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NEW ROAD SURFACE SOURCE CORRECTION FACTORS FOR NORD2000 CALCULATIONS IN SWEDEN

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ABSTRACT

On June 1st 2024 Sweden transitioned from the previous Nordic Prediction Method, revised 1996 (Nord96) to Nord2000 as recommended road traffic community noise calculation method. The road traffic source model in Nord2000 was extensively updated in 2005-2006 when major results from the EU-projects Harmonoise and Imagine were incorporated. As part of that inclusion was the oportunity to provide corrections for road surfaces other than the virtual reference surface included the Nord2000 (as well as in Harmonoise/Imagine). In Nord96 there was a table published presenting frequency independent, single value correction factors for certain reference traffic situations and road surfaces which were seldom used in practice. The updated Nord2000 road traffic source model allows for more detailed corrections, and in this paper speed and frequency dependent corrections for some common Sedish road surfaces are presented. These factors are based on extensive CPX measurements, and results show large source level impacts in certain frequency bands pointing to the importance of properly including road surface effects.

Keywords: *tyre-road noise, nord2000, corrections*

1. INTRODUCTION

The influence of the road surface texture on radiated noise from the tyre-road contact has been investigated for a relatively long time and two ISO-standardised measurement methods are currently used to determine the noise properties of the road surface relative to a reference surface: Statistical Pass-by (SPB) described in ISO 11819-1:2023 [1] and Close Proximity (CPX) ISO i 11819-2:2017 [2]. SPB is a method where normally occurring traffic is the source of noise and variation in speed is correlated with variation in radiated noise level for a certain type of road surface. In the SPB method the measurement microphone is placed 7.5 meters from the center of the road and thus representative of the method used for determining road traffic noise source terms for community noise calculations. The spread in level between individual vehicles is often large because the characteristics of the tires vary between vehicles and because noise from the engine and driveline is also captured by the measuring equipment, so a large number of vehicle passages need to be recorded to obtain a reliable relation between road surface and noise emission which makes it time consuming and costly to perform measurements for all relevant road surface types. CPX, instead, means that a standardized tire is mounted on a bespoke trailer with measurement microphones mounted 0.2 meters diagonally to the side and in front and behind of the tire. The deviation is very small between individual measurements of the same surface as it is a single tire that constitutes the noise source and the tire is placed far from other noise sources such as engine and drive line. The two standard tires used are designated P1 for the standardized passenger car tire and H1 for the corresponding heavy vehicle tire and they are described in 11819-3:2021 [3]. As Sweden is using Nord2000 as recommended noise prediction method for road traffic noise since June 2024, there is a need for an updated method to include the influence of road surface properties in the road traffic noise emission. While the two different standardized methods for

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measuring the influence of road surface properties on road trafiic noise have different advantages and disadvantages and complement each other, in this report, correction values for tire-road noise for different pavements have been developed based exclusively on CPX measurements, kaming the assumption that the standardized tires are representative of how the entire vehicle population behaves in contact with the road surface types of interest.

