
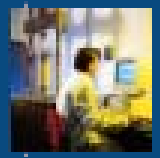

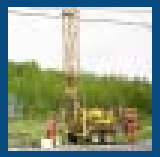


UNE EXPERTISE À PARTAGER

DLC

Transports Québec

Direction du
Laboratoire des chaussées

Type of Tires : Impact on Pavements

Rencontre interprovinciale - Charges et dimensions des véhicules 3 Décembre 2003

Fritz Prophète, ing.

Presentation outline

- Scope
- Testing Program
- Model (Validation)
- Failure criterion
- ESAL for different tires
- Load limits : Regulation
- Conclusions
- Further works recommanded

Scope

- Provide technical informations concerning pavement response with different type of tires.
- Propose an adaptation to the regulation concerning axial loading.

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Type of Tires : Impact on Pavements

Experimental Program SERUL

2 testing période
- Spring: Mai 2002
- Summer: July 2002

4 types of tires tested

Pavement response with different load

Report of experimental study

Strutural pavement analysis

FWD testing
- Spring: Mai 2002
- Summer: July 2002

Pavement response Modeling

Calculated pavement response

Comparaison with experimental datas

Load limits

Adapation to road network

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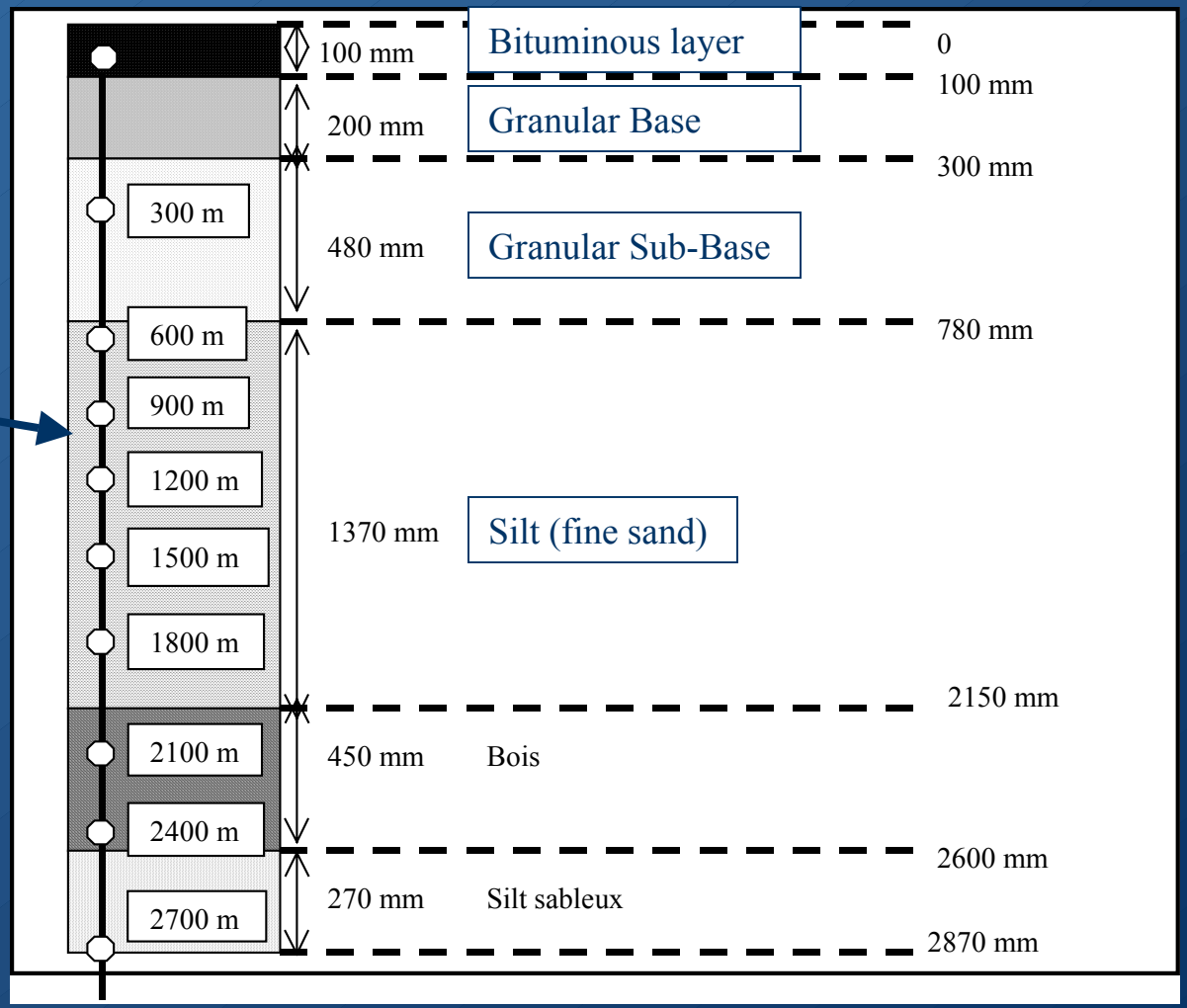
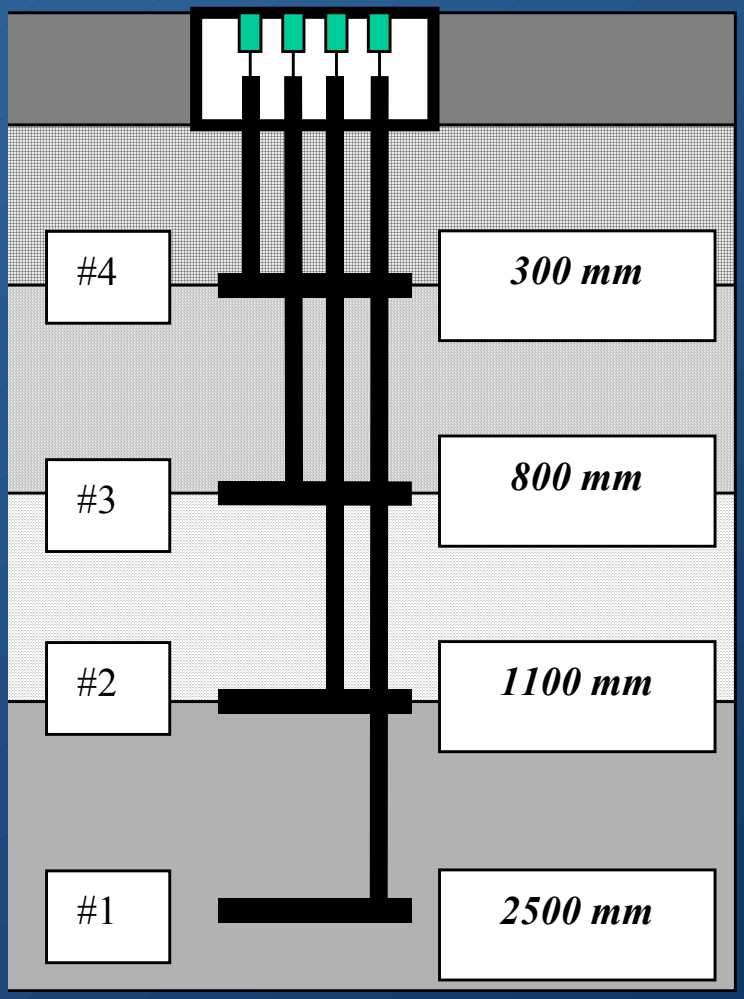
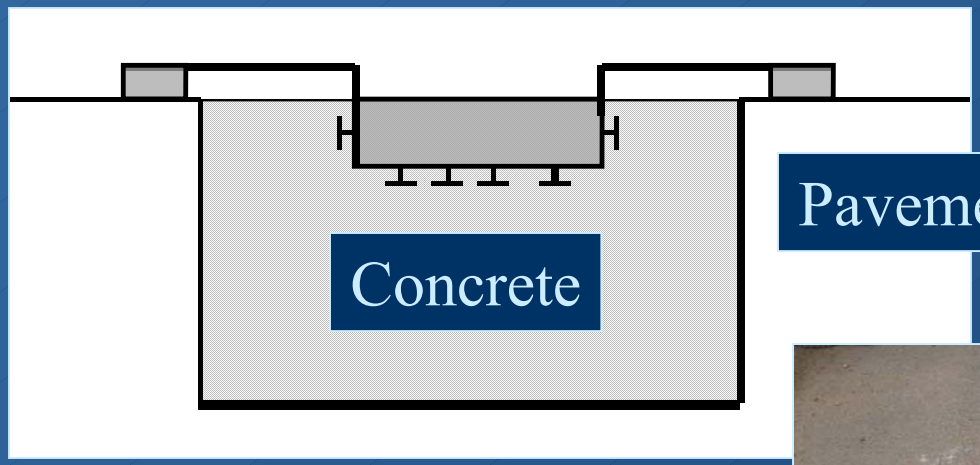
Pavement Structure

