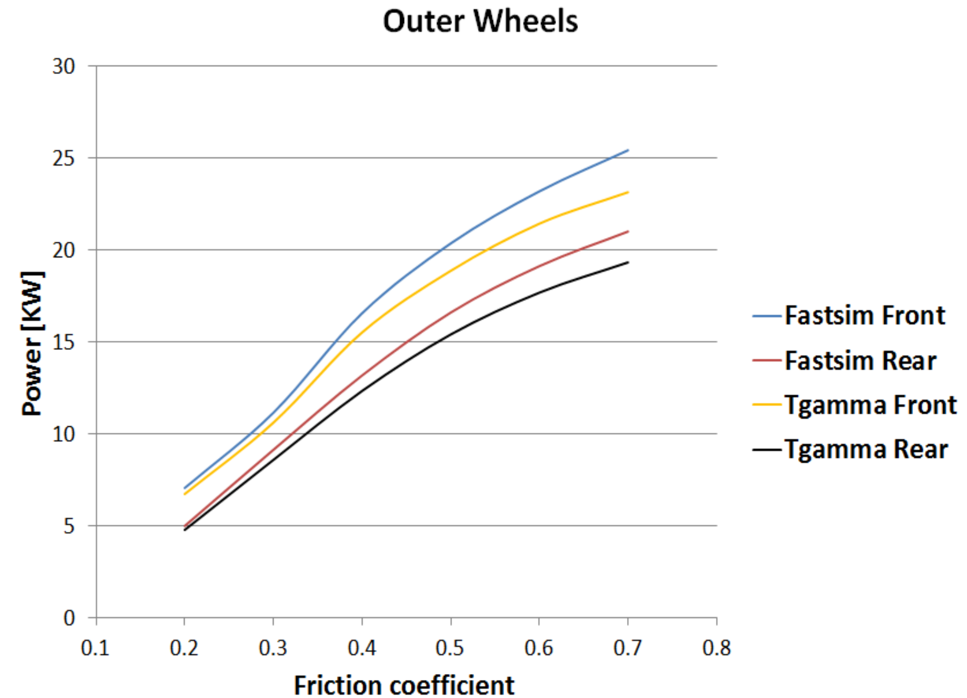
m: Vehicle mass R: Wheel radio

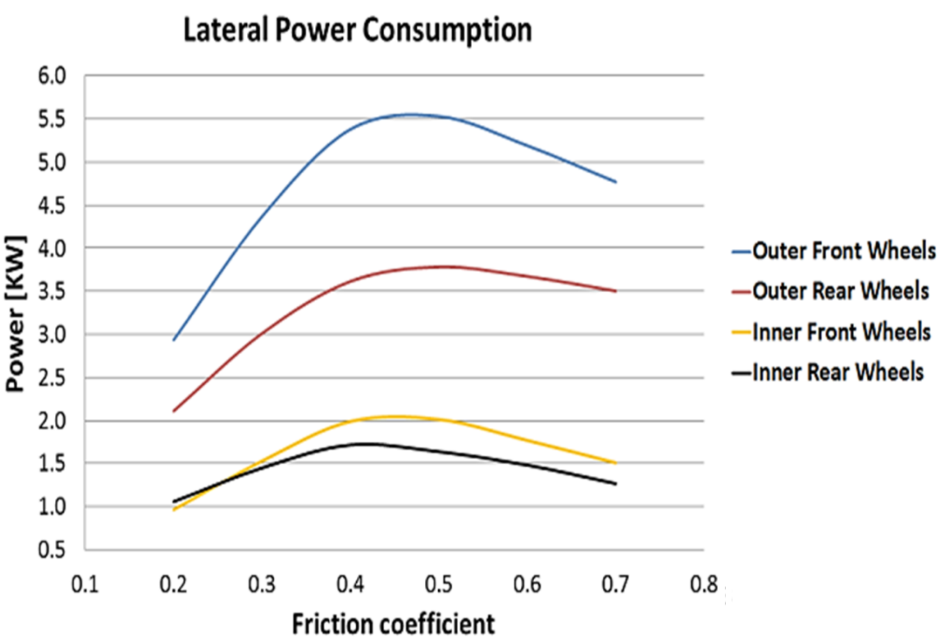
$a(t)$: vehicle acceleration

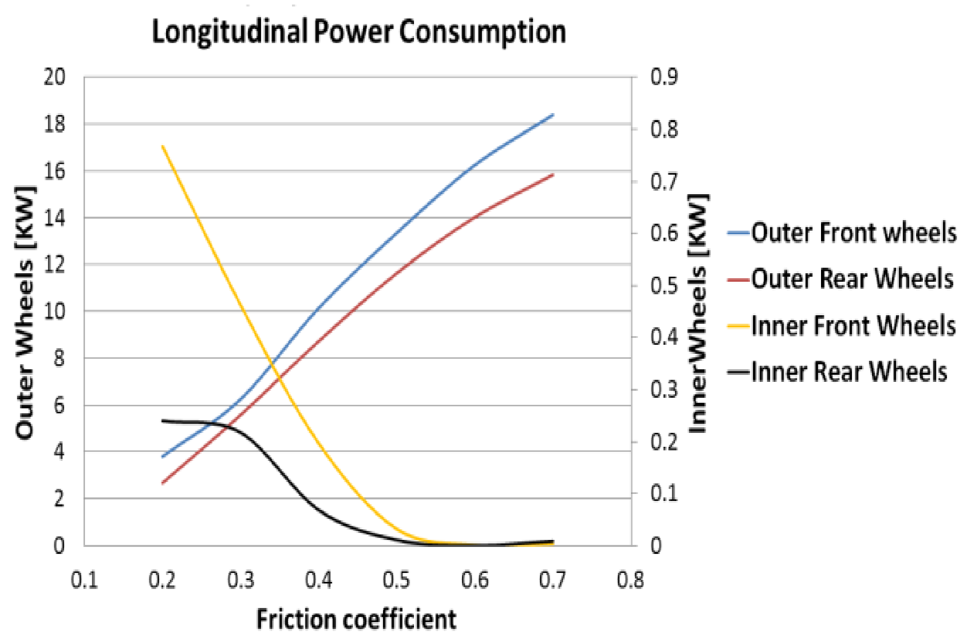


