

Delft Tyre



Latest and Future Developments
of
DELFT-TYRE
in
ADAMS and ADAMS/CAR

Jan J.M. van Oosten

12th European ADAMS Users' Conference, Marburg, 1997



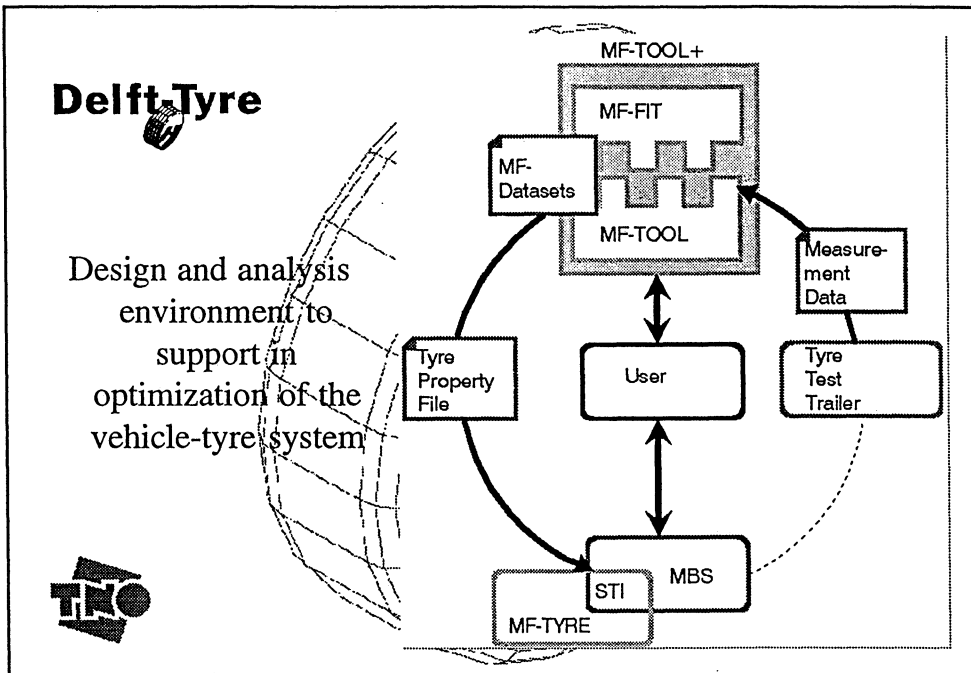
Delft Tyre



Contents

- DELFT-TYRE review
- DELFT-TYRE latest developments
- DELFT-TYRE and ADAMS
- Future tyre modeling
 - Motorcycle tyre modeling
 - Advanced high frequency tyre modeling
 - Tyre - soft soil interaction
- Tyre and vehicle measurements
- Concluding





Delft Tyre

Review

MF-Tyre

- Robust tyre model for general vehicle dynamics applications
- Magic Formula for steady state Latest version
- Transient using tyre relaxation lengths x- and y-direction
- Standard Tyre Interface

MF-Tyre

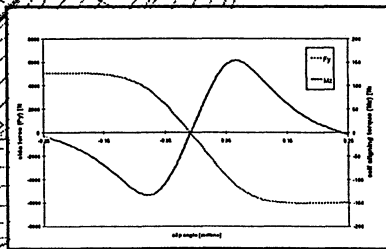
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Review

MF-Tyre steady state

Latest version of Magic Formula

- Self Aligning torque with pneumatic trail
- Combined with weighting functions
- Non-dimensional parameters
- Scaling factors

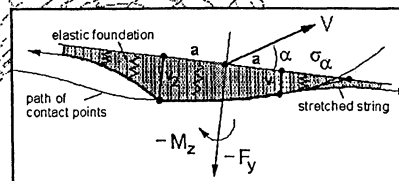


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Review

MF-Tyre transient

- Start from zero velocity (standing still possible)
- Gyroscopic couple included
- Tyre relaxation lengths x- and y-direction depending on vertical load



Delft Tyre

Review

MF-Tyre specifications

- 6-8 Hz steering angle excitations
- vertical load fluctuations
- road undulations \leq tire circumference
- braking, driving and stand still
- input: $\alpha, \kappa, \gamma, F_z$
- output: $F_x, F_y, F_z, M_x, M_y, M_z$




Delft Tyre

Review

MF-Tyre application examples

- steady state circular test
- lane change
- braking or power-off in a turn
- cornering and/or braking on bumpy roads
- stand still on 4 post rig
- ...
- robust for extreme input values


