Picture: Loesche GmbH, Germany

CEMENT
SikaGrind®
FOR VERTICAL ROLLER MILLS

BUILDING TRUST

SikaGrind®
FOR VERTICAL ROLLER MILLS

Concrete is an essential element for innovation in construction. The industry's continuous development, for more than 150 years, has made concrete to be the most important construction material of all.

The cement industry has contributed a significant share to the progress of the concrete technology:

- Good and long lasting workability
- Adaption to different ambient temperatures (summer/winter)
- Pumpability, long distance and/or high elevation, no separation
- Fast strength development, high early strength
- Durability

In addition to rising technical demands, the cement industry is continuously improving its ecological footprint. The production of clinker is still an unavoidable source of CO_2-emissions. New clinker types with lower burning temperatures and/or less calcium carbonate are in the pipeline respectively and are being used already. Nevertheless, in the past decade, the main measures to improve sustainability have been the use of alternative fuels and the reduction of the clinker factor through the use of secondary cementitious materials (granulated blast furnace slag, fly ash, pozzolanes, limestone etc.).

ELECTRICAL ENERGY

The grinding of the finished cement consumes approximately one third of the total electrical energy of a cement plant. Vertical Roller Mills (VRM) have a clearly higher energy efficiency than ball mills, even if the ball mill is combined with a roller press. This and further arguments led to the increased share of VRM for the grinding of finished cement. Taking into account that VRM usually have a bigger output than ball mills, it can be declared that the major part of the cement production with newly installed mills comes from VRM.

The grinding of raw material and especially the challenging slag grinding has been for many years almost completely in the hands of VRM.

In a ball mill, the particles are ground by repeated impact forces. The material usually needs more than 20 minutes of grinding from mill entrance to outlet, with uncountable impacts take place on this way. Depending on the efficiency of the separator and the Grinding Aid, agglomerates of fine particles are rejected and pass the ball mill again. Repeated impact and attrition cause a certain proportion of very fine particles and a broad particle distribution. Expressed as inclination of the particle size distribution according to RRSB, cements from ball mills generally have a rather low slope [n'].

In a VRM the grinding takes place by pressure and shear force. The clinker passes within seconds between the roller and the table. The energy input into the material during one passage between the grinding rollers and grinding track is relatively low. The thickness of the material bed between the roller and the table is a multiple of the particle size.
Thanks to the integrated separator (classifier) the grounded material is separated after each passage. In comparison to a ball mill (with an external separator), the separation is sharper. Therefore the particle size distribution (PSD) of the cement has the tendency to be narrow (high n' according to RRSB). This feature is very advantageous for the production of Portland-Limestone Cement.

SikaGrind®
FOR PORTLAND CEMENT

The production of Portland Cement (OPC, CEM I) with Vertical Roller Mills can demand the following benefits from a Grinding Aid:

- Increased production rate - energy saving
- Higher fineness - faster strength development
- Reduced vibration - less wear
- Reduced water injection - less pre-hydration
- Improved particle size distribution - better concrete workability
- Higher powder flowability of the finished cement - good de-loading of silos and trucks

A high content of very fine particles on the grinding track usually affects the stability of the grinding bed. Fine particles lower the interparticle friction, which reduces the grinding efficiency. Fine particles on the grinding table cause disruption with compaction and de-aeration, resulting in vibration and higher wear of the equipment. Water injection is a common method to overcome these problems, but due to the pre-hydration of the cement this possibility is limited and doesn't improve the cement quality.

