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Nature Conservation and Reactor Safety

Noise Control

Research report 299 54 114

Determination of rolling noise and rolling-resistance coefficients and conduct of wet-surface brake tests on utility-vehicle tires

second edition

by
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Es sollen in den Dimensionen 225/70 R15C , 215/75 R17,5 , 275/70 R22,5 und 315/80 R22,5 an jeweils einem Lenkachs- und Antriebsachsreifenkollektiv Geräusch, Rollwiderstand sowie Nassbremsverhalten untersucht werden. Die Kollektive umfassen je 4 bzw. 5 Reifenmarken und wurden nach marktrelevanten Gesichtspunkten zusammengestellt.</td></tr>
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Abstract:

The aim of the study was to investigate rolling noise, rolling-resistance and wet-braking characteristics of various tires of the following size categories 225/70 R15C , 215/75 R17.5 , 275/70 R22.5 and 315/80 R22.5 mounted either to the steering axle or the drive axle. Each tire population comprised 4 or 5 tire brands selected according to market relevance.

Keywords:

Tires, rolling noise, rolling resistance, wet braking

Price:		

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I.2 Abbreviations:

ABS	anti-lock braking system
dB(A)	decibels A-scale
FA	front axle
RA	rear axle
FL	wheel position front left
FR	wheel position front right
RL	wheel position rear left
RR	wheel position rear right
LT	light truck

II Determination of rolling noise and rolling-resistance coefficients

II.1 Foreword:

Apart from the influences of vehicle technology, driving behavior, road surface and the number of vehicles driving on roads, traffic noise is crucially influenced by rolling sounds (tires -- road surface) which, in turn, are caused to a large extent by tires.

This is especially true when vehicles are driven at high speed. But, even in moving city traffic, the rolling sounds of tires are frequently louder than the noise caused by the vehicle engines.

The amount of rolling noise produced by currently marketed tires varies greatly (even within one and the same tire-size category). The widespread introduction of low-noise tires would reduce traffic noise by an average of 50%. On motorways and country roads, the reduction potential may even be higher.

Besides minimizing noise, new tires frequently also offer less rolling resistance, thus enabling a considerable reduction in fuel consumption.

Within the scope of our study we discovered that tire types of any one size can vary in weight by as much as 15%. Less weight also helps to conserve resources. In this context, service life / mileage and, in particular, regroovability depending on the purpose of use must be taken into consideration.

On the other hand, when tires which have been optimized with respect to rolling noise and rolling resistance are launched on the market, general service characteristics and in particular traffic safety must be kept in mind. Care must be taken in particular to ensure that the vehicles' performance under wet conditions, especially braking on wet surfaces, continues to correspond to the state of the art, since safety-relevant criteria are involved here.

II.2 Introduction:

With a view to the issue of an environmental label for new truck and bus tires which make less noise and save fuels, the properties of a representative cross section of the current tire market in Germany were examined.

The following measurements

- rolling resistance as per ISO 8767 at 50, 90 and 120 km/h (only applicable to size category 225/70 R15C),or as per ISO 9948 at 50 km/h.
- tire/road surface noise as per the proposal concerning 92/23/EEC (as at March 2000),
- braking distance on a wet road,

were carried out on:

- 4 sets of summer tires of size category 225/70 R15C (LT, delivery transport)
- 5 sets of steering-axle tires of size category 215/75 R17.5 (medium-sized truck, local transport)
- 5 sets of drive-axle tires of size category 215/75 R17.5 (medium-sized truck, local transport)
- 4 sets of steering-axle tires of size category 275/70 R22.5 (bus, municipal transport)
- 4 sets of drive-axle tires of size category 275/70 R22.5 (bus, municipal transport)
- 5 sets of steering-axle tires of size category 315/80 R22.5 (heavy truck, long-distance transport)
- 5 sets of drive-axle tires of size category 315/80 R22.5 (heavy truck, long-distance transport).

The selected tires were subdivided into four fields of application: municipal transport, delivery transport, local transport and long-distance transport. In consultation with vehicle manufacturers, a characteristic tire size was determined for each field of application. Subsequently, tire treads appropriate for the respective field of application were selected from the manufacturers' current product ranges. In addition, tire selection was also based on market analyses and sales statistics taking the state of the art into account.

