inter•noise 96
25th Anniversary Congress – Liverpool

INCE: 82

EFFECT OF TYRE NOISE LIMITS ON TRAFFIC NOISE

G J van Blokland, D F de Graaff & F Reinink

M & P Consulting Engineers, The Netherlands

INTRODUCTION

Road traffic is the most important source of environmental noise in Western Europe [1]. Several studies have shown that the noise of free flowing traffic is dominated by tyre/road noise. Therefore regulations with respect to the noise of vehicles nowadays focuses on the tyres. The European Commission has mandated the ERGA-noise III to develop a standardized measuring method and a system of limit values for car and truck tyres. General agreement has been reached on the measuring method. Basically the tyre is tested in a free rolling condition at a speed of 80 km/h for car tyres and 60 km/h for truck tyres on a road surface as described in ISO 10844 [2]. Next, a set of limit values must be proposed to the Commission.

In the present study we investigate the effect of a system of limit values on the average level of traffic noise. Three major effects have been taken into account:

1. a regulation does not affect the total population but only the products that are close to or exceed the limit value.
2. the distribution of types of tyres offered in the market differs significantly from the distribution of tyres that are actually sold. For instance, the fraction of types of tyres in the high speed segment is much higher than the market share of this segment.
3. it was found that differences between tyres measured on an ISO surface are much greater than the difference measured on other surfaces. One could say that the ISO surface "magnifies" the differences.

PARAMETERS INFLUENCING TYRE/ROAD NOISE

Car tyres

A statistical analyses was performed on a single set of data obtained from existing measurement data [3,4,5,6]. All trailer measurement data have been corrected with +3 dB to be able to compare them with total vehicle measurements. It proved that the most important parameter is the width of the tyre. In fig. 1 the total data set at 80 km/h on ISO surface together with the best fitting linear function, is displayed as a function of the width of the tyre. The standard deviation from individual points to the regression line was found to be 1.5 dB.

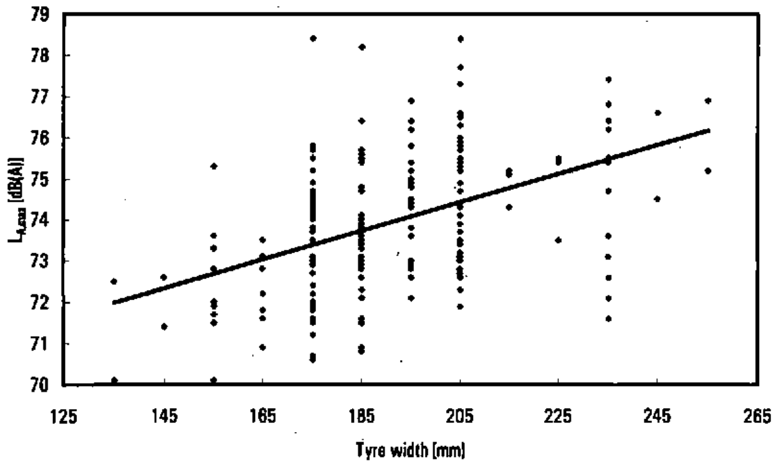


Fig. 1: noise levels of tyres at 80 km/h on ISO surface, [3,4,5,6] and the best fitting linear function.

Truck tyres

A statistical analysis has been performed on the data set from [3,5,7]. In this set, which also comprised "super singles" no significant relation was found between tyre width and rolling noise level. A significant relation was found with the type of the tyre. Results are given in table I.

Table I: Average rolling noise level of 3 types of truck tyres at 70 km/h.

Profile type	noise level	standard deviation
Rib	74.7 dB(A)	1.8 dB(A)
Block	76.7 dB(A)	2.3 dB(A)
Off road	77.6 dB(A)	2.1 dB(A)

Road surfaces

Road surfaces not only have a significant influence on the absolute level of tyre road noise but also affects the differences between tyres. A clear relation is found between the macro/mega texture level of the surface and the standard deviation of rolling noise levels of different tyres (see fig 2). On smoothly textured surfaces like the ISO surface the mean noise emission of tyres is relatively low, but the differences between tyres are relatively high. Coarsely textured road surfaces like transversely grooved concrete show a relatively high mean noise emission but small differences between rolling noise levels of tyres. For truck tyres a similar relation was found [8].

