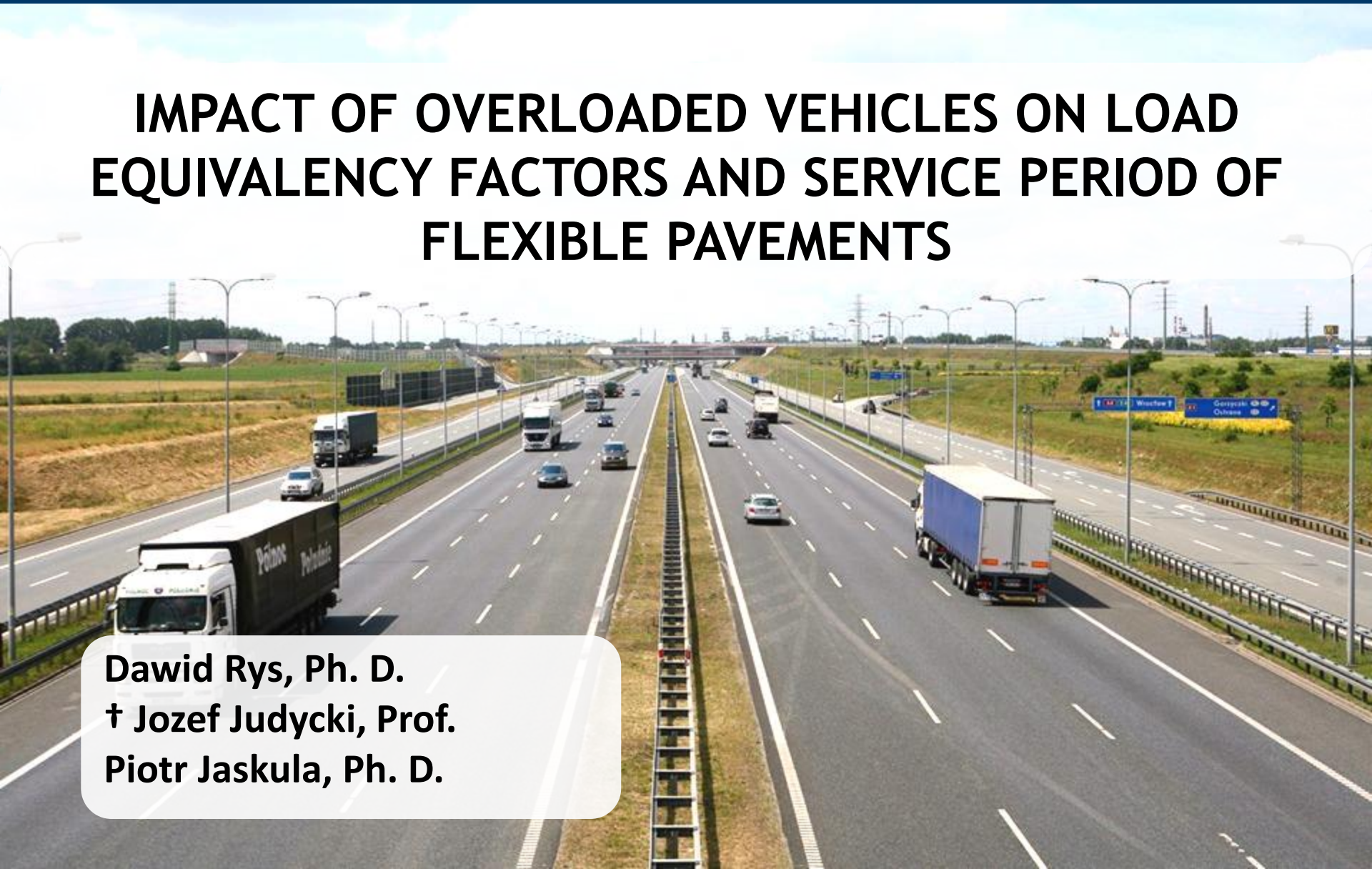
GDAŃSK UNIVERSITY OF TECHNOLOGY
Faculty of Civil and Environmental Engineering
Department of Highway Engineering