2. TIRE ROAD NOISE MECHANISMS

Several different mechanisms contribute to the generation and emission of noise from the interaction between the tyre and the road surface [4]. The contact between a passenger car tire and the road surface takes up an area about the size of a palm. Within this contact patch, energy is transferred to the tire mainly through two mechanisms. The first is that the uneven road surface indents the soft rubber as the tire rolls along the road causing waves to propagate in the tire that radiate sound to the surroundings. The second mechanism is that the rubber of the tyre stick to the road surface so that the rubber blocks that make up the tread remain for a short time where they have hit the road surface and are then ”dragged” along the surface for a short distance, or that they adhere and are then pulled up from the road surface. These two phenomena are called ”stick-slip” and ”stick-snap” and, like the unevenness of the road surface, contribute to vibrations in the tire. When the tire, loaded with a quarter of the vehicle's weight, rolls along the road, air can be trapped in small cavities that occur between the smallest parts of the tread pattern and gaps between the aggregate chips in the pavement. The air in the cavity is compressed, and when the cavity is opened again, the air puffs out with a hiss. The sound that occurs is not related to vibrations in the tire but is a separate sound source, and the effect is called ”air pumping”. To what extent air-pumping actually occurs along ordinary roads with ordinary vehicles is not clear. All these mechanisms create sounds that are loudest near the contact patch between the tire and the road. The round shape of the tire together with the plane of the road forms two horn-like shapes, one facing forward and one backward. The horns have only top and bottom, no sides, but it is enough to amplify the sound of the contact between the tire and the road. This reinforcement is naturally called the horn effect. Exactly how these different mechanisms relate to different properties of the road surface is not fully understood, but some connections are clear. Larger unevenness in the road surface, such as due to larger aggregate sizes, contributes to higher vibration energy and thus higher noise levels. Smoother road surfaces mean a greater possibility for the rubber to stick and thus contribute to greater contribution from stick-slip and stick-snap. Rubber is a non-linear material and can act as a mechanical spring for some cases of load and temperature, while for other cases it acts more like a viscous fluid, which means that the occurrence of stick-slip and stick-snap can vary for an individual tire depending on external conditions. When it comes to air pumping, the connection is more complex as it is the combination of tire tread and the unevenness of the road surface that determines how big the effect is.

3. PREVIOUS ROAD SURFACE CORRECTIONS

Table 1: Figure captions should be placed below the figure.

Vägbeläggning			Korrektionsterm i dB(A) för viss andel (%) tunga fordon							
Nr.	Typ (här anges även max. stenstorlek)	Ålder [år]	0-60 km/h			61-80 km/h			81-130 km/h	
			0-5%	6-19%	20-100	0-5%	6-19%	20-100	0-5%	6-100%
1.a	Asfaltbetong, tät, slät (max 12-16 mm)	1-20	ref	ref	ref	ref	ref	ref	ref	ref
1.b	D:o, nylagd	<1	0	0	-1	-2	-1	-1	-2	-2
2.a	Asfaltbetong, tät, slät (max 8-10 mm)	1-20	0	0	0	-1	0	0	-1	-1
2.b	D:o, nylagd	<1	-1	-1	-1	-2	-1	-1	-2	-2
3.a	Skelettasfalt (mastic) (max 12-16 mm)	1-20	0	0	0	+1	0	0	+1	0
3.b	D:o, nylagd	<1	0	0	0	+1	0	0	+1	0
4.a	Skelettasfalt (mastic) (max 8-10 mm)	1-20	-1	-1	0	-1	-1	-1	-1	-1
4.b	D:o, nylagd	<1	-2	-1	0	-2	-2	-1	-2	-2
5.	Bituminiserad chip-sten (BCS)	0-20	+1	0	0	+2	+1	0	+2	+1
6.a	Ytbehandling, enkel (Y1), max 16-20 mm	1-20	+1	0	0	+2	+1	0	+2	+1
6.b	D:o, nylagd	<1	+2	+1	0	+3	+1	-1	+2	+1
7.a	Ytbehandling, enkel (Y1), max 10-12 mm	1-20	0	0	0	0	0	0	0	0
7.b	D:o, nylagd	<1	0	0	0	0	0	-1	0	0
8.a	Ytbehandling, enkel (Y1), max 6-9 mm	1-20	0	0	0	-1	0	0	-1	0
8.b	D:o, nylagd	<1	-1	0	0	-1	-1	-1	-1	-1
9.a	Ytbehandling, dubbel (Y2), max 16-20mm	1-20	0	0	0	+1	0	-1	0	0
9.b	D:o, nylagd	<1	+1	0	0	+1	0	-2	0	0
10.a	Ytbehandling, dubbel (Y2), max 10-12mm	1-20	0	0	0	0	0	-1	0	-1
10.b	D:o, nylagd	<1	0	0	0	0	-1	-2	0	-1
11.a	Dränasfalt, max 14-16mm (≥20% hålrum)	3-7	0	0	0	-1	-1	-1	-1	-1
11.b	D:o, "medelgammal"	1-2	-1	-1	0	-1	-1	-1	-1	-2
11.c	D:o, nylagd	<1	-2	-2	-2	-2	-2	-3	-2	-3
12.a	Dränasfalt, max 8-12 mm (≥20% hålrum)	3-7	0	0	0	-1	-1	-1	-2	-2
12.b	D:o, "medelgammal"	1-2	-1	-1	-1	-2	-2	-2	-3	-3
12.c	D:o, nylagd	<1	-3	-3	-3	-4	-4	-5	-5	-5
13.	Cementbetong, tät, slät, max 20-80 mm	0-40	+2	+1	+1	+2	+2	+2	+2	+2
14.	Cementbetong, tät, slät, max 12-18 mm	0-40	+1	+1	+1	+2	+2	+2	+2	+2
15.	Cementbetong, slipad (slipning ej sliten)	0-5	-1	-1	-1	-2	-2	-2	-1	-1
16.	Gatsten, kullersten (äldre typ)	0-90	+3	+3	+2	+5	+4	+3	+5	+4
17.	Cementblocksten (modern typ)	0-20	0	0	0	0	0	0	0	0

