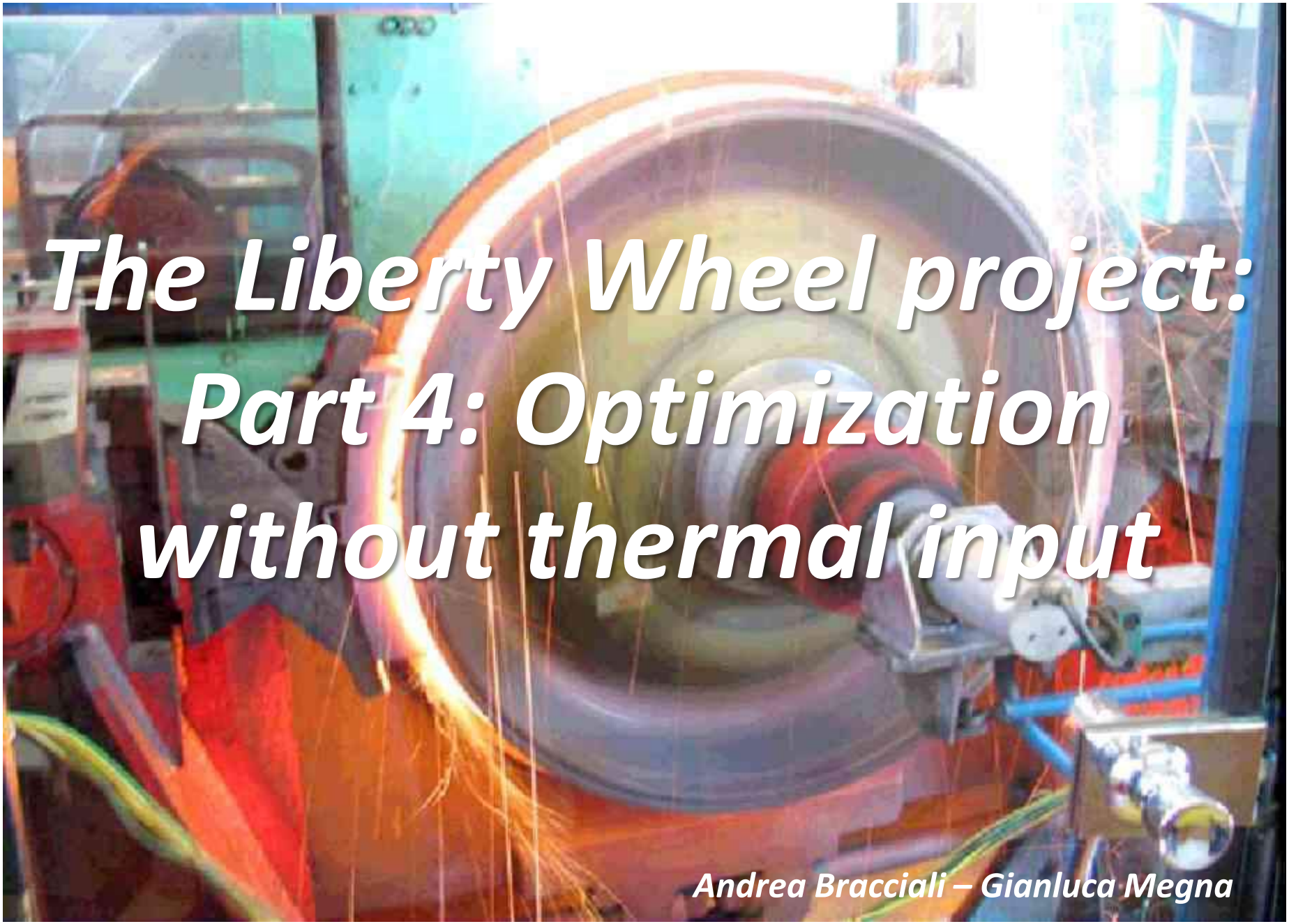
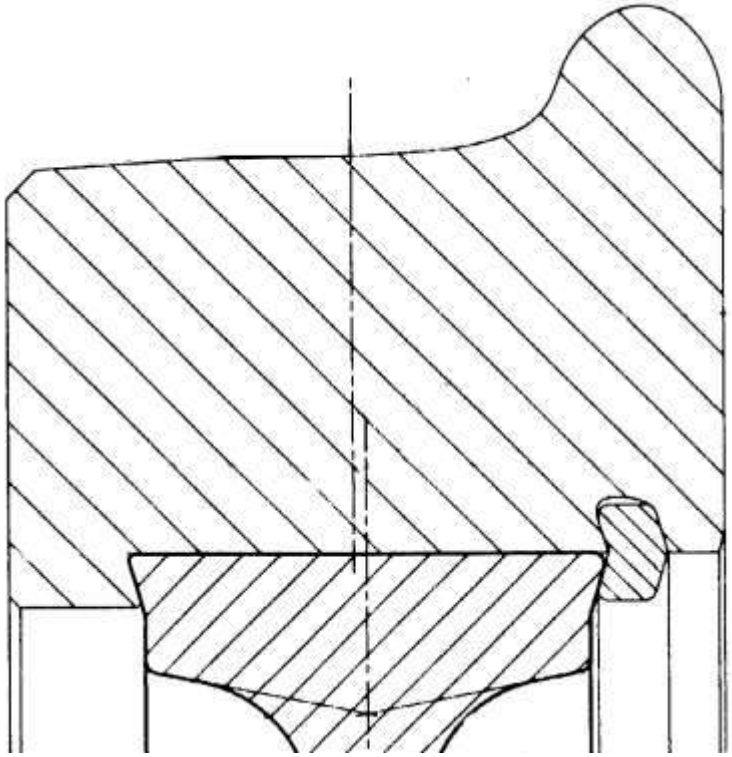