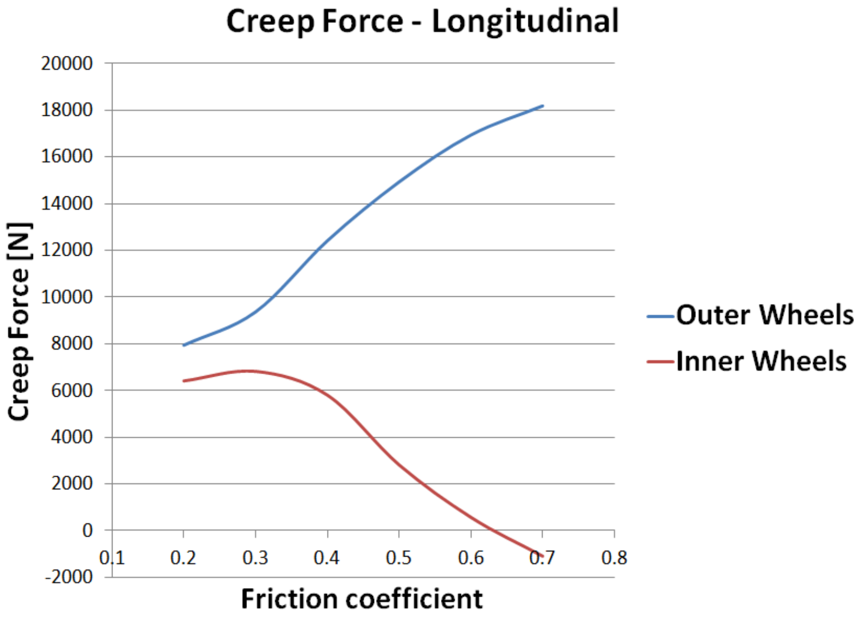


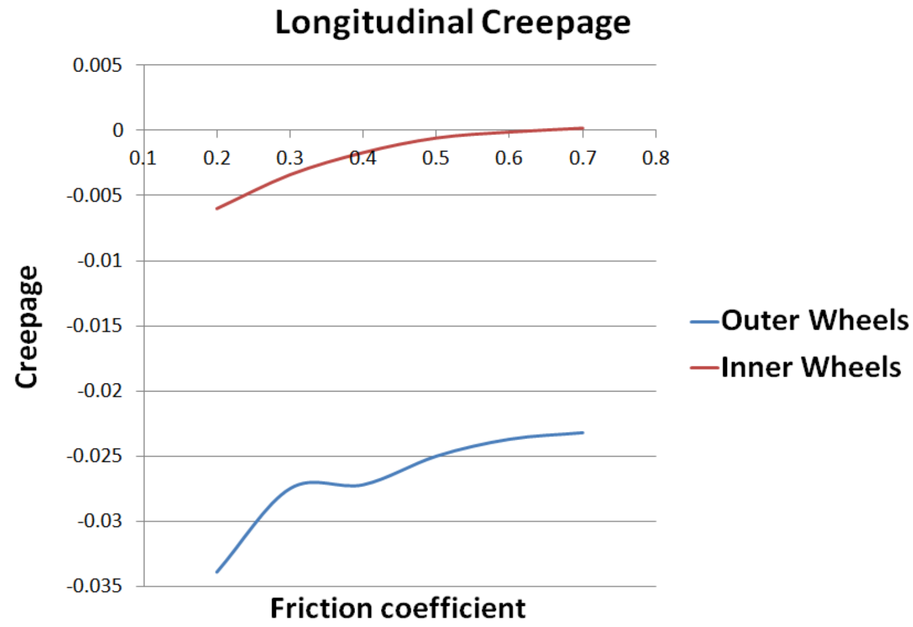

Inner Wheels
Power [KW]
Friction coefficient
Fastsim Front
Tgamma Front
