Truck Tyre Rolling Resistance and Fuel Economy

&

Safety

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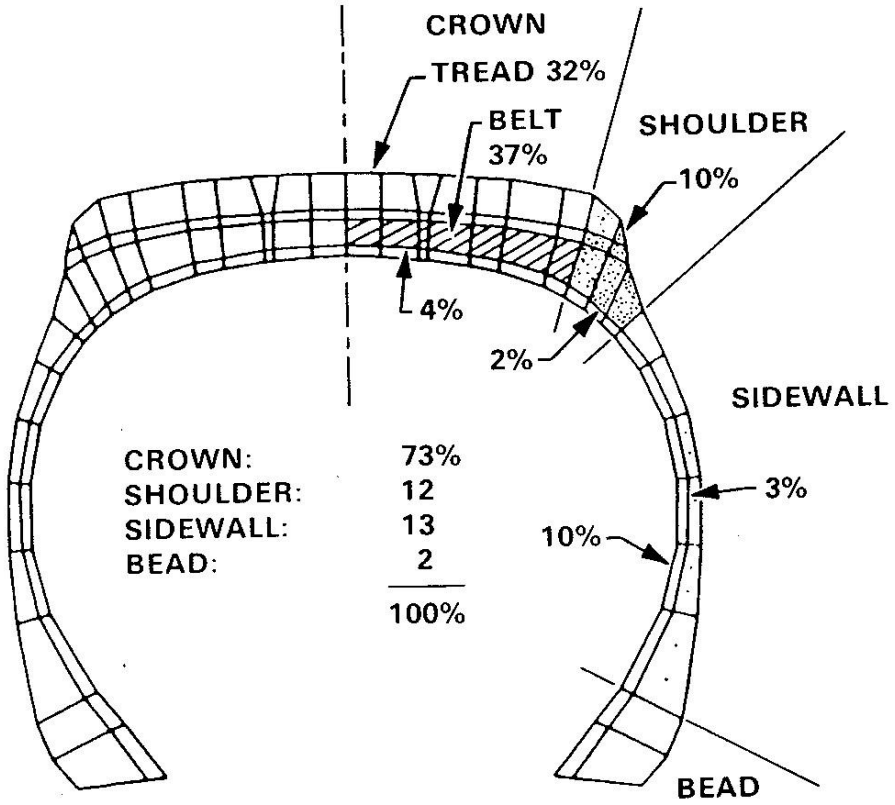
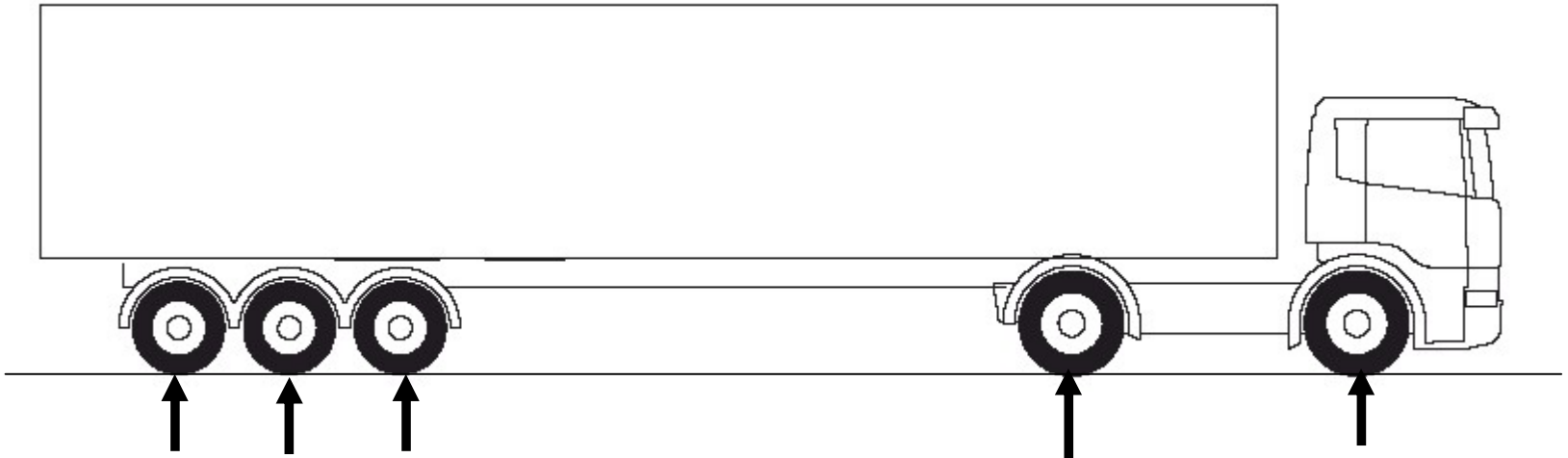
Truck tyre energy loss