IMPACT OF OVERLOADED VEHICLES ON LOAD EQUIVALENCY FACTORS AND SERVICE PERIOD OF FLEXIBLE PAVEMENTS



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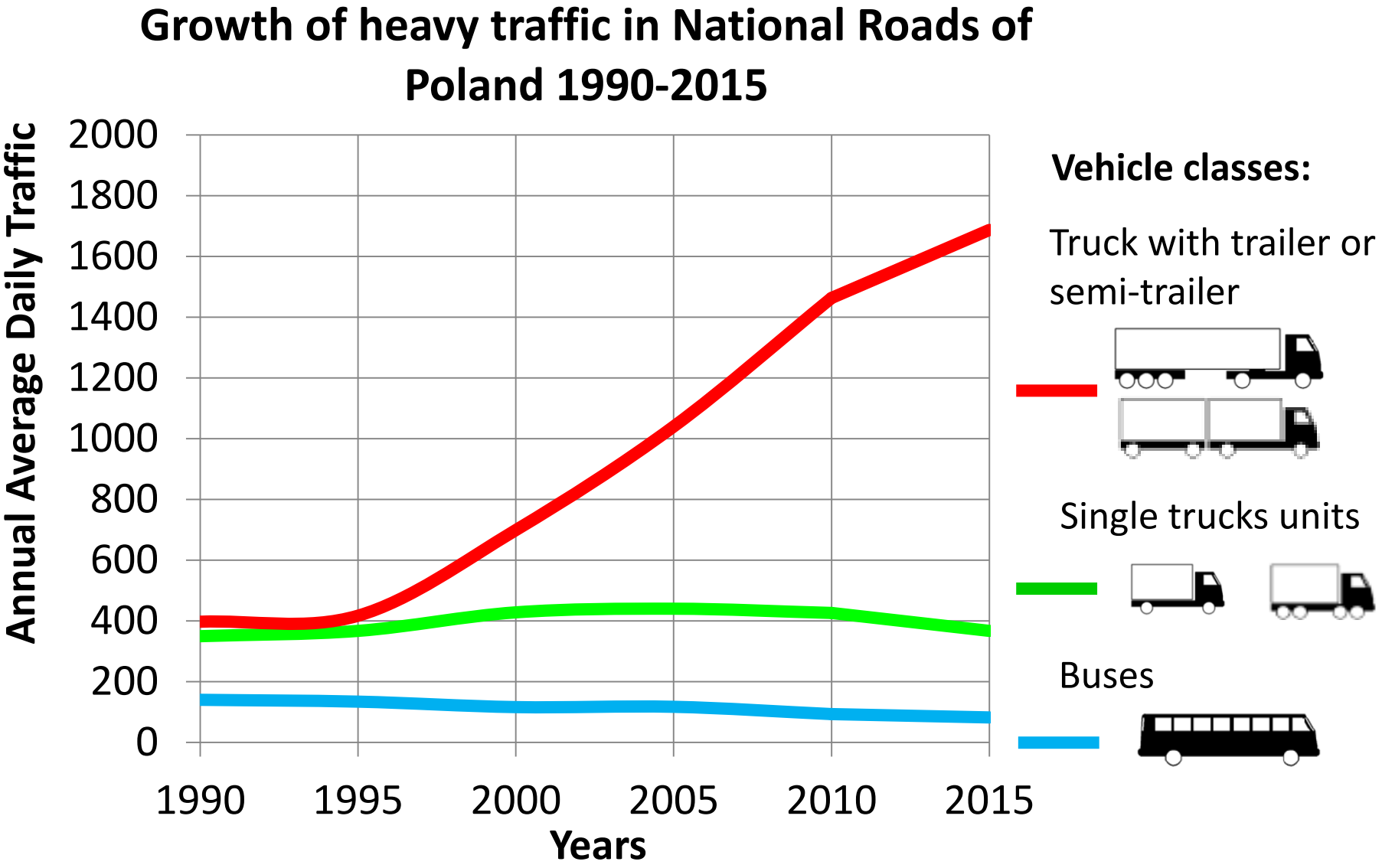
Background of research



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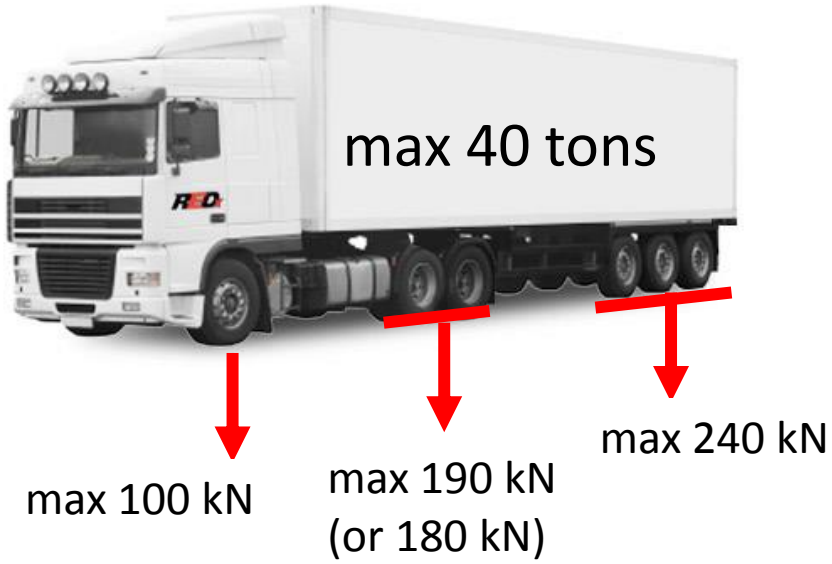
Problem of overloaded vehicles

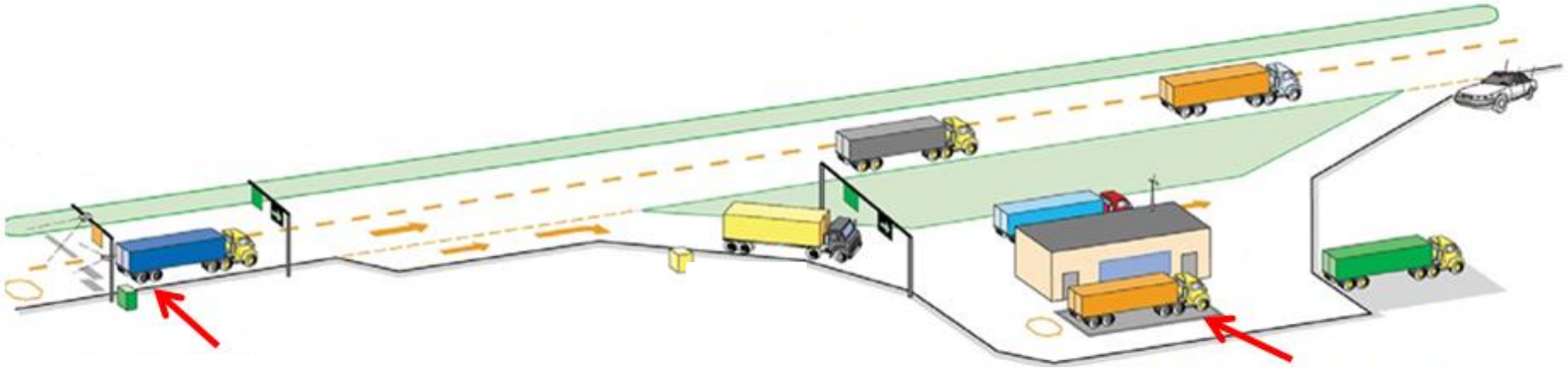
- There are set legal limitations of gross weigh and axle loads of vehicles
- Some vehicles exceed this legal limits
- Overloaded vehicles have much higher detrimental effects on pavement structure than properly loaded vehicles