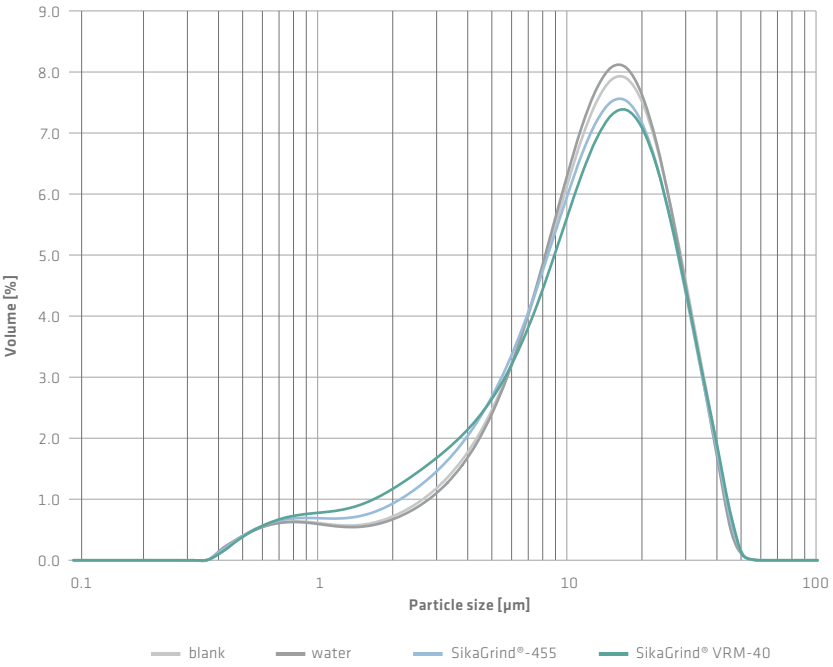
SikaGrind® is preferably sprayed onto the material bed, close to the rolls.

It is a common opinion that the Grinding Aid should stabilise the material bed by a sticky effect. However, the result of Sika Research and Development, combined with pragmatic tests on a pilot mill of Loesche GmbH in Germany, proved something else. The benchmarks for state of the art Grinding Aids are the ability to:

- Increase the share of coarse particles on the grinding track to obtain high interfriction
- Improve the properties of the finished cement

Pilot Mill (Picture: Loesche GmbH, Germany)

Concrete producers dislike cements with narrow PSD's because this can decrease the concrete workability. Counteractive measures of the VRM, e.g. higher grinding pressure, are used to increase the share of very fine particles (diameter below 5 µm) if necessary. Advanced cement additives, specifically designed for VRM, can be a helpful support for the cement industry to broaden the PSD and increase the productivity at the same time.



Cement particles with a diameter below 3 µm are known to have no or very little influence on the strength development. On the other hand, the graph above shows that SikaGrind® VRM-40 shifted a considerable share of the cement particles into this range. Thanks to improved workability and the chance to lower the water/cement - factor, the concrete strength will profit from this PSD.

RECOMMENDATION

Cement qualities for non-structural applications with low specific surface areas (low Blaine) are no technical challenge for VRMs, unpretentious Grinding Aids add a perfect cost/benefit ratio. Sophisticated cements or certain process limitations, e.g. a bottle-neck, demand a Grinding Aid with the highest effectiveness.

Our knowledge of strength and performance enhancers can be applied for cements from ball mills as well as from VRM's.

Portland Cement (ASTM C150) or CEM I (EN 197-1)

Requirement	Product	Characteristics
Recognisable increase in production rate Moderate improvements in cement quality	SikaGrind®-421	Economic treatment cost Typical dosage: 0.05% Chloride free
High increase in production rate Significant improvements in cement quality	SikaGrind®-455	Moderate treatment cost Typical dosage: 0.05% Chloride free
Highest impact on productivity, e.g. as solution for a bottle neck in production process Highest improvement in cement quality, e.g. as solution for premium quality cement	SikaGrind® VRM-40	Significant treatment cost Typical dosage: 0.05% Chloride free

SikaGrind®
FOR SLAG CEMENT

Granulated blast-furnace slag (GBFS or GBS) is a by-product of the steel industry. By water quenching of the molten iron slag a very dense and glassy product with an appearance like coarse sand is generated.
Slag Cements are well recognised in many countries with traditional and powerful steel production. High chemical resistance, low heat of hydration and sustainability are strong arguments for Slag Cements. The main disadvantage of Slag Cement is the slow strength development.