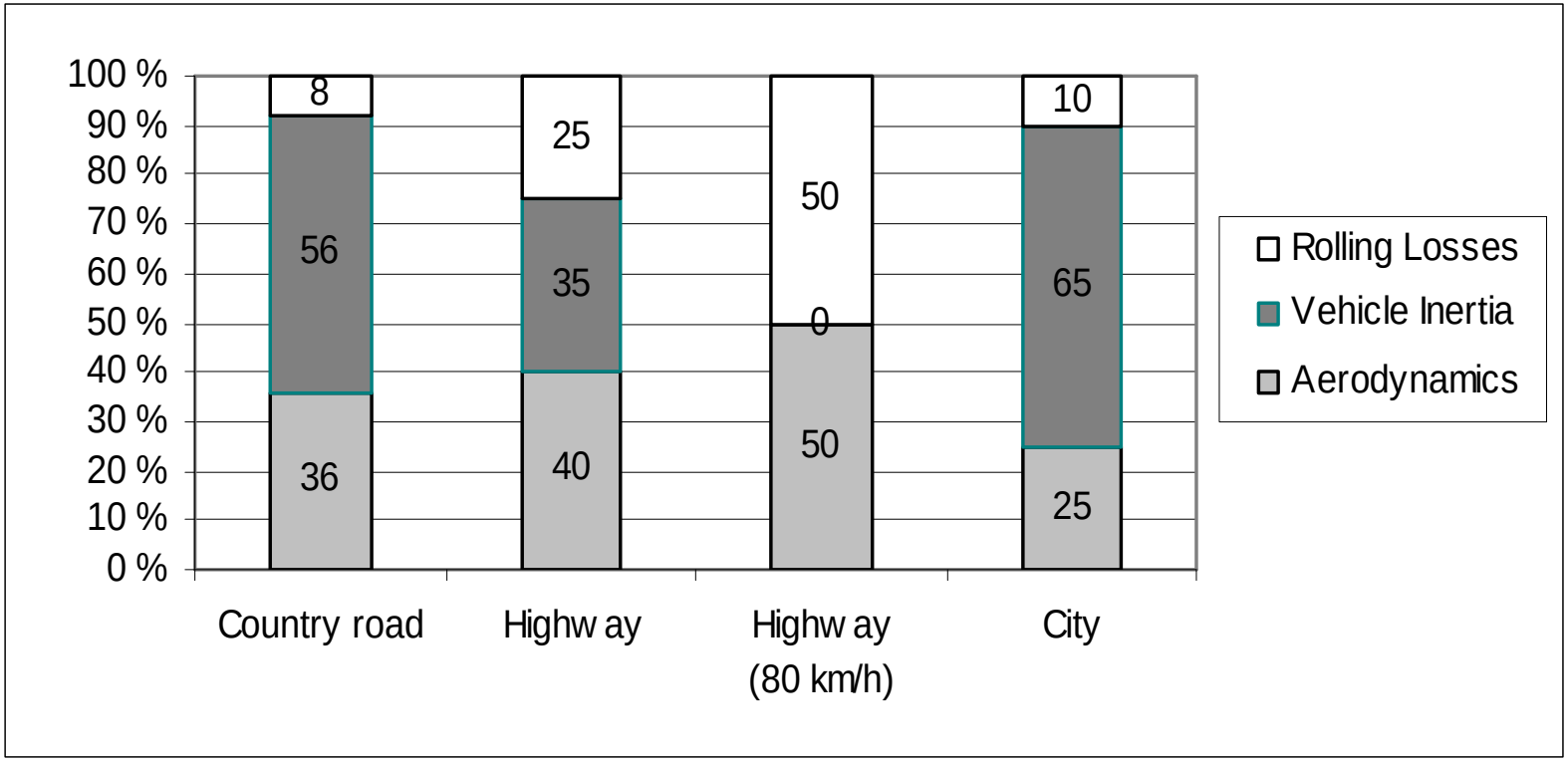


Rolling resistance on different axles



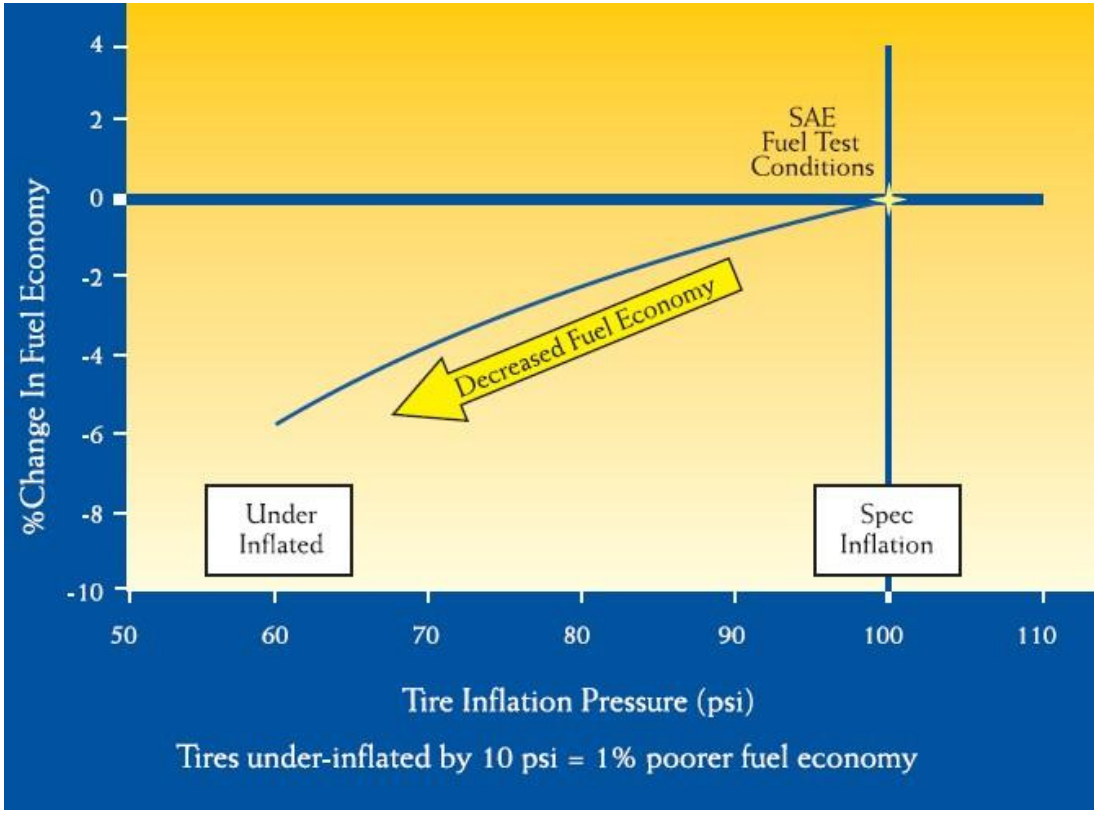
- Resistance = Wheel load x RR coefficient (Cr)
- Around 60 % on trailer when fully loaded (all combinations)