Fastsim Rear
Tgamma Rear

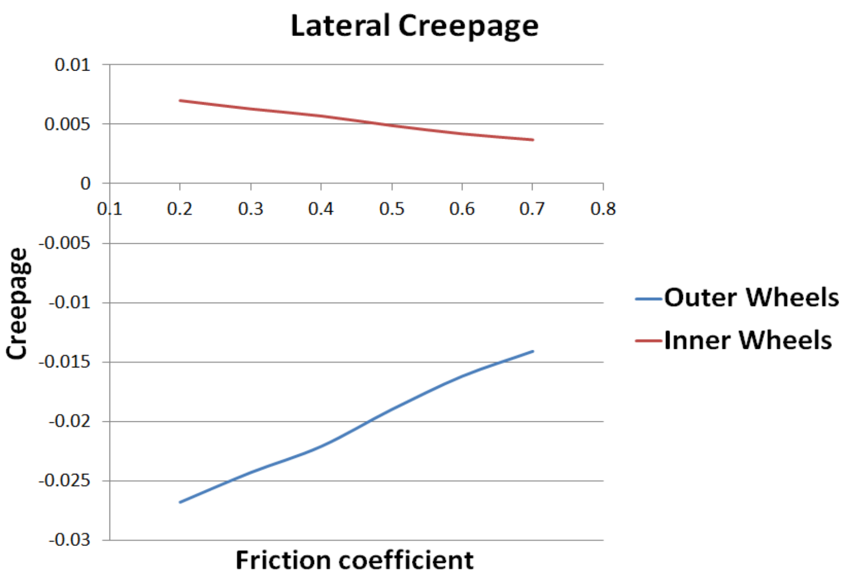

Outer Wheels
Power [KW]
Friction coefficient
Fastsim Front
Fastsim Rear
Tgamma Front
Tgamma Rear

