Rolling resistance and CO_2

The effect of rolling resistance classes on CO_2 emissions

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Introduction

- Guidance needed for the draft GTR on tire selection
- Concerns by Japan about the effect of RR on CO_2
- Input needed to quantify this effect
- Based on the outcome an informed decision can be made

➢ This study is sponsored by ICCT

Literature survey

- Effect of RR on CO_2 is quantified by many sources (EPA, CARB, IEA, LAT, TNO, TRL, IEEP, Continental, Michelin etc.)
- Quite good agreement between sources:
  10% lower RR will result in 1.5 to 2 % lower CO_2 emissions
- Older literature sources show lower effects than recent sources

Theory

- According to SAE 2008-01-0154 by Michelin, the *relative* effect of RR on CO_2 depends on cycle parameters, engine efficiency etc.
- BUT the *absolute* effect behaves linear:

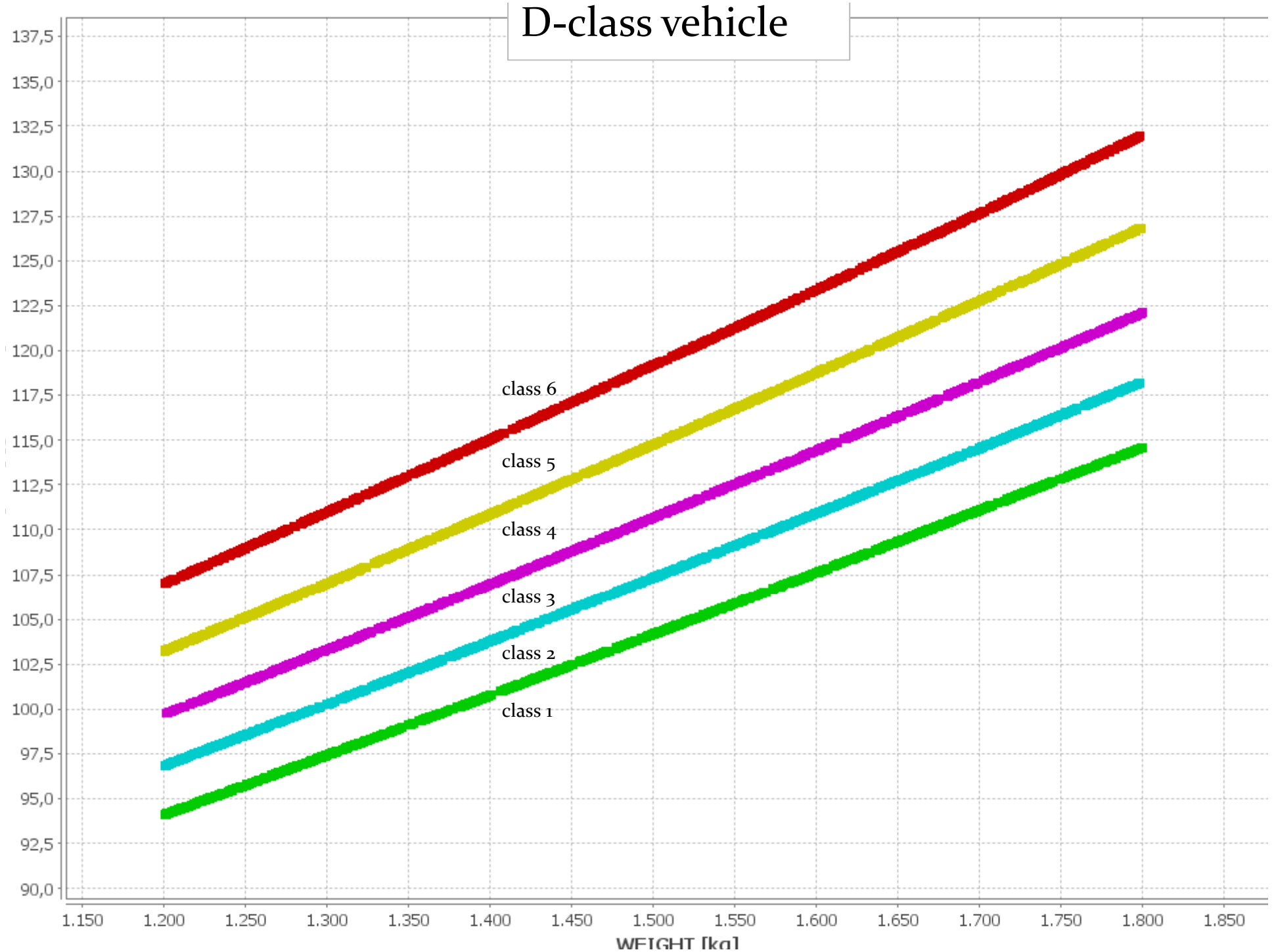
$$\Delta CO_2 = \alpha \cdot \Delta C_{RR} \cdot M$$