Granulated blast-furnace slag is difficult to grind:

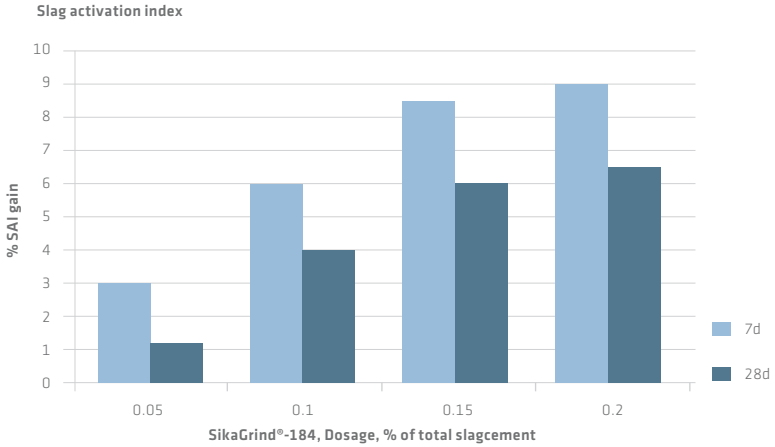
- Slag requires 30-50% more grinding energy than clinker to achieve the same fineness
- Slag needs a higher fineness to reach similar early strength as Portland Cement
- The microstructure of slag is very abrasive which causes high wear of the mill
- GBFS typically has a high moisture content (up to 15%) when delivered to the cement plant

VRM are meant for grinding slag as the specific advantages of VRM fulfill these challenges. Unsurprisingly, VRM have a share of more than 90% of the delivered slag mills for years because:

- The specific energy demand is lower
- VRM are suitable for grinding and drying of considerable moisture content in one unit
- The wear of the grinding equipment is easier to manage

Slag and clinker are mostly ground separately to minimize energy consumption and optimise the fineness of each component. If storage and mixing facilities are available, a wide product range can be made.

RECOMMENDATION
Wet slag is usually ground without any cement additives, as the moisture helps to form a stable grinding bed. The improvement of the grinding efficiency of dry slag by Grinding Aids is less pronounced than with clinker. Therefore, more interest is paid to the chemical activation of the slag reactivity, especially at early age. The strength increase can just as well be utilized to increase the production rate at lower fineness.



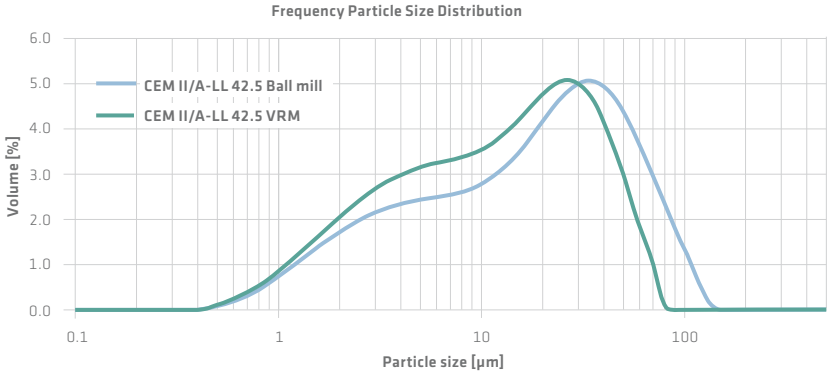
Slag (ASTM C 989 and EN 15167) or Slag cement (ASTM C 595 and EN 197-1)

Requirement	Product	Characteristics
Recognisable increase in early strength	SikaGrind®-200	Minor treatment cost Typical dosage: 0.04% Chloride free
High increase in early strength	SikaGrind®-120	Moderate treatment cost Typical dosage: 0.15% Contains Chlorides
Very high increase in early as well as final strength	SikaGrind®-184	Significant treatment cost Typical dosage: 0.15% Contains Chlorides

SikaGrind®
FOR PORTLAND-LIMESTONE CEMENT

Limestone is much easier to grind than clinker. The common intergrinding of limestone and clinker in classical ball mills is therefore producing a cement of very high surface area. The higher the limestone content, the higher the negative impact of its surface area on water demand and powder flowability. The intergrinding of Portland-Limestone Cement (PLC) with Vertical Roller Mills avoids excessive limestone surface area.

