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Performance of construction aggregates as ruled by their mineral surface properties

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Aggregates are the most common construction material and by far the least expensive of the materials used. A challenge today is to integrate the knowledge of the role played by aggregates in the performance of end-products with approaches of resource management and quality control during the production phase.

Whether aggregates are used alone, in concrete or asphalt, their properties strongly determine the material performance. Some easily quantifiable characteristics such as geometry, density and mechanical resistance are criteria used to determine the best use for a particular type of aggregate. However, those characteristics are all dependent on the properties of the minerals constituting the stone material.

The type and characteristics of aggregate minerals is of great importance. The mineral surfaces can affect the adhesion between aggregate and binder (either cement or bitumen) influencing not only the extent of the contact area but also the bond strength. The mineral type, but also the aggregate size and structure appear to be relevant in the weathering process of aggregates, concrete and asphalt. The mineral composition can thus be decisive for the cementing and overall performance of asphalt and concrete.

Specifically for concrete purpose, feldspars and mica have proved to have a key role.
Feldspars are predominant minerals in most Norwegian aggregates, and a relation can be found between the strength of cement mortars and the type and condition of the feldspars present. Especially the type and extent of mineral alteration (Saussuritization, Sericitization) appears to be of importance for the development of the contact zone between cement paste and mineral surfaces during cement hydration, and thus contribute to strength. Concerning mica, these minerals reveal a significant influence even though their per cent amount is limited. Dependence has been demonstrated between the mica properties in plastic as well as hardened concrete – and the weathering conditions of the minerals. Naturally occurring mica – in sand deposits – proves far less negative to concrete properties than mica in crushed, manufactured aggregates. There is a probable connection with the depletion of alkali cations from the minerals during natural weathering. For similar reason there is a difference between the mica types (biotite and muscovite). Specifically regarding natural sand deposits, the relation between mineral composition and weathering conditions seems of significance for the surface properties of the aggregates and their performance in cement mortar and concrete.

This article aims to describe how the mineral surface chemistry of the aggregate particles and its alterations can be used to predict the future adhesion properties with both cement and bitumen.