The main criterion, i.e. tire/road surface noise was measured in line with the proposal concerning EC Directive 92/23/EEC. The second major criterion was the determination of rolling resistance in line with ISO 8767 or ISO 9948 and of weight as described in Annex 2.

For the criterion "measurement of brake distance on a wet road" we could not fall back on standardized test procedures. A braking trailer with anti-lock braking system was used for the tests conducted with tires of the size categories 17.5'' and 22.5''. Since the control properties of the pneumatic anti-lock braking system are not defined under 30 km/h, the determined measurement range for tires of the size category 22.5'' was between 70 and 30 km/h.

For tires of size category 17.5", a measuring range of between 60 and 30 km/h was defined.

Tires of the size category 225/70 R15C were tested with the help of a commercial Mercedes Sprinter. The measurement range was 90 to 10 km/h.

Measurements were carried out between March and June 2000.

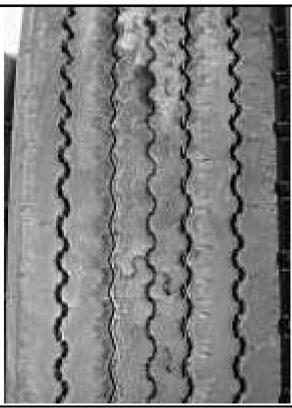
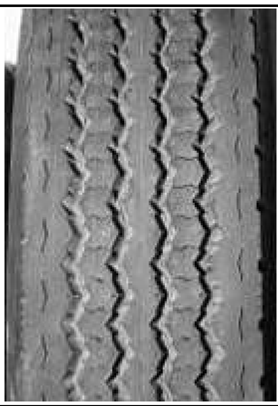
Measurements were conducted on a single test sample in each case, without taking serial-production-related variations in quality into account. Statistical evaluation of the results obtained on the basis of these samples and a general quality statement are therefore impossible.

II.3 Test populations:

II.3.1 Summer tires of size category 225/70 R15 C, light truck, delivery transport

	
Michelin XCA	Goodyear CARGO G26
	
Continental Vanco 8	Dunlop SP LT 8

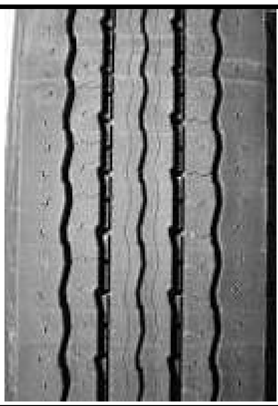
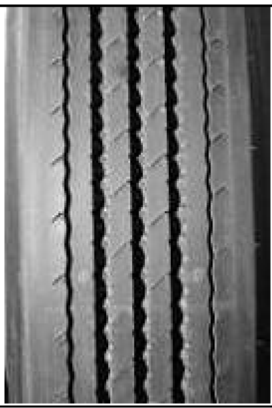
II.3.2 Steering-axle tires of size category 215/75 R 17.5, truck, local transport

	
Michelin XZE 1	Goodyear Unisteel G 291
	
Continental LS 45	Dunlop SP 351
	
Toyo M 109	

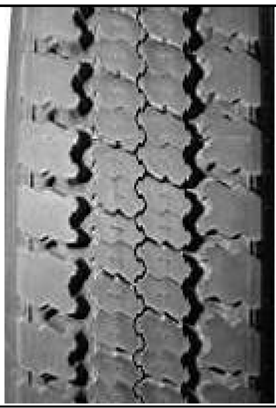
II.3.3 Drive-axle tires of size category 215/75 R 17.5 M&S, truck, local transport

	
Michelin XDE 1	Goodyear Unisteel G 124
	
Continental LD 75	Dunlop SP 431
	
Toyo M 608 z	

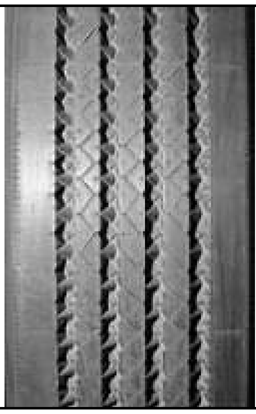
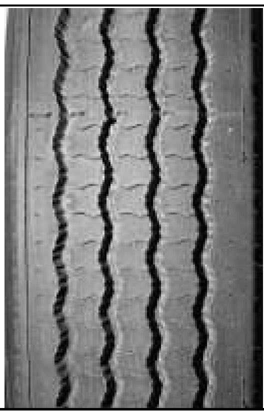
II.3.4 Steering-axle tires of size category 275/70 R 22.5, bus, municipal transport