System of weigh in motion (WIM)

Weigh in motion station

Control on static weight



Weighing of all vehicles
Preselecting
Providing the statistical data

Weighing of preselected vehicles on static, legal weights.
Imposition of punishment

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Data delivered from weigh in motion

Data include:

- gross weight
- axle loads
- distance between axles
- speed
- vehicles class

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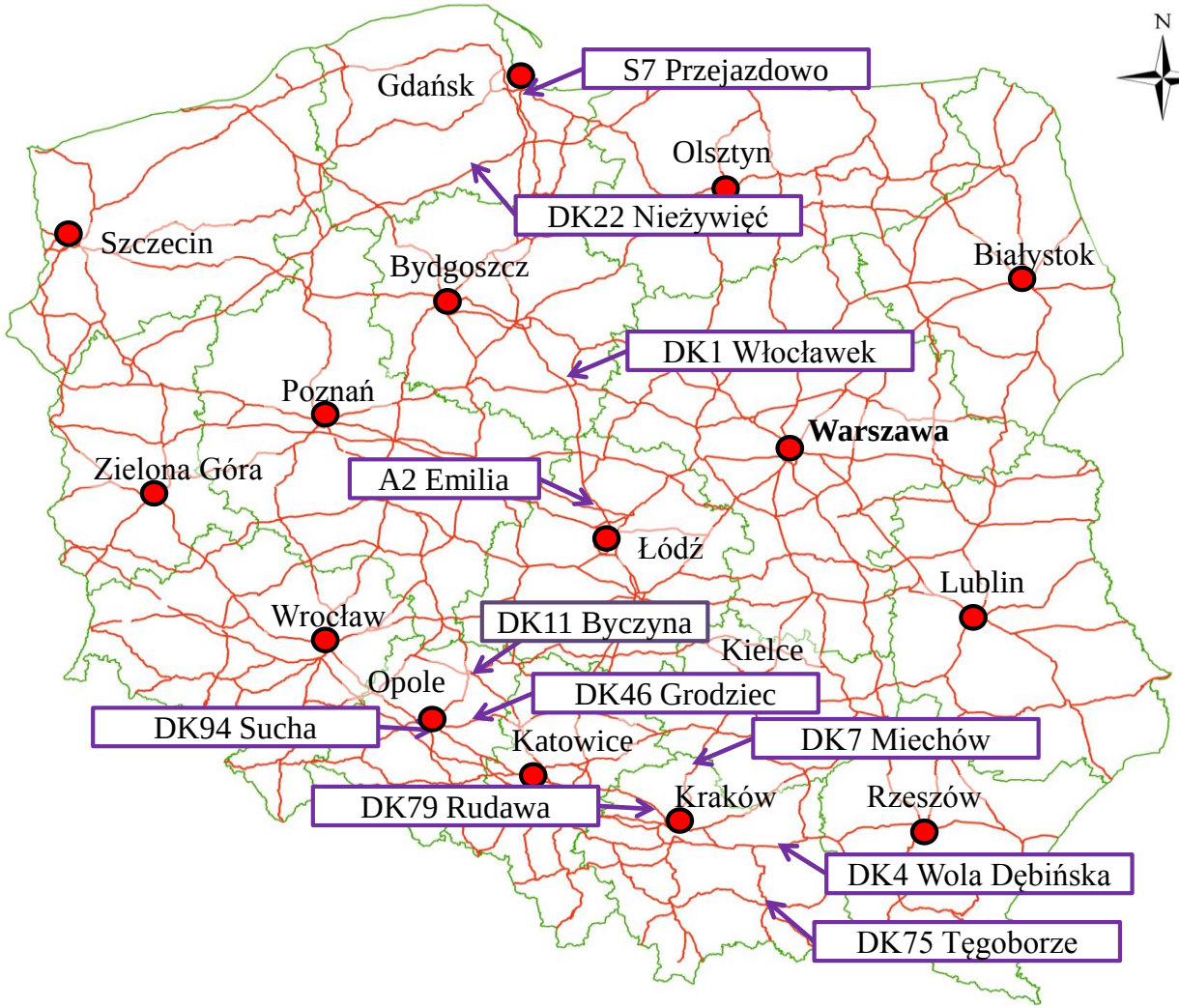
Data used in the analysis



