First TIRE-DYN testing results

C. Gonzalez Diaz, P. Kindt, J. Middelberg
Goodyear Innovation Center Luxembourg
Tire Vehicle Mechanics - Vibration Mechanics Group

B. Pluymers, P Sas, W. Desmet
Katholieke Universiteit Leuven, dept. Mech. Engineering

G. Rocca, B. Peeters
LMS international

Overview

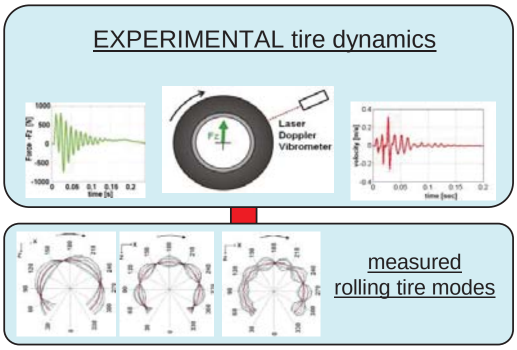
- Motivation and goals
- Experimental setup
- Static measurements
    - Unloaded
    - Loaded
- Problems when attempting to acquire vibrations on rolling tires
- Dynamic measurements
- Conclusion and future work

Motivations and goals

Although tire/road noise has been studied for several decades there are still some **missing links** in the process of accurately predicting and controlling the overall tire/road noise.

What is the effect of rolling on the dynamic behavior of a tire ?

Obtain more accurate structural tire models through a better understanding of the influence of rolling on the tire dynamic behavior.



Perform the experimental characterization of the dynamic behavior of rolling tires under different operating conditions.

Problems when attempting to acquire vibration on rolling tires

- Placement of the transducer; the most interesting regions of vibrations are in and near the contact patch.
- Alternative: use of LDV to allow measurements close to the contact patch.

- To prevent damage and for safety reason the LDV is placed away from the contact patch
- Dropout of the signal and false velocity measurements caused by the grooves of a tire with a tread pattern suggested us to use a slick tire.
- Reflective paint was used to increase the signal to noise ratio of the laser measurements → the paint quickly wore off → data collection very difficult
- DC offset produced by the rotation of the tire; if laser beam is not perpendicular to the direction of rotation → reduction in signal to noise ratio → mechanical fixture were developed to assist in these adjustments.

- Vibration of the Mirror

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Setup - Tire

- tire 205/55R16
- Inflation pressure 2.2 bar
- Alloy rim
- Slick/smooth tire

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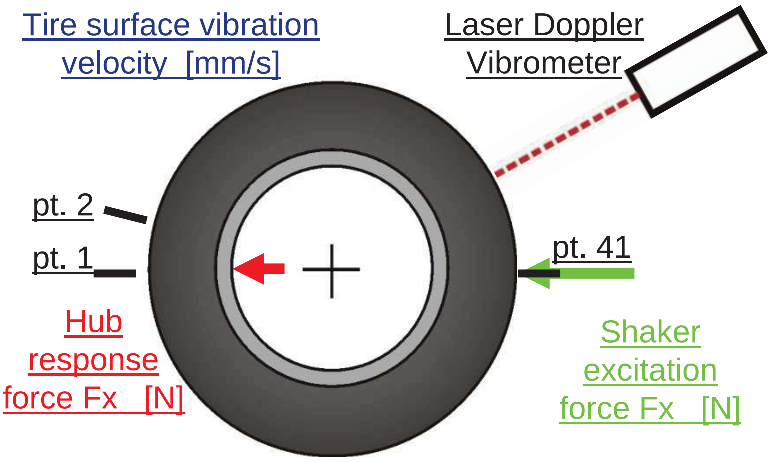
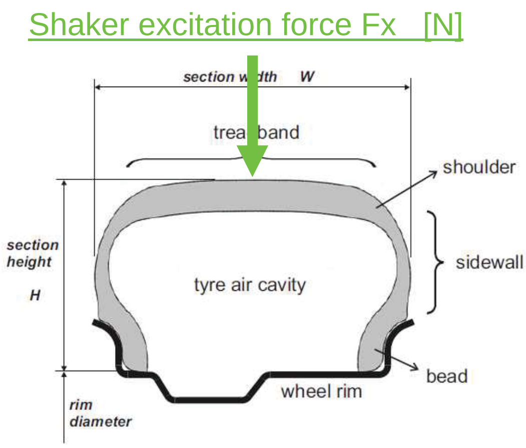
Setup – Unloaded – Non rotating tire