In the previous recommended noise prediction method in Sweden, The Nordic Prediction Model, revised 1996 [5] (Nord96), corrections for different road surfaces are given in a table (see Tab. 1) in the form of single integer value A-weighted emission level differences. The differences are given in comparison with the reference pavement that applies to the model, which is the one referred to in the table as ”Asphalt concrete, dense, smooth (max 12–16 mm)” which corresponds to SMA16 which is the most common pavement type on national roads and highways in Sweden. The table shows corrections for three different speed ranges and for three different distributions of heavy and light vehicles, except for the maximum speed range where there are two distributions of heavy and light vehicles. The pavement types included in the table are those that were commonly used when the data was collected.

4. ROAD SURFACE MEASUREMENTS

Measurements using the CPX method have been carried out for 8 different pavement types at different times between the years 2010 and 2020 under the supervision of Ulf Sandberg at VTI. The designation for each pavement is accompanied by a number indicating the largest stone size in millimetres of the pavement:

- SMA is Stone Mastic Asphalt. The aggregate consists mostly of larger stone sizes and almost no smaller than the maximum aggregate size. The aggregate creates a layer of tightly packed stones and relatively little binder open to wear.
- DAC is Dense Asphalt Concrete. Unlike SMA, the aggregate basically consists of stone sizes in the entire spectrum up to the largest stone size and thus has a slightly higher binder to aggregate ratio and is also slightly smoother.
- UTBWC is Ultra-Thin Bonded Wearing Course. It is a layer that is thinner than the others, often as thin as the maximum aggregate size, and is often used as a top layer when "refurbishing" existing, worn road surfaces.

For the first two types, maximum aggregate sizes of 8, 11 and 16 mm have been measured. For UTBWC only 11 and 16 mm have been measured. Instead of the SMA16 reference pavement in the previous method, Nord2000 defines the reference surface as: "It is a virtual reference defined as the average of SMA 0/11 and DAC 0/11, 1 year or older but not at the end of its life time" [6]. The reference pavement in Nord2000 is the same as for the Harmonoise prediction method [7] as well as for the common European method Cnossos-EU [8]. Since the CPX measurement data contains both SMA 11 and DAC 11 surfaces, the reference surface was constructed by calculating the average one-third octave band noise levels in the CPX measurements of these two surface types. In the continuation of this document, this calculated virtual reference pavement is referred to as N2K-REF.

Fig. 1 shows the results of the CPX measurements as difference in third-band levels between the N2K-REF and the different measured pavement types. The differences are presented for the two different measurement speeds 50 km/h and 80 km/h and for the two reference tyres P1 and H1, which represent vehicles of category 1 and category 2 and 3 respectively. According to the CPX standard, one-third octave bands between 315 and 5000 Hz must be reported, but the underlying measurements contain one-third octave bands also outside this range so the entire frequency range from the measurements is presented here. The DAC 16 pavement seems to exibit high levels in higher frequency bands for the P1 tire at 50 km/h, but since tire-road noise emissions are not very high in the higher frequency bands, this has a limited influence on an A-weighted aggregate value.