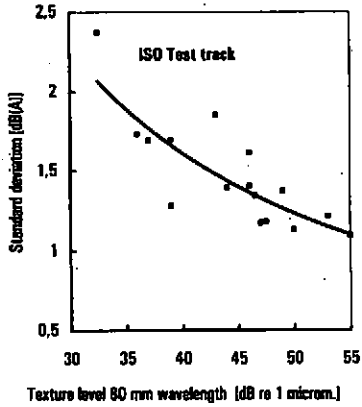


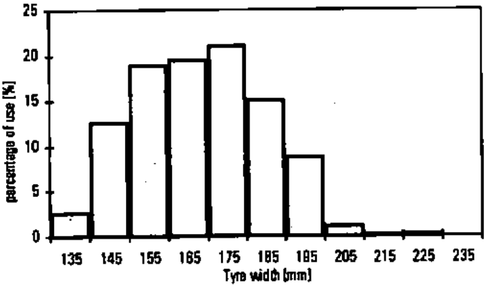
Fig. 2:

Spread in rolling noise levels of car tyres in relation to the macro/mega texture of the road surface.

NUMERICAL DATA ON TYRES TYPES AND ROAD SURFACES

The data have been obtained from statistics on vehicle use, road surfaces and product information from major tyre manufacturers.

In fig. 3 the distribution of tyres widths of car tyres and tyre types for truck tyres sold in the Netherlands is given.



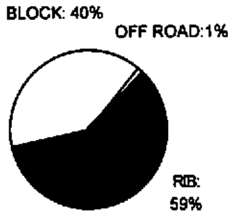


Fig. 3: The market share in the Netherlands of car tyres as a function of its width and truck tyres as a function of its type (1994).

In Table II, numerical data on road surfaces are displaced. The figures are characteristic for the situation in the Netherlands on motor ways, where an increasing share of porous asphalt is applied. The share of coarse surfaces like asphalt concrete with chipping sizes up to 22 mm is very low. The compression ratio is defined as the ratio of the standard deviation of the given surface over the standard deviation of the ISO-surface.

Table II: Share, relative noise emission level and compression factor of tyre noise differences of four classes of road surfaces.

surface type	share	noise emission	compres-sion ratio
smooth	5%	0 dB	1
medium	68%	+ 1.5 dB	0.86
coarse	1%	+4.5 dB	0.69
porous	26%	-1 dB	0.53

SCENARIOS OF TYPE APPROVAL REGULATIONS

On base of the relations and market shares presented above we have calculated the effect of two scenarios of limiting regulations of the noise level of tyres:

I. a single limit value of 79.3 dB(A) for car tyres and a single limit of 79.2 dB(A) for truck tyres, both based on the 80 percentile value over tyre types;

II. a limit value for car tyres, depending on the width of the tyre and for truck tyres, depending on the type of tyre. Limit for car tyres is given by:

$$L_{limit} = 0.035.[width\ (in\ mm)] + 68.6\ dB(A)$$

For truck tyres the limit value has been fixed on the 80 percentile levels of the truck tyre populations of the three types (see table III).

Table III: Limit values for truck tyres based on 80 percentile values within each type

tyre type	RIB	BLOCK	OFF ROAD
limit value	76.8 dB(A)	78.6 dB(A)	80.1 dB(A)

We have calculated the effect of these two scenarios on the mean level of traffic noise. The results are given in table IV.

Table IV: effect of tyre noise limits on the mean level of traffic noise on through roads.

scenario	reduction of mean traffic noise level
I: single limit	0.1 dB
II: width and type depended limit	0.6 dB

The dissapointing effects are caused by two mechanismes:

1. the limit system is effective on tyre types that have very low market share. About 50 % of the available tyre types have widths exceeding 200 mm while less than 5% of the tyres actually sold are within this width range.
2. reductions in tyre noise levels found on ISO surfaces are about twice as high as found on average road surfaces.