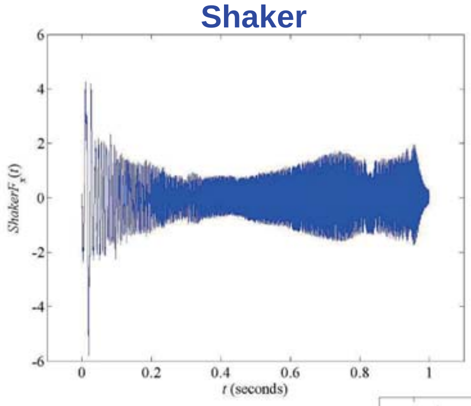




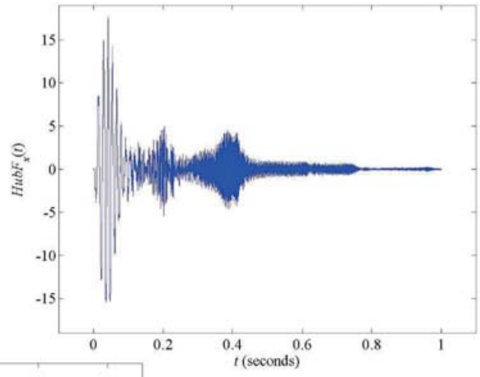
- Wheel is rigidly clamped (rotation constrained) onto a Kistler hub dynamometer
- Excitation at the centre of the tire cross-section
- Vibration velocity response is measured at 41 points evenly distributed over one half of the tire circumference (unloaded tire is symmetric).
- Burst chirp excitation (sine sweep + dropping to zero at end)