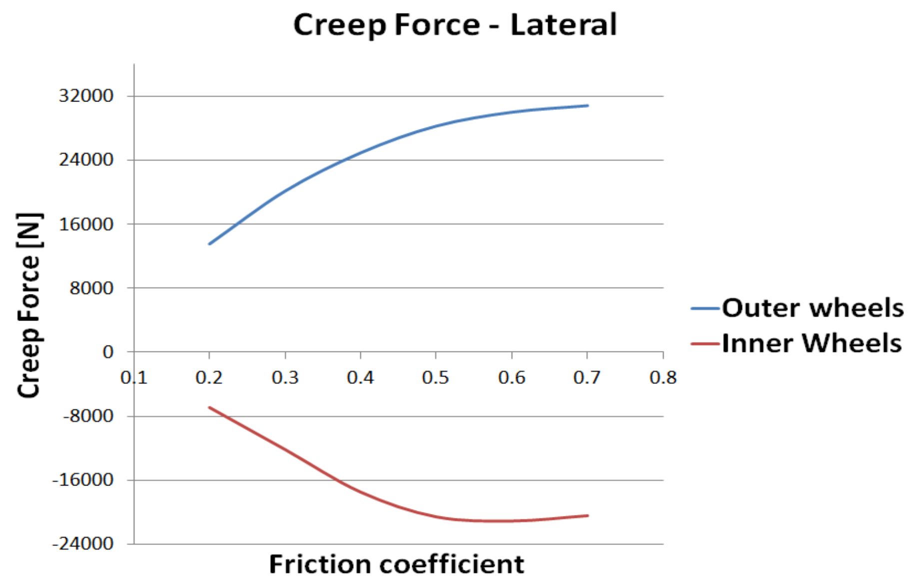

Lateral Power Consumption
Power [KW]
Friction coefficient
Outer Front Wheels
Outer Rear Wheels
Inner Front Wheels
Inner Rear Wheels


Longitudinal Power Consumption
Outer Wheels [KW]
InnerWheels [KW]
Friction coefficient
Outer Front wheels
Outer Rear Wheels
Inner Front Wheels
Inner Rear Wheels







