DELIVERABLE 3.3.1b

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Work Package 3	
3.3	Development of a grinding technology for rough asphalt as a noise mitigation measure
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	Acoustic Control	ACL	SE
	Accon	ACC	DE
	Alfa Products & Technologies	APT	BE
	Goodyear	GOOD	LU
	Head Acoustics	HAC	DE
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	Stockholm Environmental & Health Administration	SEP	SE
	Netherlands Organisation for Applied Scientific Research	TNO	NL
	Trafikkontoret Göteborg	TRAF	SE
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	University of Cambridge	UCAM	UK
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Dissemination Level

PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restrictec to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for the members of the consortium (including the Commission Services)	

Nature of Deliverable

R	Report	
P	Prototype	
D	Demonstrator	
O	Other	

SEVENTH FRAMEWORK PROGRAMME

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0 EXECUTIVE SUMMARY

0.1 OBJECTIVE OF THE DELIVERABLE

Develop an optimal low noise road for the quiet vehicle by grinding the old pavement.

0.2 DESCRIPTION OF THE WORK PERFORMED SINCE THE BEGINNING OF THE PROJECT

Lab tests have shown that a rough asphalt surface might be grinded without the loss of adequate friction. To make a rough asphalt surface smooth is a two-stage affair, including both milling and grinding/polishing. The second step is very costly.

0.3 MAIN RESULTS ACHIEVED SO FAR

It has been concluded that the optimal solution is the alternative, i.e. to mill the completely old surface and pave a new thin asphalt pavement.

0.4 EXPECTED FINAL RESULTS

0.5 POTENTIAL IMPACT AND USE

It has been concluded that the optimal solution is the alternative, i.e. to mill the completely old surface and pave a new thin asphalt pavement.

0.6 PARTNERS INVOLVED AND THEIR CONTRIBUTION

ACL has measured road texture spectrum and road texture profile for the grinded pavements.

0.7 CONCLUSIONS

To smooth a rough rutted asphalt pavement is a two-stage affair. First it has to be milled in a traditional manner and then grinded in a very costly manner as the grinding capacity will be very low as well. It has also to remind that the pavement/road construction will lose important bearing capacity when layers of asphalt are being removed without being replenished.

In delivery 3.3.1 the smooth thin road surface is considered and with the solutions there presented this approach will be much better, i.e. the optimal solution is to mill the completely old surface and pave a new thin asphalt pavement.

1 INTRODUCTION

As part of the work in WP3.3, the possibility of grinding a rough asphalt surface would be studied. The intention was to reduce its surface roughness (or texture) thereby reducing the external tyre/road noise. In the Concept and project objectives for the Cityhush project it was described as follows

"There is extensive experience gathered from grinding of concrete surfaces e.g. in USA. Grinding of concrete surfaces reveals that if a worn concrete road surface is ground, the tyre/road noise level can be reduced by 3-5 dB(A) units. This is of the same order as what can be achieved by open graded sound absorbing asphalt surfaces but with the advantage that the noise reduction effect from the surface cannot be eliminated by clogging.

However, grinding a worn asphalt surface will probably be more difficult compared to grinding a concrete surface. The ballast stone material is more firmly anchored by the cement in the concrete surface compared to what is the case for an asphalt surface. This is because the bitumen binder gives less adhesion compared to cement. This will be further accentuated by the heat generated by the grinding process. Therefore, we expect that it would be necessary to select a much more cautious grinding process compared to what can be used for concrete surfaces.

Road grinding also opens up new strategies with respect to low noise roads. It is conceivable that it would be favourable with respect to noise to pave a surface with e.g. 16 mm stones and then after some time grind it smooth. Thereby we may achieve both a durable and low noise road surface. The potential of this innovative approach will be investigated."

The possibility of grinding a rough asphalt surface has been looked into with some laboratory tests, but mainly doing a theoretical studying before conceiving field tests.

2 LAB TESTS ON CORES

2.1 GRINDING

Cores from an old pavement of SMA 16 70/100 layer in 1992 have been subjected to polishing by a grinding process to look at the possibility to renew an old pavement concerning roughness and by this reduce the noise from the contact between tyres and pavement surface. An important feature has also been to study the eventual loss of friction by the grinding process.