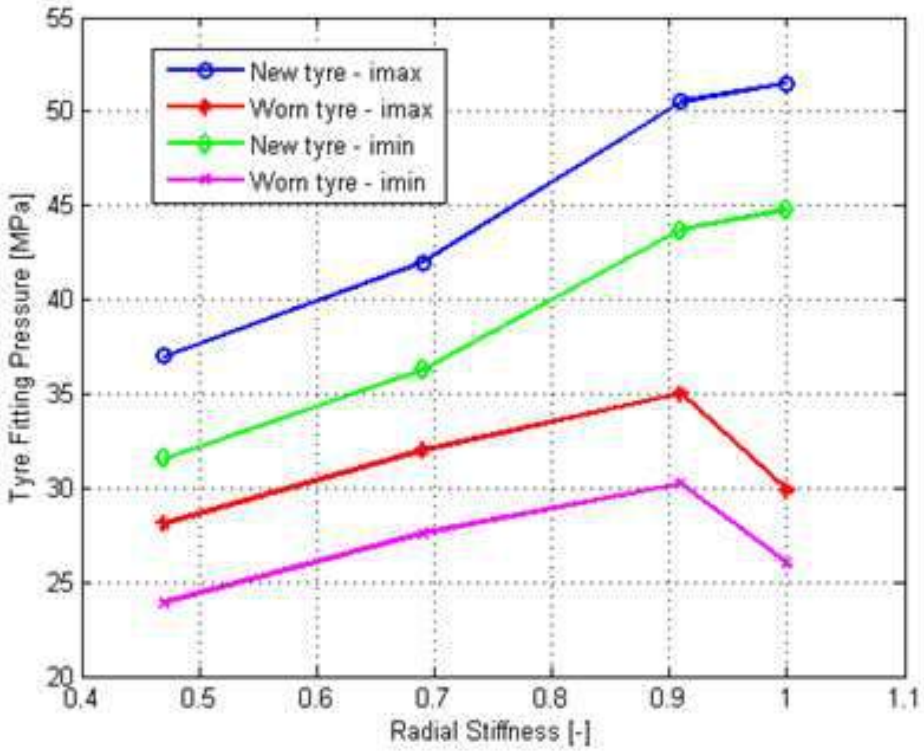