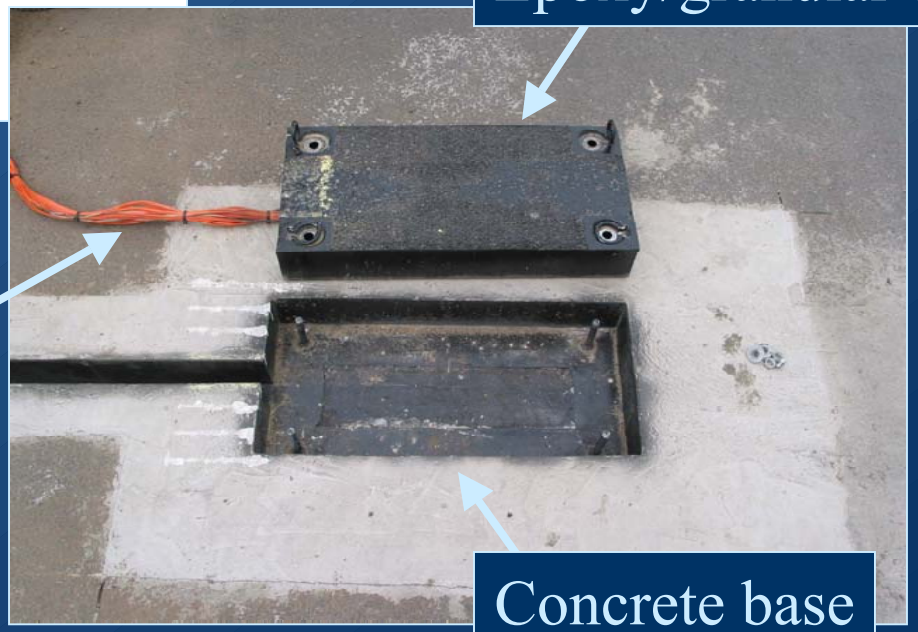


Multi-depth Deflectometer



Vertical strain cell





Tire tested

Truck used for testing

Benkelman beam test

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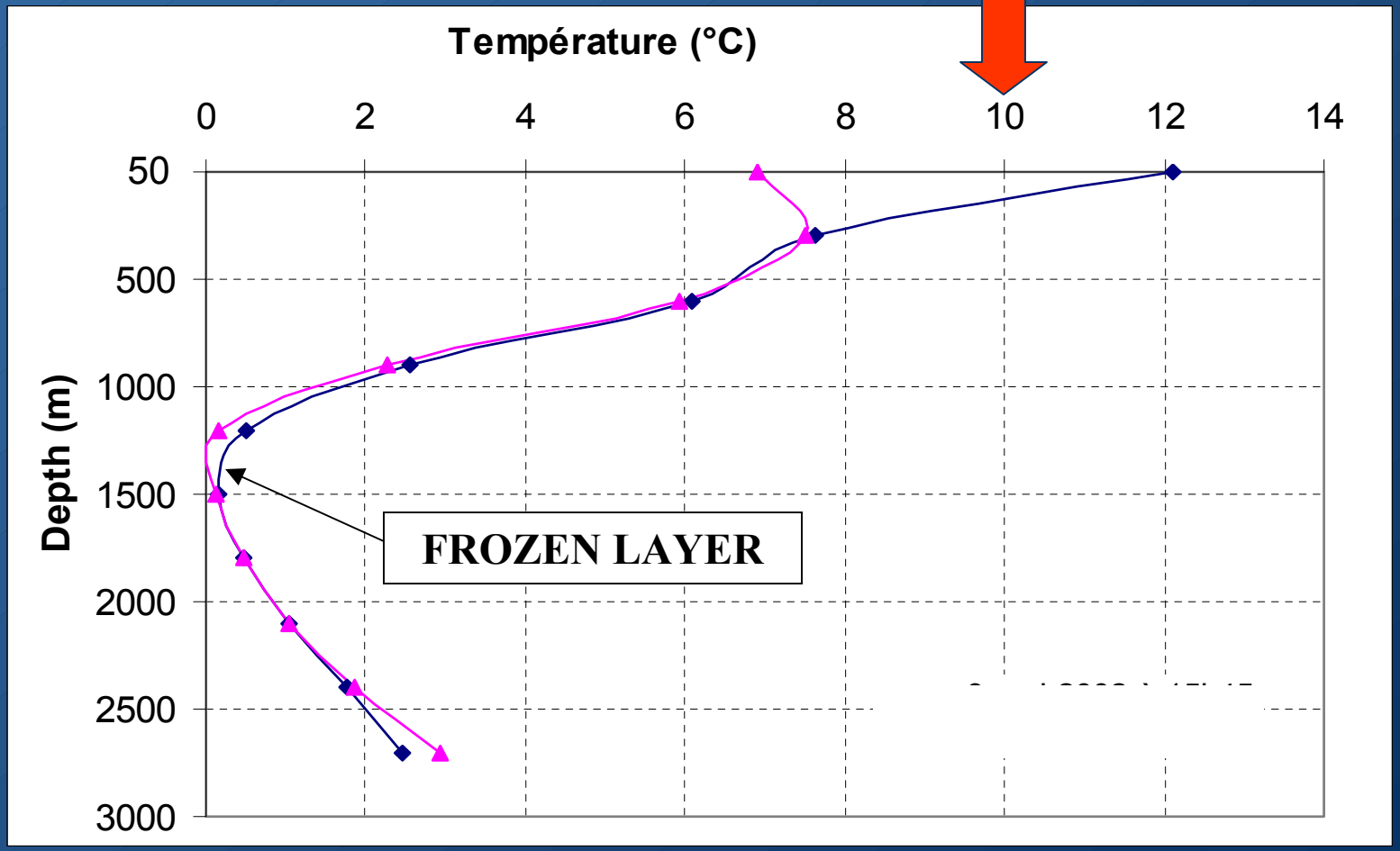
Temperature distribution in pavement (spring)