Particle Size Distribution of 2 cements with identical limestone content, ground in different mill types.
The VRM grinds the clinker to a higher degree, but the fineness of the limestone is not increased proportionally.



Standard mortar without SikaGrind®

Standard mortar with SikaGrind® LS-43

Consistence of standard mortar by flow table

RECOMMENDATION

Portland-Limestone Cements are by all means predisposed for strength enhancing additives, for early and final strength. But the effect of strength enhancers by chemical activation is limited.
The strategy of SikaGrind® LS is to compensate the strength loss with strength enhancers as far as it makes sense and to increase the surface area, predominantly through the clinker fineness. The eventual impacts of the higher surface area on productivity, powder flowability or workability are reduced by SikaGrind® LS.
Sika is successfully using Polycarboxylate ether (PCE) as a component in cement additives for PLC in order to reduce the water demand and increase the workability.

Limestone Cement (ASTM C595 and EN 197-1)

Requirement	Product	Characteristics
High increase in early and final strength Increase powder flowability	SikaGrind®-700 SikaGrind®-870	Minor treatment cost Typical dosage: 0.04% Chloride free
High increase in early and final strength Improve concrete workability Increase powder flowability	SikaGrind® LS-273	Moderate treatment cost Typical dosage: 0.10% Chloride free
Very high increase in early and final strength Highest improvement in concrete workability High increase in powder flowability	SikaGrind® LS-43	Significant treatment cost Typical dosage: 0.15% Chloride free

SIKA FULL RANGE SOLUTIONS FOR CONSTRUCTION:

LIQUID APPLIED ROOFING

SINGLE PLY ROOFING

CONCRETE

CONCRETE REPAIR

STRUCTURAL STRENGTHENING

WATERPROOFING

JOINT SEALING

FAÇADE STRUCTURAL ADHESIVES

FLOORING

INDUSTRY

DISTRIBUTION

BUILDING TRUST

FOR MORE INFORMATION:

Visit **www.sikaconcrete.co.uk**

WHO WE ARE

Sika Limited and Sika Ireland Limited are part of the global Sika Group, specialising in the manufacture and supply of chemical based products. Sika have a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing, and protecting in the building sector and the motor vehicle industry. Sika has subsidiaries in 101 countries around the world and manufactures in over 200 factories. With more than 20,000 employees Sika generates annual sales of CHF 7.09 billion (£5.45bn). We are also committed to providing quality, service, safety and environmental care.

In the UK and Ireland, we provide market-leading solutions for concrete, waterproofing, roofing, flooring, refurbishment, sealing & bonding, and industry, and have manufacturing sites in Welwyn Garden City, Preston, Leeds and Dublin with more than 870 employees and a turnover of more than £260 million.

SIKA LIMITED
Head Office
Watchmead
Welwyn Garden City
Hertfordshire, AL7 1BQ
United Kingdom

Contact
Phone +44 1707 394444
Fax +44 1707 329129
E-Mail enquiries@uk.sika.com
www.sika.co.uk
@SikaLimited

SIKA IRELAND LIMITED
Sika House
Ballymun Industrial Estate
Dublin 11
D11 DA2V
Ireland

Contact
Phone +353 1 862 0709
Fax +353 1 862 0707
E-Mail info@ie.sika.com
www.sika.ie
@SikaIreland

BUILDING TRUST

CONCRETE AND WATERPROOFING/SIKAGRIND FOR VERTICAL ROLLER MILLS MARCH 2019