The Liberty Wheel project: Part 4: Optimization without thermal input

Andrea Bracciali – Gianluca Megna

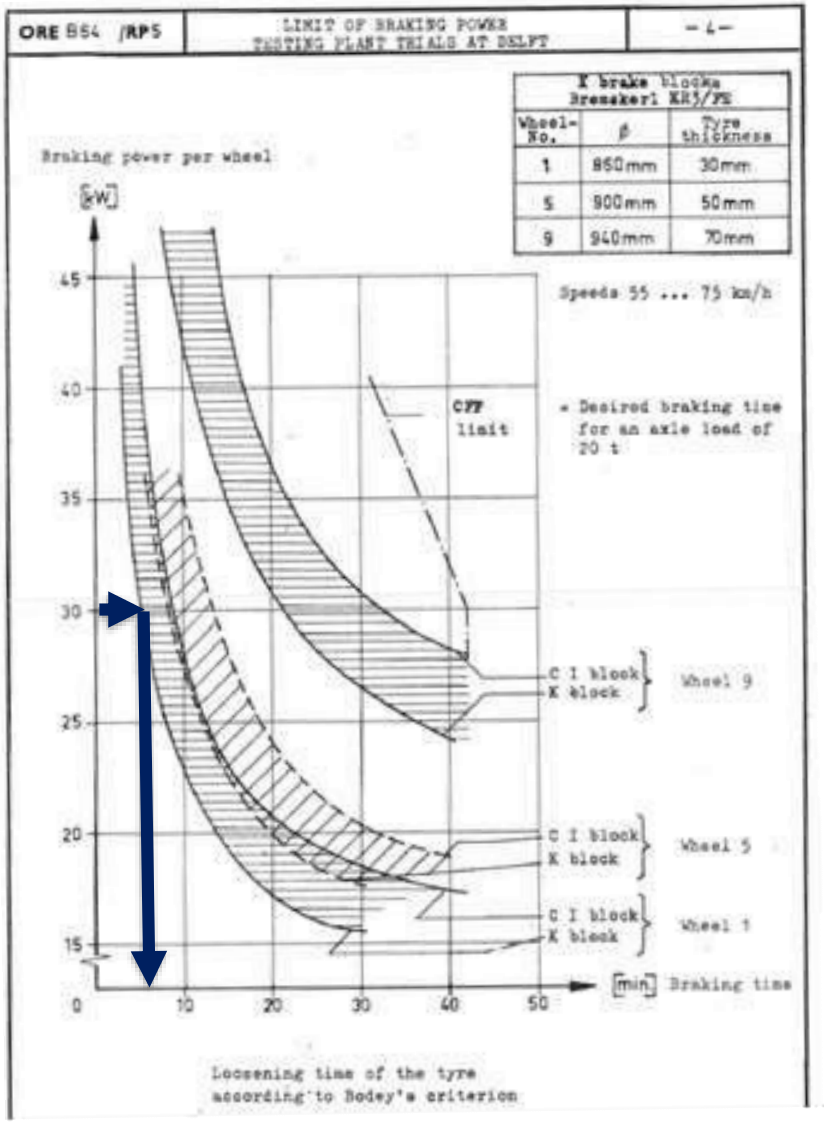
Pressure at the wheel-tyre interface





Minimum value: 24 MPa
WITHSTAND TREAD
BRAKING

The downfall of tyred wheels



1. **ORE B64 /RP5 "**Limits of energy dissipation during braking with tyred wheels" – 1968
2. **UIC Code 510-2** "Trailing stock: wheels and wheelsets. Conditions concerning the use of wheels of various diameters" – 1978

1.3.1 - From 1.1.89, new wagons are to be equipped with solid wheels.