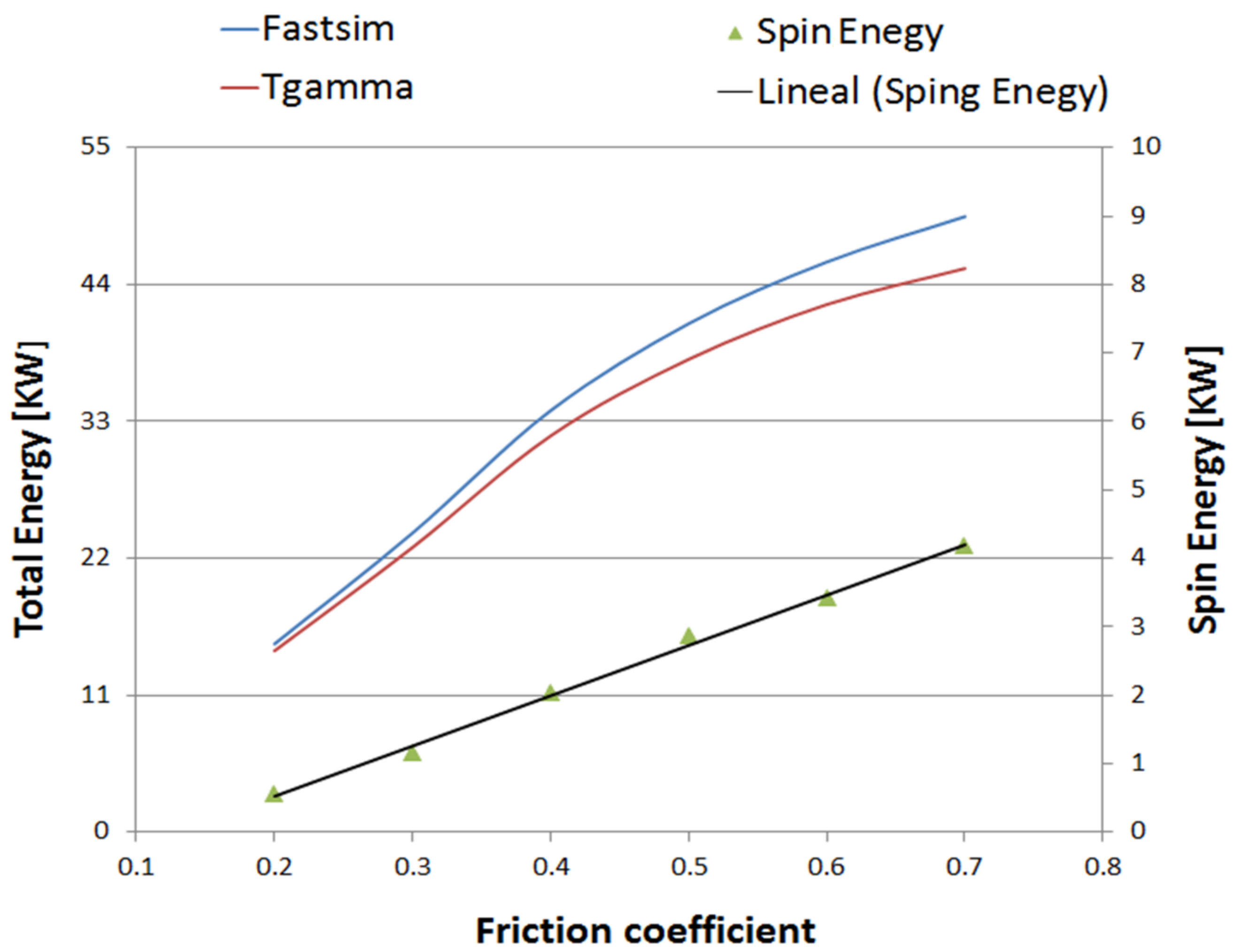


TUDelft

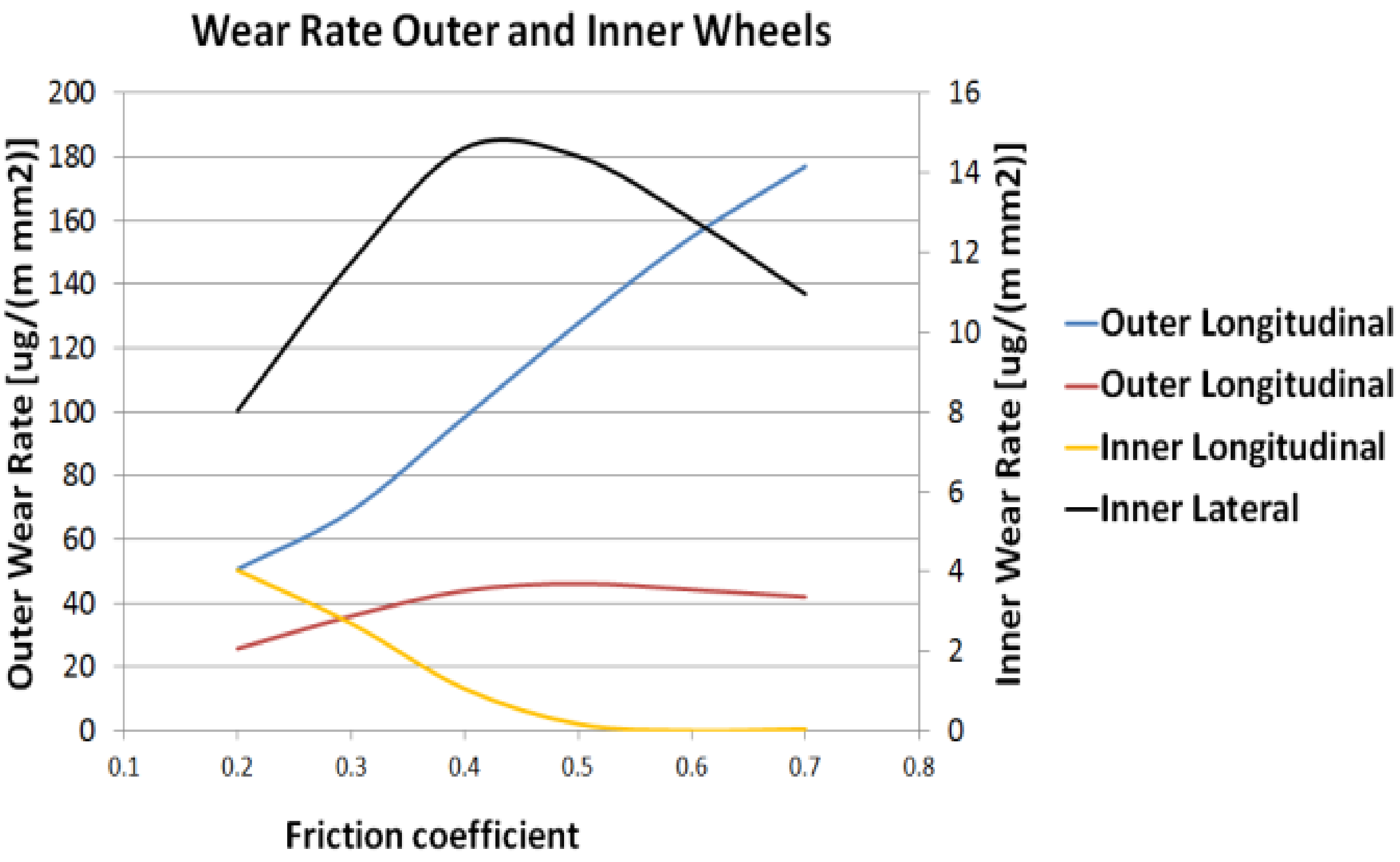
UNIVERSIDAD NACIONAL DE COLOMBIA