10 WIM stations

Measurement period from 1 to 6 whole years

More than 12 millions heavy vehicles after data validation

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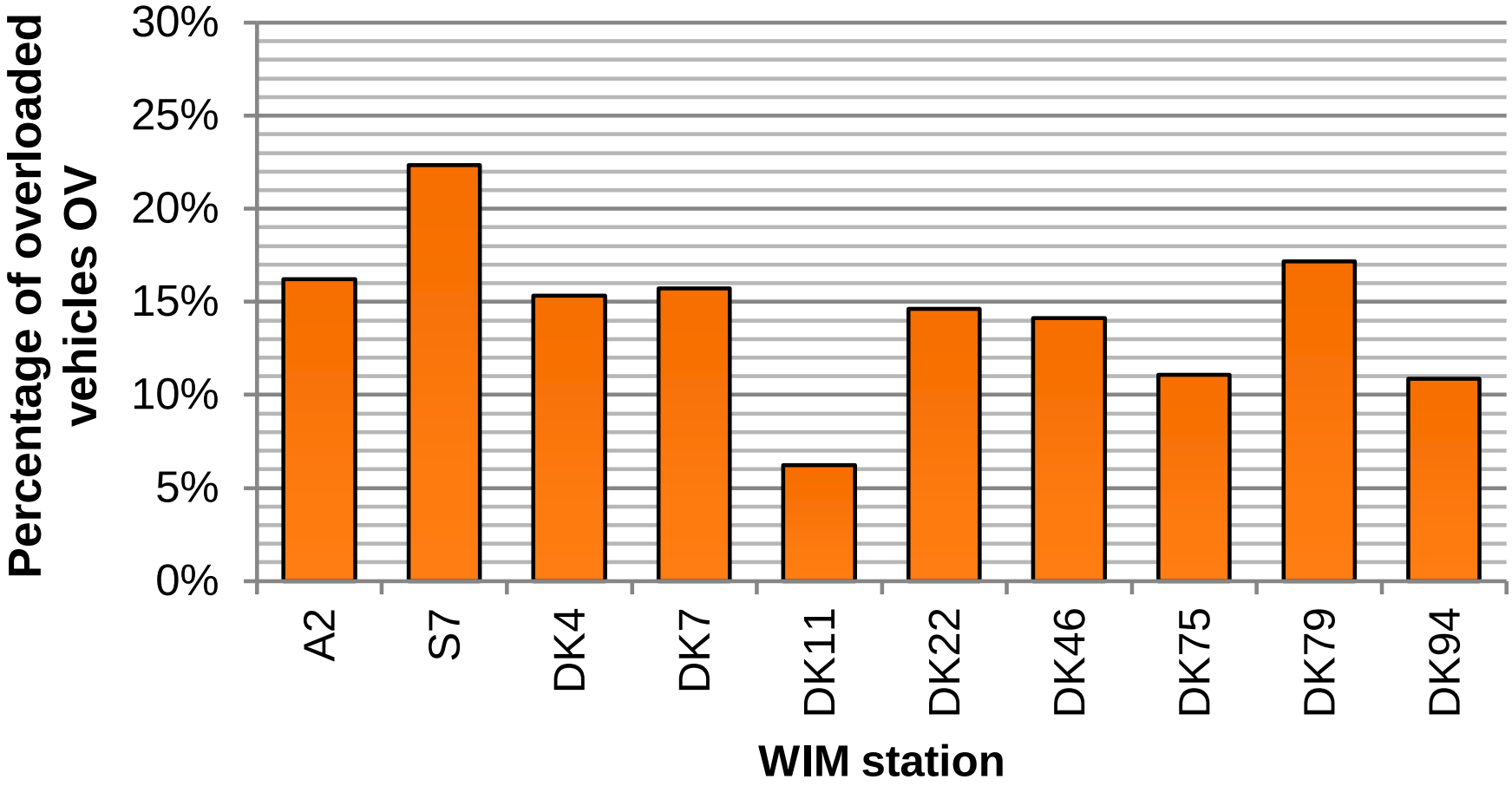
Average percentage of overloaded vehicles – different stations



$$\boldsymbol{OV} = \frac{Number\ of\ overloaded\ vehicles}{Total\ number\ of\ trucks}\ [\%]$$

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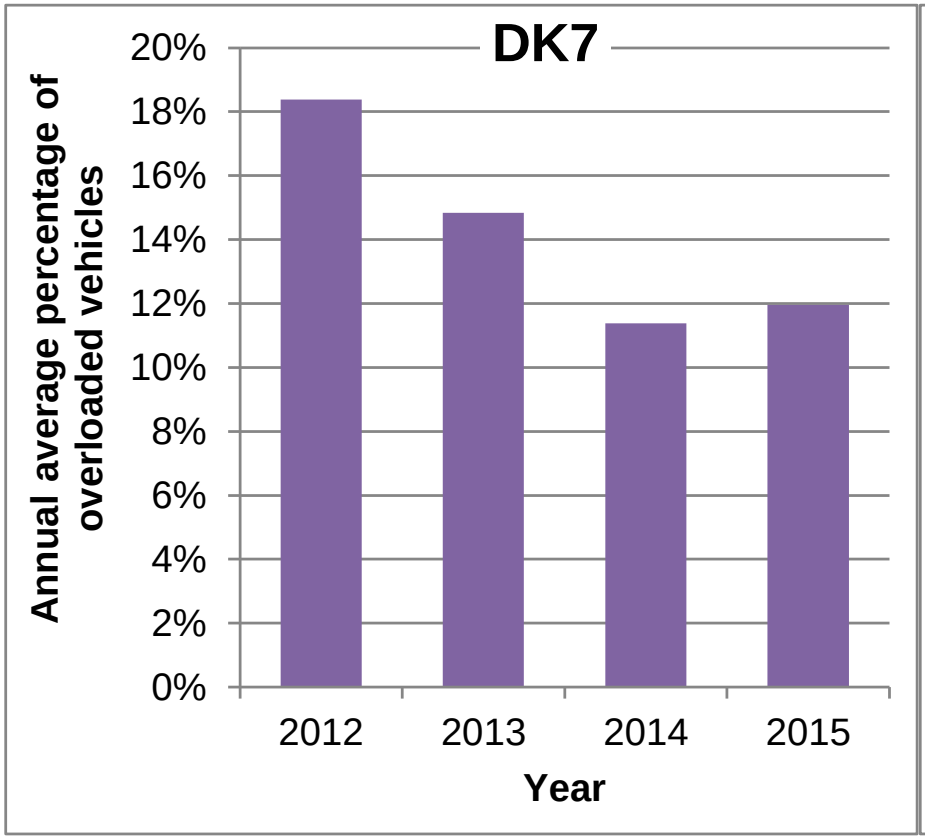
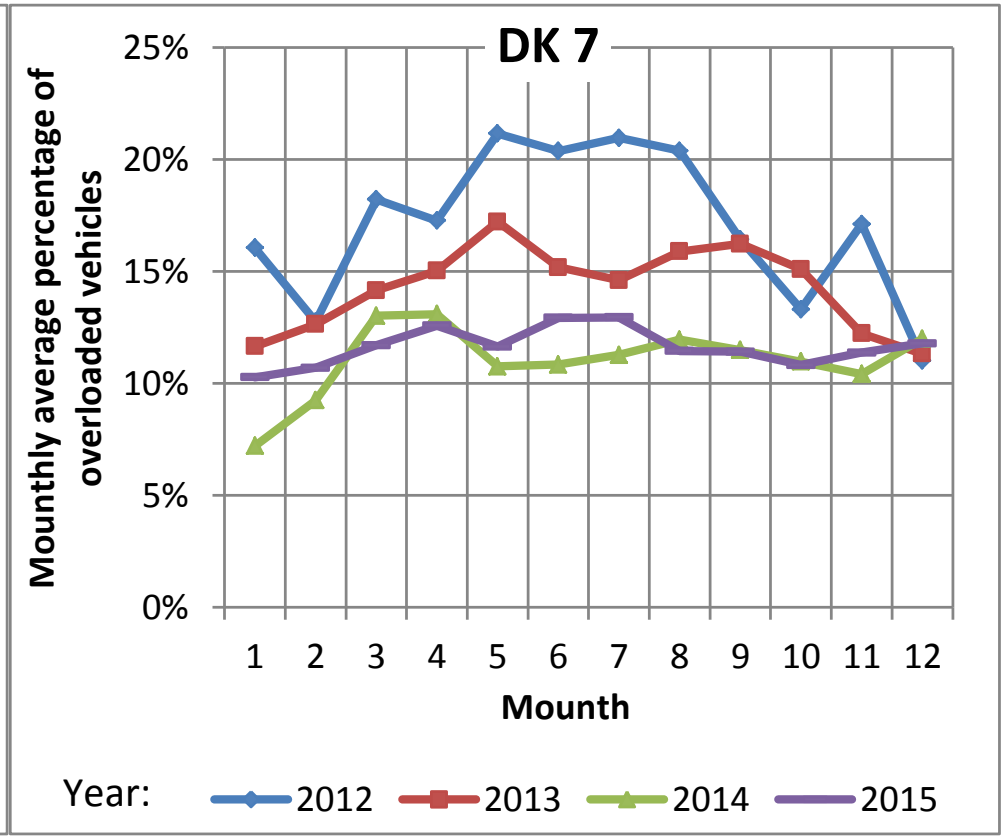
Variations in the percentage of overloaded vehicles – an example





