# MINERALOGY, TEXTURE AND MECHANICAL PROPERTIES OF ANTI-SKID AND ASPHALT AGGREGATES CONTRIBUTING TO URBAN DUST

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## 1. INTRODUCTION

In northern latitudes mineral dust is formed when cars use studded tires and roads are sanded to obtain more traction on the icy road surfaces. Mineral dust originates from both asphalt and anti-skid aggregates and the dust is deposited on the ground. During late winter, especially when the surfaces of roads dry out, the dust rises into the air.

Urban dust can be hazardous to health and it lowers the quality of everyday life in cities. In order to protect people from the effects of airborne particles, new European limiting values for $PM_{10}$ (thoracic particles <10 μm) concentrations in the air have been decided (European Council Directive 1999/30/EC). During springtime, dust episodes, the actual $PM_{10}$ concentrations in Finnish cities are often clearly higher than the new limiting values. The European Union member states are allowed to exceed the prevailing limiting values in specified areas, if it can be shown that this is caused by the winter maintenance of roads.

The present study is an extension to studies of Kupiainen et al. (2001) and Räisänen et al. (2002). Kupiainen et al. (2001) found that anti-skid aggregate wears the pavement more than expected and named this phenomenon as the sandpaper effect. According to Räisänen et al. (2002) successive breakage of particles into smaller particles with more wearing surface can be minimized by using anti-skid aggregates with good resistance to fragmentation. The other important property, relevant to production of urban dust, is the particle size distribution of anti-skid aggregates (Räisänen et al. 2002).

In the present study, more emphasis has been put on the particle size distribution of anti-skid aggregates and new anti-skid materials have also been tested.

## 2. METHODS AND MATERIALS

In the present study we have tested medium-grained subophitic diabase (DB), fine (GRp) and medium-grained (GR) granite anti-skid aggregates with an indoor road simulator fitted with studded and friction tires. Figure 1a shows the particle size distribution of Ämmässuo anti-skid aggregates. The pavement material (asphalt concrete particle size 0 to 11 mm) of the test ring was made of mafic volcanic rock. Samples were collected from a height of 2.5 m with a high-volume particle sampler ($PM_{10}$ –gravimetric Wedding & Associates Sampler). The pre-separator filter removed >10 μm particles from the test sample. From each filter randomly selected

100-150 dust particles were analysed with a scanning electron microscope (SEM) coupled to an energy dispersive X-ray microanalyser (EDX) (Figure 1b).

