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High fines in concrete

Contrary to popular belief, the presence of quantities of microfines can be beneficial in most concrete mixes. In fact, the use of quality high microfines crushed sand in concrete has been common practice in some countries for over 20 years. As a result of long experience, these markets have developed systems and procedures to make its use standard.

The use of fines followed extensive trials that suggested satisfactory performance could be obtained, so experience and use grew. Where crushed sand containing high fines had a history of successful applications, batching plant managers would not think twice about applying it.

There has been a good deal of research into the use of microfines and along with site experience, this indicates there is a substitution effect when microfines are used in cement. The optimum microfine content for lean mixes is up to 15% and in some cases can be as high as 20%. However, for fat mixes the optimum percentage of microfines will be as low as 5%. The microfines content acts as a filler, reducing void space that would require cement paste to fill.
Experience in the field illustrates this point. Where microfines are used in concrete, there is an associated increase in 28 day concrete density. This increase in density results in higher compressive strengths and even higher flexural strengths. Examples from the field have shown that the substitution of cement with microfines has improved the quality of the concrete and reduced the cost of production.

Most of the negative connotations concerning microfines relate to the increase in water demand and the increase in shrinkage. This certainly occurs where mineral clays or similar materials are present. However, if the material has been generated during rock fracturing then its performance in concrete will be similar to that of sand and coarse aggregate and it will be inert. The presence of mineralclays is detrimental though and in the concrete sector this distinction is not well known.

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Mineral clays do have limitations and this has limited their use. The term clay mineral refers to phyllosilicate (sheet-like) minerals and to minerals that impart plasticity to clay and which harden upon drying or firing. When applying these materials under the ASTMC33 specification, which is based around the use of natural sand, there can be a poor performance in concrete. As mentioned earlier, high water demand, high shrinkage and reduced compressive and flexural strengths are common.

There are many types of mineral clays and their structures vary, along with their capacity to absorb water and shrink and swell. The clay mineral Kaolinite for example features a sheet like structure that allows water to be absorbed. Between the sheets there is a space called the interlayer. It is here that the clay particle absorbs water and cations.

Microfines (or rock flour as they are sometimes called) created by the crushing circuit do not have the capacity to absorb water. By definition most of the particles contained are silt in grain size (ranging from 63 - 2microns) with a structure similar to that of sand. Absorption of water is over the surface of the particle not within it, so they must be treated differently.

The slightest presence of clay minerals causes a reduction in the tensile strength of hardened concrete. For example, Montmorillonite is a swelling clay and causes the greatest reduction in tensile strength while Kaolinite has a similar but lesser effect. By comparison, fines containing crusher dust can improve the tensile strength up to a certain point followed by a gradual tailing off in that strength.

To ensure best performance, the reactivity of the microfines contained must be determined as part of the evaluation of a crushed sand. If the source rock has weathered or contains certain minerals there may be the capacity for the microfines to be reactive (in other words, with properties similar to those of mineral clays and having the ability to increase water demand).

To determine reactivity Methylene Blue Titration provides a good measure as it determines the absorbency of the microfine fraction. Calibration of the test results to field performance provides good accept/reject criteria.

However, removing microfines by washing creates a crushed sand that will increase the harshness of concrete. The minus 0.015mm has little influence on the fresh properties except to provide cohesion and lubrication to the mix. Controlled amounts allow greater mobility of larger particles, which improves packing and density.

This is the last in the current series of technical articles prepared by **Metso Minerals**. It forms part of an expanding range of in-depth contributed articles that are featured in full on: **www.worldhighways.com**

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