Intensivity of vehicle overloading can be reduced by improving enforcement

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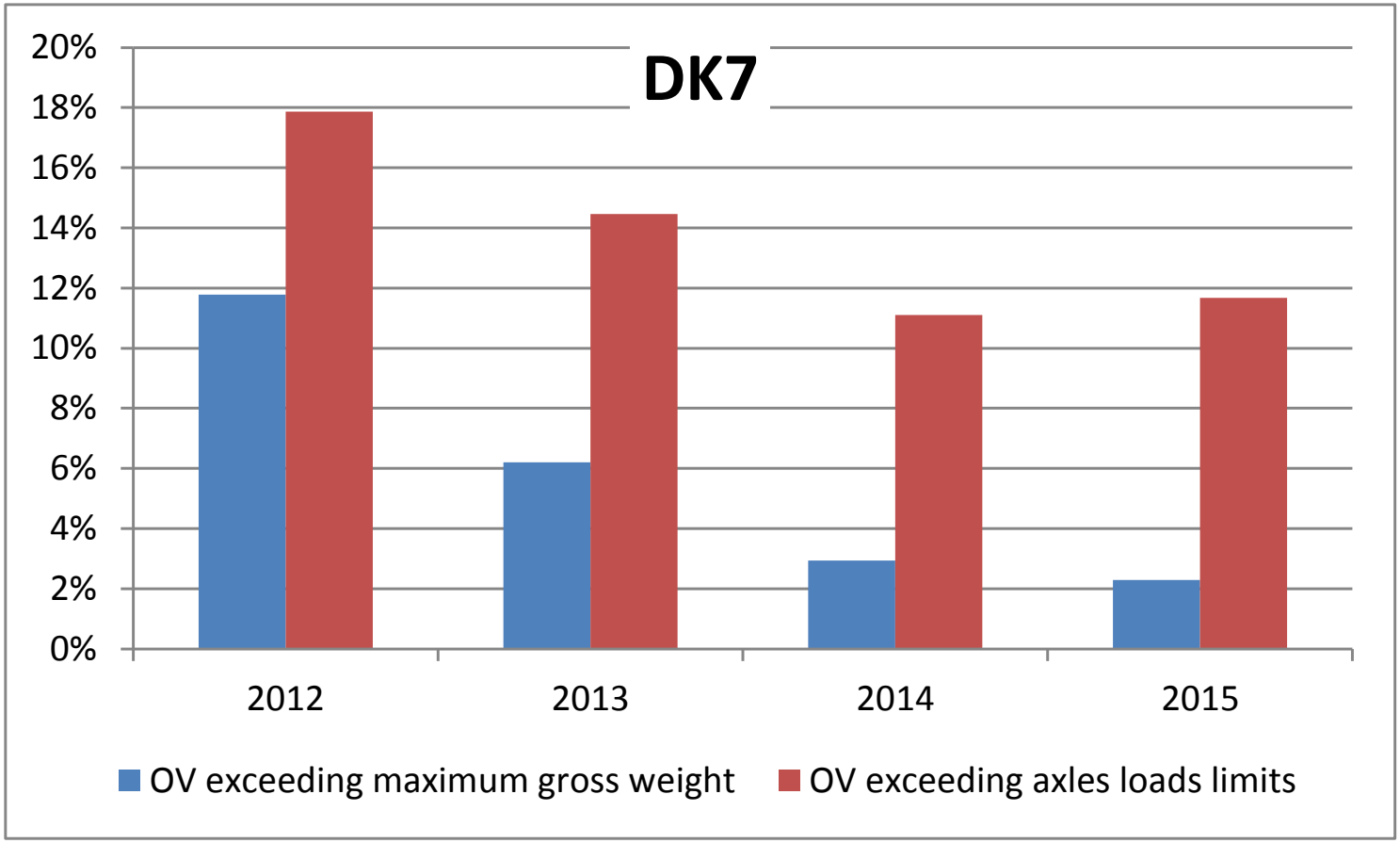
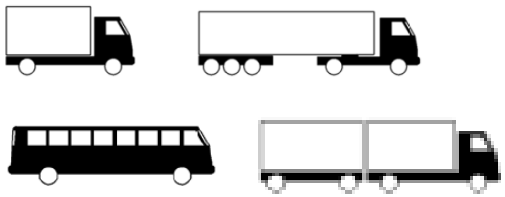
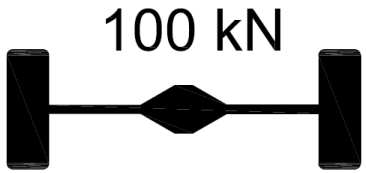
Structure of vehicles overloading