Time signals

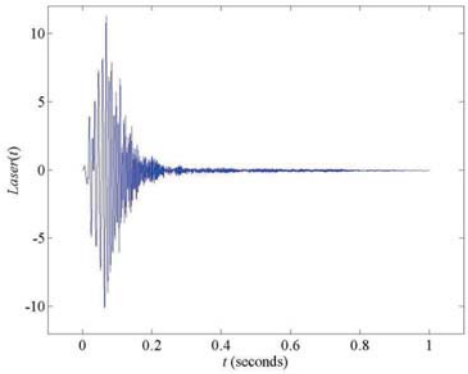
Shaker



Hub Fx

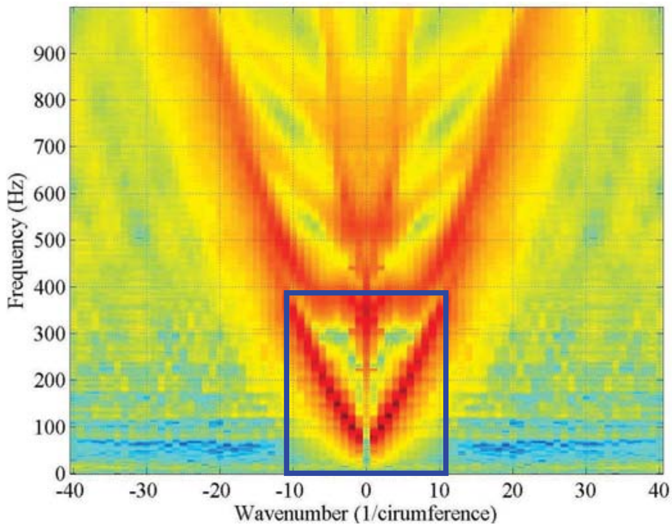


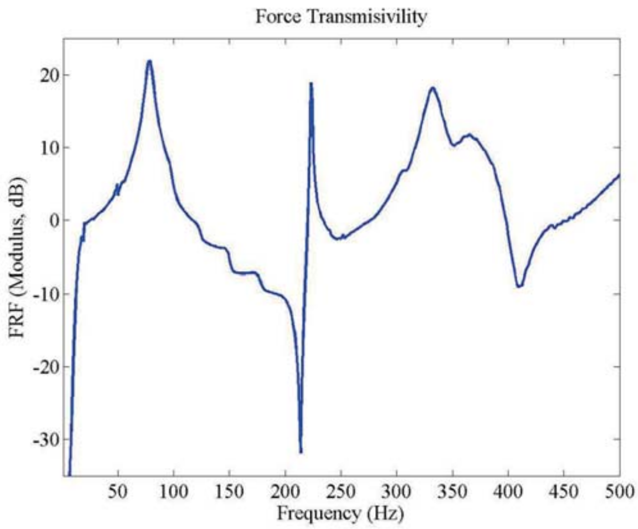
Laser



- Point n
- Single excitation

Force transmissibility and wavenumber plot; Unloaded, Non rotating tire





ZOOM IN

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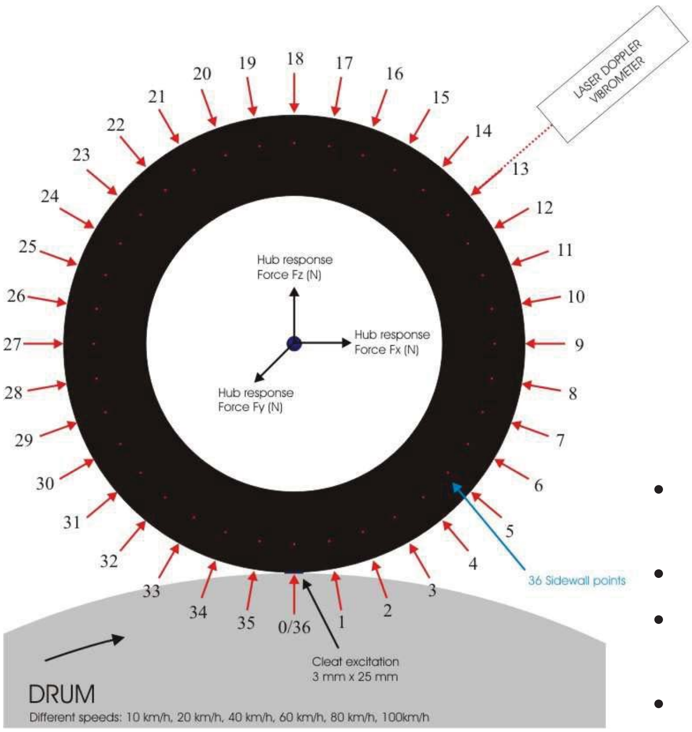
Setup Unloaded – Loaded – Non rotating – Rotating Tire



- Wheel is rigidly clamped onto a Kistler hub dynamometer
- Cleat Excitation (3mm x 25 mm)
- Vibration velocity response is measured at 36 points evenly distributed.
- Load = 4000N

