Change in traffic noise levels after road pavement maintenance using diamond grinding or milling

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ABSTRACT

Where asphalt roads are pot-holed, uneven, and in poor condition, road maintenance often involves repairing or relaying the asphalt surface. In Sydney, current suburban road maintenance projects are increasingly refraining from relaying the asphalt, and instead leaving the concrete base exposed, using fine milling or diamond grinding techniques to finish the road surface. Whilst concrete pavements are commonly noisier than asphalt pavements on high speed roads, this is not necessarily the case on low speed suburban roads due to the smaller contribution of tyre noise to the overall traffic noise level. Furthermore, recent developments in low-noise diamond grinding techniques have led to lower noise concrete surfaces. This paper analyses pre-works and post-works roadside noise measurements conducted for low speed suburban roads where diamond grinding or milling has been performed, with the aim of quantifying any noise level difference or change in tonality.

INTRODUCTION

In recent years road surface diamond grinding has been performed on several suburban roads in the Sydney metro area as part of road rehabilitation and maintenance. Diamond grinding is the process of removing surface irregularities from concrete pavements. These irregularities are “often caused by faulting, curling and warping of the slab” (Correa and Wong, 2001).

When considering the contribution of road tyre noise to the overall traffic noise level, the traffic speed is a key factor. The RTA Environmental Noise Management Manual (Roads and Traffic Authority of NSW, 2001) states that:

> For individual vehicles road tyre noise begins to dominate power-train noise at vehicle speeds of between 30 and 50 km/h for cars and between 40 and 80km/h for trucks. For traffic as a whole, road tyre noise appears to dominate at around 70 km/h.

This paper is a review of a four suburban road rehabilitation projects where diamond grinding (DG) or surface milling (SM) has been performed on the exposed concrete surface. In three of the four cases, the existing pavement was asphalt, which has been removed prior to rehabilitation works. The traffic speeds on the tested roads are no greater than 80km/h. The aim of the analysis is to show the typical noise level change going from a degraded asphalt surface to a well finished concrete surface.

In each case the noise measurements were conducted on the roadside close to the kerb for short term measurements, or at residential properties where traffic noise was dominant for long term measurements.

As much as was practical, measurement locations were selected away from intersections, and measurement times were out of peak hours, to avoid congestion and stationary traffic.

CASE ROAD 1

Road 1 Description

Road 1 is a 4 lane undivided carriageway with a posted speed limit of 60 km/h. The original road surface was worn Dense Graded Asphalt (DGA). The DGA was removed and the finished surface of the road was divided into two sections, with DG performed to the concrete surface in one section and SM performed to the concrete surface on the other section. Short term attended noise monitoring was conducted for this road.

The following figures display the road surface pre rehabilitation works, post DG works and SM works.

Figure 1. Road 1 – Pre rehabilitation works

Figure 2. Road 1 – Post DG works

Figure 3. Road 1 – Post SM works

Road 1 Noise Monitoring Results

Roadside, short term, attended noise monitoring was conducted at two locations, one location within the DG section of works and the other within the SM section of works. Measurements were conducted for a period of between 30 to 60 minutes at each location. The noise monitor was approximately 4m from the road kerb in each case. Corrections were applied to the post works measurements to account for the variations in traffic volume and heavy vehicles relative to the pre works measurements, although the adjustment was small, less than 0.3dB.

The one-third octave band results of the short term noise monitoring are presented in Figure 4 and Figure 5 and the overall summary is presented Table 1.