5. METHOD FOR DETERMINING ROAD SURFACE CORRECTIONS

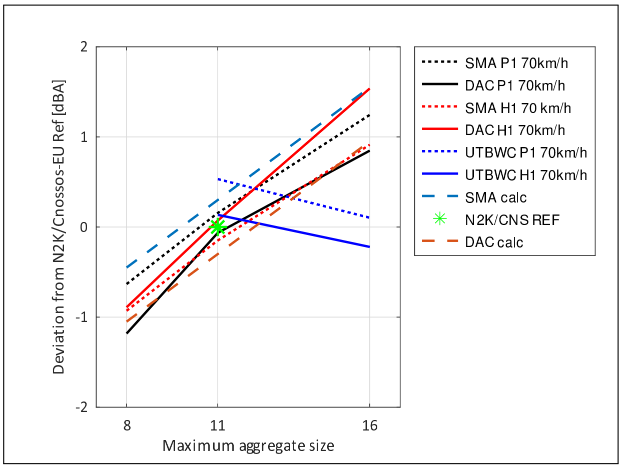
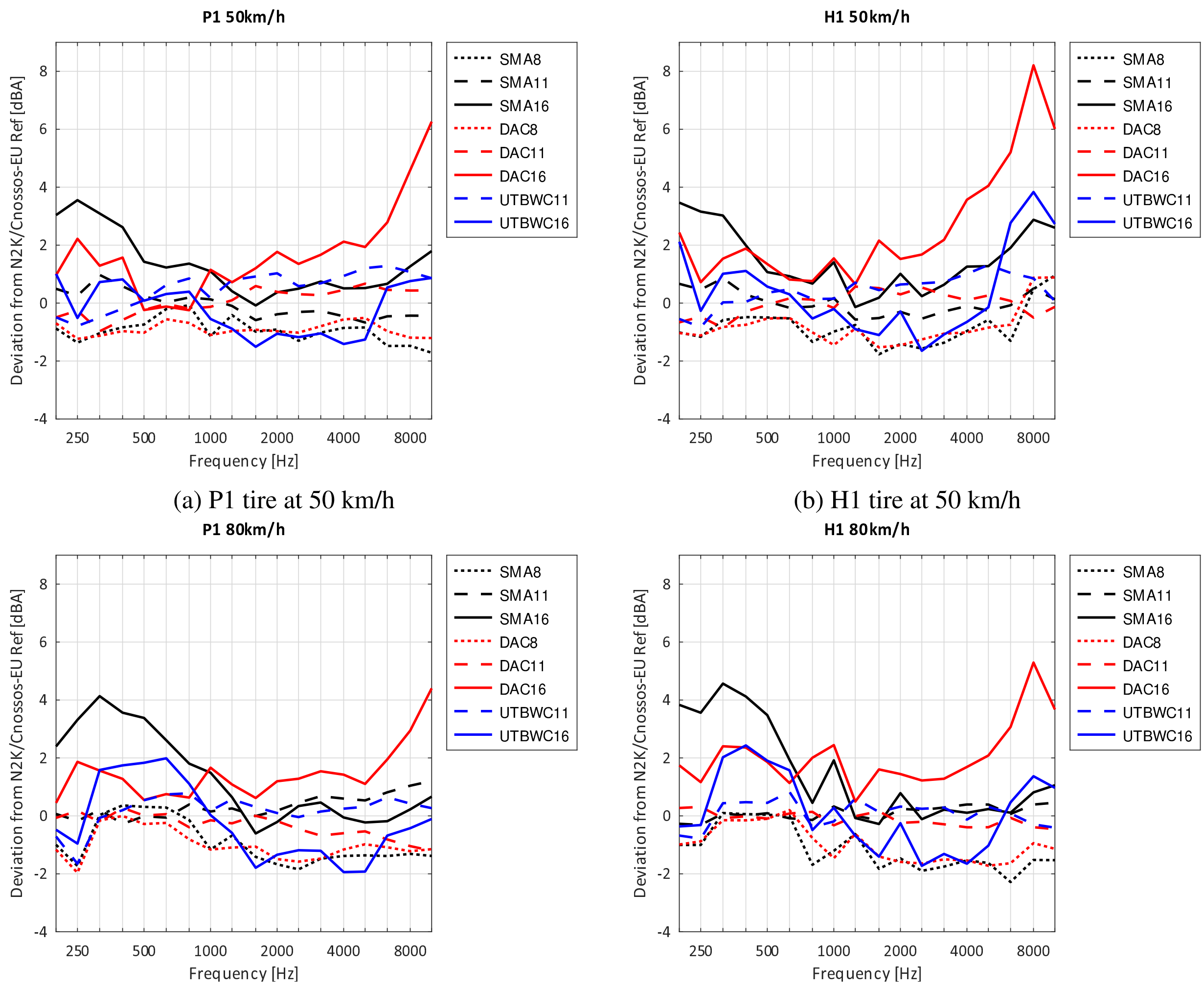