	
Michelin XZU	Goodyear Metro MCS
	
Continental HB	Dunlop SP 741 city

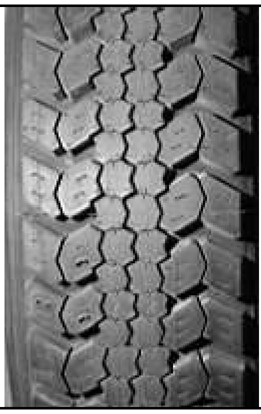
II.3.5 Drive-axle tires of size category 275/70 R 22.5 M&S, bus, municipal transport

	
Michelin XZU 2T	Goodyear G 267
	
Continental HDU	Dunlop SP 531 city

II.3.6 Steering-axle tires of size category 315/80 R 22.5, truck, long-distance transport

	
Michelin XZA 2 Energy	Goodyear Marathon LHS
	
Continental HSL eco - plus	Dunlop SP 351
	
Toyo M 111	

II.3.7 Drive-axle tires of size category 315/80 R 22.5 M&S, truck, long-distance transport

	
Michelin XDA 2 Energy	Goodyear Marathon LHD
	
Continental HDL eco - plus	Dunlop SP 451
	
Toyo M 622	

II.4 Tests

II.4.1 Measurement of rolling resistance as per ISO 8767 respectively ISO 9948

Definition of rolling-resistance coefficient $c_{R:}$
The coefficient c_R [%] is calculated from the mean rolling-resistance values in newtons [N] divided by the wheel load in [N] multiplied by 100 [%].

II.4.1.1 Tire preparation

Prior to actual measurement, tires of size category 225/70 R15C are run in under test conditions for a period of 30 minutes at 50 km/h.

Tires of size categories 215/75 R17.5, 275/70 R22.5 und 315/80 R22.5 are run in under test conditions for a period of 120 minutes at 80 km/h.

All tires were conditioned, however, for at least six hours under test-room conditions.

II.4.1.2 Test rig

Rolling resistance is determined on a test rig with a drum diameter of

2000 mm for size category 225/70R15C as per ISO 8767

and a diameter of

1707 mm for size categories 215/75R17.5, 275/70R22.5 and 315/80R22.5

as per ISO 9948.

II.4.1.3 Test procedure

For tires of the size category 225/70 R15C, the electrical input is measured both when the tire is pressed down and when the tire is raised; the difference between the two values deceleration represents the rolling resistance.

For tires of size categories 215/75 R17.5, 275/70 R22.5 and 315/80 R22.5, the speed declension and the attended time is measured when the tire is pressed down. The speed difference must not be higher than 1 km/h and the measured time must be shorter than 0,5s. The rolling resistance is then calculated by using a formula defined in the ISO 9948 standard.

Measurement is conducted on two tires of each manufacturer and of each size category.

The tire pressure is adjusted on the conditioned tire; during the measurement pressure can build up freely. Tire load and inflation pressure are determined as outlined in the ISO 8767 respectively ISO 9948 standard.

	225/70R15C	215/75 R17,5 275/70 R22,5 315/80 R22,5
Drum diameter:	2000 mm	1707 mm
Test speed:	50, 90, 120 km/h	80 km/h
Camber angle:	0°	0°
Test-room temperature:	25°C	25°C

II.4.1.4 Tire size 225/70 R15 C

Wheel load: 896 kg

Inflation pressure (cold): 3.6 bar

II.4.1.5 Tire size 215/75 R17.5

Wheel load: 1473 kg

Inflation pressure (cold): 7,0 bar

II.4.1.6 Tire size 275/70 R22.5

Wheel load: 2730 kg

Inflation pressure (cold): 9,0 bar

II.4.1.7 Tire size 315/80 R22.5

Wheel load: 3466 kg

Inflation pressure (cold): 8,5 bar

II.4.2 Weight determination

The mean weight of all tire types was determined on a calibrated weighing machine prior to rolling-resistance measurement.