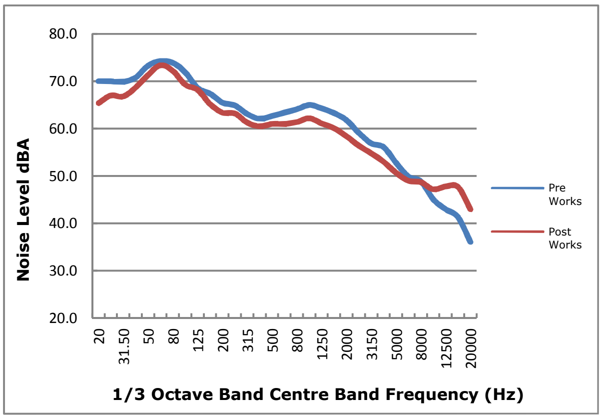

Figure 4. Road 1 – Noise level change for DG

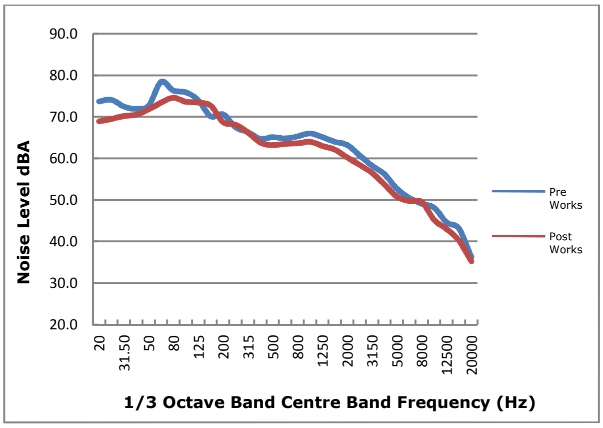

Figure 5. Road 1 – Noise level change for SM works

The post works noise level are generally less than the pre works levels across the spectrum, for both the DG and SM processes. The reduction in noise is probably mostly due to the removal of pot holes and roughness in the asphalt, more so than the finished concrete being quiet.

The increase in the upper frequencies (10kHz – 20kHz) on the DG section (see Figure 4) can be attributed to a piece of loose metal within an expansion joint that had become exposed after the removal of the asphalt. This increase in upper frequencies did not alter the overall dBA results.

Table 1. Road 1 – Noise level summary

Measurement	Normalised L_{Aeq}	Difference dBA
Pre DG Works	73.1	
Pre SM Works	74.6	
Post DG Works	70.5	-2.6
Post SM Works	72.9	-1.7

The following conclusions can be drawn for Road 1:

- A noise reduction in the order of 1 to 2dBA was measured after removal of the asphalt and concrete surface treatment. This reduction is probably mostly due to the removal of pot holes and roughness in the asphalt
- The measurements results suggest that the finished DG surface is approximately 1dBA quieter than the SM surface.
- The removal of the asphalt and exposing the concrete surface did not introduce any 'whine' or tonal component on this low speed suburban road of the type that is sometimes heard on high speed concrete roads.

CASE ROAD 2

Road 2 Description

Road 2 is a six lane divided carriageway with a posted speed limit of 80 km/h, although traffic was typically travelling slower than 80km/h in the tested section of road. The original road surface was worn DGA which was removed and DG was performed on the exposed concrete surface. Both short term attended and long term unattended noise monitoring was conducted for this road.

The following figures display the road surface pre rehabilitation works and post DG works.

Figure 6. Road 2 – Pre rehabilitation works

Figure 7. Road 2 – Post DG works

Road 2 Short Term Noise Monitoring Results

Roadside, short term, attended noise monitoring was conducted for the pre rehabilitation works and post DG works. Each measurement was conducted for a period of 60 minutes. The noise monitor was installed approximately 4m from the road kerb. A correction was applied to the post works measurements to account for the variations in traffic volume and heavy vehicles relative to the pre works measurements.

The one-third octave band results of the short term noise monitoring are presented in Figure 8 and the overall summary is presented Table 2.

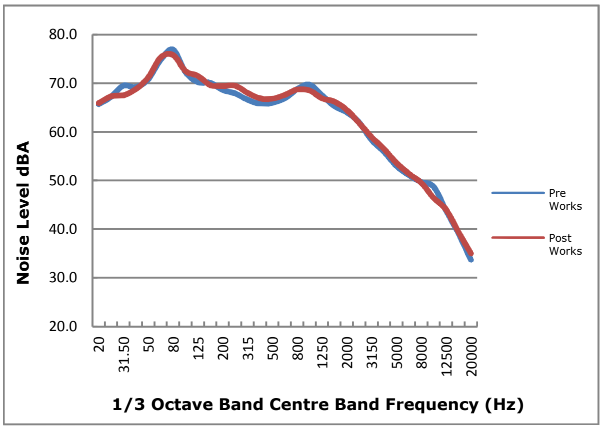

Figure 8. Road 2 – Short term noise level change for DG

Table 2. Road 2 – Short term noise level summary

Measurement	Normalised L_{Aeq}	Difference dBA
Pre Works	76.4	
Post DG	76.5	+0.1

Road 2 Long Term Noise Monitoring Results

Long term unattended noise monitoring was conducted for both the pre rehabilitation works and post DG works at a residence within the section of works for a total of 7 days for each measurement period (including a weekend). Noise monitoring was conducted during February 2011 for the pre rehabilitation works measurements and May 2011 for the post DG works.