Figure 2: Difference in A-weighted noise level between N2K-REF and the different measured pavements as a function of maximum aggregate size.

In Harmonoise as well as in Nord2000 Road, a simple function was introduced to normalize vehicle noise emissions for the different reference pavements that occur in different European countries if they differ from the "golden standard" N2K-REF:

$$\Delta L_{\text{Road}} = RS + 0,25(CS - 11) \ (dBA) \tag{1}$$

where RS means "Road Surface" and is given as +0.3 dBA for SMA or -0.3 dBA for DAC according to stan-



(a) P1 tire at 50 km/h

(b) H1 tire at 50 km/h

(c) P1 tire at 80 km/h

(d) H1 tire at 80 km/h

Figure 1: Measured difference in third-band sound levels between NK2-REF and the different pavements measured with CPX method reference tires P1 and H1 at measurement speeds 50 km/h and 80 km/h.

dard values in Nord2000. CS means "(maximum) Chip Size" i.e. largest aggregate size in the pavement. The "slope" 0.25 represents the influence of aggregate size in the pavement on the emission level and is given in units of dBA/mm. To compare with the measurements carried out, the difference in A-weighted level was calculated as a function of aggregate size. Fig. 2 shows the difference in A-weighted sound level for the different measured pavements as a function of the largest aggregate size at the reference speed of 70 km/h, as well as calculated levels calculated using equation (2). As can be seen in the figure, the slope of the lines is essentially consistent with the slope of the calculated A-weighted differences in accordance with the method in Nord2000 / Harmonoise, which means that the relationship with maximum aggregate size agrees reasonably well between the measured results and the calculated values for SMA and DAC pavements. On the other hand, the UTBWC pavement appears to exhibit different properties than SMA and DAC in that the level difference remains relatively unchanged or even decreases with increasing aggregate size, although it should be noted that this pavement only occurred with two aggregate sizes, 11 and 16 mm. However, UTBWC is not a pavement that is part of the cluster of reference pavements mentioned in the Harmonoise report [7] so a single value reference surface correction for that pavement type is not as critical. The difference in level depending on the type of pavement seems to differ between measured and calculated values and it is also noteworthy that the ratio between the type of pavement and the difference in level differs between vehicles of category 1 (P1 tyres) and categories 2 and 3 (H1 tyres). Given these conditions, the recommendation is therefore to keep 0.25 as the slope for SMA and DAC pavements, but that it is difficult to justify keeping the values of the road type factor RS in (2), 0.3 and -0.3 for SMA and DAC respectively, especially considering that there are relatively large differences between the two tire types.