Contribution of tyre to fuel economy



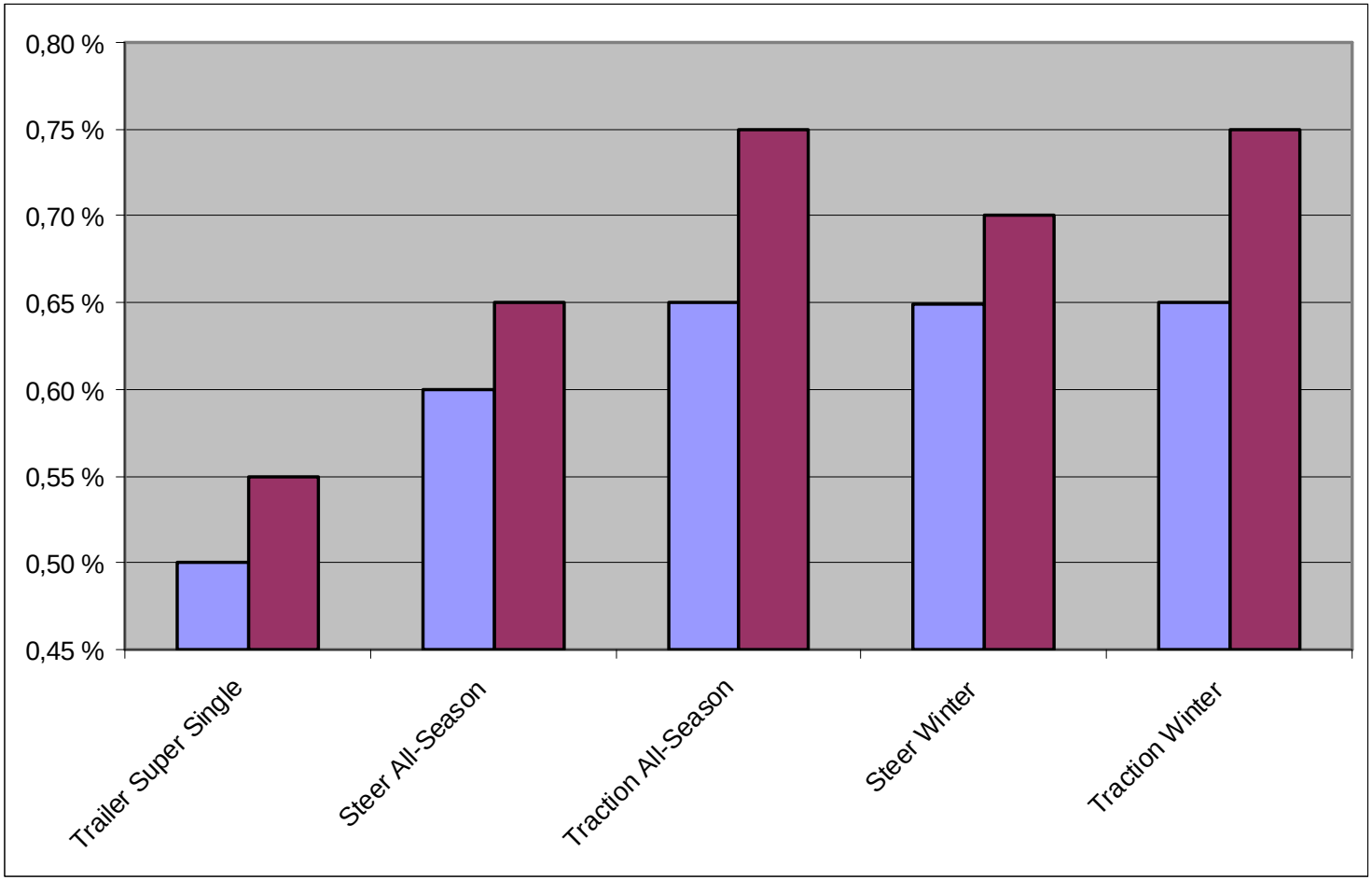
➢ Rolling resistance 15-25 % of total losses on long/medium haul
=> 5 % change in RR means ~1 % fuel savings

Inflation pressure vs. fuel consumption



- Simple rule: 10% under-inflation, 1 % more fuel consumption

Rolling resistance values



Target values: Drive axle tyres: Cr < 0,7 %; Free rolling tyres: Cr < 0,6 %

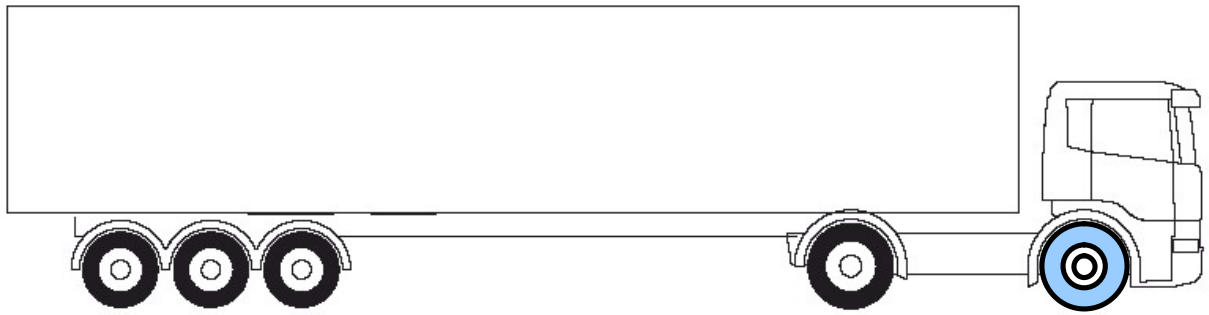
Tyre use in winter time

- **It is essential that in winter time tyres are suitable winter use, which means that the tread pattern is enough deep and open with siping and also having right kind of rubber compound.**

- **Climate warming means more changes in weather conditions. The temperature varies more near to zero degree which is the most demanding for the tyre grip. Also amount of snow might be more at one time.**