- **Lot of vehicles exceed axle loads limits despite having proper gross weight**
- **Result of wrong charge distribution**

Load equivalency factors





Number of trucks or axles x Load equivalency factors F_j = Number of equivalent standard axle loads

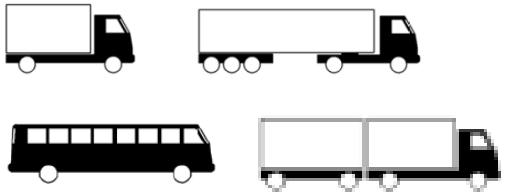
- Fourth power equation – general level

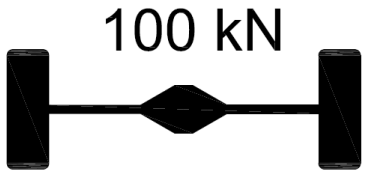
$$F_j = \left(\frac{Q_j}{Q_s} \right)^4$$

Q_j – *actual axle load*

Q_s – *standard axle load*

Load equivalency factors





Number of trucks or axles x Load equivalency factors F_j = Number of equivalent standard axle loads

- Mechanistic-empirical approach – site specific level

$$F_j = \frac{d_j}{d_s}$$

d_j – fatigue damage caused by actual axle load Q_j

d_s – fatigue damage caused by standard axle load Q_s

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Truck factors

- Truck factor characterize detrimental effect of particular vehicles on pavement structure

$$TF_v = \sum_{j=1}^{n} F_j$$

- Calculated separately for each vehicle (more than 12 million vehicles included)

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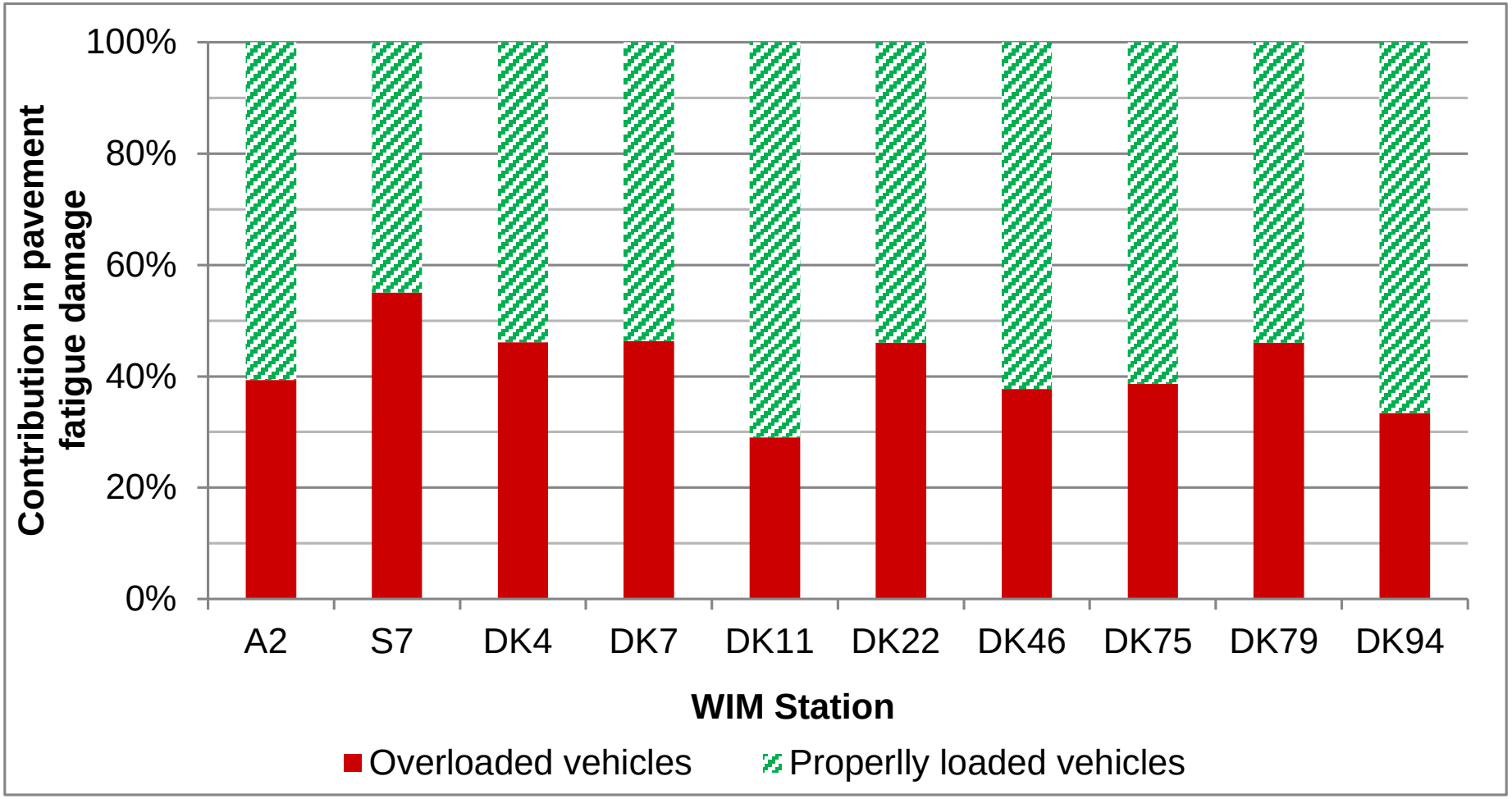
The contribution of overloaded vehicles in the fatigue damage of pavement structure