Tab. 2 shows new recommended values for the pavement type factor (RS) given maintained "slope" (0.25 in (2)) for P1 tyres and H1 tyres and the combination of both. The Nord2000 Road source data report mentions that the singular reference road surface normalization that can be calculated in accordance with (2) should only be used for category 1 vehicles. However, as Nord96 included road surface corrections for different proportions of light and heavy vehicles (Tab. 1) the combined value of the road surface factor RS has been calculated for the distribution of traffic of 90% of category 1 vehicles and 10% of category 2 and 3 vehicles, which is also justified by the fact that category 1 represents 80 to 90 % of traffic on most major roads and thus has the greatest influence on equivalent noise levels, whereas categories 2 and 3 constitute the dominant contribution to maximum noise levels. In the calculations behind Tab. 2 the DAC16 pavement has been excluded as only a single specimen of the pavement has been measured on a single occasion and therefore lack statistical validity. Both Nord2000 and Harmonoise are

Table 2: Pavement type factor and gradient for P1 tires and H1 tires, as well as for both combined, calculated for SMA and DAC from CPX measurement data.

	RS SMA (dBA)	RS ABT (dBA)	Slope (dBA/mm)
P1	0.09	-0.16	0.25
H1	-0.30	-0.03	0.25
BOTH	0.05	-0.15	0.25

intended to be used in different countries where different reference pavements apply. There are examples of road surface corrections published in section 6.10.4 of the Harmonoise source data report [7] for a few different pavement types in other countries. Whether corrections from countries other than Sweden are suitable for Swedish conditions depends on whether the conditions that apply to the corrections correspond to Swedish conditions. An example is Danish road surface corrections, which represent an annual average value and have been corrected for temperature variations and for that the road surface is damp some of the time. The conditions for the current guideline values in Sweden are that the road surface is dry and that the air temperature is 15 °C, which means that Danish road surface corrections cannot be used. Correspondingly, the conditions for any road surface corrections from countries outside Sweden that are available need to be carefully examined by the user to determine whether they are useful for Swedish conditions. During the developement of the current Nord2000 source model for road traffc it was noted that pass-by measurements from Sweden, Norway and Finland showed consistently higher levels for the same type of pavement than other countries, which is probably due to the fact that the use of studded tyres in these three countries increases the wear of the pavement, which increases the roughness of the road surface. This is handled in Nord2000 with a special spectrum adaptation for Swedish, Norwegian and Finnish conditions. Since the spectrum adaptation is based on pass-by measurements, contributions of different origins cannot be separated, which means that the spectrum adaptation includes both the greater surface roughness of Swedish roads due to studded tire wear as well as any differences in tire-road noise due to differences in the composition of the Swedish vehicle fleet compared to the one included in the emission data included in Nord2000. The spectrum adaptation published in 2006 [**?**] has later been updated when an adaptation for propulsion noise was also developed to better match today's Swedish vehicle fleet [9, 10]. All measurements that form the basis for the road surface corrections presented in this report are measured on the Swedish road network, with a reference surface calculated from Swedish measurement data. Thus, it can be assumed that the ratio between the measured Swedish pavements and the Swedish version of the Nord2000 reference pavement is the same as the ratio between the reference pavement and the measured pavement in other countries.

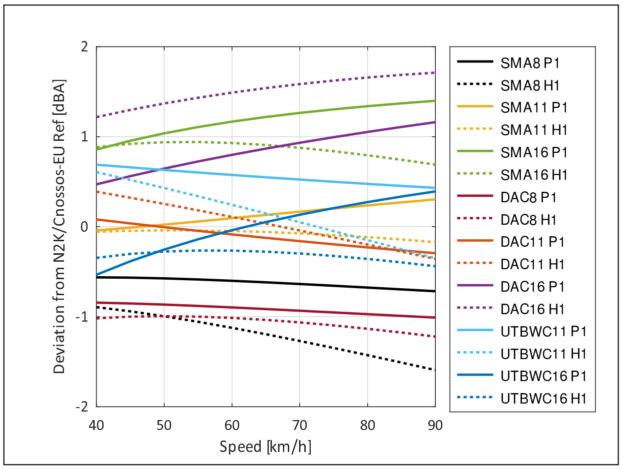


Figure 3: A-weighted road surface correction relative to N2K-REF as a function of speed for different pavements and different reference tyres.