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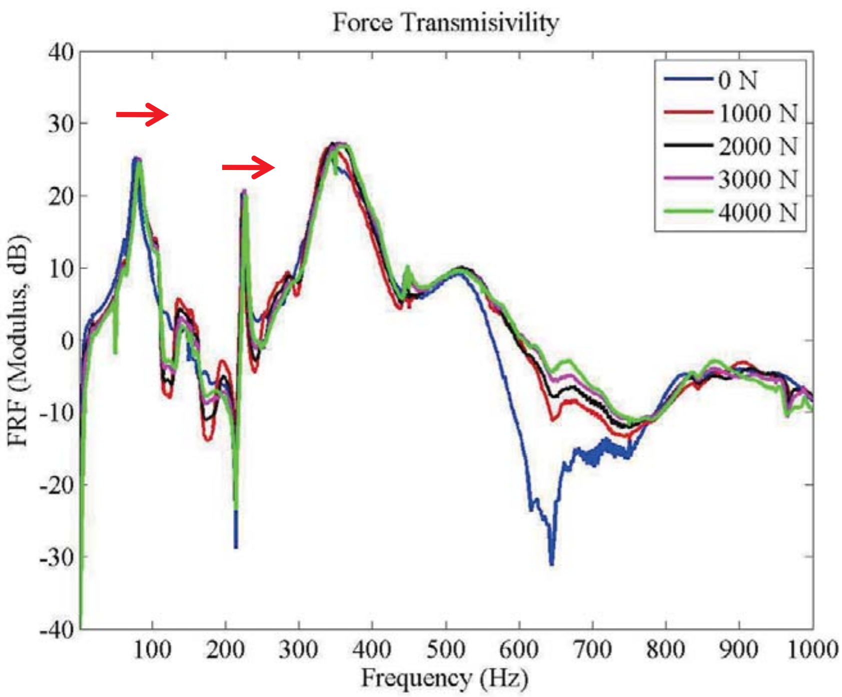
Force transmissibility – Different loads



- ➢ Transmissibility resonance freq (1,0) Increases with the load.
- ➢ First air Cavity resonance Increases with load.

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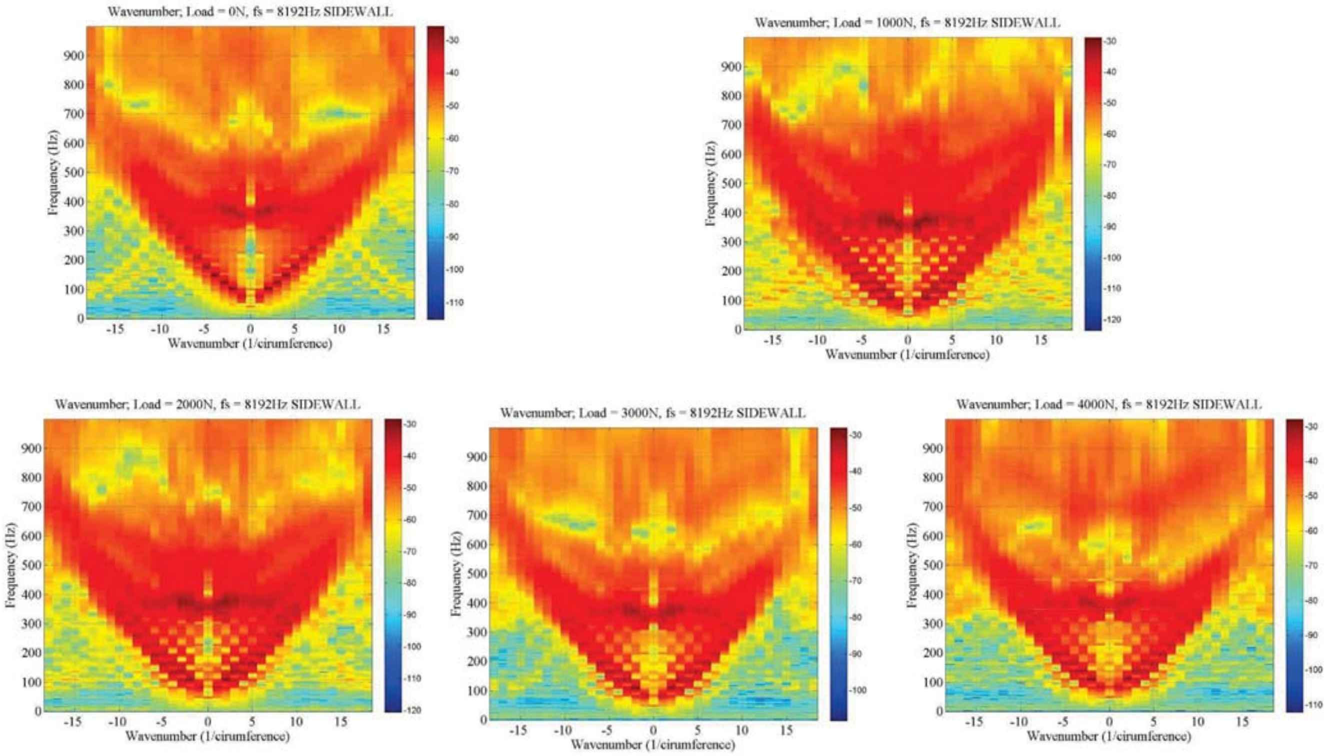
Wavenumber plots – Different loads – Non rotating