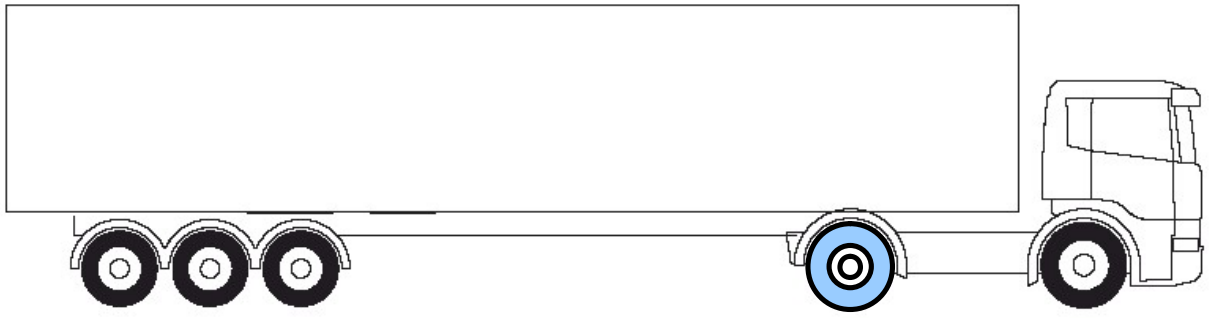
Steer axle tyres

- On steer axles typically so called All-Season tyres with M+S marking are used on main road operations.
- Also Winter Steer tyres are used typically if there is driving on roads with less maintenance. These tyres are fitted in autumn time. Typically tyres are used the year around.
- Not recommended to use retreaded tyres on steer axle. Only on local driving retreads are used.



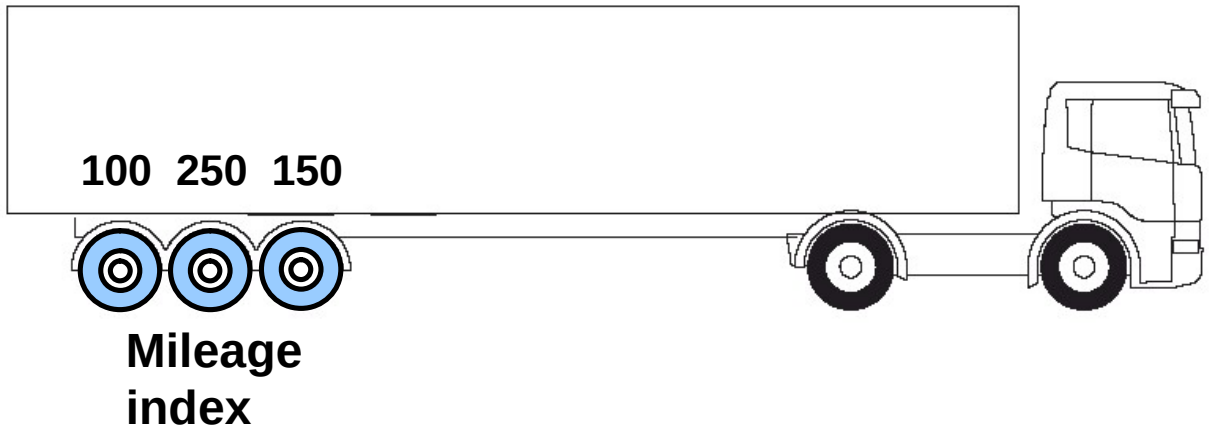
Drive axle tyres

- Typically the best tyres are put on drive axle use because poor tyres spin easily on slippery surfaces
- Mainly winter tyres or All-Season with M+S marking are used
- Tyres are fitted on autumn time and can be used year aroud.
- Retreaded tyres are very typical choice on drive axle



Trailer tyres

- On trailers various kind of tyres are used, both new and retreaded
- Normally tyres are changed by axles when fully worn
- Problem is the different wear rate on different axles
- Several accidents because of the loose of the grip (main reason situational speed)

