EFFECT OF MICA ON DEFORMATION PROPERTIES OF UNBOUND AGGREGATES – RESULTS FROM TRIAXIAL TESTS

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1. INTRODUCTION

The last years, damages have developed on some newly constructed Swedish roads. A possible reason to this is said to be high content of mica in the unbound base material.

The project described here started in spring 2002 and has the overall objective to study the effect of mica on deformation properties of unbound road aggregates. By means of tests in the laboratory and in the field it will give help to establish restrictions on mica content, if any, in the Swedish guidelines for road materials (ATB VÄG). The project has two parts: Part one comprises laboratory tests on seven materials. Part two includes selection of four materials, further laboratory tests on these and field tests. This abstract describes the first part of the project.

2. METHODS

The following investigations have been performed

- *Compaction tests* by means of modified proctor with evaluation of maximum density and optimum water content. Furthermore, the grain size distribution was analysed before and after compaction to indicate possible degradation.
- *Repeated load triaxial tests* with evaluation of stiffness and stability. Note that the tests were performed with the actual grain size distribution for each material without any "normalisation" to a standard grading. The reason was that all materials were supposed to have a similar grading and that the materials used in the laboratory and the field studies should be the same. Note also that only singular specimens were used in this first part of the project. When preparing the specimens the density was chosen to 97% of maximum and the water content was chosen to 60% of optimum for each material respectively.

The Swedish National Road and Transport Research Institute (VTI) performed all laboratory tests.

Besides the investigations described here the Swedish National Road Administration (SNRA) has analysed the mica content, partly as frequency of free mica particles in certain fractions, partly through petrographic studies in microscope. Furthermore, the particle density, the ball mill value and the flakiness index have been determined for the different rock materials.

3. MATERIALS

Materials from seven different quarries with varying content of mica have been studied. The materials were to be used as base course materials and consisted of crushed rock with grain size 0–40 mm. The grain size distributions are shown in Figure 1 and short petrographic descriptions are given in Table 1.

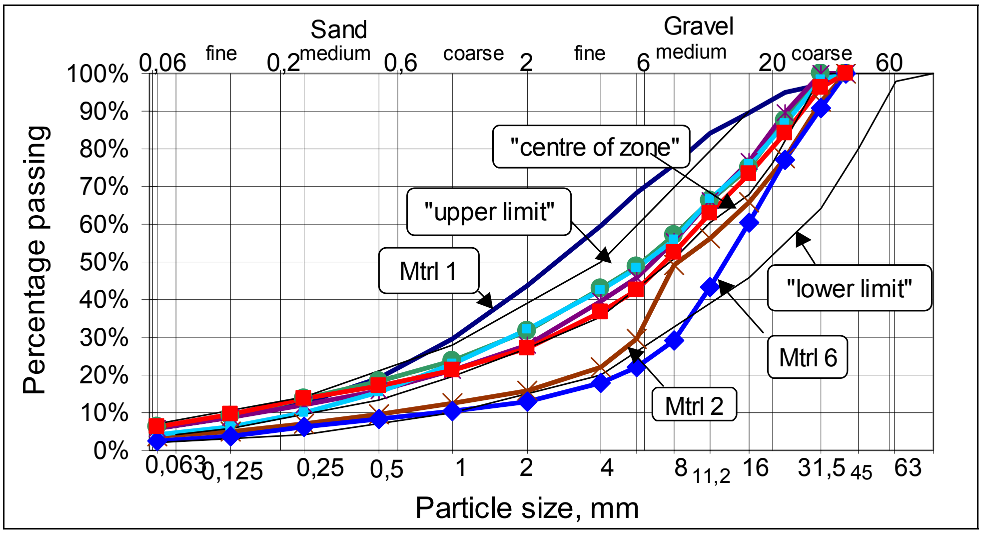

Figure 1: Grain size distribution of materials studied. Thin lines represent outer limits for Swedish base materials.

Table 1 reports mica content in different fractions of the seven rock materials studied.

Table 1: Mica content in materials studied, according to Swedish standard method VVMB 613. (data from SNRA)

Material	mica frequency/100 grains in fraction 0.125–0.25	in fraction 0.25–0.5	in fraction 0.5–1	Preliminary short petrographic description
Mtrl 1	8	8	5	medium grained, pegmatitic granite
Mtrl 2	5	3	2	medium grained, gneissy granite
Mtrl 3	27	9	5	medium grained, granodioritic gneiss
Mtrl 4	35	23	12	medium grained, biotite rich gneiss
Mtrl 5	5	4	2	medium grained granite
Mtrl 6	36	28	15	medium grained, hornblende rich gneiss
Mtrl 7	28	13	6	fine grained gneiss

4. RESULTS

From the triaxial tests the *stiffness* has been evaluated and expressed as resilient modulus as a function of the mean normal stress, p. After completed test, Mtrl 6 was the stiffest material at mean normal stresses below 400 kPa, while Mtrl 7 was the stiffest at higher stresses. Mtrl 1 had the lowest stiffness during the whole test. Mtrls 5 and 1 failed before the test was finished.