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GOAL

How the reduction of overloaded vehicles will contribute to increase of service period of pavement structure

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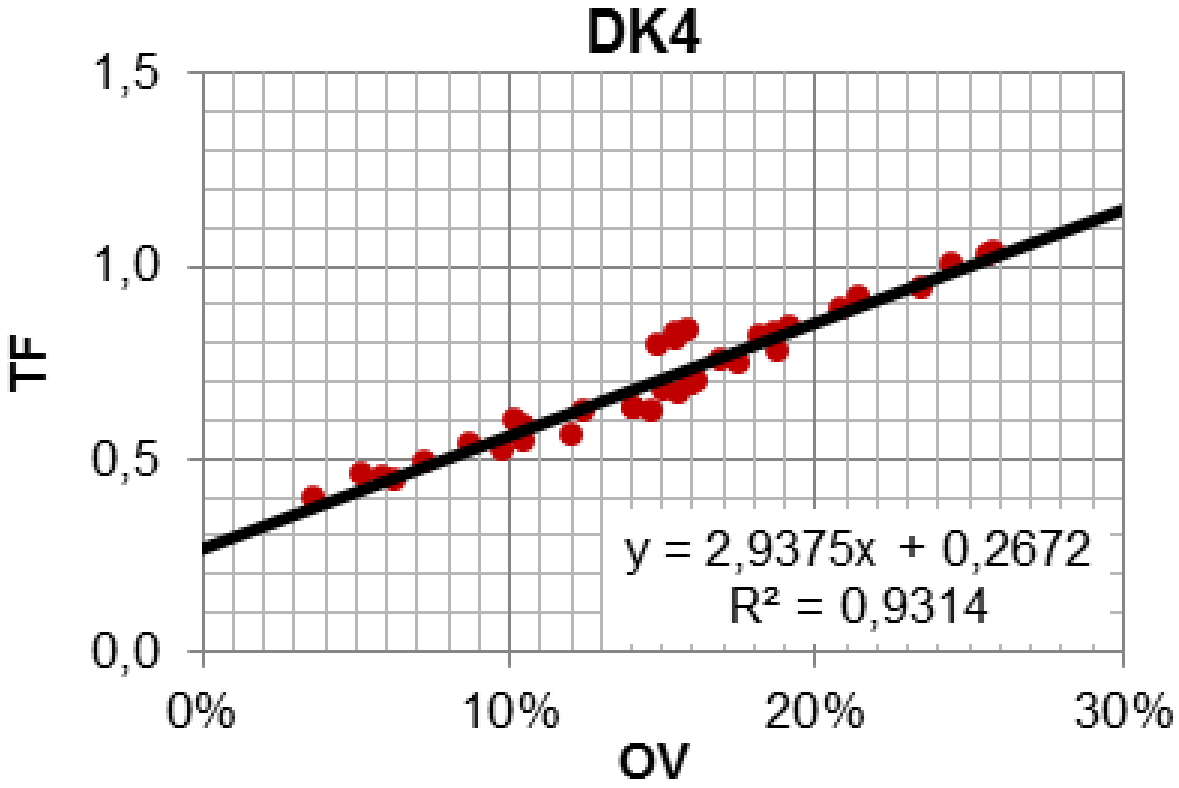
Effect of overloaded vehicles on truck factors

- Linear regression between monthly percentage of overloaded vehicles OV and average truck factors TF
- Determinated for particular 11 WIM stations
- High coefficient of determination R^2 from 0,76 to 0,99