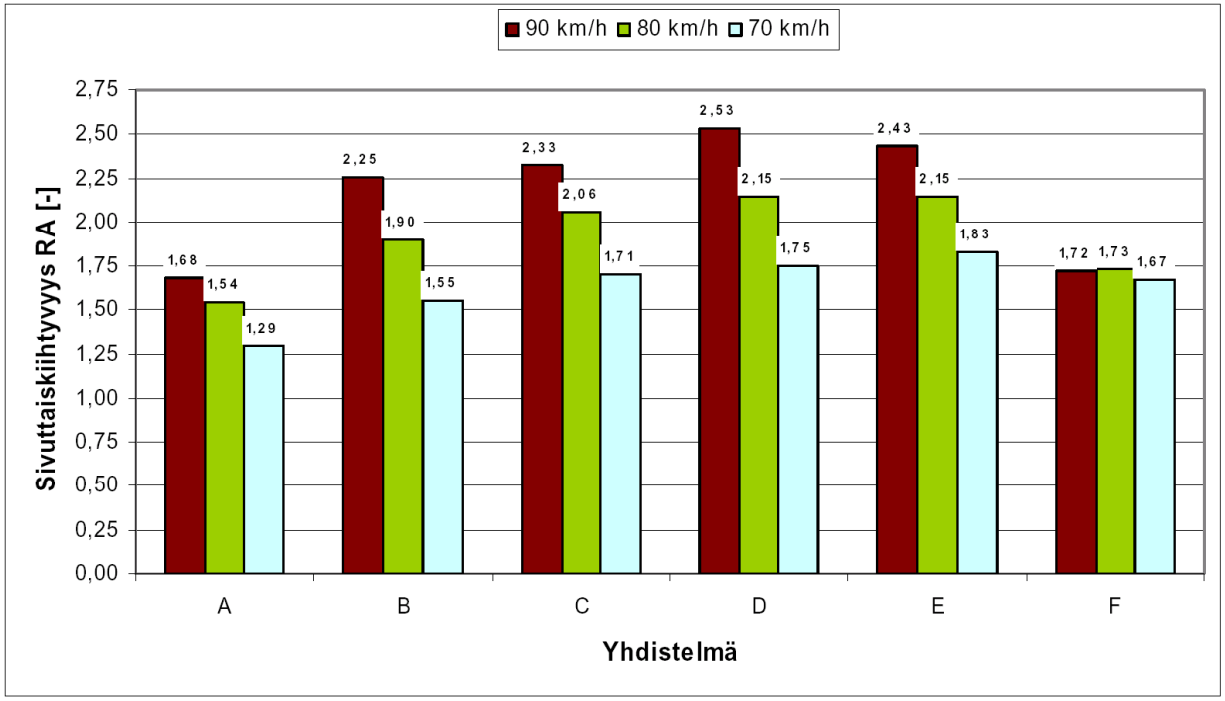


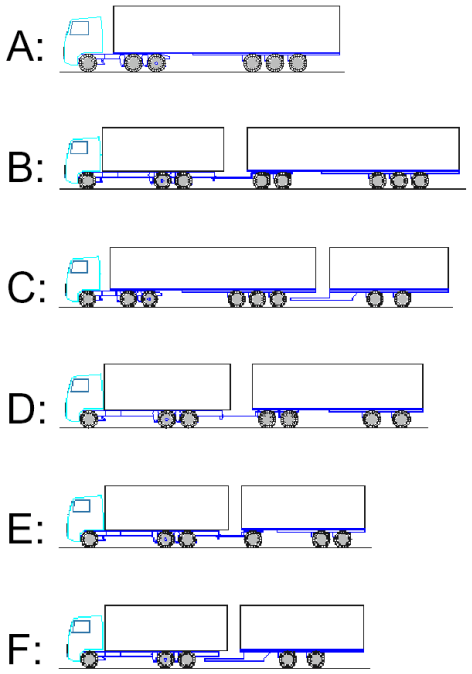
Background

- Trailer behavior with different tyres on slippery surfaces not studied
- Actual testing on ice/snow surfaces very difficult. For example lane change maneuvers would need a very large track with safety areas
- What is the meaning of different type of tyres for trailer stability (lateral movements)?
- What would be the optimal tyres considering the safety and economy?