3. **Joint Sector Group,** "Final report on the results of the Joint Sector Group activities linked to the action plan defined under the Task Force Freight Wagon Maintenance" - 2012

The sector itself agreed to stop tyred wheels operation by 2020 at the latest

What happen if tread braking …

… is removed ?

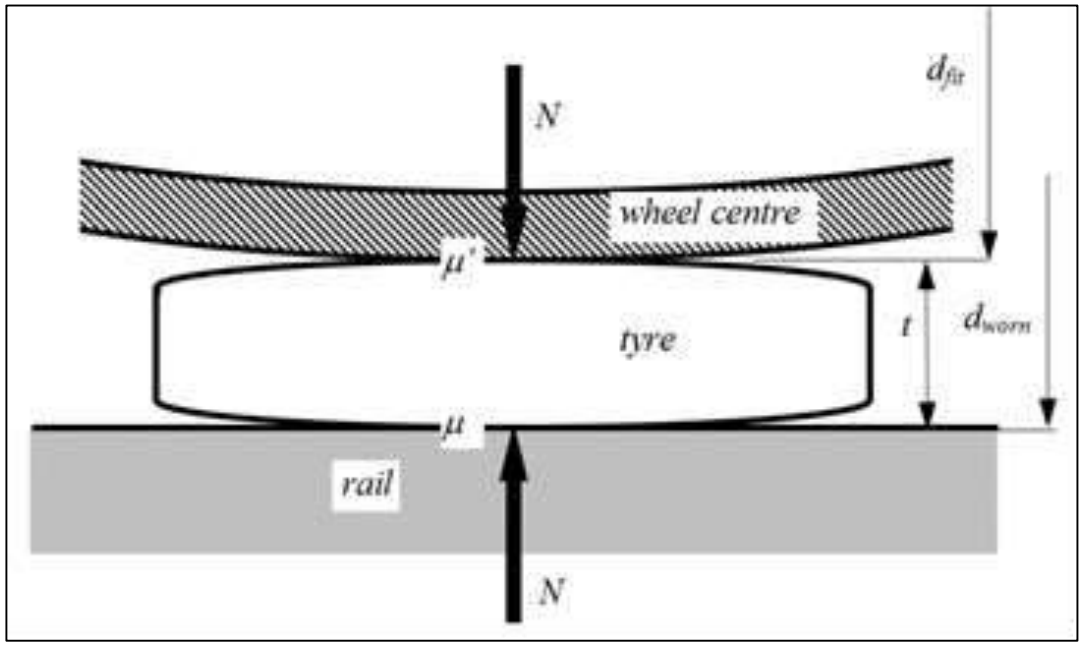
- Without tread braking there is no thermal input that reduces the interface pressure
- Small effect of the centrifugal force due to vehicle speed
- Torque can be transmitted from a lower value of fitting pressure
- Traction torque can be considered the worst situation for tyred wheels

WHICH IS THE MINIMUM PRESSURE NEEDED TO TRANSMIT STARTING TORQUE?

Minimum pressure at starting

Tyre as a third body between the rail and the wheel centre

- μ = friction coefficient at the tyre-rail contact
- μ' = friction coefficient at the wheel centre-tyre contact



As μ is higher than μ' (0.3 steel on steel) the pressure needed to transmit the torque is generated by the difference μ - μ'

Starting friction coefficient

- Locomotives suffer by transmission overload (*broutage* for hydraulic locos or *broutage + motor short circuit* for electric locos)
- These overloads are usually considered using an equivalent wheel-rail friction coeffcient of about 0.6 ÷ 0.8

DMU 11 t/axle (μ = 0.33)

Electric Loco 17.2 /axle (μ = 0.8)

Electric Loco 21 /axle (μ = 0.8)

Hydraulic Loco 20 /axle (μ = 0.6)