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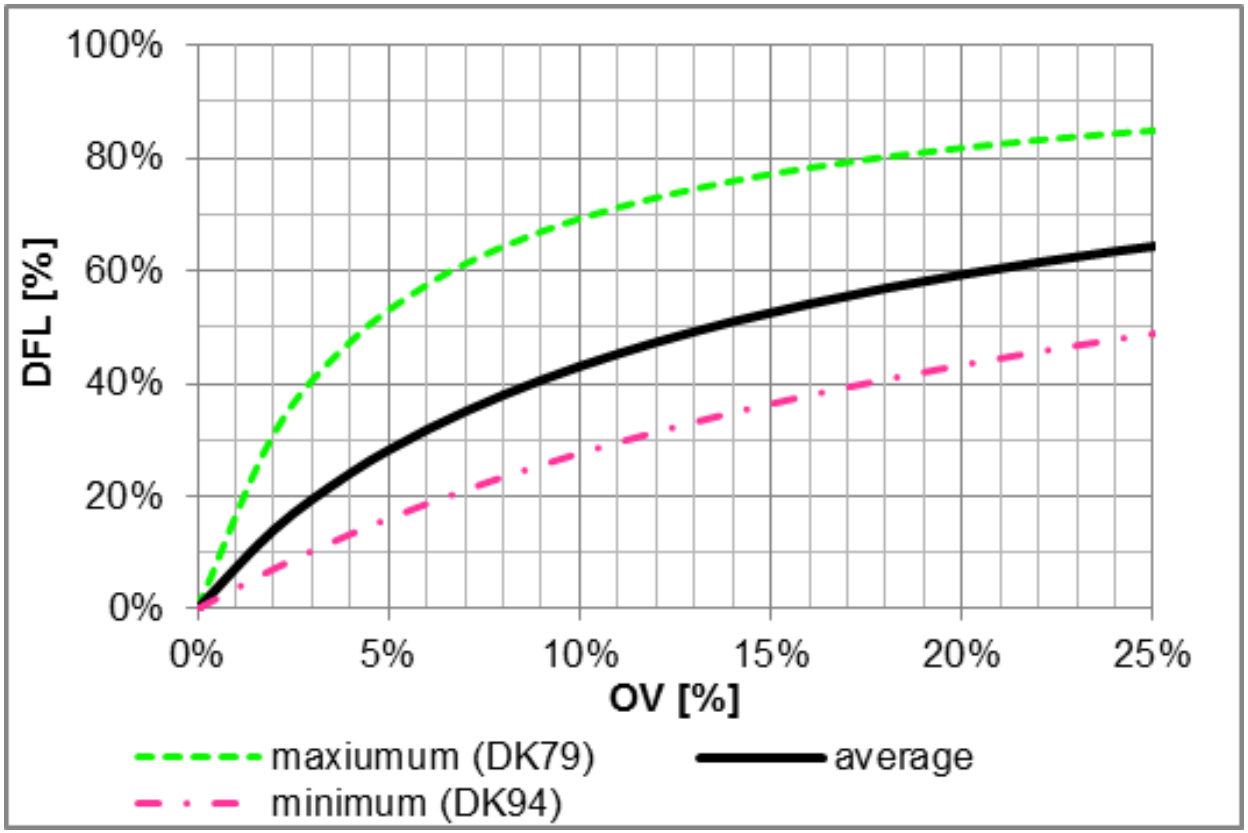
Decrease of Fatigue Life of pavement structures caused by overloaded vehicles

Fatigue life of pavement structure: $N_{100} = NT_0 \cdot TF_0 = NT_{OV} \cdot TF_{OV}$

Decrease of Fatigue Life: $DFL = 1 - \frac{TF_0}{TF_{OV}}$



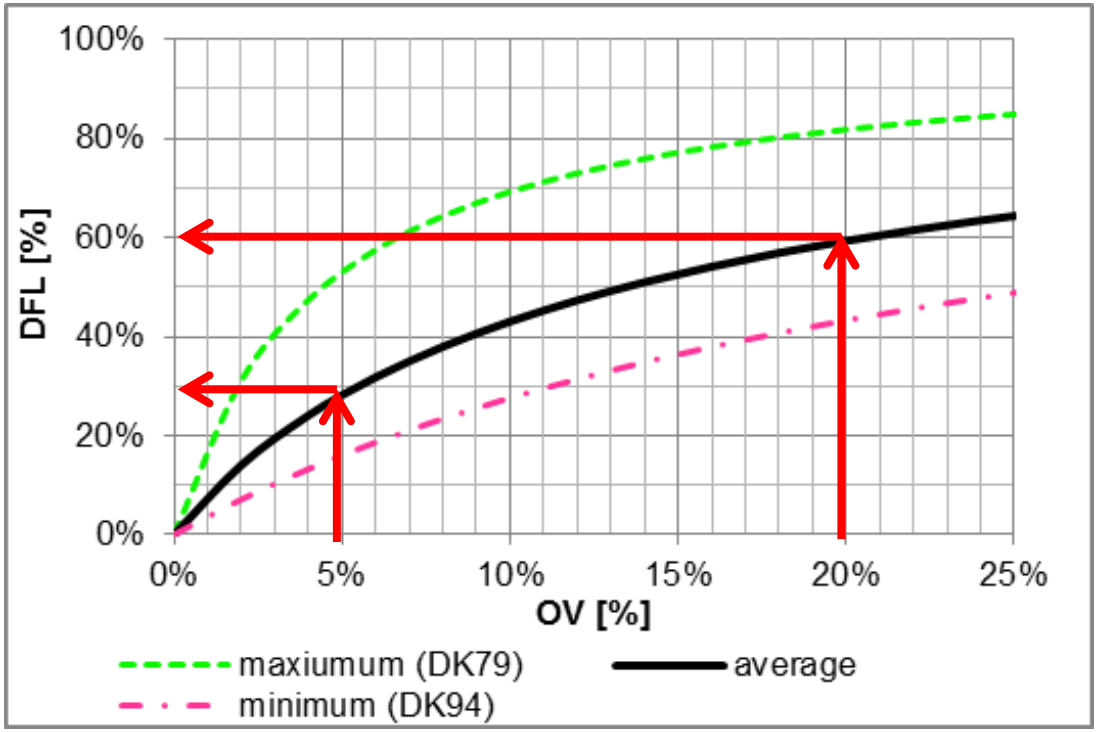
Extencion of residual service period after reduction of overloaded vehicles

Example:

Residual Service Period **RSP** at OV = 20% equals **10 years**

Higher enforcement causes **reduction of OV from 20% to 5%**

$$RSP_{OV-\Delta OV} = RSP_{OV}\frac{1-DFL_{OV-\Delta OV}}{1-DFL_{OV}} = 10\frac{1-0{,}29}{1-0{,}60} = 18 \quad [years]$$



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Conclusions...

1) Vehicle overloading is a serious problem. The percentage of overloaded vehicles in Poland range from 7% to 23%
2) Percentage of overloaded can be decreased by improvement of enforcement
3) Truck Factor which characterizes the fatigue damage of pavements structure caused by an average vehicle is very well correlated with percentage of overloaded vehicles
4) Increase of the percentage of overloaded vehicles from 0% to 15% will cause Decrease of Fatigue Life approximately twice
5) Decreasing of the percentage of overloaded vehicles will cause the significant extension of pavement service period

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Thank you for attention…