RA-values / combination type

Stability of truck and trailer combinations

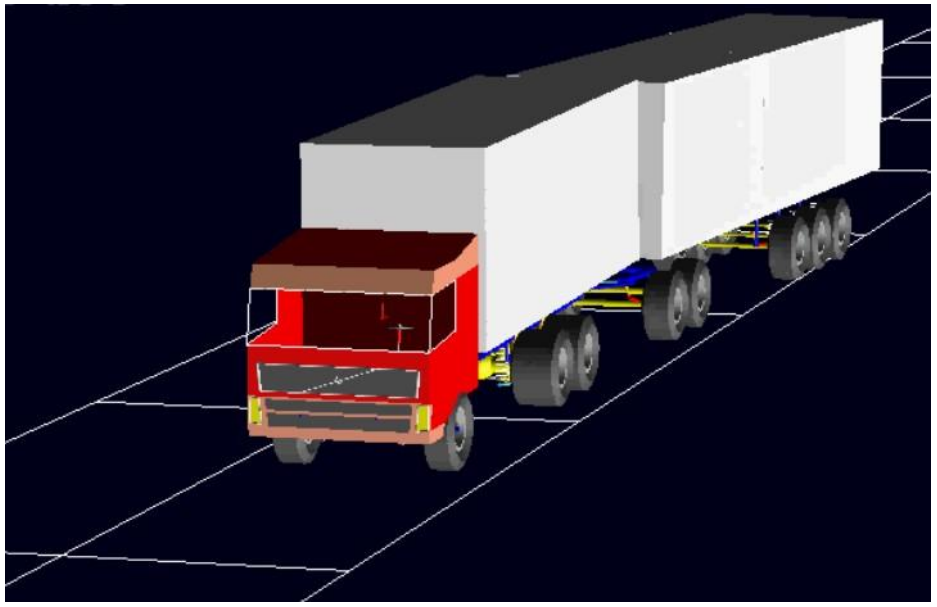




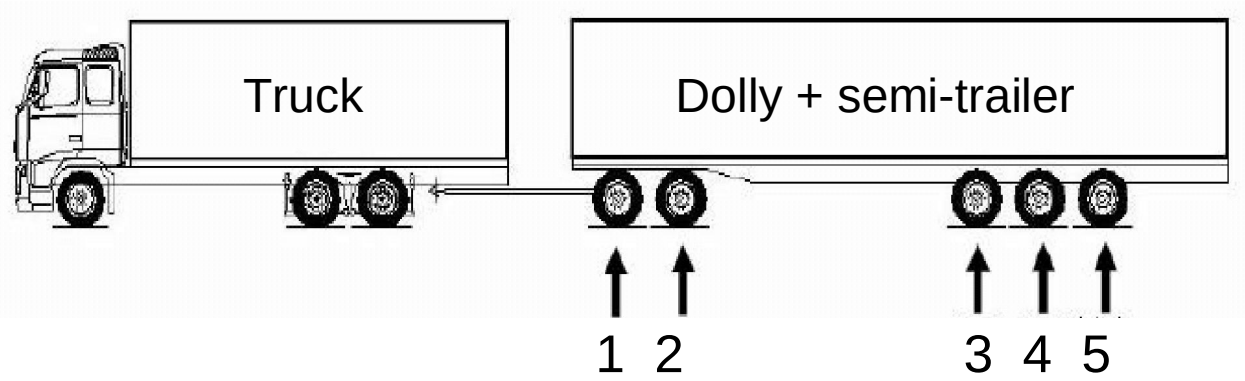
When RA > 1, the movements of the trailer are bigger than truck movements

Case Study

HELSINKI UNIVERSITY OF TECHNOLOGY		ABSTRACT OF THE MASTER'S THESIS	
Author	Mikko Lehessaari		
Title of the Thesis	Development stability of vehicle combinations based on the modular concept by tires		
Date	3.12.2007	Number of pages	107



Simulation with ADAMS model



- Both lane change and sinusoidal steering input was modelled with the ADAMS dynamic vehicle combination model
- Tyre size 385/65R22.5
- Coefficient of friction was 0,2
- ”New tyre” = All-Season tyre (M+S marked)
- ”Worn tyre” = Half worn, a commonly available tyre
- Difference in lateral grip between new and worn tyre was ”only” 10-15 %. According to Swedish research (VTI) differences between tyres can be up to 50 %!

Simulation results

- **New tyre on 1st axle (Dolly)**
  - Not a good solution, increases trailer movements
- **New tyre on 2nd axle (Dolly)**
  - Reduces and absorbs trailer movements considerably on rapid lane changes
- **New tyre on 5th axle (Semi-trailer)**
  - Reduces trailer movements on slow lane changes
- **New tyres on 2nd and 5th axles**
  - Reduces and absorbs trailer movements considerably on rapid and slow lane changes

All tyre combinations were modelled. These were the most remarkable results.

Difference between “All new” and “All worn” was 40 %

Adams model picture

(Overshoot after lane change)

1. New on 2- ja 5-axles 2. All worn 3. All new

Conclusions

How to achieve the best compromise between safety and costs?