II.4.3 Tire/road surface noise as per 92/23/EEC

II.4.3.1 Tire preparation

Prior to actual measurement, the tires were run in for about 200 km on public roads, to remove mold-release agents, mold discharges etc. from the tires.

Tires of size categories 215/75 R17.5, 275/70 R22.5, and 315/80 R22.5 were run in at a mean speed of approximately 80 km/h; tires of the size category 225/70 R15 C were run in at a mean speed of approximately 120 km/h. Tire wear in bends was largely avoided.

II.4.3.2 Test course

The test course satisfies the requirements of ISO 10844. Measurement equipment corresponds to class 1 of ISO 651.

The microphones are arranged at a distance of 7.5 m to the center line at a height of 1.20 m above the measurement surface.

The microphones were calibrated prior to commencement of measurement.

Figure 1: Test course for noise measurement

II.4.3.3 Test procedure

The vehicle was rolled across the test course in neutral gear with the engine switched off. The maximum sound pressure levels in dB(A) right and left of the vehicle were recorded together with the speed.

This measurement was carried out 8 times at different speeds; the different speeds were distributed as evenly as possible across the defined speed range. Regression analysis is used to establish the relationship between the results and the reference speed.

Figure 2: Noise measurement conducted for MB Actros, tire size 315/80 R22.5

The wheel load should be between 50% and 90% of the tire's maximum permissible load carrying capacity. At the same time, the total weight of the respective vehicle should be between 70% and 80% of the tire's maximum load carrying capacity multiplied by the number of tires (in line with the proposal outlined in 92/23 EEC). The tire inflation pressure is calculated by means of a given formula.

Tire size:	225/70 R15C	215/75 R17.5 275/70 R22.5 315/80 R22.5
Reference speed:	80 km/h	70 km/h
Speed range:	70 - 90 km/h	60 - 80 km/h

II.4.3.4 Tire size 225/70 R15 C mounted on MB Sprinter

Wheel load front axle: 785 kg

Tire pressure front axle: 3.1 bar
(calculated in line with the guidelines on label award)

Max. axle load (front): 70 %

Wheel load rear axle: 795 kg

Tire pressure rear axle: 3.1 bar
(calculated in line with the guidelines on label award)

Max. axle load (rear): 71 %

Total max. load 71 %

II.4.3.5 Tire size 215/75 R17.5 mounted on MB Atego

Wheel load front axle: 1300 kg

Tire pressure front axle: 5.2 bar
(calculated in line with the guidelines on label award)

Max. axle load (front): 76 %

Wheel load rear axle: 1300 kg

Tire pressure rear axle: 5.2 bar
(calculated in line with the guidelines on label award)

Max. axle load (rear): 76 %

Total max. load: 76 %

II.4.3.6 Tire size 275/70 R22.5 mounted on MB Actros

Wheel load front axle:	2740 kg
Tire pressure front axle:	7.7 bar (7.8 bar for Dunlop SP 741)*
(calculated in line with the guidelines on label award)	
Max. axle load (front):	87 %
Wheel load rear axle:	1680 kg
Tire pressure rear axle: (calculated in line with the guidelines on label award)	4.2 bar
Max. axle load (rear):	53 %
Total max. load:	70 %

* Note: Due to a higher load index, the Dunlop SP741 tire required a higher inflation pressure to achieve the same percentage load as for the other test tires.

II.4.3.7 Tire size 315/80 R22.5 mounted on MB Actros

Wheel load front axle:	2850 kg
Tire pressure front axle: (calculated in line with the guidelines on label award)	6.2 bar
Max. axle load (front):	76 %
Wheel load rear axle:	2735 kg
Tire pressure rear axle: (calculated in line with the guidelines on label award)	6.2 bar
Max. axle load (rear):	73 %
Total max. load:	74 %

II.4.4 Braking on a wet surface

II.4.4.1 Tire preparation

The tires had already been run in for the previous noise measurement.

The tire pressure was adjusted to the values specified by the vehicle manufacturer for the loads in question.

II.4.4.2 Test course

The tests were carried out on an artificially wetted asphalt road surface.

II.4.4.3 Test procedure

The Mercedes Sprinter and the test trailer were loaded to 65% ± 5% of the tires' load carrying capacity.

The Mercedes Sprinter used for tire size 225/70 R15C was decelerated by means of its serial 4-wheel anti-lock braking system.