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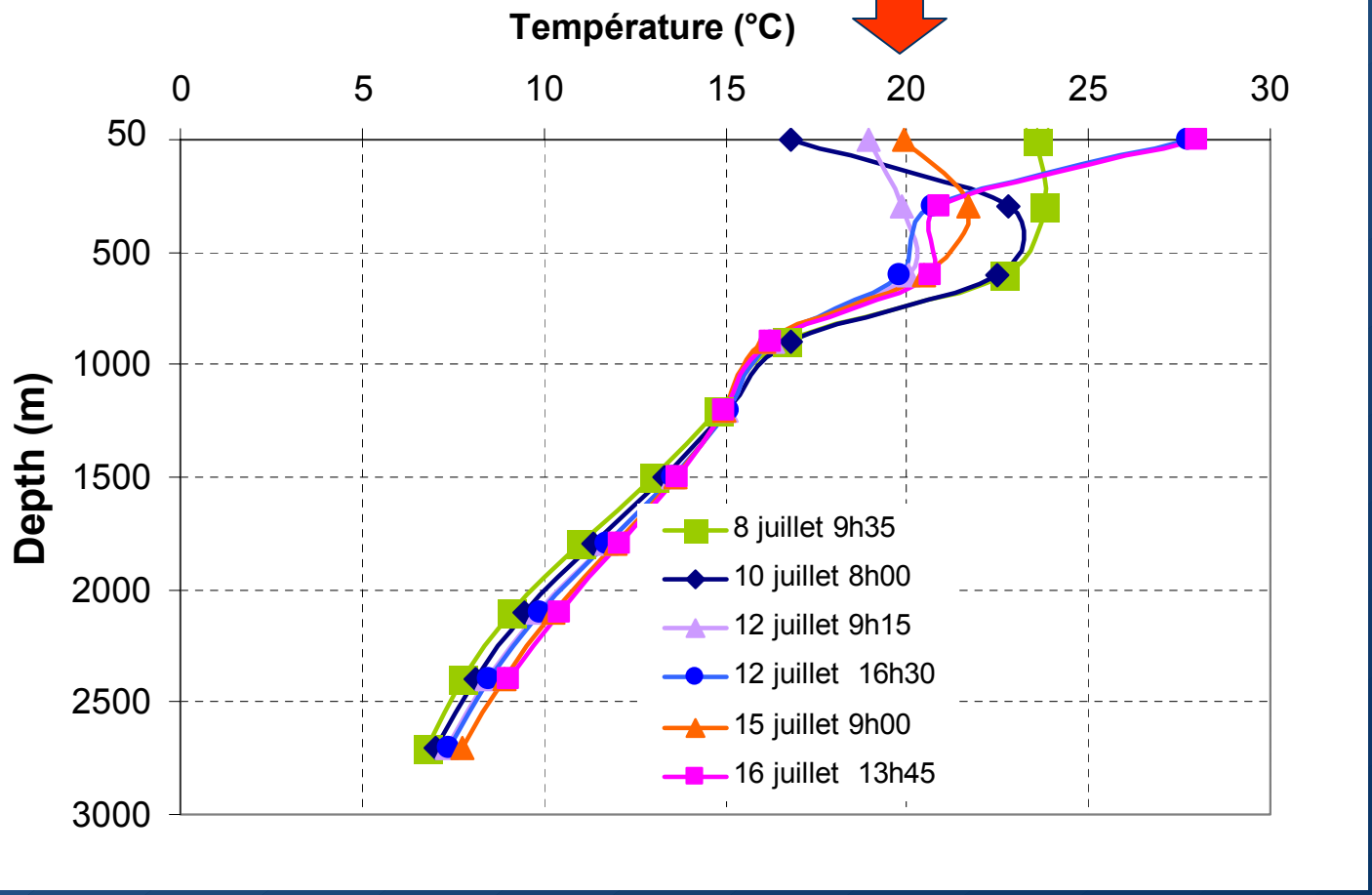
Temperature distribution in pavement (summer)



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Type of Tires : Impact on Pavements

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- Spring: Mai 2002
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4 types of tires tested