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SYNCHRONISATION

➢ Response in different points due to cleat excitation is not measured simultaneously (sequential measurement)

➢ Sequential measurements can only yield information about the complete vibration pattern if the phase relation between the different responses is maintained.

2 approaches:

1) measure simultaneously the response point and a reference point (use of two Laser Doppler Vibrometers)

2) Use of a time reference (if excitation is perfectly repetitive).

The acquisition of the individual responses has to be triggered by :

1. Tacho signal used as reference (Cross Correlation)
2. Vertical Force used as reference
3. Vertical Force used as reference + Cross correlation

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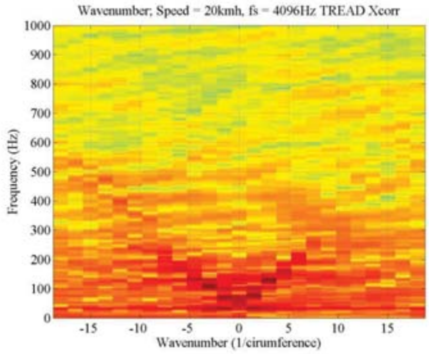
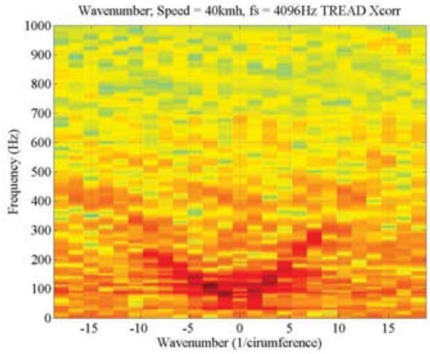
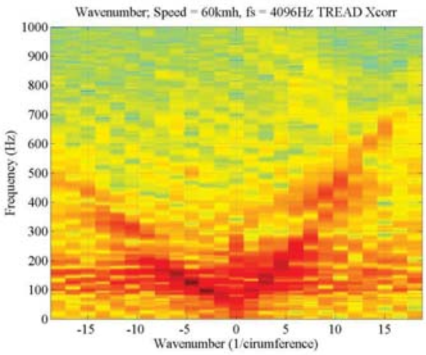
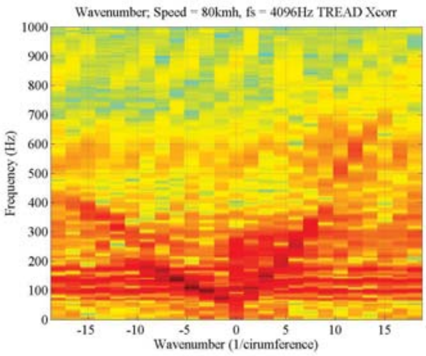
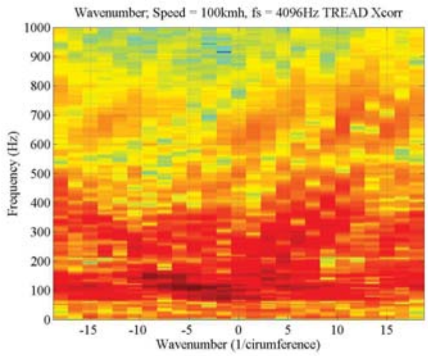
Wavenumber – Freq. Avg. Fs = 4096hz Time length = 20 s TREAD Band 25 Points; Load → 4000 N.