The single-axle test trailer was equipped with two tires. It was decelerated by means of an anti-lock braking system. The traction vehicle was in neutral gear and not decelerated. Full-braking operation was applied via an electrovalve at the trailer-brake valve.

Speed and braking path were recorded with the help of a radar sensor; mean deceleration was calculated.

	Speed
225/70 R15 C	90 - 10 km/h
215/75 R17.5	60 - 30 km/h
275/70 R22.5	70 - 30 km/h
315/80 R22.5	70 - 30 km/h

A total of five tests were evaluated for each set of tires.

Figure 3: Braking on a wet surface with test trailer, tire size 215/75 R17.5

II.5 Test conditions

II.5.1 Measurement of rolling resistance as per ISO 8767

Temperature:	25°C
Drum surface:	steel, smooth

II.5.2 Weight determination

Weighing machine:	Sartorius F150S, No. QS-06M0027

II.5.3 Tire/road surface noise as per 92/23/EEC

II.5.3.1 225/70 R15C

Ambient temperature:	21°C to 22°C
Road temperature:	41°C to 50°C
Road surface:	asphalt as per ISO10844

II.5.3.2 215/75 R17.5

Ambient temperature:	12°C to 15°C
Road surface:	asphalt as per ISO10844

II.5.3.3 275/70 R22.5

Ambient temperature:	8°C to 13°C
Road surface:	asphalt as per ISO10844

II.5.3.4 315/80 R22.5

Ambient temperature:	18°C to 23°C
Road surface:	asphalt as per ISO10844

II.5.4 Braking on a wet surface

II.5.4.1 225/70 R15C

Ambient temperature:	17°C - 19°C
Road temperature:	20°C - 24°C

II.5.4.2 215/75 R17.5

Ambient temperature:	14°C to 19°C
Road temperature:	15°C to 26°C

II.5.4.3 275/70 R22.5

Ambient temperature:	21°C to 26°C
Road temperature:	19°C to 26°C

II.5.4.4 315/80 R22.5

Ambient temperature:	14°C to 24°C
Road temperature:	17°C to 28°C

II.6 Results

II.6.1 Measurement of rolling resistance as per ISO 8767

Mean rolling resistance force at 50, 90 and 120 km/h(only II.6.1.1) or 40, 60 and 80 km/h and rolling-resistance coefficient c_R:

II.6.1.1 Summer tires of size category 225/70 R15 C

Manufacturer	Designation	Rolling resistance [N]	c_R[%]
Michelin	XCA	81.40	0.93
Goodyear	CARGO G26	81.27	0.93
Continental	Vanco 8	79.19	0.90
Dunlop	SP LT8	86.18	0.98

II.6.1.2 Steering-axle tires of size category 215/75 R17.5

Manufacturer	Designation	Rolling resistance [N]	c_R[%]
Michelin	XZE 1	92.73	0.65
Goodyear	Unisteel G291	101.58	0.72
Continental	LS 45	105.69	0.75
Dunlop	SP 351	94.98	0.67
Toyo	M 109	107.91	0.76

II.6.1.3 Drive-axle tires of size category 215/75 R17.5 M&S

Manufacturer	Designation	Rolling resistance [N]	c_R[%]
Michelin	XDE 1	106.71	0.75
Goodyear	Unisteel G124	108.82	0.77
Continental	LD 75	121.28	0.86
Dunlop	SP 431	114.64	0.81
Toyo	M 608 z	120.09	0.85

II.6.1.4 Steering-axle tires of size category 275/70 R22.5

Manufacturer	Designation	Rolling resistance [N]	c_R[%]
Michelin	XZU	170.53	0.65
Goodyear	Metro MCS	149.61	0.57
Continental	HB	169.88	0.65
Dunlop	SP 741	158.03	0.60

II.6.1.5 Drive-axle tires of size category 275/70 R22.5 M&S

Manufacturer	Designation	Rolling resistance [N]	c_R[%]
Michelin	XZU 2T	160.09	0.61
Goodyear	G 267	159.38	0.61
Continental	HDU	183.08	0.70
Dunlop	SP 531 city	181.92	0.69