The cores as taken from the road show a worn, but not detoriated, surface with coarse aggregate particles protruding (Figure 2.1).

Figure 2.1 Core from worn SMA 16.

The surfaces have been measured with the sand-patch method (Figure 2.2).

Figure 2.2 Measuring sand-patch value on a core.

The mastic between the coarse aggregate is dense, as the sand-patch values for six cores have given the results as presented in table 1. The values are normal and show that the asphalt pavement, even if it is worn, is in good condition.

Table 1 Sand-patch values for cores of old SMA 16

Sample	1	2	3	4	5	6
Sand-patch value mm	0,70	0,72	0,75	0,76	0,94	0,97

The two cores with the highest sand-patch values have been subjected to polishing in a lab aperture (see figure 2.3). The polishing is performed at a temperature of about 0-1°C (by supplying cooling ice water) to avoid clogging by the bitumen. Earlier experiences of grinding/polishing asphalt samples have clearly shown the necessity of keeping a low temperature at the interface between sample and grinding disc. After a polishing time of about 30 seconds, the roughness of surface has been substantially reduced and sand-patch values as presented in table 2 were achieved. A comparison between not grinded and grinded samples is shown in figure 2.4.

Table 2 Sand-patch values for cores of old SMA 16 after polishing

Sample	**5**	**6**
Sand-patch value mm	0,56	0,59
Reduction mm	0,38	0,38

Before, during and after polishing the profile of the surface has been measured (see Delivery 3.3.1).

We observe that it takes a lot of polishing with this kind of equipment to achieve a good effect, i.e. it is time consuming and the capacity is low as it takes about 30 seconds to grind about 1-2 mm. It is probably not much better in the field.

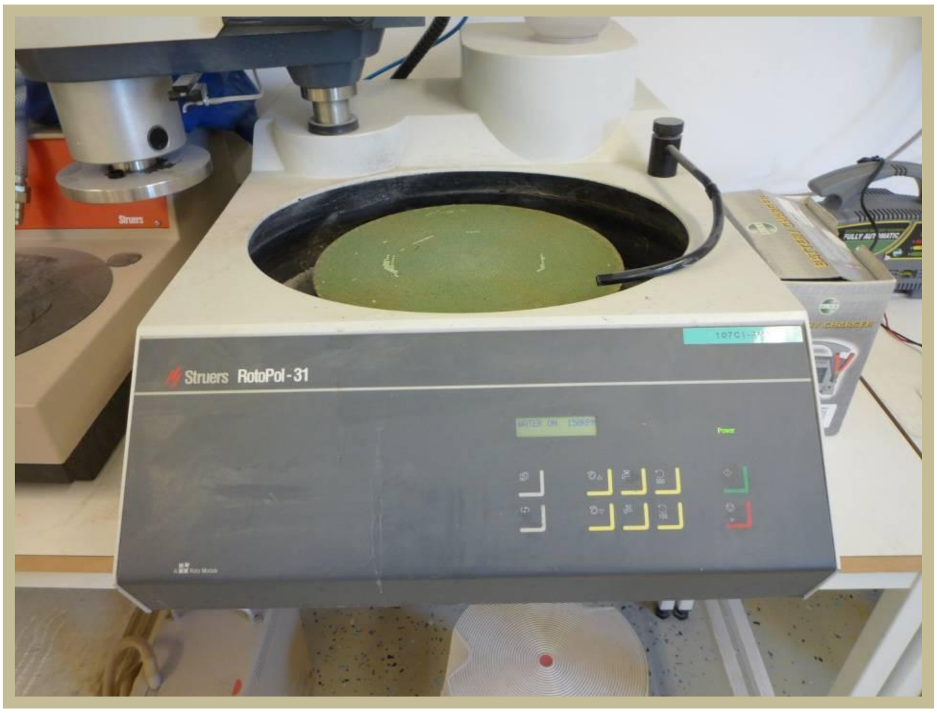

Figure 2.3 Polishing/grinding machine.

Figure 2.4 Comparison between a not grinded and a grinded sample.

2.2 Friction

A question that arises is how will this reducing of the sand-patch value and the polishing of the coarse aggregate influence the friction?