- CO_2 effect is better observed as an absolute difference rather than a relative difference

Simulation

- Calculations are based on the Data Visualization Tool, developed by Ricardo (provided by ICCT)
- Simulation tool for different LD vehicle configurations, engines and transmissions in the 2020-2025 timeframe
- Analysis through parameter variations

For more information, refer to the report "Computer Simulation of Light Duty Vehicle Technologies for Greenhouse Gas Emission Reduction in the 2020–2025 Timeframe" (RD.10/157405.8; Ricardoand SRA, 2011)


D-class vehicle
137,5
135,0
132,5
130,0
127,5
125,0
122,5
120,0
117,5
115,0
112,5
110,0
107,5
105,0
102,5
100,0
97,5
95,0
92,5
90,0
class 6
class 5
class 4
class 3
class 2
class 1
1.150
1.200
1.250
1.300
1.350
1.400
1.450
1.500
1.550
1.600
1.650
1.700
1.750
1.800
1.850
WEIGHT [kg]

Results for D-class vehicle

Absolute CO_2 differences between RR classes

NEDC simulation	Lowest CO_2 difference [g/km]	Highest CO_2 difference [g/km]
Low weight (1200 kg)	2.9	3.6
High weight (1800 kg)	3.7	5.1

FTP simulation	Lowest CO_2 difference [g/km]	Highest CO_2 difference [g/km]
Low weight (1200 kg)	2.7	3.9
High weight (1800 kg)	3.2	3.3

Simulation results

CO2 difference is 2-5 g/km, depending on RR class and vehicle weight

These results have restrictions:

- Only NEDC / FTP results, not WLTC
- Vehicle/engine/transmission configurations cannot be checked
- Fairly straightforward simulation method

➢ Absolute effect on CO_2 over WLTC expected to be similar

Conclusions

- Literature sources and simulations suggest that 15% change in RR results in about 3% change in CO_2
- Effect of RR on CO_2 is absolute, not relative.
- The absolute differences in NEDC CO_2 between RR classes will amount to 2-5 g/km, depending on the vehicle weight and RR class.
- Differences are higher for heavier vehicles and for the worst RR classes.
- Absolute differences are expected to be similar for WLTC
- Discussion needed to decide if these differences are acceptable

Questions & discussion

Input/output

Input (2 scenarios)