II.6.1.6 Steering-axle tires of size category 315/80 R22.5

Manufacturer	Designation	Rolling resistance [N]	c_R[%]
Michelin	XZA 2 Energy	162.59	0.49
Goodyear	Marathon LHS	145.18	0.44
Continental	HSL eco - plus	154.90	0.46
Dunlop	SP 351	161.11	0.48
Toyo	M 111	181.43	0.54

II.6.1.7 Drive-axle tires of size category 315/80 R22.5 M&S

Manufacturer	Designation	Rolling resistance [N]	c_R[%]
Michelin	XDA 2 Energy	194.21	0.58
Dunlop	Marathon LHD	190.43	0.57
Continental	HDL eco - plus	187.05	0.56
Goodyear	SP 451	220.31	0.66
Toyo	M 622	233.68	0.70

II.6.2 Weight determination

Mean tire weight in kg.

II.6.2.1 Summer tires of size category 225/70 R15 C

Manufacturer	Designation	Weight [kg]
Michelin	XCA	14.71
Goodyear	Cargo G 26	15.51
Continental	Vanco 8	15.22
Dunlop	SP LT 8	17.53

II.6.2.2 Steering-axle tires of size category 215/75 R 17.5

Manufacturer	Designation	Weight [kg]
Michelin	XZE1	24.48
Goodyear	Unisteel G291	24.65
Continental	LS 45	25.18
Dunlop	SP 351	24.20
Toyo	M109	25.27

II.6.2.3 Drive-axle tires of size category 215/75 R 17.5 M&S

Manufacturer	Designation	Weight [kg]
Michelin	XDE1	24.42
Goodyear	Unisteel G124	24.57
Continental	LD 75	25.54
Dunlop	SP 431	25.29
Toyo	M 608 z	25.41

(weight determination, continued)

II.6.2.4 Steering-axle tires of size category 275/70 R 22.5

Manufacturer	Designation	Weight [kg]
Michelin	XZU	57.96
Goodyear	Metro MCS	56.63
Continental	HB	52.04
Dunlop	SP 741	54.42

II.6.2.5 Drive-axle tires of size category 275/70 R 22.5 M&S

Manufacturer	Designation	Weight [kg]
Michelin	XZU 2T	53.18
Goodyear	G 267	51.11
Continental	HDU	52.35
Dunlop	SP 531 city	57.18

II.6.2.6 Steering-axle tires of size category 315/80 R 22.5

Manufacturer	Designation	Weight [kg]
Michelin	XZA 2 Energy	64.13
Goodyear	Marathon LHS	71.28
Continental	HSL eco - plus	59.64
Dunlop	SP 351	64.30
Toyo	M111	62.91

II.6.2.7 Drive-axle tires of size category 315/80 R 22.5 M&S

Manufacturer	Designation	Weight [kg]
Michelin	XDA 2 Energy	72.60
Goodyear	Marathon LHD	75.73
Continental	HDL eco - plus	68.20
Dunlop	SP 451	71.90
Toyo	M 622	67.39

II.6.3 Tire/road surface noise as per 92/23/EEC

Recorded tire/road surface noise in dB(A), in the case of size category 225/70 R15 C temperature-compensated for a road temperature of 20°C and rounded off.

II.6.3.1 Summer tires of size category 225/70 R15 C

Manufacturer	Designation	Noise level [dB(A)]	Rounded off [dB(A)]
Michelin	XCA	72.32	72
Goodyear	CARGO G26	73.14	73
Continental	Vanco 8	70.89	71
Dunlop	SP LT8	72.71	73

II.6.3.2 Steering-axle tires of size category 215/75 R 17.5

Manufacturer	Designation	Noise level [dB(A)]	Rounded off [dB(A)]
Michelin	XZE 1	72.49	72
Goodyear	Unisteel G291	71.28	71
Continental	LS 45	70.96	71
Dunlop	SP 351	69.99	70
Toyo	M 109	69.81	70

II.6.3.3 Drive-axle tires of size category 215/75 R 17.5 M&S

Manufacturer	Designation	Noise level [dB(A)]	Rounded off [dB(A)]
Michelin	XDE 1	75.54	76
Goodyear	Unisteel G124	74.88	75
Continental	LD 75	73.48	73
Dunlop	SP 431	74.29	74
Toyo	M 608 z	72.72	73

(tire/road surface noise as per 92/23/EEC, continued)