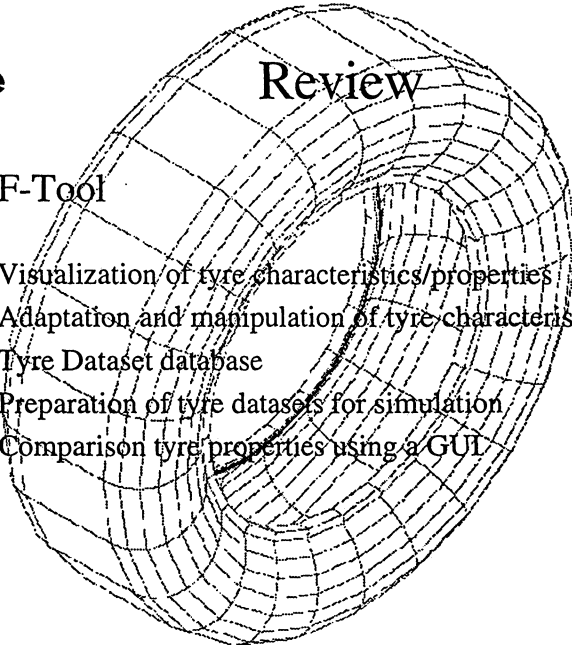



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Review

MF-Tool

- Visualization of tyre characteristics/properties
- Adaptation and manipulation of tyre characteristics
- Tyre Dataset database
- Preparation of tyre datasets for simulation
- Comparison tyre properties using a GUI


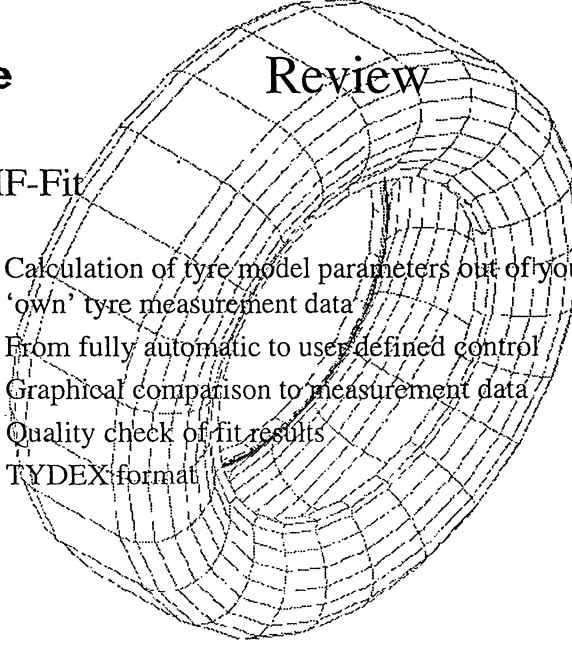


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Review

MF-Fit

- Calculation of tyre model parameters out of your 'own' tyre measurement data
- From fully automatic to user defined control
- Graphical comparison to measurement data
- Quality check of fit results
- TYDEX format



Delft-Tyre



Review

MF-Datasets

- Library with wide range of tyres
- Tailor made datasets and tyre testing



Delft-Tyre



Latest Developments

MF-Tyre in ADAMS/Car

- Standard Tyre Interface 1.4
- Durability tyre/contact
- Position dependent friction levels
- Overturning couple introduced
- Rolling resistance properties improved



Delft Tyre

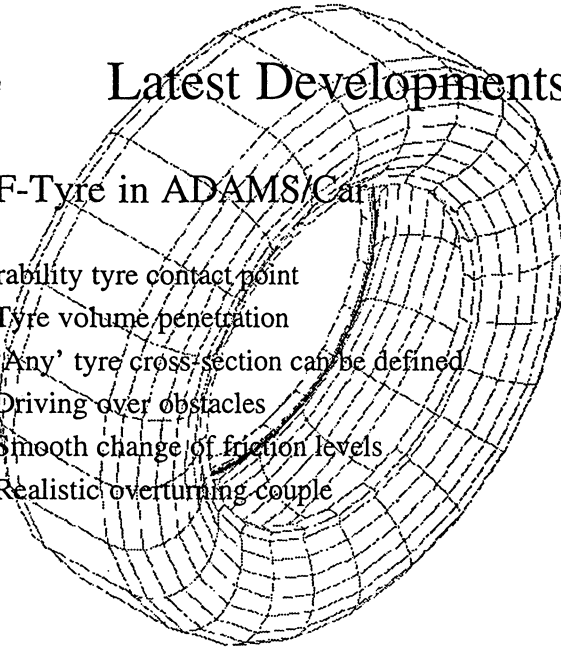


Latest Developments

MF-Tyre in ADAMS/Car

Durability tyre contact point

- Tyre volume penetration
- 'Any' tyre cross-section can be defined
- Driving over obstacles
- Smooth change of friction levels
- Realistic overturning couple