This has been checked with the so-called SRT-pendulum by VTI, where the friction has been measured on both cores that have and have not been subjected to polishing and for both dry and wet conditions. The results are presented in table 3.

Table 3 Friction measured by the SRT-pendulum (for dry conditions the mean of 10 measurements, angling 90° after five, and for wet the mean of 5 measurements).

Cores		Condition	
Sample		Dry	Wet
1	Unpolished	88,2	59,4
2	Unpolished	85,9	59,0
3	Polished	84,9	69,4
4	Polished	85,4	69,8

The values show a good level of friction in all cases and it might be noticed that the wet friction after polishing are better than before. This is probably due to the larger total contact area as the tops of the aggregate has been reduced and thus levelled into larger areas for each stone.

Therefore, it can be concluded that friction is not an issue when polishing an asphalt pavement under these conditions.

3 FIELD APPLICABILITY

The lab tests including the frictions tests show that it is feasible to polish a rough even asphalt surface to get a even more even and smooth surface and thereby lower the noise emission without jeopardizing the friction characteristics.

This type of polishing machine is normally found as a mean to polish concrete floors and have a rather low capacity, why they are not suitable for use on roads, especially because of the cross profile of the road (see below). Today concrete road grinding is made by using a machine as shown in figure 3.1. The capacity of these machines might make them feasible to use.

Figure 3.1 Middle size model of polishing machine for diamond polishing.

However, the surface which transpires from this work is shown in figure 3.2.

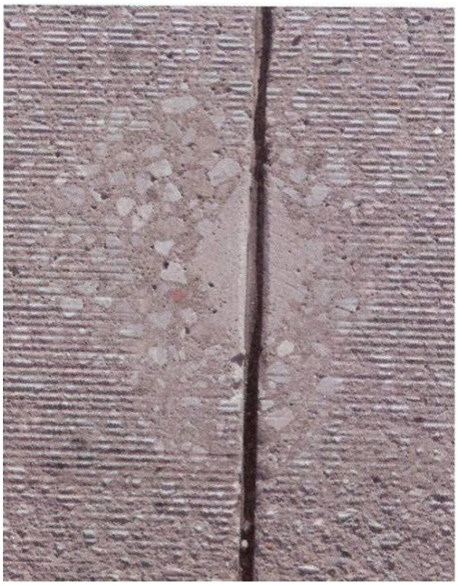

Figure 3.2 Example of reparation of a joint that shows the pattern (horizontal tight lines) after grinding the concrete road surface.

This is a pattern that is very much unlike the results from floor polishing as achieved in the lab and will not have much of a reducing effect on noise emission from the asphalt surface. This means that we need another polishing unit, which gives a real smooth result. The disadvantage with these units are, as mentioned above, the rather low capacity and as a result of that the high cost perhaps about 10 Euro/m2. The cost is not only dependant on the low capacity but also on all the dust that must be taken care of. The easiest way to do this would be by adding water but as this probably will be considered as unclean (heavy metals from the cars/road) this must be collected and deposited, which also adds to the overall cost.

The other point of view is the profile of a worn rough road surface, as the traffic wears down the road more in the wheel tracks than in between (especially with the use of studded tyres). The ruts may be up to 20-25 mm in depth, but even if it is only 10 mm it is a substantial difference between the rut and the height between or outside the ruts. It is only the wheel tracks that need polishing, but how to do that without milling the surface in between and outside the tracks? This means that besides considering what was mentioned above the grinding must be a two stage affair.

This will be very costly. In delivery 3.3.1 the smooth even road surface is considered and with the solutions there presented that will be much better, i.e. the optimal solution is to mill the whole old surface and pave a new thin asphalt pavement.

We have also to bear in mind as well that all the asphalt layers are part of the total bearing capacity of the road/street. If we mill/grind away part of the surface without replenshing it we will lose bearing capacity. Our experience is rather that we don't have any extra bearing capacity, it's more the other way around.

4 CONCLUSIONS

To smooth a rough rutted asphalt pavement is a two stage affair. First it has to be milled in a traditional manner and then grinded in a very costly manner as the grinding capacity will be very low as well. It has also to minded that the pavement/road construction will lose important bearing capacity when layers of asphalt is being removed without being replenished.

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