EFFECT OF ADDITIONAL LOWERING OF LIMIT VALUES

Once a type approval system and a set of limit values is established, it may be expected that the limits will become more stringent after some time, based on what is thought to be the state of technology available for further reduction of noise levels. As was shown with the type approval limits for vehicles, the original limits were easy to obey. Noticeable reduction of mechanical noise did only take place when limits were significantly lowered.

Therefore we have also calculated the effects of further reduction of limit values. In all cases it is assumed that all tyres that do not meet the limits are banned from the market. The tyres that do meet the limit remain unaffected. The results of these calculations are given in table V.

Table V: Effect of additional lowering of limit values on the percentage of tyres that will be removed from the market and on the resulting level of traffic noise.

scenario	additional lowering of limit value	percentage of tyre types		reduction of traffic noise
		car tyres	truck tyres	
scenario I: a single limit	0 dB	20	20	0.1 dB
	1 dB	34	33	0.2 dB
	2 dB	53	48	0.5 dB
	4 dB	83	78	1.4 dB
scenario II: width and type depended limits	0 dB	20	20	0.6 dB
	1 dB	45	35	0.9 dB
	2 dB	72	55	1.5 dB
	4 dB	96	87	2.7 dB

CONCLUSIONS

The following conclusions can be drawn:

1. car tyres within the width range of 155 to 195 mm contribute heavily to traffic noise;

2. road surface texture affects differences between tyres. The reduction of noise levels assessed on ISO-tracks are about twice as high as on medium textured surfaces;

3. regulations based on a single limit have virtually no effect on traffic noise, unless dramatic low levels are required. Most probably, such limits cannot be met by tyres that are mounted on luxury vehicles and sports cars;

4. limit values depending on type and width of the tyre are more effective than a single limit. However drastic changes in the market share of tyres will be needed to acquire a noticeable reductions of mean traffic noise levels;

Although the results presented here are based on statistical data from the Netherlands, the conclusions will not be basically different when European based data will be applied.

REFERENCES

1. A. von Meier, prepared for the EC, DGXI, Task Force European Environment Agency: "Europe's environment 1993, noise pollution", report nr. EG.93.1.1, M+P raadgevende ingenieurs b.v., Aalsmeer the Netherlands, August 1993.
2. ERGA-noise document 12/1, "Permissible sound level of tyres related to tyre/road noise", draft proposal amending directive 92/23/EEC relating to tyres, European Commission DG III, Brussels Belgium, November 1993.
3. P.M. Nelson, G.J. Harris, B.J. Robinson, ERGA-noise document 39, "An examination of the relationship between tyre noise and safety performance", European Commission DG III, Brussels Belgium, January 1994.
4. A. Köllmann, "Ermittlung des Standes der Technik hinsichtlich der Geräuschemission von PKW-Reifen", FIGE report 10505144, FIGE, Herzogenrath Germany, October 1993.
5. J.L. Marduel, ERGA-noise document 44, "Report on sound level tests related to the definition of limits for tyre/road noise", European commission DG III, Brussel Belgium, January 1995.
6. G.J. van Blokland, D.F. de Graaff, "Influence of meteorological conditions on the noise of tyres and vehicles during type-approval", M+P report MVM 93.5.1, M+P raadgevende ingenieurs b.v., 's Hertogenbosch the Netherlands, October 1994.
7. D.F. de Graaff, G.J. van Blokland, "Aspects of a standardized noise-measuring method for the type-approval of tyres", M+P report MVM 92.7.3, M+P raadgevende ingenieurs b.v., 's Hertogenbosch the Netherlands, November 1994.
8. D.F. de Graaff, G.J. van Blokland, "The effect of low noise road surfaces on the noise of truck tyres", ICA Trondheim Norway, June 1995.