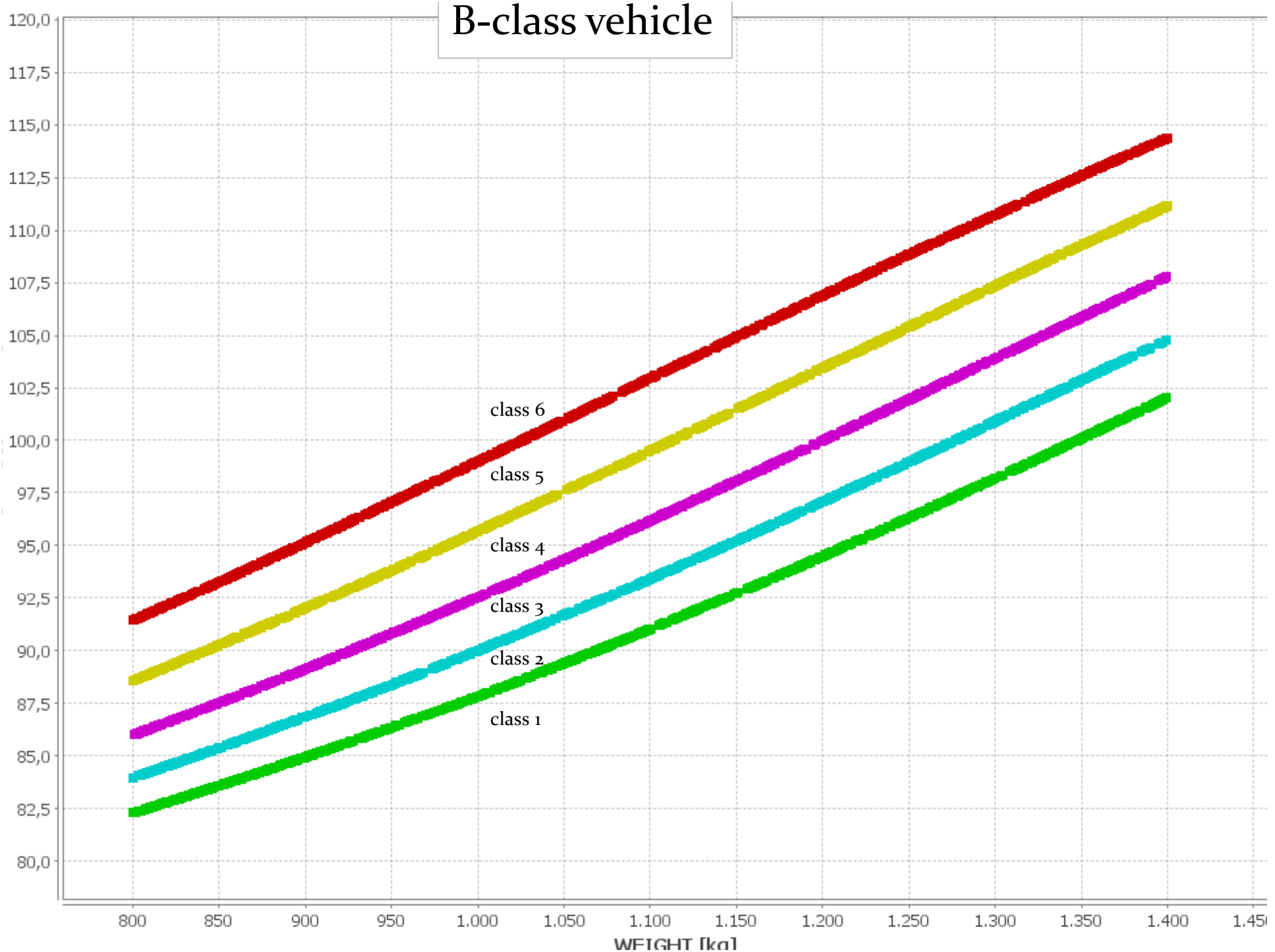
- B-class LD vehicle 2020 (e.g. Toyota Yaris)
- D-class LD vehicle 2020 (e.g. Ford Mondeo)
- Engine: DI-Stoichiometric with turbo
- Transmission: Dry DCT (6 resp. 8 gears)

Parameters

- Rolling resistance: boundaries of RR classes
- Weight: (800 to 1400 kg resp. 1200 to 1800 kg)

Output

CO_2 emissions over NEDC and FTP


B-class vehicle
120,0
117,5
115,0
112,5
110,0
107,5
105,0
102,5
100,0
97,5
95,0
92,5
90,0
87,5
85,0
82,5
80,0
class 6
class 5
class 4
class 3
class 2
class 1
800
850
900
950
1.000
1.050
1.100
1.150
1.200
1.250
1.300
1.350
1.400
WEIGHT [kg]

Results for B-class vehicle

Absolute CO_2 differences between RR classes

NEDC simulation	Lowest CO_2 difference [g/km]	Highest CO_2 difference [g/km]
Low weight (800 kg)	1.7	2.9
High weight (1400 kg)	2.8	3.4

FTP simulation	Lowest CO_2 difference [g/km]	Highest CO_2 difference [g/km]
Low weight (800 kg)	1.8	2.8
High weight (1400 kg)	3.1	4.3