Figure 2 shows the relation between mica content and stiffness at two different stress conditions.

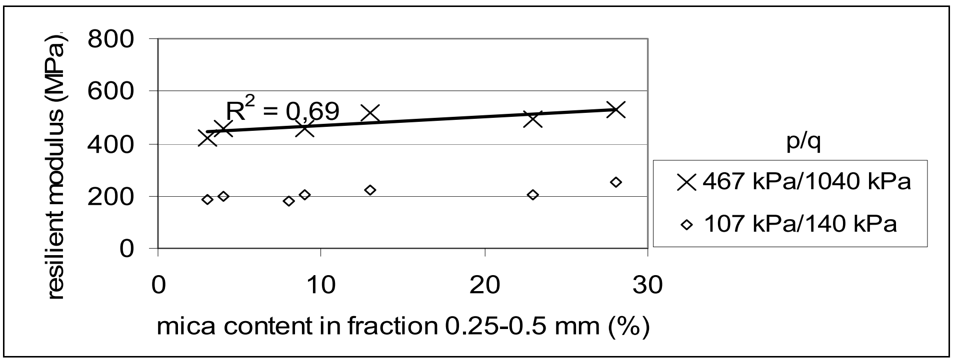

Figure 2: Mica frequency – stiffness, evaluated from repeated load triaxial tests.

The *stability* of the seven materials have been evaluated and expressed as accumulated permanent compression of the specimen as a function of number of loading cycles. After completed test, Mtrl 1 was deformed the most and Mtrl 4 the least of the seven materials. At mean normal stresses below 500 kPa, Mtrl 6 was deformed the least.

Figure 3 shows the relation between mica content and stability at two different stress conditions.

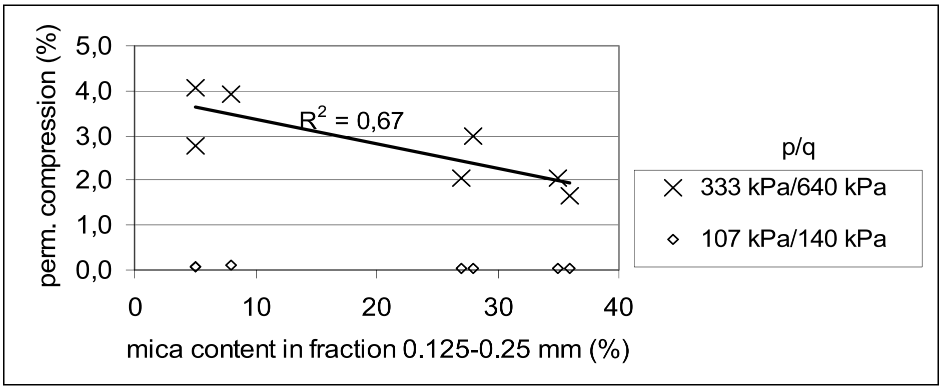

Figure 3: Mica frequency – stability, evaluated from repeated load triaxial tests.

5. DISCUSSIONS AND CONCLUSIONS

The test conditions chosen were not fulfilled for all materials. Mtrl 7, for instance, had lower relative density than the other materials. This depended on flakier particles, which made it harder to compact. Such deviations could have affected the test results.

Even the differences in grading could have had impact on the results. Previous studies on crushed rock material have shown that the shape of the grain size distribution curve as well as the fines content and the maximum grain size have an impact on the stiffness and stability of the material (Arm, 1996–98).

The fact that the gradings differs much and that only singular specimens were investigated complicates the evaluation. Is it only the mica content that makes the result differ? How much do other minerals, the grading of the materials or the specimen handling influence?

Despite the limited data and the questions mentioned above, the following observation could be made. Those materials that have the highest mica content (Mtrls 3, 4, 6 and 7) show less permanent deformation during the test. The difference is most evident at mean normal stresses of 300 kPa or more and when the deformation is related to the mica content in the finest fractions. An explanation could be that the mica increases the adhesion between the particles, at least in dry conditions (Höbeda & Chytla, 1999; Höbeda, 2001).

The next step in the project is further laboratory studies together with field studies. The laboratory studies include completion to twin specimens for more secure results. Furthermore, testing at several water contents will be performed, which will make the tests more decisive.

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