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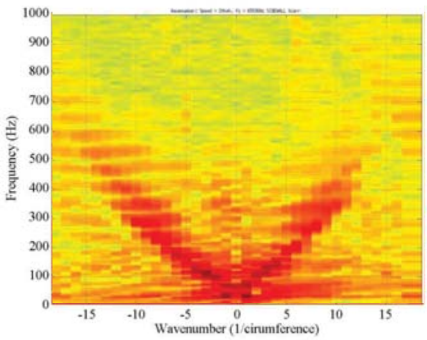
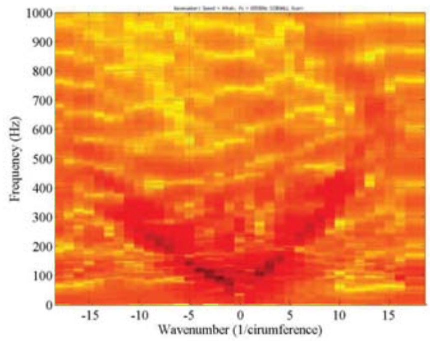
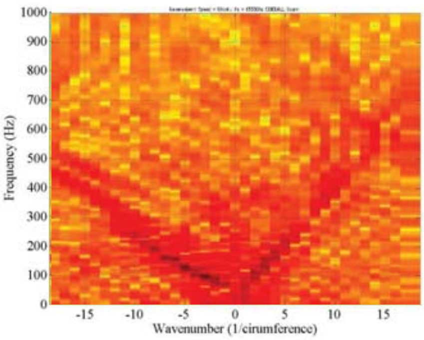
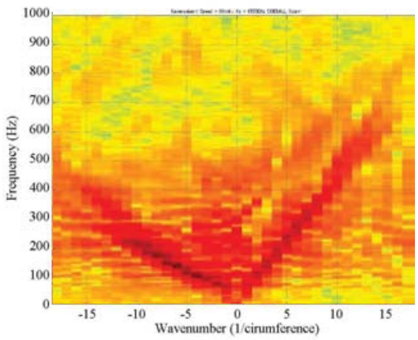
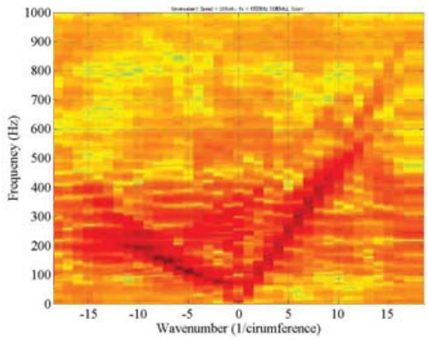
Wavenumber – Freq. Avg. Fs = 65536 Hz Time length = 20 s SIDEWALL 36 Points; Load → 4000 N.











Conclusion and Future work

- Vibration velocity on the tread and sidewall have been measured by a LDV.
- Measuring vibration in the tread is extremely difficult due to the complex nature of the rolling tire. (placing an accelerometer on the tread band has many problems.
- Therefore the use of Laser Doppler Vibrometer (LDV) have been seen as an improvement, except that the LDV has to be placed away from the contact patch.
- The collection of vibration data on the sidewall is fairly straightforward and is relatively simple compared to the collection of data on the tread band.

Future work

- Increase number of points → increase resolution
- Use of a second LDV as reference for synchronisation