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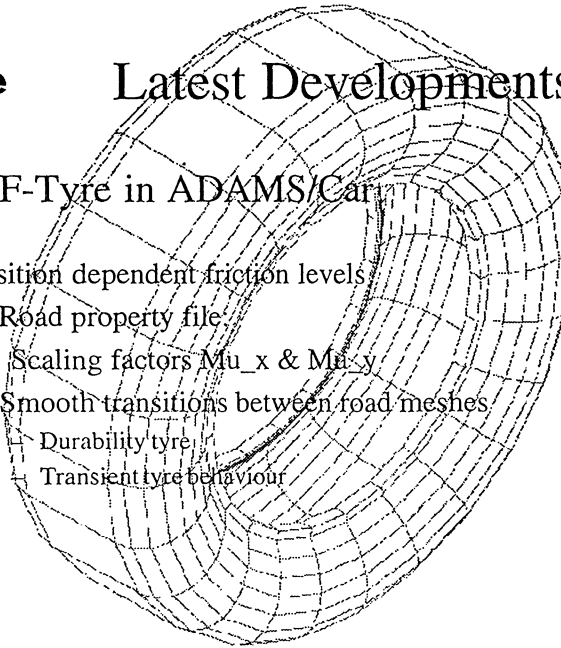


Latest Developments

MF-Tyre in ADAMS/Car

Position dependent friction levels

- Road property file
 - Scaling factors μ_x & μ_y
- Smooth transitions between road meshes
 - Durability tyre
 - Transient tyre behaviour



Delft Tyre

Latest Developments

MF-Tyre in ADAMS/Car

Overturning couple

$$M_x = F_z R_0 (a_{sx1} + a_{sx2} \gamma + a_{sx3} F_y / F_z) k_{Mx}$$

Rolling resistance (modified)

$$M_y = -F_z R_0 (a_{sy1} + a_{sy2} F_x / F_z) k_{My}$$



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MF-Tyre and ADAMS

ADAMS 8.2

- MF-Tyre 4.3 standard available in ADAMS/Tire
- MF-Tyre 5.0 patch available

ADAMS 9.0

- MF-Tyre 5.0 standard available in ADAMS/Tire
- ADAMS/Tire

ADAMS/Car

- MF-Tyre 5.0 implemented using STI 1.4
- Durability contact

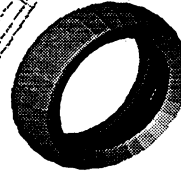


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Future Tyre Modeling

Motorcycle Tyres

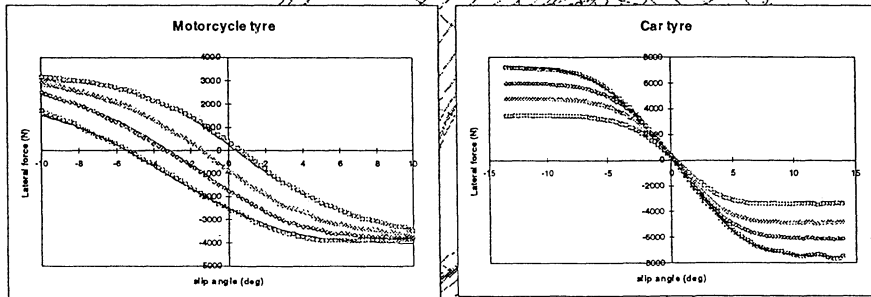
- Wide range of tyres measured
- Magic Formula for Motorcycle tyres
- Large camber angles (up to 45°)
- Including transient tyre behaviour
- DELFT-TYRE products will be available for Motorcycle tyre modeling:
 - MF-MCTyre
 - MF-MCTool
 - MF-MCFit



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Future Tyre Modeling

Motorcycle Tyres



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Future Tyre Modeling

SWIFT

Short Wavelength Intermediate Frequency Tyre model

- Frequencies up to 50 Hz
- Pragmatic model based on physical models
 - fast
 - accurate
- In-plane and out-of-plane tyre behaviour
- Project with 9 automotive partners
- Result: general applicable model for simulation studies



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Future Tyre Modeling

SWIFT

Specifications:

- 50 Hz vibrations in- and out-of-plane
- road undulations > 0.2 m
- steady state basic Magic Formula
- switch from simple to complex tyre behaviour

Type of applications:

- Advanced ABS or traction control
- Ride comfort
- Braking vibrations
- ...