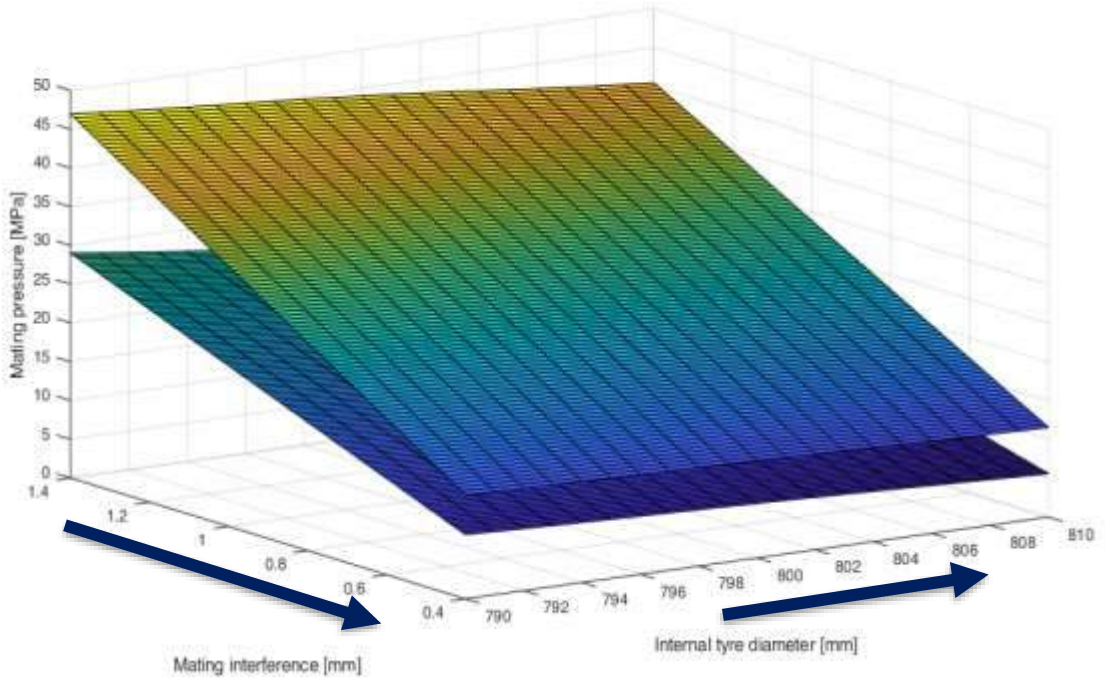
Reducing pressure at the interface

In the worst conditions the minimum pressure p_0 needed to transmit the torque is about 1 MPa!