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Pavement response Modeling

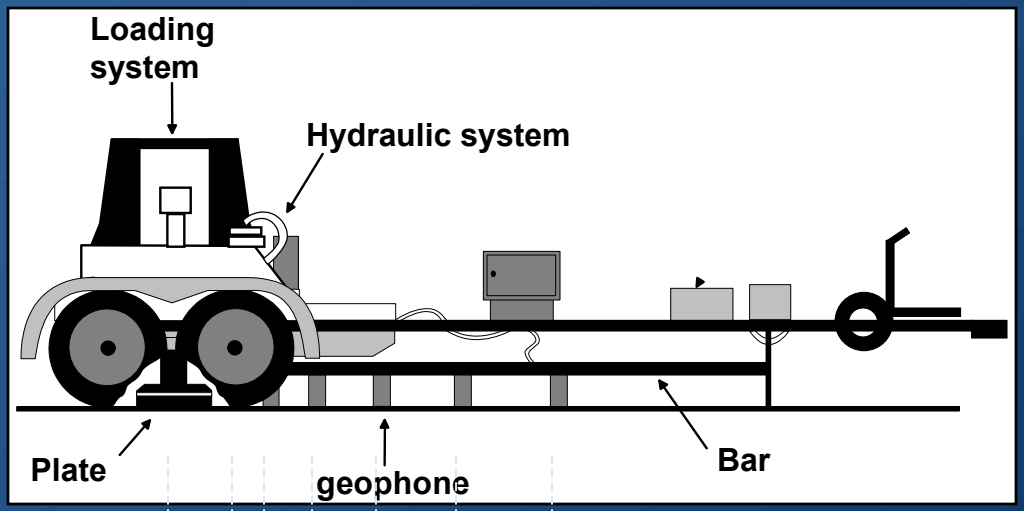
Calculated pavement response

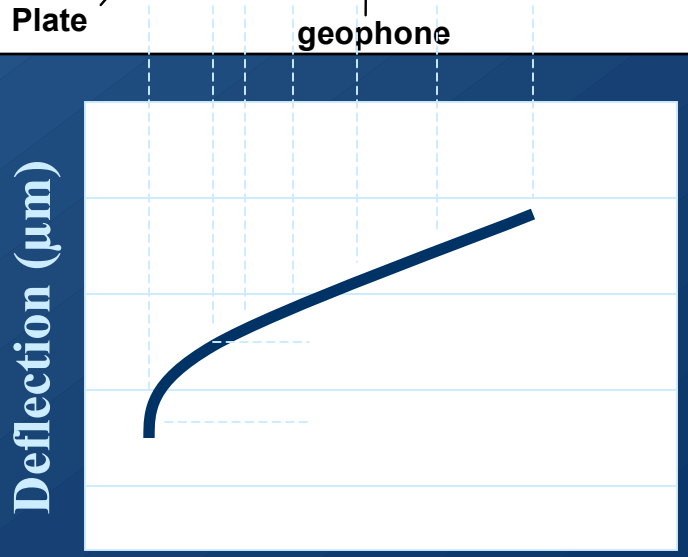
Comparaison with experimental datas

Load limits

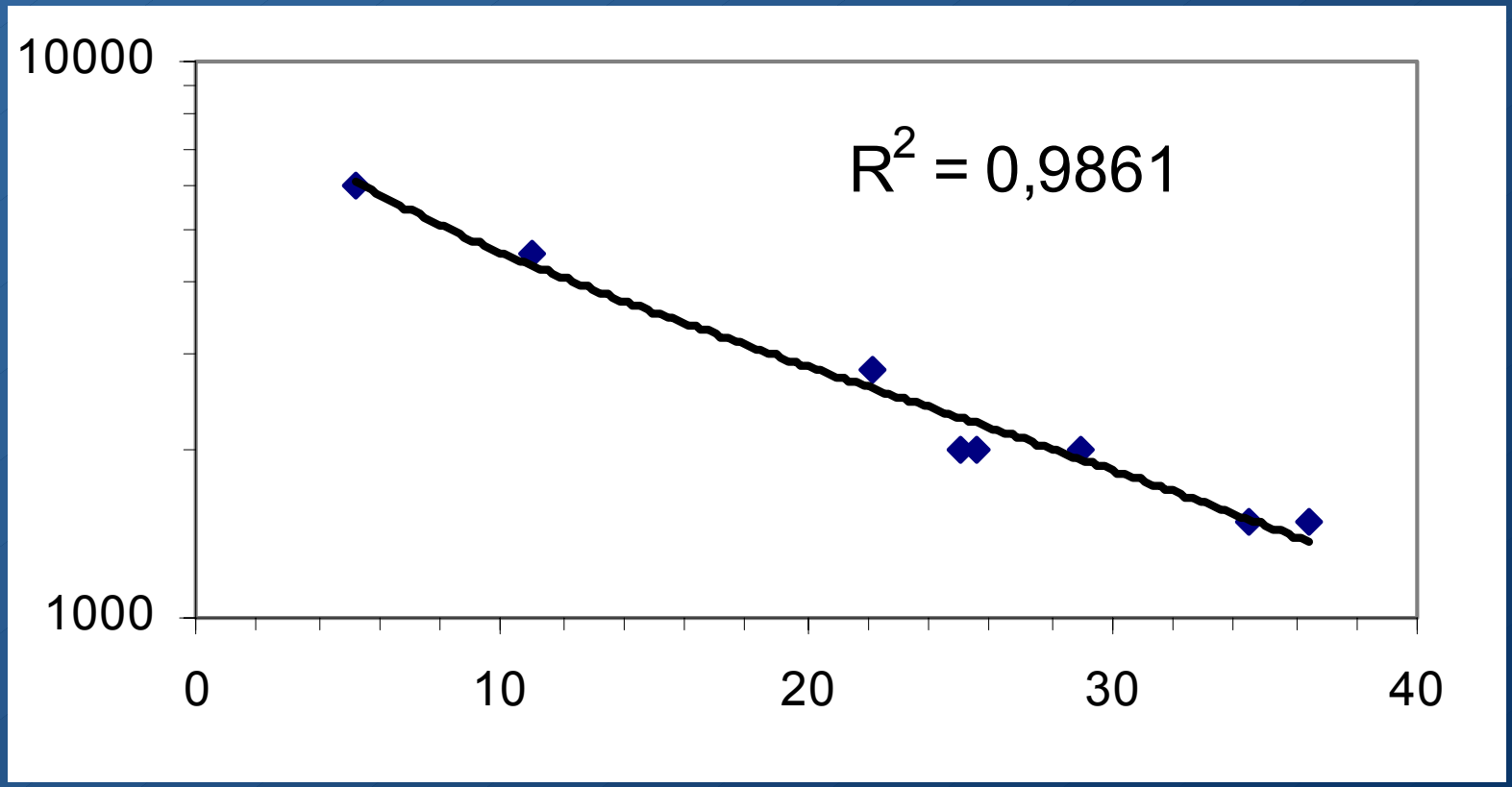
Adapation to road network

FWD deflection

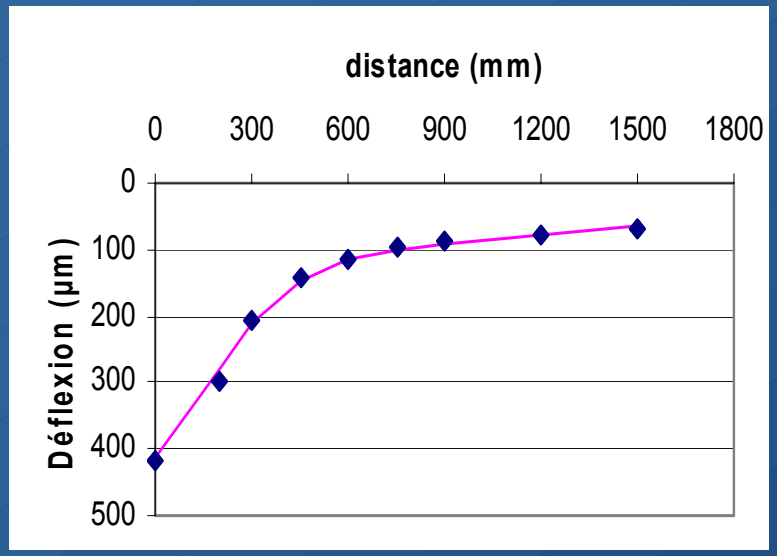


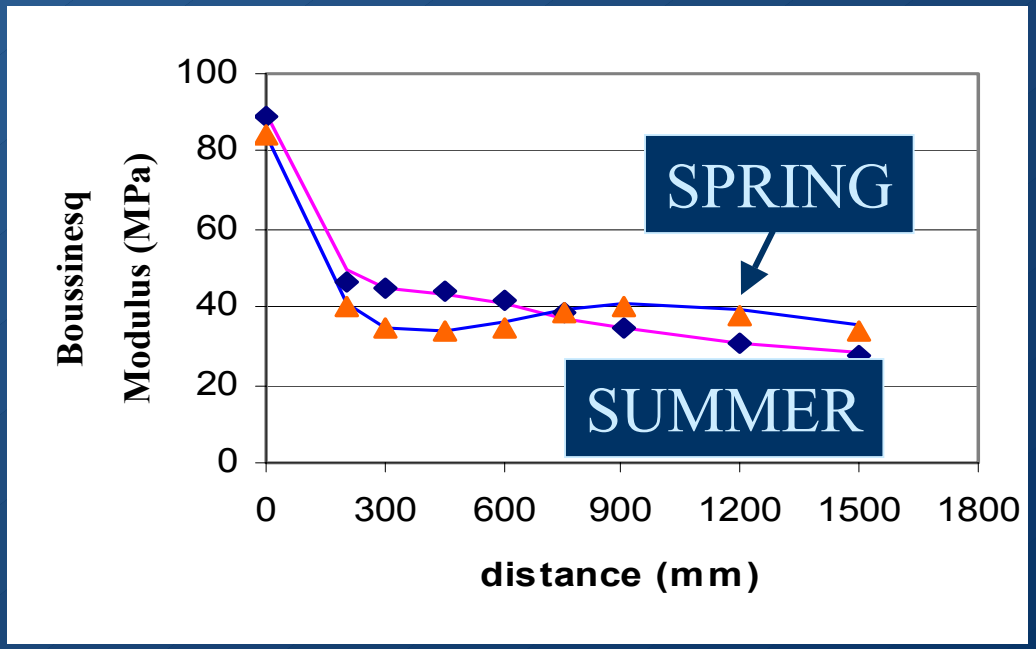


Asphalt Modulus (MPa) vs Temperature (°C)