The noise monitor was installed in the front yard of the residences approximately 13m from the road kerb and 1m from the building facade.

The one-third octave band results of the long term noise monitoring are presented in Figure 9 for the daytime (7:00am – 10:00pm) and Figure 10 for the night-time (10:00pm – 7:00am) period, and the overall summary is presented Table 3.

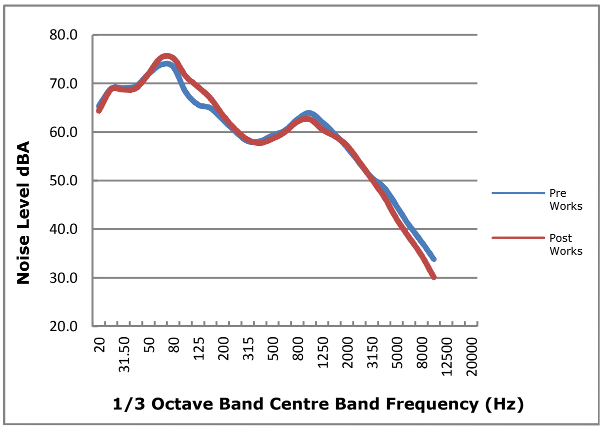

Figure 9. Road 2 – Long term noise level change for DG (Daytime)

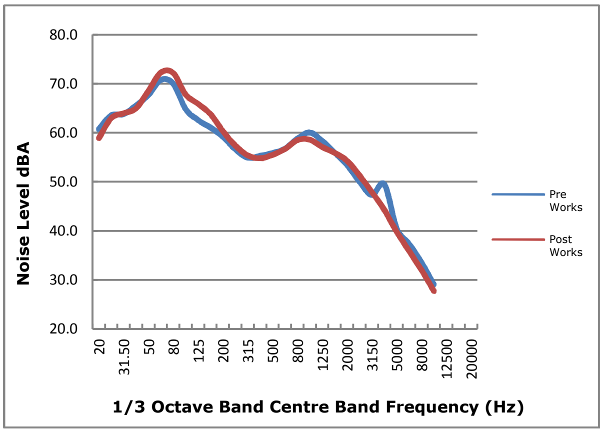

Figure 10. Road 2 – Long term noise level change for DG (Night-time)

The emergent 4kHz level on the pre rehabilitation works measurement during the night period (see Figure 10) can be attributed to insect noise at night.

Table 3. Road 2 – Long term noise level summary

Measurement	Normalised L_{Aeq}	Difference dBA
Pre Works (Day)	70.2	
Pre Works (Night)	66.6	
Post DG (Day)	69.7	-0.5
Post DG (Night)	66.3	-0.3

The following conclusions can be drawn for Road 2:

- Changing from an asphalt surface to a DG concrete surface caused no significant change in overall traffic noise levels.
- The concrete pavement was slightly noisier than the asphalt pavement between the 100 and 200Hz frequencies.

CASE ROAD 3

Road 3 is the same road as Road 2, but the measurement location approximately 500m further along.

The original road surface was worn DGA. The DGA was removed and a process of SM followed by DG was performed. Noise measurements were conducted for the pre rehabilitation works, post SM works and finally post DG works. Both short term attended and long term unattended noise monitoring was conducted for this road.

The following figures display the road surface pre rehabilitation works, post SM works and post DG works.

Figure 11. Road 3 – Pre rehabilitation works

Figure 12. Road 3 – Post SM works

Figure 13. Road 3 – Post DG works

Road 3 Short Term Noise Monitoring Results

Roadside, short term, attended noise monitoring was conducted for the pre rehabilitation works, post SM works and post DG works. All measurements were conducted for a period of 60 minutes. The noise monitor was installed approximately 4m from the road kerb. A correction was applied to the post works measurements to account for the variations in traffic volume and heavy vehicles relative to the pre works measurements, the adjustment was less than +0.3dB(A) for both measurements.