II.6.3.4 Steering-axle tires of size category 275/70 R 22.5

Manufacturer	Designation	Noise level [dB(A)]	Rounded off [dB(A)]
Michelin	XZU	70.46	70
Goodyear	Metro MCS	70.30	70
Continental	HB	70.76	71
Dunlop	SP 741 city	70.90	71

II.6.3.5 Drive-axle tires of size category 275/70 R 22.5 M&S

Manufacturer	Designation	Noise level [dB(A)]	Rounded off [dB(A)]
Michelin	XZU 2 T	74.71	75
Goodyear	G 267	72.35	72
Continental	HDU	75.37	75
Dunlop	SP 531 city	74.90	75

II.6.3.6 Steering-axle tires of size category 315/80 R 22.5

Manufacturer	Designation	Noise level [dB(A)]	Rounded off [dB(A)]
Michelin	XZA 2 Energy	68.04	68
Goodyear	Marathon LHS	69.12	69
Continental	HSL eco - plus	68.57	69
Dunlop	SP 351	70.34	70
Toyo	M 111	70.93	71

II.6.3.7 Drive-axle tires of size category 315/80 R 22.5 M&S

Manufacturer	Designation	Noise level [dB(A)]	Rounded off [dB(A)]
Michelin	XDA 2 Energy	73.64	74
Goodyear	Marathon LHD	72.76	73
Continental	HDL eco - plus	75.70	76
Dunlop	SP 451	73.06	73
Toyo	M 622	74.08	74

II.6.4 Braking on a wet surface

Mean braking path for deceleration on a wet asphalt road surface and deviations from the interpolated overall mean.

A positive deviation indicates a shorter-than-average braking path, i.e. a 'better' tire.

II.6.4.1 Summer tires of size category 225/70 R15 C

Manufacturer	Designation	Braking path [m]	Deviation [%]
Michelin	XCA	60.65	-10.45
Goodyear	CARGO G26	49.24	12.87
Continental	Vanco 8	65.12	-17.09
Dunlop	SP LT8	44.90	25.12

II.6.4.2 Steering-axle tires of size category 215/75 R 17.5

Manufacturer	Designation	Braking path [m]	Deviation [%]
Michelin	XZE 1	107.16	-8.24
Goodyear	Unisteel G291	92.76	7.87
Continental	LS 45	97.38	2.93
Dunlop	SP 351	97.58	3.27
Toyo	M 109	98.84	2.42

II.6.4.3 Drive-axle tires of size category 215/75 R 17.5 M&S

Manufacturer	Designation	Braking path [m]	Deviation [%]
Michelin	XDE 1	101.92	-2.93
Goodyear	Unisteel G124	100.66	-1.62
Continental	LD 75	96.74	2.54
Dunlop	SP 431	98.52	0.70
Toyo	M 608 z	95.32	4.23

II.6.4.4 Steering-axle tires of size category 275/70 R 22.5

Manufacturer	Designation	Braking path [m]	Deviation [%]
Michelin	XZU	114.30	0.86
Goodyear	Metro MCS	112.84	1.89
Continental	HB	118.84	-3.45
Dunlop	SP 741 city	114.60	-0.16

II.6.4.5 Drive-axle tires of size category 275/70 R 22.5 M&S

Manufacturer	Designation	Braking path [m]	Deviation [%]
Michelin	XZU 2 T	115.76	-2.73
Goodyear	G 267	106.30	5.61
Continental	HDU	111.66	-0.11
Dunlop	SP 531 city	111.02	-0.04

II.6.4.6 Steering-axle tires of size category 315/80 R 22.5

Manufacturer	Designation	Braking path [m]	Deviation [%]
Michelin	XZA 2 Energy	101.62	2.44
Goodyear	Marathon LHS	100.68	2.19
Continental	HSL eco - plus	104.14	-2.24
Dunlop	SP 351	104.96	-4.06
Toyo	M 111	100.24	-0.77

II.6.4.7 Drive-axle tires of size category 315/80 R 22.5 M&S

Manufacturer	Designation	Braking path [m]	Deviation [%]
Michelin	XDA 2 Energy	105.58	0.60
Goodyear	Marathon LHD	107.60	-1.47
Continental	HDL eco - plus	104.48	1.26
Dunlop	SP 451	107.82	-2.05
Toyo	M 622	104.28	1.06

