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COMPARISON OF THE NOISE EMISSION OF SIX DIFFERENT TRAMCAR TYPES IN THREE DIFFERENT CITIES

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INTRODUCTION

Numerous mechanisms have been proposed for the generation of rolling or roar noise of rail bound vehicles.
The main mechanisms are:
- the roughness of the surface of the wheel
- the roughness of the surface of the rail
- aerodynamic sources
- air pumping
- hertzian deformation
- creep forces etc.

To avoid aerodynamic sources and air pumping the measurements were performed by the low velocity of 40 km/h.
The influence of the hertzians deformation and creep forces in the rail construction can be eliminated by embedding the rail in asphalt
Only the roughness on the surface of the wheel and rail are responsible for the noise generation.
It is postulated that this roughness, having wavelengths of 0,5 m down to small fractions of 2 cm, excites both the wheel and the rail. then radiate sound to the wayside.

EXPERIMENTAL PROGRAMS

The programs has been designed to provide a realistic assessment of the acoustic performance of the influence of the grinding of the track, the truing of the wheel and the wheelstructure.

Railcars
The tests are being perfomed using overhauled tramcars of six different types, in three different cities:
Amsterdam, "Werkspoor" type 6G and L.H.B. type 8G
The Hague, P.C.C. type 1100 and 1300
Rotterdam, Schindler and Duwag.

Wheels
The type of wheels on the tested tramcars are for the tramcar in Amsterdam and Rotterdam: Bochum and for The Hague type S.A.B. All the wheels are trued up to three days before the tests are performed.

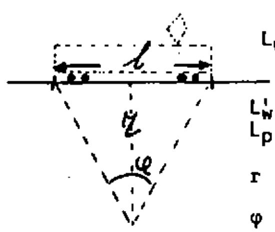
Railgrinding
In the three cities a different manner of rail grinding was executed. By visual inspectation the smoothness of the rail head contour was controlled.

Test tracks
To eliminate the acoustical difference of the six different tracks the transfer function from the noise source of the tramcar to the measuring microphone for each track were measured. This transfer function is highly dependable on the locations of the noise source and the measuring point. The exact position of the noise source is not known. For the measuring distance of 7,5 m we have chosen nine source locations with a height of 0,1; 0,2 and 0,4 m above the railhead.
For the measuring distance of 25 m, 15 source locations are measured. The used transfer function is the average of all the transfer functions of one location.

Measurement conditions
The measurement conditions, as much as possible, are in compliance with the socalled "type keuring" measurements (RL-HR-01-01 or ISO 3095).
The testing is performed at a nominal speed of 40 km/h, 1,5 m above the top of rail on 25 m distance at a height of 3,5 m above the top of the rail.

RESULTS WAYSIDE NOISE

From the measurements of the sound pressure level the sound power level of the tramcar can be calculated by the formular:



$$L_W' = L_p + 10 \lg 2\pi r - 10 \lg \frac{\varphi}{180^\circ} - 10 \lg \frac{\pi}{2} + D$$

L_W' = sound power per 1 m length of the tramcar
L_p = the maximum of the sound pressure level in point A
r = distance between center of the tramcar and the measuring point
φ = the angle of sight of the source
D = the average of the transfer functions
l = length of total tramcar

The source sound power level we can also calculate for one truck

$L_W' = L_W + 10 \lg 1 - 10 \lg n.$
L_W = sound power level of one truck
n = the number of trucks of a tramcar.

In figure 1 you will find the average sound power level of one truck for a track on ballast.
In figure 2 you will find the average difference of the sound power level of one truck for the tramcars in The Hague, Rotterdam and Amsterdam measured on a ballast track and a track embedded in asphalt.
The conclusions from this figure are:

a) the influence of the rail noise is not pronounced at a speed of 40 km/h
b) the acoustical difference between the different tracks is not only dependable on the fact that the rail on ballast or embedded in asphalt.

In figure 3 we have showed that there is a difference by calculating the sound power level of a truck, starting the measurement on 7,5 m or 25 m distance. This means that at a distance of 7,5 m the sound pressure level is dominated by the noise produced by the small scale roughness on wheels and rails.
When we compare the measurement for The Hague with results of other tramcar measurements in The Hague along straight tracks (no wheel or trackgrinding), we find a maximum difference in sound pressure level from 0 up to 4 dB(A).
When we compare the average of the sound power levels of one truck of tramcars with S.A.B. - wheels and with Brochums wheels than we will find that the tramcar with S.A.B. - wheels has about 3 dB(A) lower sound power (only for straight tracks).

CONCLUSION

In the preceding sections we have attempted to present a broad overview of the numerous measurements of tramcars wayside noise in Holland. The results of the investigations did not give a confirmation of the used model of the generation of rail-wheel noise. The dependence on the locations of the test tracks is dominating the result of the measurements, so that a more precise description in measuring standards is required.

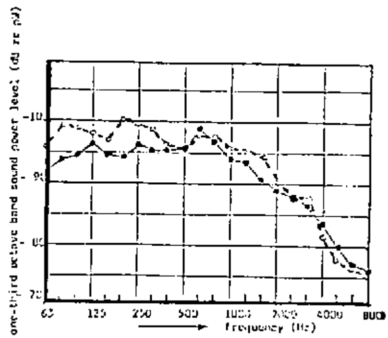


Fig. 2: ←→ average sound power level of one truck, track on ballast
•—• average sound power level of one truck, track embedded in asphalt

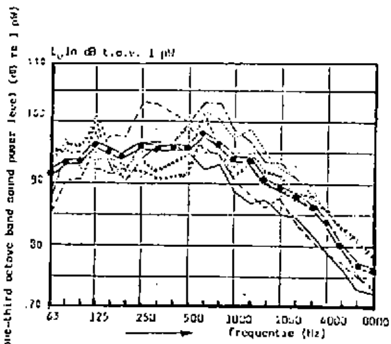


Fig. 1: average sound power level of one truck, track on ballast

———	P.C.C. car type 1100
- - - -	P.C.C. car type 1300
—·—	Schindler
....	Duwag
ooooooo	Werkspoor car type 8G
xxxxxxx	L.H.B. car type 6G
▬▬	average sound power level of one truck, track on balk

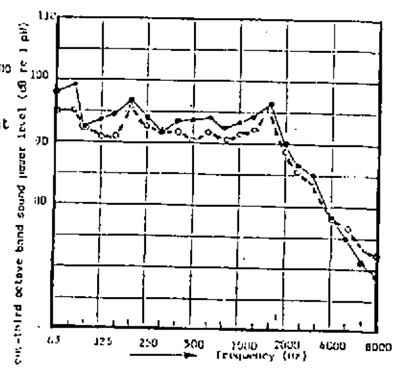


Fig. 3: max. sound power level of one
←→ truck calculated from measurements on 7,5 meter
•—o max. sound power level of one truck calculated from measurements on 25 meter