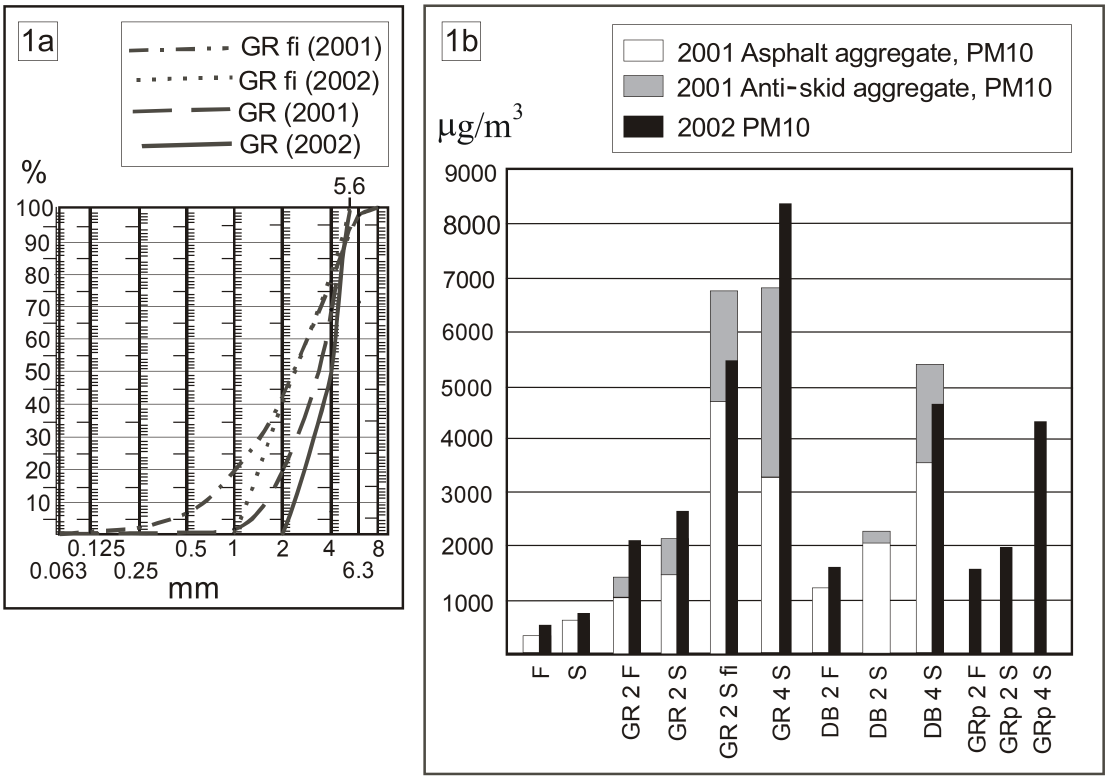


**Figure 1a**: Particle size distribution curves of Ämmässuo granite anti-skid aggregates (GR) (samples GR2F, GR2S, GR2Sfi and GR4S in figure1b), fi = higher % fine fraction, 2001/2002 = the year that samples were collected and analysed. **Figure 1b**: The proportions (2001) from asphalt and anti-skid aggregates in the $PM_{10}$ mineral dust and the total amount of $PM_{10}$ dust (2001/2002), the SEM/EDX analysis of 2002 samples is not finished, F=friction tires, S=studded tires, 2 or 4 liters of anti-skid aggregate, DB= Eurajoki diabase, GRp=Pernaja granite (modified after Kupiainen et al. 2001).

An anti-skid aggregates resistance to fragmentation should be defined with correct particle size (same as the product anti-skid aggregate), because the resistance to fragmentation is not linear to fractions 10-14 and 4-5.6 mm. The Los Angeles test (EN 1097-2) was performed with fractions 10-14 and 4-5.6 mm; the latter according to Annex A with 8 balls (Table 1).

**Table 1**: The mechanical properties of aggregates and the amount of anti-skid aggregate dispersed on the road simulator ring. MV = Mafic volcanic rock (asphalt aggregate), STT = Studded tyre test value (EN 1097-9), LA 10-14/4-5.6 = Los Angeles test value for fractions 10-14/4-5.6 mm (EN 1097-2).

| Sample | STT | LA 10-14/ 4-5.6 | Mass/area: 2 – 4 $dm^3$ ($g/m^2$) |
|---|---|---|---|
| GR / GRfi (2001) | 20.7 | 42/43 | 926 – 1853 (2001)<br>880 – 1760 (2002) |
| GRp (2002) | 5.2 | 15/ 24 | 932 – 1865 |
| DB (2001/2002) | 11.6 | 16/23 | 1056 – 2112 (2001)<br>1046 – 2093 (2002) |
| MV (2001/2002) | 6.2 | 11/- | - |

## 3. RESULTS

GRfi samples with high % of fine fraction created most dust. GRfi (2001) created more dust than GRfi (2002), because of its higher percentage of 0-1 mm fraction. GR (2001) anti-skid aggregate produced less dust compared to 2002 samples. Aggregates with the lowest LA value (GRp and DB) created least dust even though, the former contains 28 % quartz and has a low studded tyre test (STT) value (Figure 1b).

## 4. CONCLUSIONS

Our results lend support to the conclusions of Räisänen et al. (2002) that successive breakage of particles into smaller particles with more wearing surface and, the consequent increase of mineral dust in the air can be minimised by using wet screened (2mm) anti-skid aggregates with low LA value (cf. Räisänen et al. 2002). The amount of fine fraction is crucial, because anti-skid aggregate particles wear the pavement and are also worn themselves. The particle size distribution of anti-skid aggregates (the amount of 0-1 mm and 1-2 mm fractions) correlated with the amount of dust in air under the test conditions.

The higher average hardness and lower STT value of GRp compared to DB and MV did not increase the total amount of $PM_{10}$ dust in the air. This suggests that the resistance to fragmentation is the most important mechanical property of anti-skid aggregates with respect to urban dust. Dust particle size distribution has also been measured and these results shall be published at 2003.


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