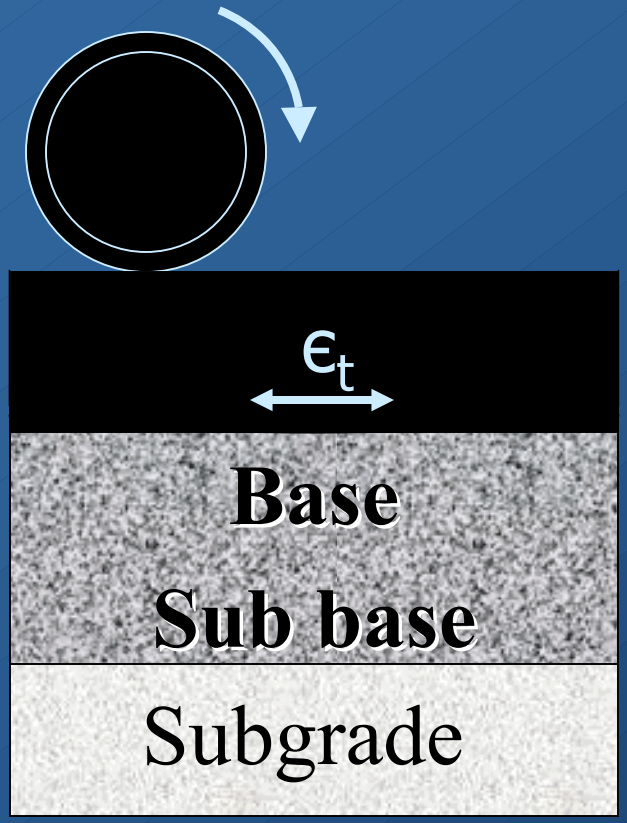


Pavement response Modeling



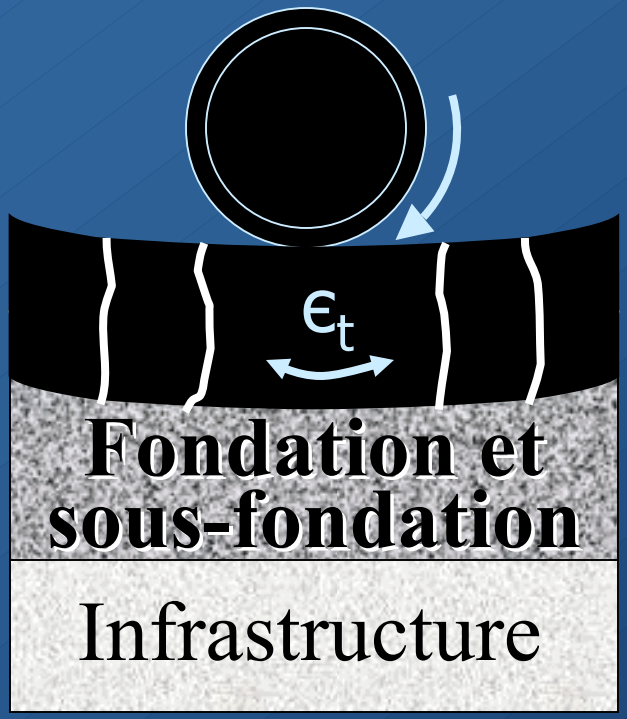


Loaded pavement response



Issue : Calculated the tension strain (ϵ_t) at the bottom of the bituminous layer

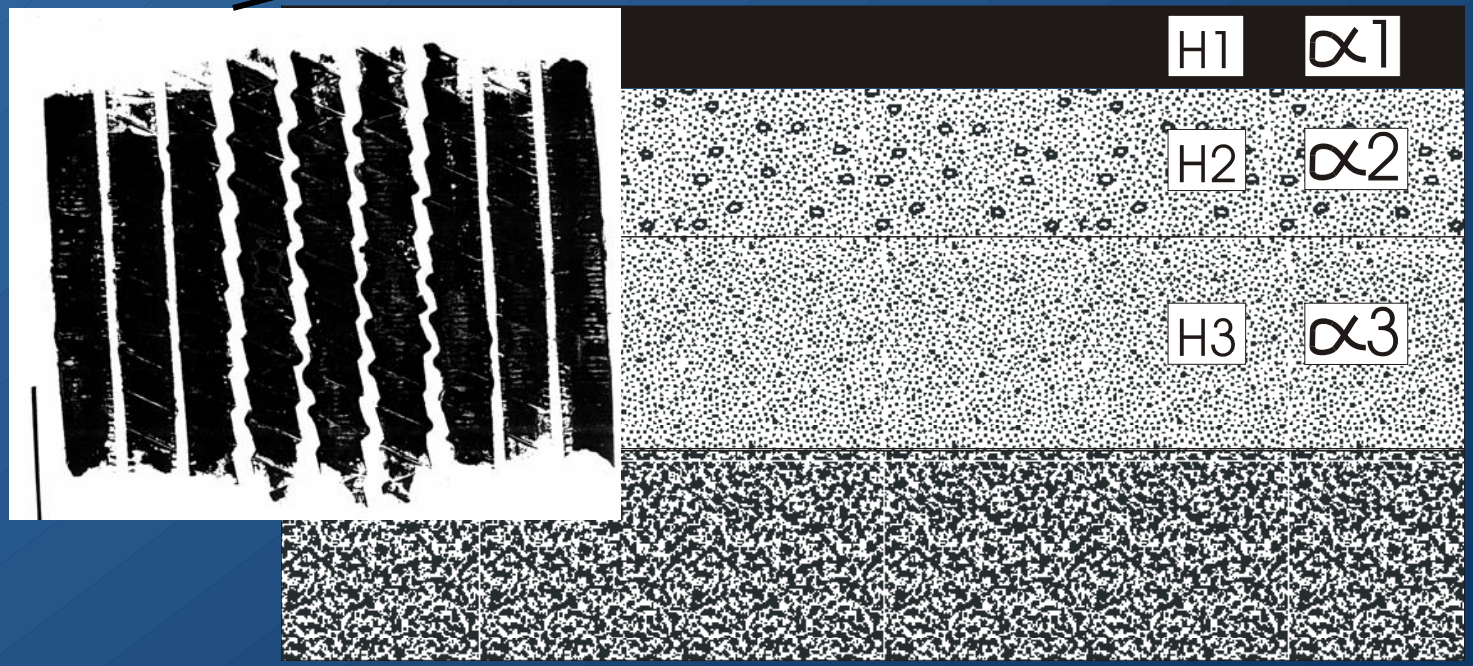
Loaded pavement response



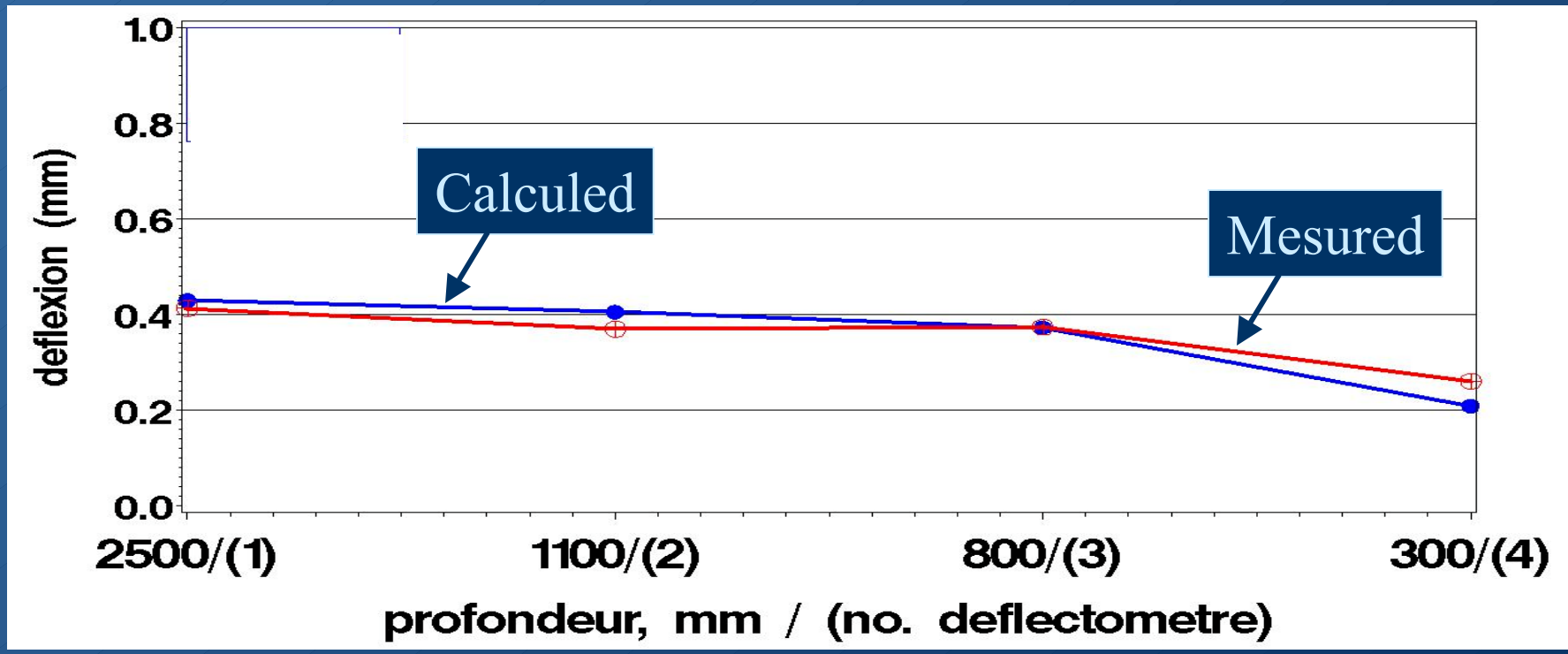
Issue : Calculated the tension strain (ϵ_t) at the bottom of the bituminous layer