The one-third octave band results of the short term noise monitoring are presented in Figure 14 and the overall summary is presented Table 4.

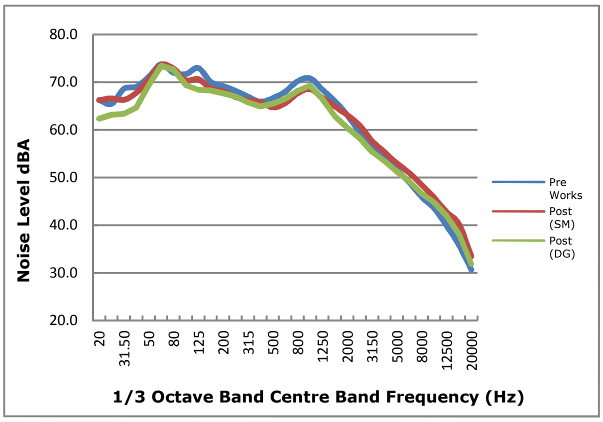

Figure 14. Road 3 – Short term noise level change for DG & SM

Table 4. Road 3 – Short term noise level summary

Measurement	Normalised L_{Aeq}	Difference dBA
Pre Works	77.0	
Post SM	75.4	-1.6
Post DG	75.2	-1.8

Road 3 Long Term Noise Monitoring Results

Long term unattended noise monitoring was conducted for the pre rehabilitation works, post SM and post DG works at a residence within the section of works for a total of 7 days for each measurement period (including 1 weekend). Noise monitoring was conducted during July 2012 for the pre rehabilitation works, November-December 2012 for the post SM works and February 2013 for the post DG works.

The noise monitor was installed in the front yard of the residences approximately 12m from the road kerb and 1m from the building facade.

The one-third octave band results of the long term noise monitoring are presented in Figure 15 for the daytime and Figure 16 for the night-time period, and the overall summary is presented Table 5.

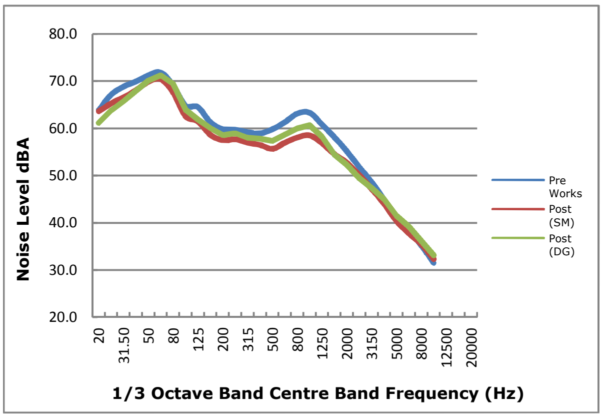

Figure 15. Road 3 – Long term noise level change for SM & DG (Day)

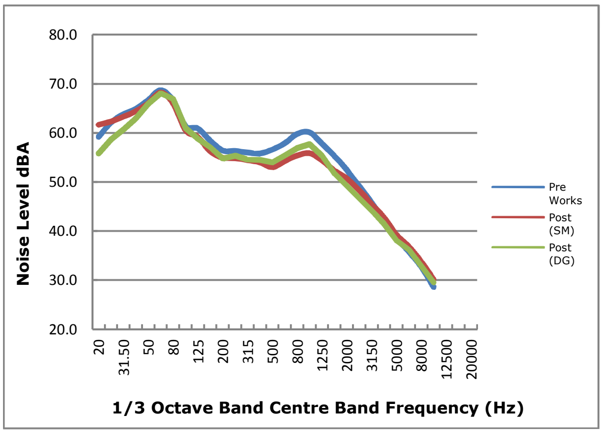

Figure 16. Road 3 – Long term noise level change for SM & DG (Night)

Table 5. Road 3 – Long term noise level summary

Measurement	Normalised L_{Aeq}	Difference dBA
Pre Works (Day)	69.6	
Pre Works (Night)	66.4	
Post SM (Day)	65.7	-3.9
Post SM (Night)	63.2	-3.2
Post DG (Day)	67.0	-2.5
Post DG (Night)	64.0	-2.5

It is interesting that although Road 3 is the same road as Road 2, a clear reduction in noise was measured for Road 3, compared to no clear change for Road 2. The measurement location for Road 2 was closer to a signalised intersection and so the lower vehicle speed combined with the engine acceleration noise associated with the intersection may have led to the road-tyre noise contributing less to the measured noise levels.