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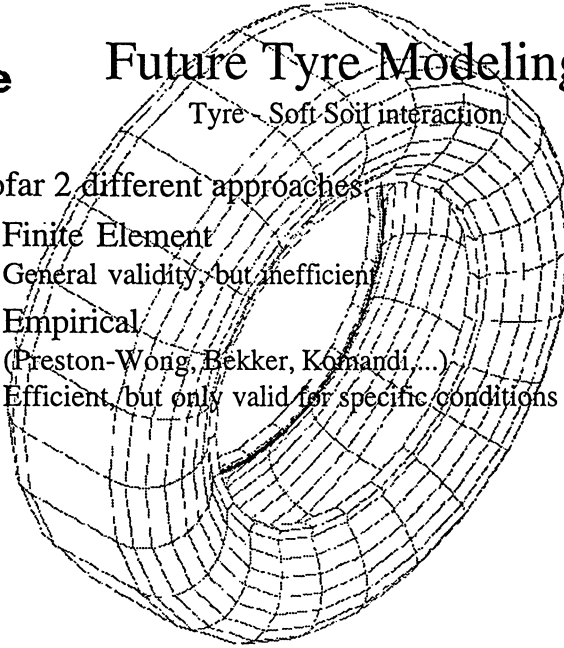


Future Tyre Modeling

Tyre - Soft Soil interaction

Sofar 2 different approaches:

- Finite Element
General validity, but inefficient
- Empirical
(Preston-Wong, Bekker, Komandi...)
Efficient, but only valid for specific conditions



Delft Tyre

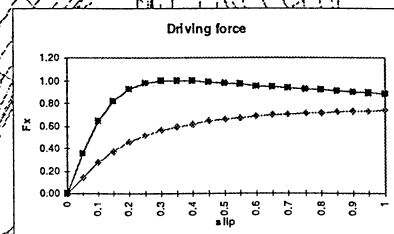


Future Tyre Modeling

Tyre - Soft Soil interaction

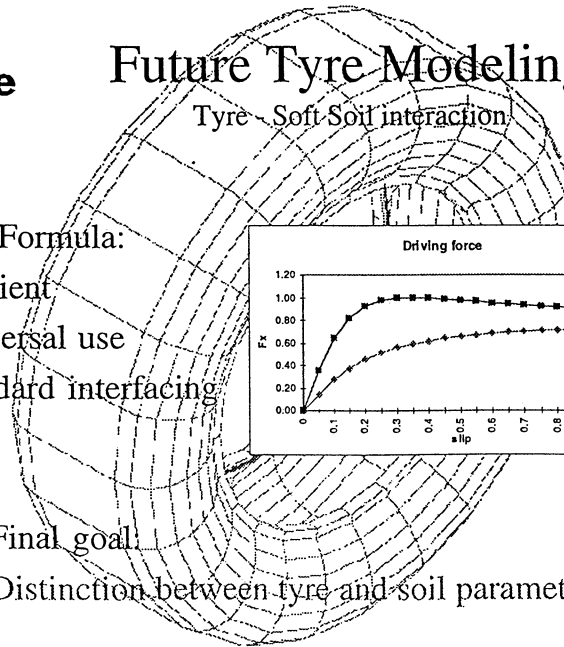
Magic Formula:

- Efficient
- Universal use
- Standard interfacing



Final goal:

Distinction between tyre and soil parameters

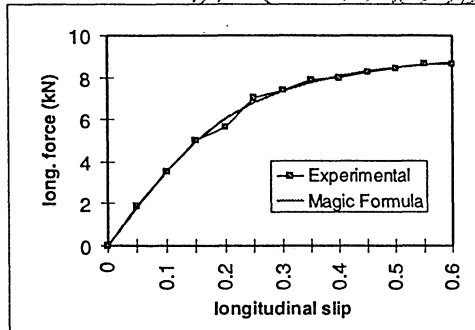


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Future Tyre Modeling

Tyre - Soft Soil interaction



Farmer tyre

size 18.4-34

pres. 1.4 bar

coh. 11 kPa

tan(ϕ) 0.85

load 16.3 kN

taft sandy

v 3.4 km/h



Delft Tyre



Tyre Testing

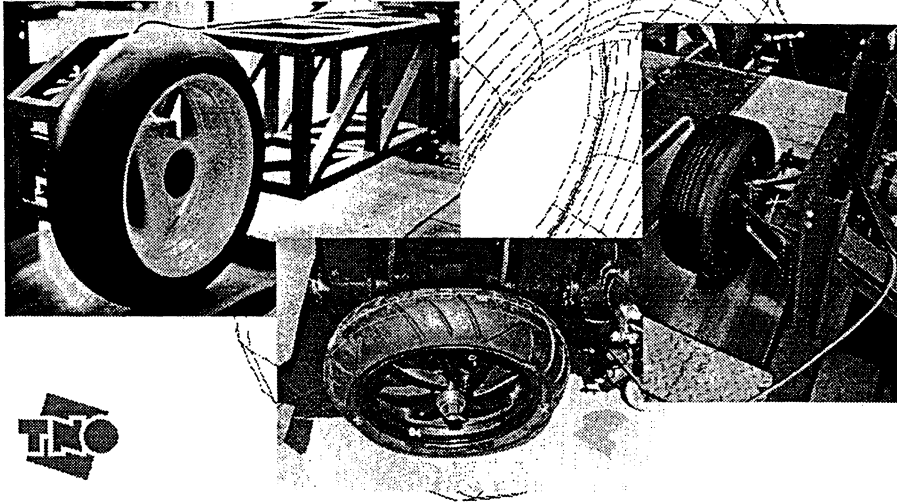
- DELFT-TYRE MF-datasets
- Tailor made tyre testing
 - Delft Tyre Test Trailer
 - steady state & transient (5 Hz)
 - external drums
 - steady state, transient & dynamic (50 Hz)
 - flat plank
 - steady state & transient (low velocity)
- Tyre types:
 - passenger car
 - motorcycle
 - truck



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Tyre Testing

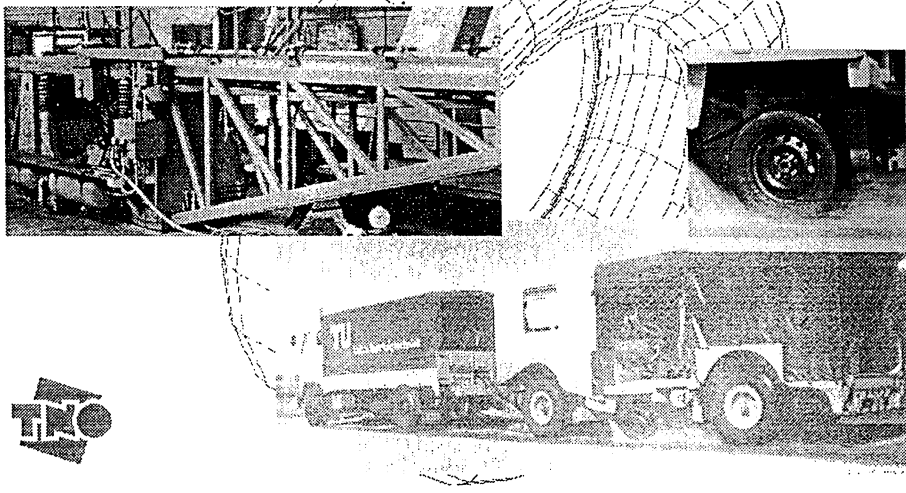
Examples



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Tyre Testing

Examples



Delft-Tyre



Vehicle Testing

- TNO Vehicle Dynamics Database
- Tailor made vehicle testing
- Development of test procedures
- Correlation subjective - objective testing
- Expertise in vehicle model validation



Vehicle Testing

TNO Vehicle Dynamics Database

- Alfa Romeo 145 1.6i
- AUDI A3 1.8
- AUDI A4 1.8
- AUDI A8 4.2
- BMW 1.6i Compact
- BMW 523i
- Fiat Brava 1.6i
- Ford Escort 1.8 GT
- Ford Scorpio 2.0i 16V
- Lancia k 2.4 20V
- Mercedes E230
- Opel Vectra 2.0i 16V CD
- Peugeot 406 2.0i 16V
- Peugeot 406 S.V. 2.0i 16V
- Peugeot 806 SR 2.0
- Renault Laguna 1.8N
- Renault Mégane Scenic, 1.6e
- Volkswagen Polo 1.6i





Vehicle Testing

TNO Vehicle Dynamics Database

8 different ISO tests in 2 loading conditions

Applications:

- Model validation
- Definition of references
- Comparison to competitors' products
- Correlation subjective - objective
- ..



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Concluding..

TNO aims to support automotive industry with their tyre & vehicle testing and modeling expertise by:

- standard products
 - DELFT-TYRE
 - TNO VDD
- tailor made products and
- consulting
- research



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Support

Questions, remarks, comments, experience,

.....?

TNO Road Vehicles Research Institute

DELFT-TYRE

phone: +31 15 2696420

fax: +31 15 269 7314

e-mail: delft tyre@wt.tno.nl