WIDE BASE TIRE

DUAL TIRES

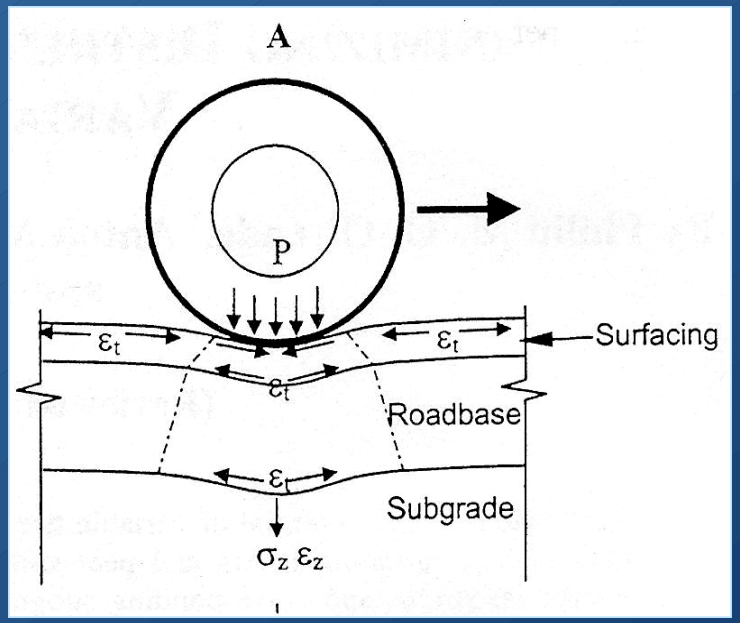


Comparaison of calculated deflection vs mesured



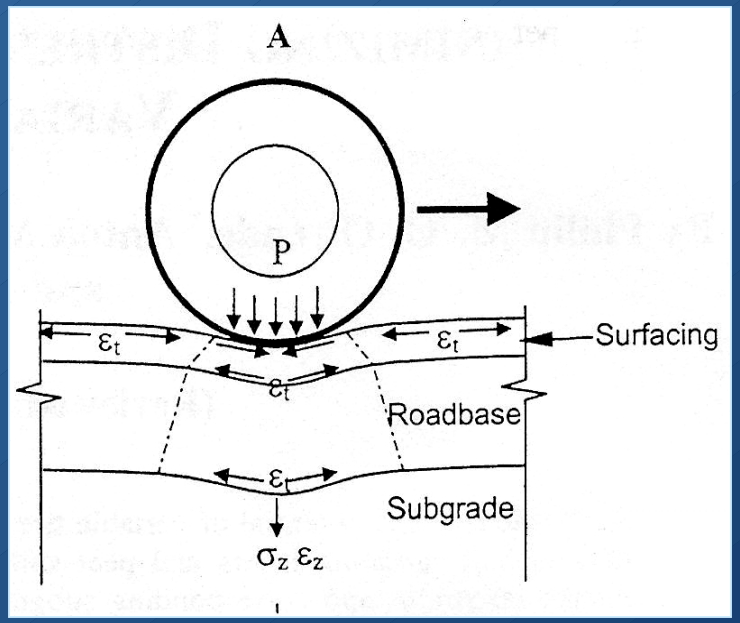
Failure criterion

- Fatigue
  - $N_t = 10^6 \times (\varepsilon_t / K)^{-a}$; K = 240 et a = 3.29 (Asphalte Institue)



Failure criterion

- Rutting in subgrade or base
  - $N_0 = 1.077 \times 10^{18} (\varepsilon_v)^{-4.483}$ (Chevron)



Failure criterion

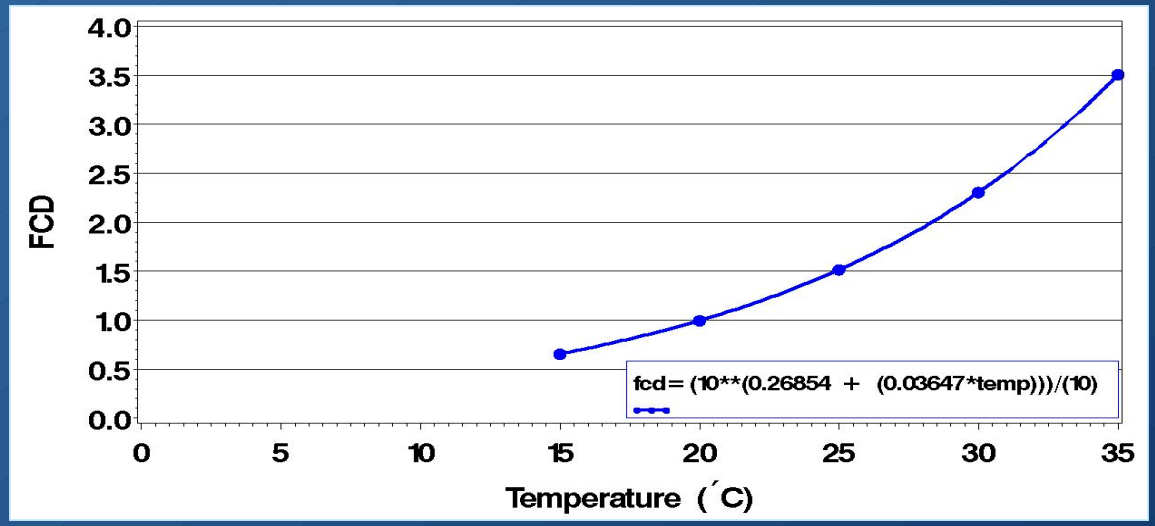
- Flow rutting
  - $\log(\varepsilon_p / \varepsilon_r) = -3.74938 + 0.4262 \log(N_o) + 2.02755 \log(T)$ (AASHTO 2002)