To further investigate which effects would be relevant to include in a road surface correction based on the CPX measurements performed, the difference in A-weighted level for the different measured pavements for both the P1 and H1 tires compared to the N2K-REF was calculated. A speed dependency was calculated by inter- and extrapolating relative to the two measurement speeds 50 km/h and 80 km/h. Fig. 3 shows how the difference in A-weighted noise level varies with speed for the measured pavements and for the two different types of tyres. It can be seen that for several of the pavement types there is a speed dependency that is different for different pavements and different tire types. Thus corrections are needed that are both frequency and speed dependent and that differentiate between vehicle types.

6. ROAD SURFACE CORRECTIONS FOR NORD2000

Tab. 3 and Tab. 4 contain α and β parameters for calculating speed and frequency dependent road surface corrections for different vehicle types according to

$$\Delta L_{\mathrm{Road,i,j}} = \alpha(i,j) + \beta(i,j) log\left(\frac{v_{\mathrm{j}}}{v_{\mathrm{ref}}}\right) \quad (dBA) \qquad (2)$$

where i represents the current one-third octave band, j represents the current vehicle type, V_{ref} = 70 km/h and where valid v_{j} is between 40 km/h and 90 km/h to minimize the risk of large errors due to extrapolation far outside the measurement speeds. Nord2000 handles a significantly larger frequency range than what is included in the CPX method, and it is possible that there are differences in the radiated sound level from tires between different road surfaces for frequencies lower than 315 Hz. Kropp et. al. [11] indicate that frequencies down to 200 Hz are relevant for noise from rolling passenger car tires, and given the larger dimensions of tires for heavy vehicles, it is not impossible to imagine that they can contribute even further down in frequency. It is possible to use pass-by measurements to capture low-frequency effects, with the risk of drive train noise affecting results. However, the corrections presented in this paper consist only of CPX measurements with the limitations in frequency range that this entails.

Table 3: Road surface corrections for Category 1 vehicles for a few different pavements that occur in Sweden. Based on CPX measurements with P1 tire at 50 km/h and 80 km/h.

	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000
	α														
SMA8	-0.27	0.02	0.01	0.15	-0.12	-1.16	-0.60	-1.29	-1.46	-1.69	-1.35	-1.23	-1.21	-1.23	-1.21
SMA11	0.43	-0.03	0.06	-0.03	0.34	0.14	0.16	-0.17	0.02	0.24	0.41	0.30	0.19	0.30	0.19
SMA16	3.84	3.29	2.83	2.22	1.68	1.38	0.58	-0.46	-0.05	0.38	0.54	0.10	-0.01	0.10	-0.01
DAC8	-0.44	-0.28	-0.49	-0.33	-0.77	-1.15	-1.06	-1.02	-1.34	-1.42	-1.28	-0.99	-0.85	-0.99	-0.85
DAC11	-0.43	0.03	-0.06	0.03	-0.34	-0.14	-0.16	0.17	-0.02	-0.24	-0.41	-0.30	-0.19	-0.30	-0.19
DAC16	1.49	1.36	0.33	0.50	0.38	1.52	0.98	0.78	1.36	1.30	1.58	1.62	1.34	1.62	1.34
UTBWC11	-0.19	0.09	0.41	0.71	0.80	0.17	0.64	0.48	0.36	0.14	0.30	0.44	0.57	0.44	0.57
UTBWC16	1.34	1.48	1.34	1.51	0.91	-0.14	-0.67	-1.71	-1.26	-1.18	-1.16	-1.79	-1.73	-1.79	-1.73
	β														
SMA8	5.24	5.88	5.16	2.43	-0.34	-0.08	-1.30	-2.09	-3.73	-2.67	-2.25	-2.58	-2.55	-2.58	-2.55
SMA11	-3.74	-4.20	-1.21	-0.43	0.98	0.11	1.74	2.87	2.78	3.72	4.67	5.16	5.89	5.16	5.89
SMA16	5.10	4.62	9.57	6.78	2.17	1.94	1.16	-2.57	-2.85	-0.77	-1.38	-2.76	-3.65	-2.76	-3.65
DAC8	4.74	4.74	3.64	1.54	-0.61	-0.30	-0.62	-0.69	-2.54	-2.74	-3.31	-2.93	-2.29	-2.93	-2.29
DAC11	3.74	4.20	1.21	0.43	-0.98	-0.11	-1.74	-2.87	-2.78	-3.72	-4.67	-5.16	-5.89	-5.16	-5.89
DAC16	1.34	-1.43	3.87	4.26	4.30	2.52	1.80	-2.87	-2.81	-0.34	-0.63	-3.42	-4.07	-3.42	-4.07
UTBWC11	2.12	1.90	2.17	0.58	-0.34	0.00	-1.09	-3.00	-4.55	-3.06	-2.61	-3.37	-4.36	-3.37	-4.36
UTBWC16	4.21	4.53	8.58	8.20	3.51	2.82	1.46	-1.38	-1.39	-0.04	-0.78	-2.59	-3.25	-2.59	-3.25