$$v_y = -\alpha \qquad P_{frict} = (T_x\gamma_x + T_y\gamma_y)V$$

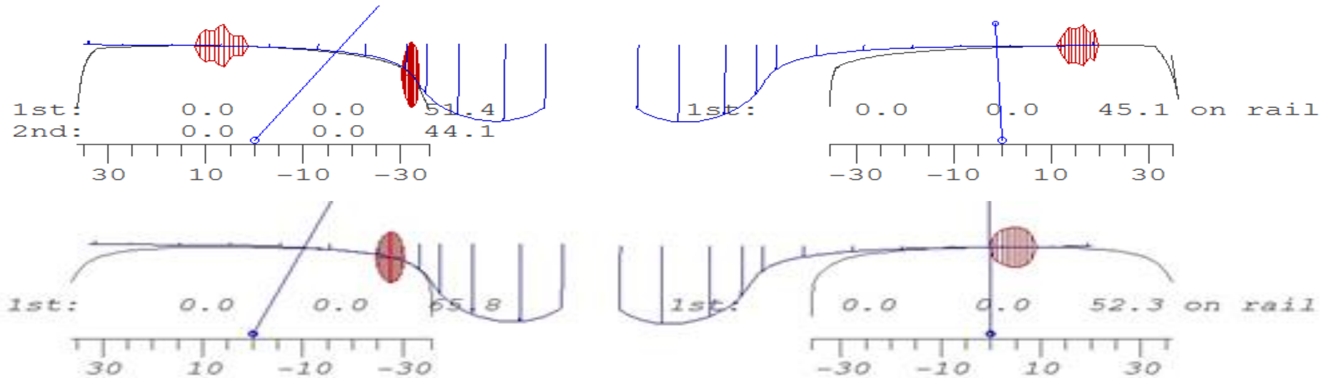
POWER CALCULATIONS:

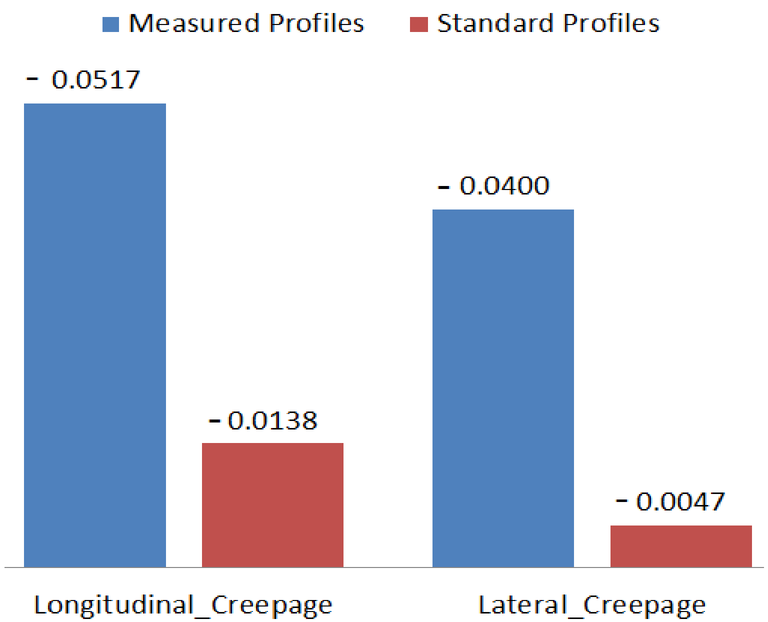


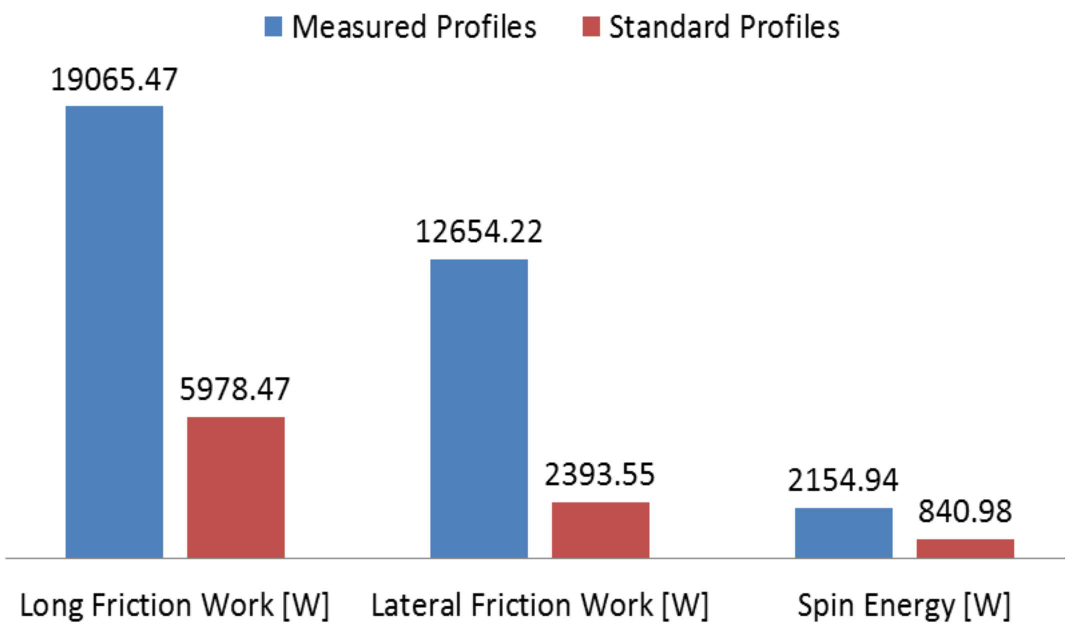
WEAR CALCULATIONS:



EFFECT OF THE PROFILES ON THE ENERGY DISSIPATION AND WEAR RATES







EFFECT OF THE PROFILES ON THE ENERGY DISSIPATION AND WEAR RATES

Wheel/rail profiles effect in the total energy dissipation of the first bogie.

	Measured profiles	**Standard Profiles**
Total Energy [KW]	33.9	9.2

Wheel/rail profiles effect in the wear rates of the first bogie.

	Measured profiles	**Standard Profiles**
Wear Rate [µg/(m mm²)]	158.1	30.6

CONCLUSIONS AND RECOMMENDATIONS

- The energy dissipation generated by spin increases as the friction coefficient grows.

- It is only recommended to neglect the effect of the spin moment in the energy calculations for low friction coefficient conditions

- As the friction coefficient increases, the inner wheel loses traction while the outer wheel increases it, this condition produces a rotational moment of the wheelset in clockwise direction, reducing the yaw angle of the wheelset.

- The energy consumption increases linearly as the friction coefficient grows

- The results of simulations with different profiles are important since they show the necessity for optimizing profiles and re-profiling procedures. An optimized wheel/rail profile combination greatly reduces the energy dissipation and the wear rates.

ACKNOWLEDGMENTS