ESAL

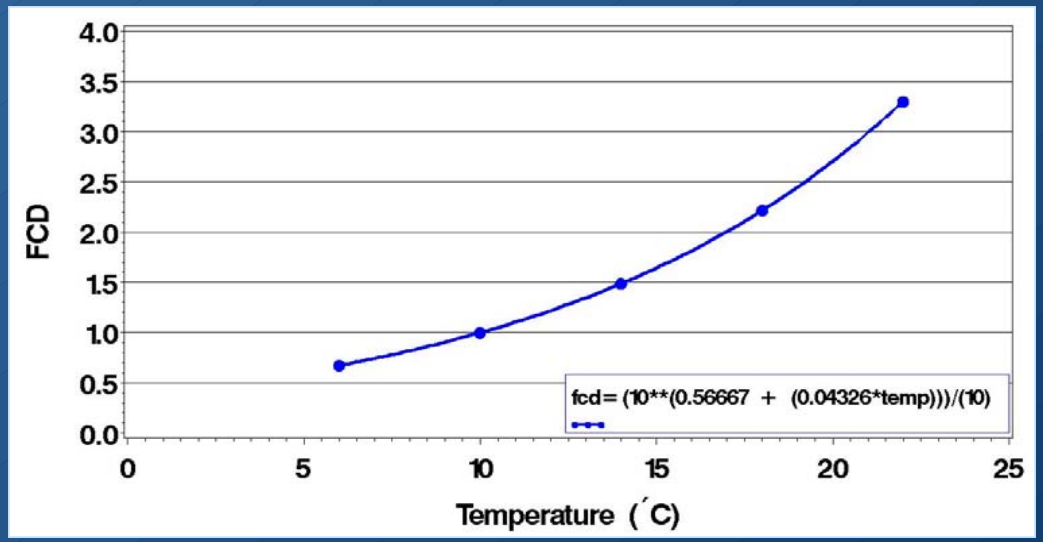
- Ratio between the pavement dammage cause by a specific load and a reference load.
  - **ESALt = Nr / Nt**
- Normalized ESAL with reference temperature
  - **ESALt = FCD × ECAStr**

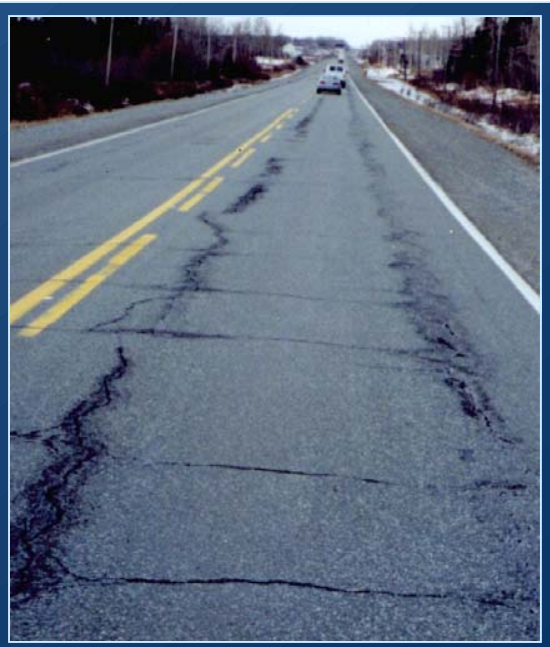
Fatigue dammage correction factor FCD

Summer



Spring





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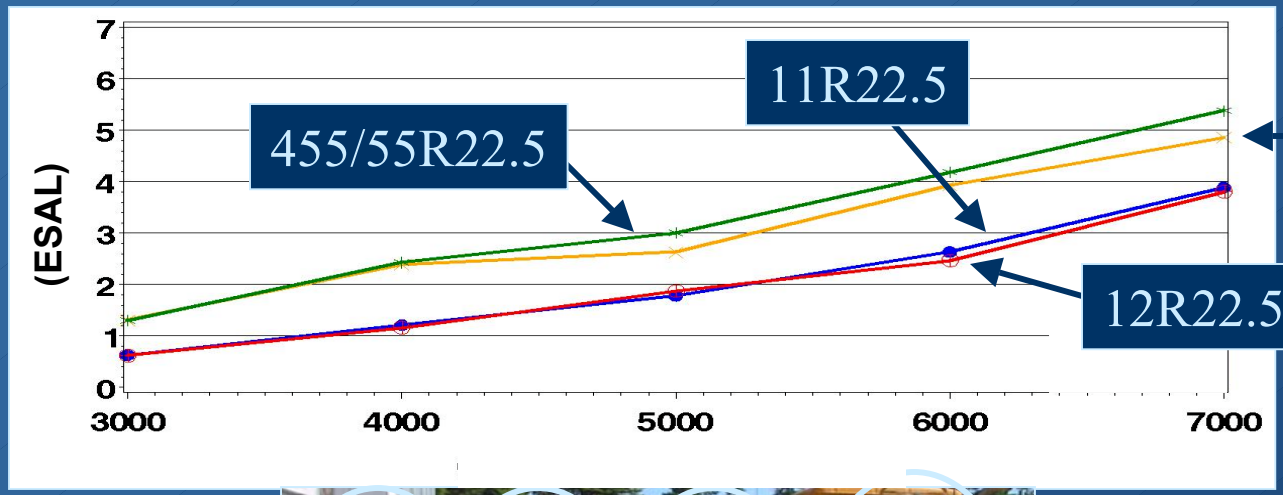
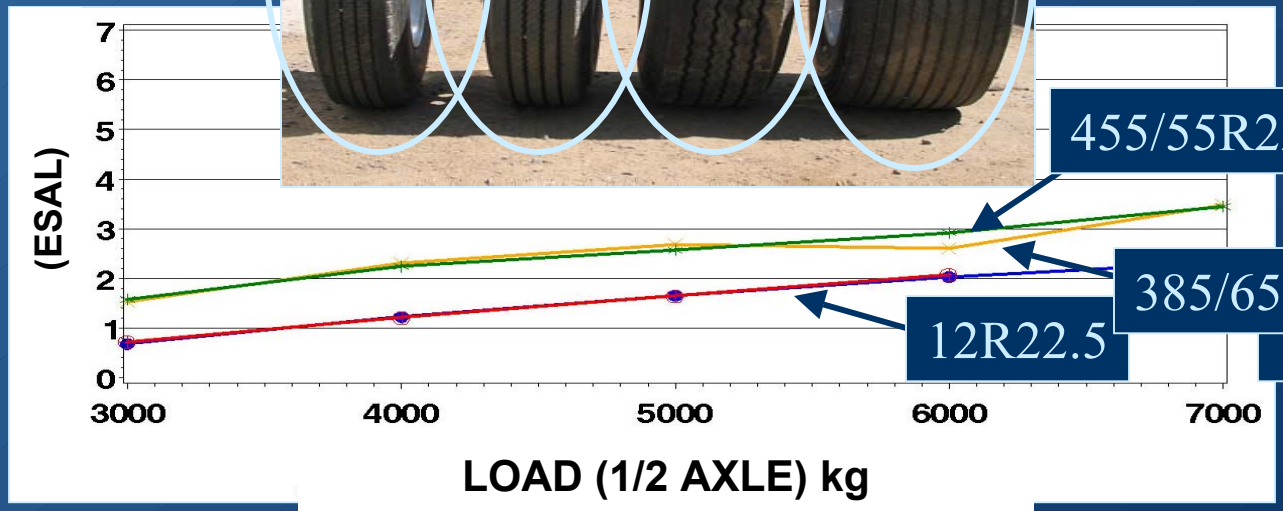
Spring



ESAL (fatigue)