=> To fit winter tyres on all axles on dolly and trailer

+ Extremely good winter grip and safety
- High purchase price
- High rolling resistance (fuel consumption)

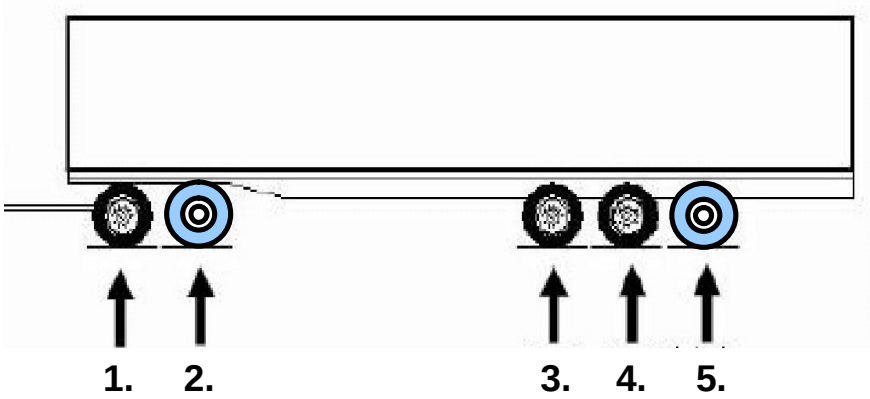
=> To fit All-Season tyres on all axles on dolly and trailer

+ Good winter grip and safety
+ Lower purchase price and RR than on previous case

Minimum requirement: To keep always good tyres on last axle of dolly and semi-trailer. On those axles can be used also winter tyres, which does not increase costs or rolling resistance remarkable. Minimum pattern depth requirement in winter time for all axles: 5 mm and M+S –marking.

At the moment for example in Finland there is no special requirements for truck tyres in winter time.

Tyre Recommendations



To make a good stability on winter roads

- New tyres with good grip on 2nd and 5th axles, like All-Season with M+S or even real winter tyres
- Other axles tyres with low rolling resistance
- Retreaded tyres can be used on 1st and 4th, sometimes also on 3rd axle depending on the severity of the use.

NOKIAN NTR-844 WS

NOKIAN HKPL TRUCK F

NORDMAN NTR 72S

NOKTOP 72 SUPER

Comparison calculation

	Tyre size: 385/65R22.5					Tyre size: 315/80R22.5				
	Trailer					Truck				
	5-axle	4-axle	3-axle	2-axle	1-axle	3-axle	2-axle	1-axle	Total (t)	**RR-Index**
Weight (ton)	7,0	7,0	7,0	7,0	7,0	8,5	8,5	7,0	59,0	
			35,0				24,0			
Tyres 1	Half worn tyres (8 mm)									
Pattern depth (mm)	8,0	8,0	8,0	8,0	8,0	15,0	18,0	15,0		
RR coefficient	0,53 %	0,53 %	0,53 %	0,53 %	0,53 %	0,65 %	0,74 %	0,65 %	Total (daN)	
Rolling resistance (daN)	37,4	37,4	37,4	37,4	37,4	54,9	63,0	45,2	349,9	**100,0**
Tyres 2	All-Season tyres (15 mm)									
Pattern depth (mm)	15,0	15,0	15,0	15,0	15,0	15,0	18,0	15,0		
RR coefficient	0,65 %	0,65 %	0,65 %	0,65 %	0,65 %	0,65 %	0,74 %	0,65 %	Total (daN)	
Rolling resistance (daN)	45,2	45,2	45,2	45,2	45,2	54,9	63,0	45,2	389,2	**111**
Tyres 3	New winter tyres on 2nd and 5th axles (17 mm), other tyres slightly worn (8 mm)									
Pattern depth (mm)	16,5	8,0	8,0	16,5	8,0	15,0	18,0	15,0		
RR coefficient	0,69 %	0,53 %	0,53 %	0,69 %	0,53 %	0,65 %	0,74 %	0,65 %	Total (daN)	
Rolling resistance (daN)	48,3	37,4	37,4	48,3	37,4	54,9	63,0	45,2	371,7	**106**
Tyres 4	New All-Season tyres on 2nd and 5th axles (15,5 mm), other tyres worn (8 mm)									
Pattern depth (mm)	15,0	8,0	8,0	15,0	8,0	15,0	18,0	15,0		
RR coefficient	0,65 %	0,53 %	0,53 %	0,65 %	0,53 %	0,65 %	0,74 %	0,65 %	Total (daN)	
Rolling resistance (daN)	45,2	37,4	37,4	45,2	37,4	54,9	63,0	45,2	365,6	**104**

= Winter New = All-Season New = Worn