The following conclusions can be drawn for Road 3:

- Aged and worn DGA is not necessarily producing any significant noise reduction properties. SM or DG concrete surfaces can give noise levels 2-4dB(A) quieter than the worn DGA.
- Once the asphalt has been milled away just exposing the concrete, diamond grinding can potentially increase noise levels by about 1dBA by exposing more of the concrete aggregate, thereby making a louder surface.

CASE ROAD 4

Road 4 Description

Road 4 is a 4 lane undivided carriageway with a posted speed limit of 50 km/h. Traffic movements occur in the centre lanes only, with street parking on the outer lanes. This road is different to he other examples in that the original road surface was already a discontinuous Plane Concrete Pavement (PCP) with expansion joints. DG was performed as part of road maintenance.

The following figures display the road surface pre rehabilitation works and post DG works.

Figure 17. Road 4 – Pre Works

Figure 18. Road 4 – Post DG

Road 4 Short Term Noise Monitoring Results

Short term, attended noise monitoring was conducted for the pre rehabilitation works and post DG works. Both measurements were conducted for a period of 4 hours. The noise monitor was installed approximately 6m from the road kerb.

A correction was applied to the post works measurement to account for the variations in traffic volume and heavy vehicles relative to the pre works measurements.

The one-third octave band results of the short term noise monitoring are presented in Figure 19 and the summary of overall noise levels is presented Table 6.

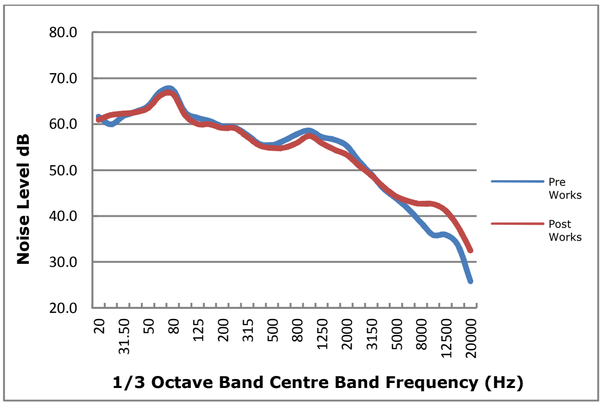

Figure 19. Road 4 – Short term noise level change for DG

The increase in the upper frequencies (4kHz – 20kHz) on the post works measurements can be attributed to an increase in ambient noise levels due to wind noise, not from the road surface.

Table 6. Road 4 – Short term noise level summary

Measurement	Normalised L_{Aeq}	Difference dBA
Pre Works	66.4	
Post DG	65.1	-1.3

Consistent with the other case roads, a noise reduction of about 1dBA was measured after diamond grinding, however this reduction is due to the smoothing of roughness and high points on the road surface as there was no asphalt to begin with.

CONCLUSION

It appears from this study that for low speed suburban roads, removing asphalt that is in poor condition and exposing the concrete base does not tend to increase traffic noise levels. As long as the concrete surface is well finished using milling or diamond grinding, the final traffic noise levels are likely to be less than the pre works levels. Noise reductions of between 0 – 4dBA have been measured at various road maintenance projects around Sydney, but typically the reduction is 1 – 2dBA.

Diamond grinding and milling give similar noise properties to the finished concrete road surface. One method is not consistently quieter than the other.

Since a noise reduction was also measured for Case 4 where the existing pavement was already concrete, it is likely that for all cases, it is the improvement in the smoothness of the road and the removal of bumps and unevenness that primarily leads to a lower traffic noise level. Nonetheless it appears that reinstatement of the asphalt surface after road maintenance is not necessary in order to match the pre-works noise levels.

Furthermore, exposing the concrete surface on these low speed suburban roads does not seem to introduce any measureable 'whine' as is often the case with high speed concrete road surfaces.

REFERENCES

Correa, A., Wong, B., *"Concrete Pavement Rehabilitation Guide for Diamond Grinding"*, Federal Highway Administration, FHWA Special Project 205, Quality Concrete Pavement Rehabilitation, June 2001.

Roads and Traffic Authority of NSW, RTA Environmental Noise Management Manual, December 2001.