Electric Loco 17.2 /axle

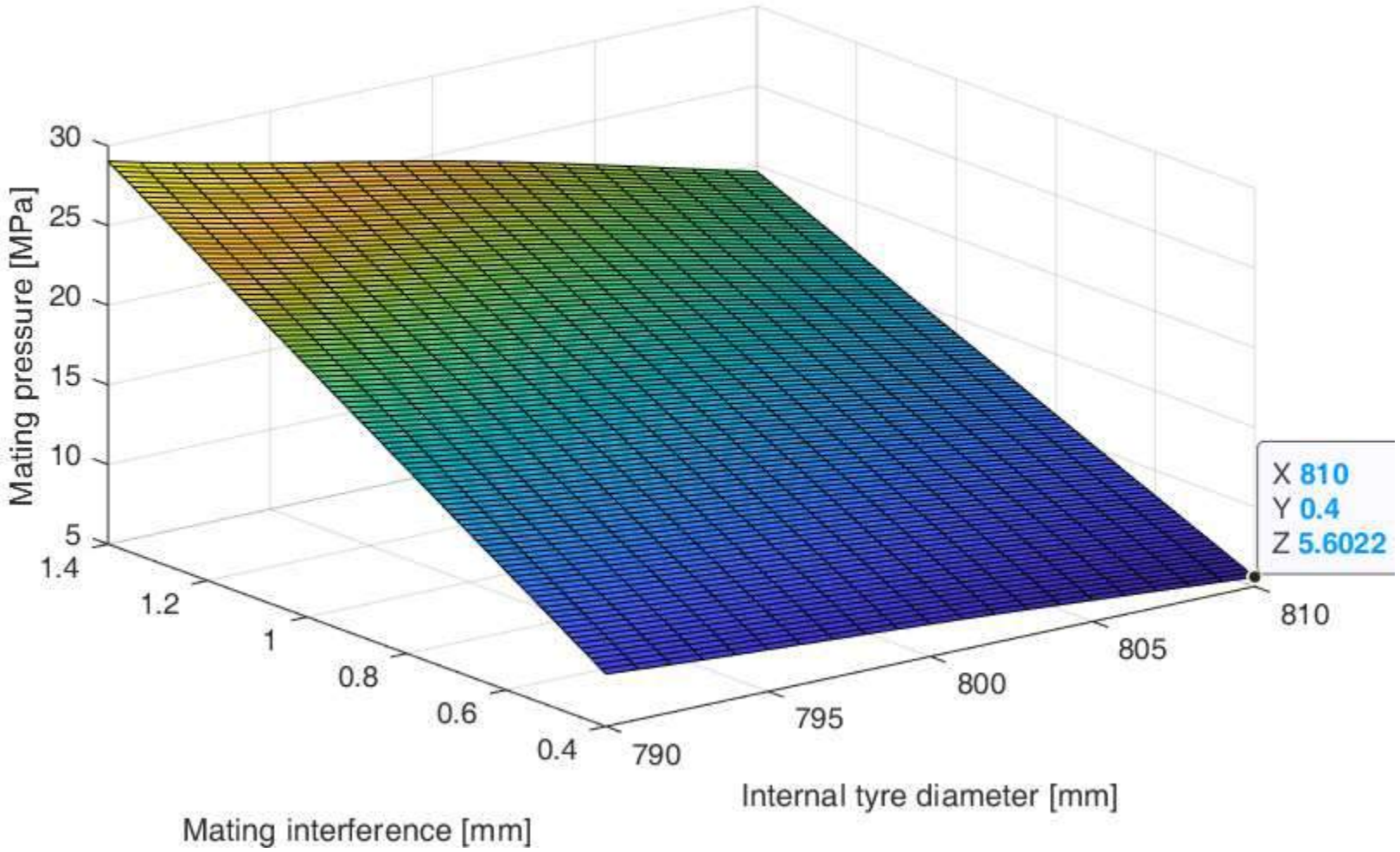
Pressure at the interface can be reduced by

- a **lower interference**
- a **lower tyre thickness (or a greater fitting diameter)**