Table 4: Road surface corrections for vehicles of Category 2 and 3 for a few different pavements that occur in Sweden. Based on CPX measurements with H1 tire at 50 km/h and 80 km/h.

	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000
	α														
SMA8	-0.10	-0.09	-0.11	-0.15	-1.59	-1.14	-0.66	-1.81	-1.45	-1.80	-1.64	-1.37	-1.33	-1.37	-1.33
SMA11	0.30	0.09	0.08	-0.11	-0.13	0.28	-0.15	-0.26	0.09	-0.01	0.13	0.25	0.21	0.25	0.21
SMA16	4.13	3.52	2.79	1.65	0.51	1.77	-0.09	-0.15	0.85	-0.01	0.33	0.43	0.53	0.43	0.53
DAC8	-0.34	-0.32	-0.22	0.00	-0.83	-1.46	-0.69	-1.44	-1.55	-1.53	-1.37	-1.39	-1.47	-1.39	-1.47
DAC11	-0.30	-0.09	-0.08	0.11	0.13	-0.28	0.15	0.26	-0.09	0.01	-0.13	-0.25	-0.21	-0.25	-0.21
DAC16	2.16	2.22	1.72	1.04	1.65	2.19	0.54	1.76	1.47	1.35	1.54	2.22	2.64	2.22	2.64
UTBWC11	0.32	0.35	0.42	0.73	-0.24	-0.09	0.63	0.22	0.41	0.37	0.41	0.20	0.60	0.20	0.60
UTBWC16	1.74	2.06	1.53	1.21	-0.50	0.14	-0.75	-1.32	-0.26	-1.70	-1.25	-1.37	-0.78	-1.37	-0.78
	β														
SMA8	3.36	2.67	2.63	2.61	-1.71	-1.09	0.63	-0.29	-0.27	-1.60	-1.87	-2.80	-5.12	-2.80	-5.12
SMA11	-3.81	-1.36	0.18	0.39	-0.10	0.77	2.83	1.75	2.66	3.64	2.84	2.43	3.22	2.43	3.22
SMA16	7.56	10.42	11.80	4.95	-1.09	2.50	0.31	-2.28	-1.11	-1.72	-2.06	-5.64	-5.09	-5.64	-5.09
DAC8	3.31	2.91	2.12	3.49	1.21	-0.07	1.26	0.62	-0.65	-1.90	-2.18	-2.57	-4.28	-2.57	-4.28
DAC11	3.81	1.36	-0.18	-0.39	0.10	-0.77	-2.83	-1.75	-2.66	-3.64	-2.84	-2.43	-3.22	-2.43	-3.22
DAC16	4.26	2.34	2.52	1.58	6.11	4.40	-0.77	-2.71	-0.39	-2.22	-4.42	-9.20	-9.62	-9.20	-9.62
UTBWC11	2.02	2.11	0.46	1.74	-2.61	-1.67	-0.51	-1.53	-1.58	-2.14	-2.18	-5.57	-4.92	-5.57	-4.92
UTBWC16	4.96	6.48	6.54	6.23	0.22	2.38	1.04	-1.49	0.18	-0.37	-1.13	-4.90	-4.30	-4.90	-4.30

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