Summer



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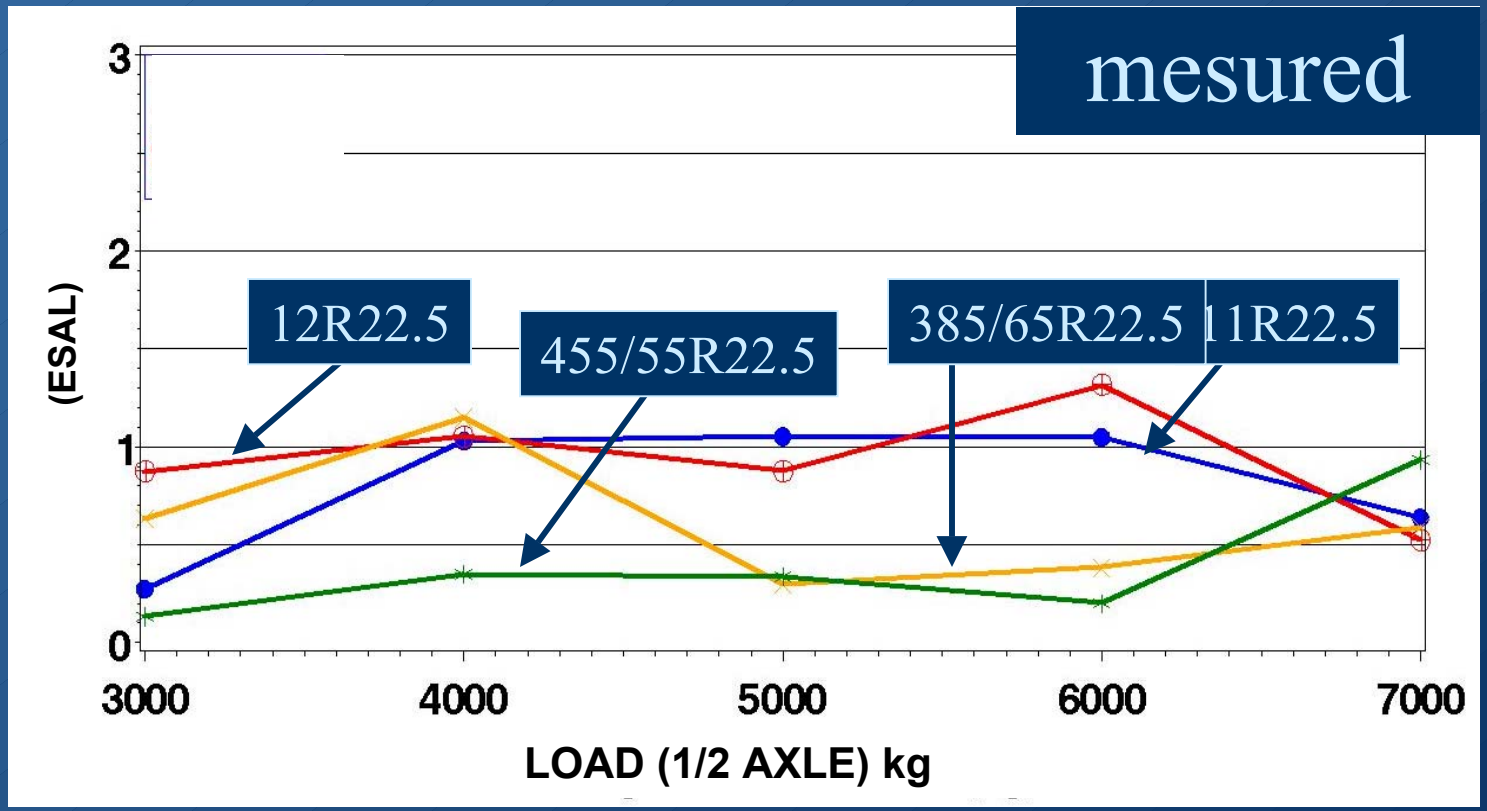
ESAL (flow rutting)

Summer

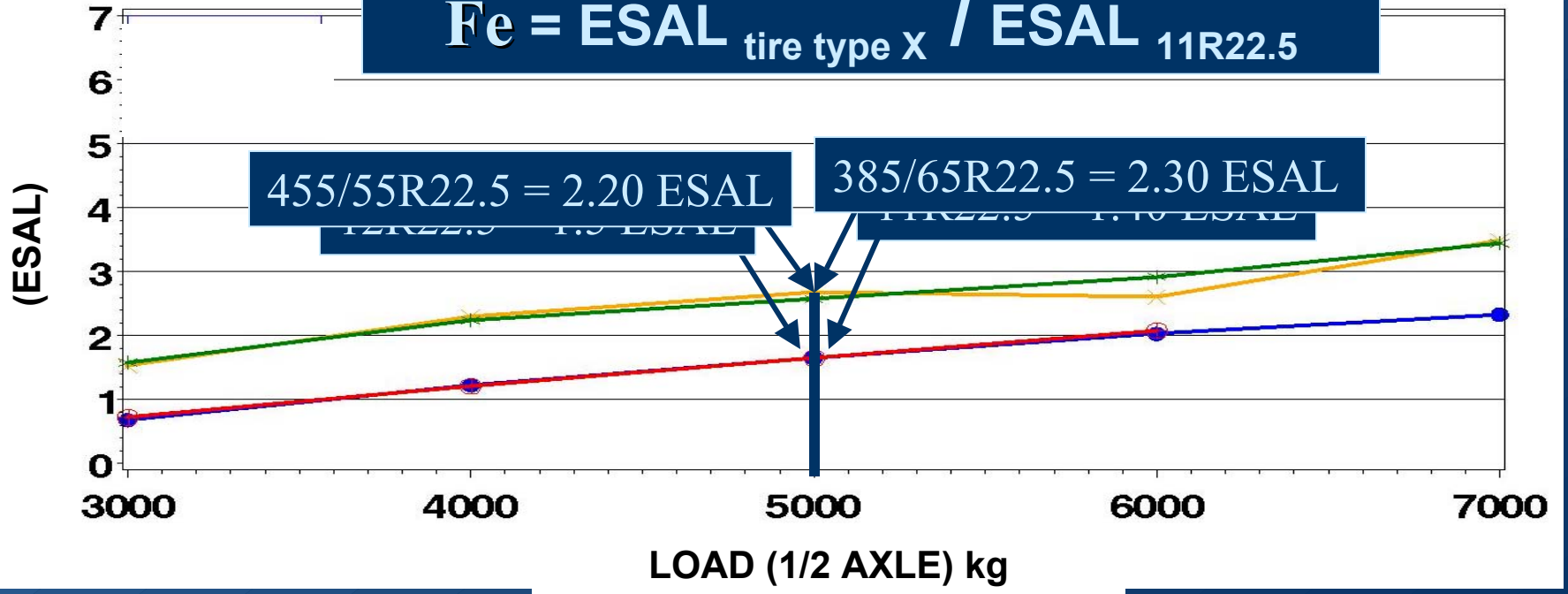


Combine « ESAL »

- Combine effect of two types of failure
  - Fatigue and flow rutting
    - Spring
    - Summer
  - Fatigue and Rutting in subgrade or base
    - Spring
    - Summer

Combine « ESAL »
(Fatigue and flow rutting)

Fe = ESAL $_{\text{tire type X}}$ / ESAL $_{\text{11R22.5}}$



Load limits

Single
10 000 kg

Tandem
1.6 * 10 000 kg

Tridem
2.13 * 10 000 kg

Load limits (Summer)

- Exemple - Single axial
  - Pneu 11R22.5 P_{limite} = 10 000 kg (Fe=1.00)
  - Pneu 12 R22.5 P_{limite} = 10 000 kg (Fe=1.00)
  - Pneu 385/65R22.5 P_{limite} = 8 400 kg (Fe=1.80)
  - Pneu 455/55R22.5 P_{limite} = 8 400 kg (Fe=1.80)

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Load limits (Spring)

- Exemple - Single axial
  - Pneu 11R22.5 P_{limite} = 8 000 kg (Fe=1.00)
  - Pneu 12 R22.5 P_{limite} = 8 000 kg (Fe=1.00)
  - Pneu 385/65R22.5 P_{limite} = 6 700 kg (Fe=1.80)
  - Pneu 455/55R22.5 P_{limite} = 6 700 kg (Fe=1.80)

Conclusion

- With the same load, Wide-base tire cause more pavement dammage than a standard dual tires
- Fatigue of bituminous layer is the critical « failure criterion »
- The axle load limit must be reduce by 16% for a wide-base tire

Further works

- Perform a road network analysis; Evaluation of **Fe** factor for differents types of roads.
- Révision of the load limits regulation according to the benefits for the transportation industry

Further works

- Complete a data analysis from SERUL experimental study to learn more about the "tire-pavement" interface impact


Québec
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