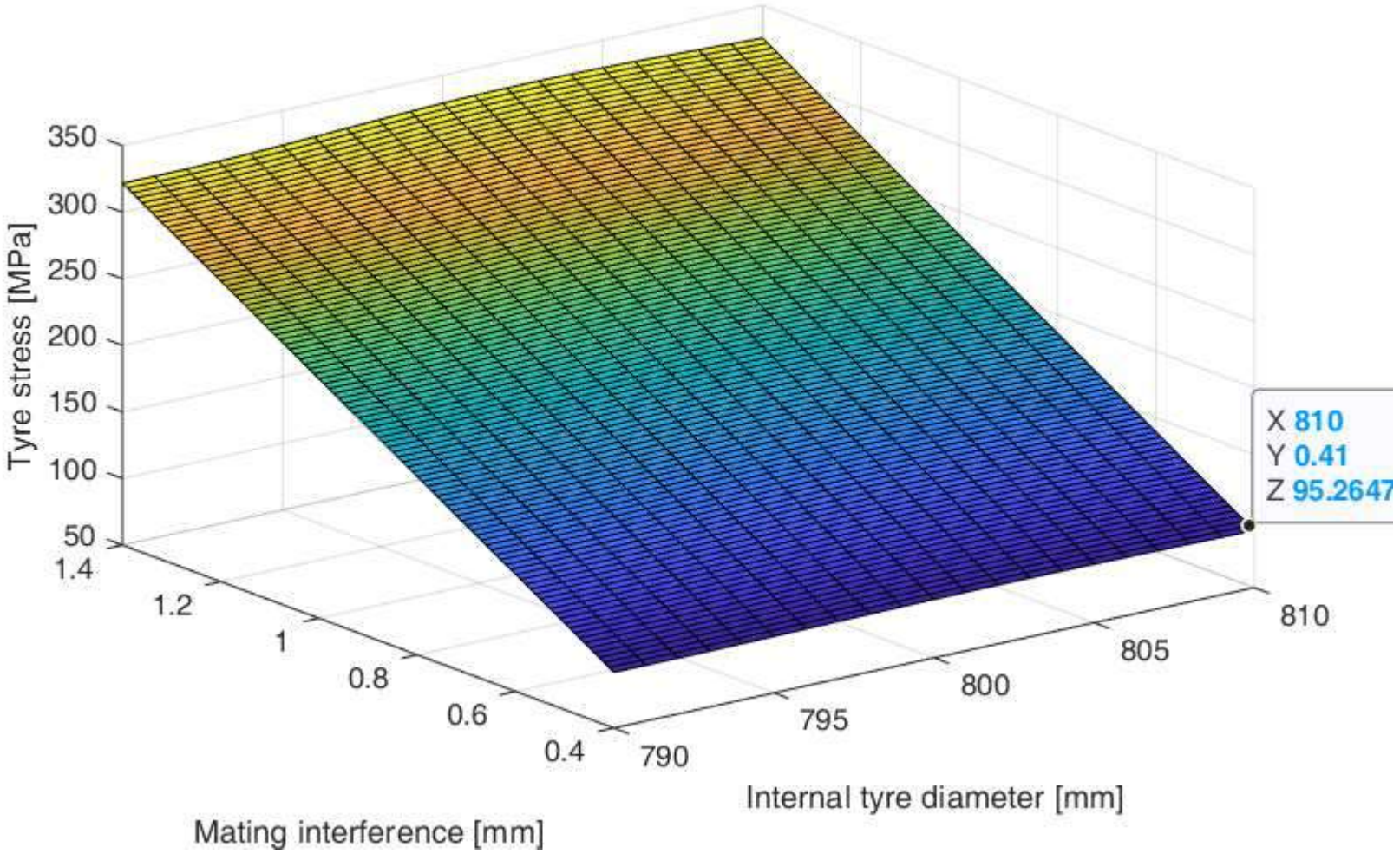
Interpolation of FEM results - 1

- Tyre thickness = 20 mm ; Interference = 0.4 mm
  - Min pressure = 5.6 MPa



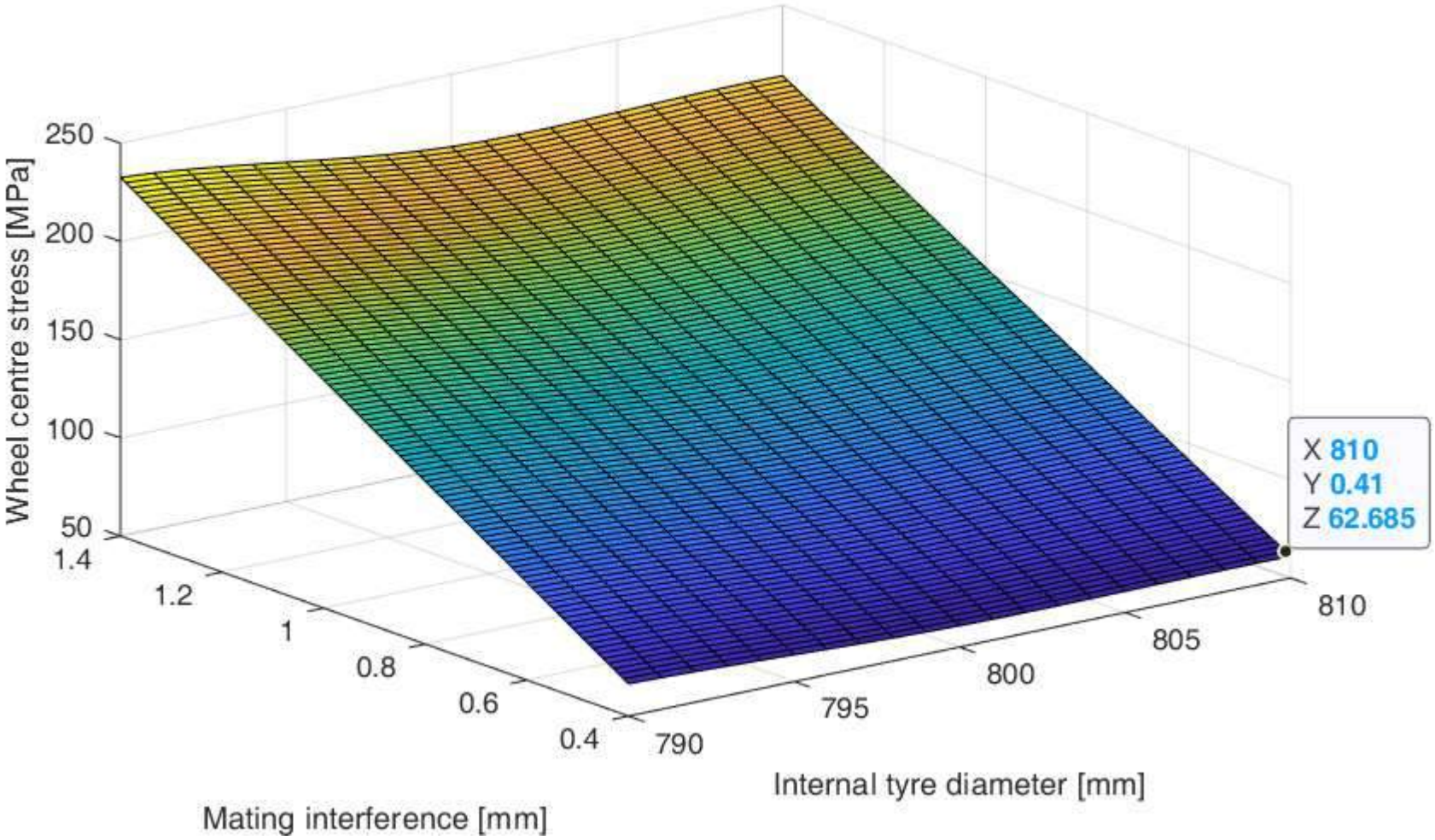
Interpolation of FEM results - 2

- Tyre thickness = 20 mm ; Interference = 0.4 mm
- Min pressure = 5 MPa
- Tyre stress = 90 MPa



Interpolation of FEM results - 3

- Tyre thickness = 20 mm ; Interference = 0.4 mm
  - Min pressure = 5 MPa
  - Tyre stress = 90 MPa
  - Wheel centre stress = 63 MPa



Conclusions

- **Tyred wheels were designed mainly to withstand to the termal input during tread braking**

- **If tread braking is not applied:**
  1. High pressure at the mating interface is not needed
  2. Lower interference value can be applied
  3. Lower stresses in the wheel centre and in the tyre
  4. Lower residual tyre thickness can be reached

- **If the design is revised and optimized tyred wheels may be interesting again for conventional passenger vehicles**