II.6.5 Summary of results

Light truck, delivery transport

225/70 R15 C, Category C2, normal				
	Rolling resis-tance	**Weight [kg]**	**Noise level [dB(A)]**	**Wet braking [m]**
Michelin	0.93	14.71	72	60.65
Goodyear	0.93	15.51	73	49.24
Continental	0.90	15.22	71	65.12
Dunlop	0.98	17.53	73	44.90

Medium-sized truck, local transport

215/75 R17.5, category C3, normal Steering-axle tires				
	Rolling resis-tance	**Weight [kg]**	**Noise level [dB(A)]**	**Wet braking [m]**
Michelin	0.65	24.48	72	107.16
Goodyear	0.72	24.65	71	92.76
Continental	0.75	25.18	71	97.38
Dunlop	0.67	24.20	70	97.58
Toyo	0.76	25.27	70	98.84

215/75 R17.5, category C3, M&S Drive-axle tires				
	Rolling resis-tance	**Weight [kg]**	**Noise level [dB(A)]**	**Wet braking [m]**
Michelin	0.75	24.42	76	101.92
Goodyear	0.77	24.57	75	100.66
Continental	0.86	25.54	73	96.74
Dunlop	0.81	25.29	74	98.52
Toyo	0.85	25.41	73	95.32

Bus, municipal transport

275/70 R22.5, category C3, normal Steering-axle tires				
	Rolling resistance	**Weight [kg]**	**Noise level [dB(A)]**	**Wet braking [m]**
Michelin	0.65	57.96	70	114.30
Goodyear	0.57	56.63	70	112.84
Continental	0.65	52.04	71	118.84
Dunlop	0.60	54.42	71	114.60

275/70 R22.5, category C3, M&S Drive-axle tires				
	Rolling resistance	**Weight [kg]**	**Noise level [dB(A)]**	**Wet braking [m]**
Michelin	0.61	53.18	75	115.76
Goodyear	0.61	51.11	72	106.30
Continental	0.70	52.35	75	111.66
Dunlop	0.69	57.18	75	111.02

Heavy truck, long-distance transport

315/80 R22.5, category C3, normal Steering-axle tires				
	Rolling resistance	**Weight [kg]**	**Noise level [dB(A)]**	**Wet braking [m]**
Michelin	0.49	64.13	68	101.62
Goodyear	0.44	71.28	69	100.68
Continental	0.46	59.64	69	104.14
Dunlop	0.48	64.30	70	104.96
Toyo	0.54	62.91	71	100.24

315/80 R22.5, category C3, M&S Drive-axle tires				
	Rolling resistance	**Weight [kg]**	**Noise level [dB(A)]**	**Wet braking [m]**
Michelin	0.58	72.60	74	105.58
Goodyear	0.57	75.73	73	107.60
Continental	0.56	68.20	76	104.48
Dunlop	0.66	71.90	73	107.82
Toyo	0.70	67.39	74	104.28

II.7 Conclusion and outlook

In recent years, a reduction in noise and exhaust emissions has become increasingly important in our society. The ever rising volume of traffic on our roads is becoming more and more stressful for people.

In this context, truck transport is gaining increasing importance, since mileage in Germany has increased by approximately 111% since 1980. Over the next 15 years, freight traffic on German roads will increase by more than 58%. According to the current report published by the Federal Ministry of Transport, road-haulage transport will increase from 236 billion ton-kilometers in 1997 to 374 billion in 2015.

These figures demonstrate that road haulage is still the most cost-effective form of freight transport. Politicians, business and industry will therefore have to exploit all opportunities of reducing the burden on our environment in the future.

In the future, we must focus on key concepts such as fuel consumption, exhaust-gas and noise emission and resource conservation.

If, for example, tires with optimized rolling resistance are used in road haulage, this will not only result in a reduction in noise emissions but also lead to a decrease in fuel consumption of between 4% and 12%. In this context, it should be noted that the more level the route and the more regular the speed, the more fuel is saved. Vehicle aerodynamics are also decisive in this context, since rolling resistance has less influence on fuel consumption if vehicles are not optimized with respect to aerodynamics.

Of course, the cost effectiveness of all measures taken to realize improvements in environmental protection must not be neglected.

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