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SELECTIVE CONCRETE RECYCLING

In the context of Greenkey Solutions, Loesche provides a solution to fully recycle crushed concrete on an industrial scale to make it available for cement production.

More than 3Bnt/yr of construction and demolition materials are produced worldwide, which corresponds to about 340,000t/hr. The recycling of gravel, sand and cement stone from old concrete into fresh concrete is often limited due to the impurity of the components. The water demand of cement stone, the ground recycled cement component of concrete, also prevents an extended application. Nevertheless, efforts to recycle construction materials in a high-quality manner is steadily increasing worldwide.

There are various methods for selective processing of old concrete. Besides conventional impact or roller crushing, high-voltage crushing underwater and modifications of jaw crushers also demonstrate the possibility of selective concrete comminution. However, some of these technologies are still in the development phase or can only be applied on a small scale. Loesche's S/Crete solution, in contrast, presents a large-scale 'selective grinding' process to separate coarse and fine aggregates and cement stone.

Selective grinding

The basic concept of selective grinding aims to separate multi-component materials into their individual parts by attrition grinding, rather than crushing. The grindability of the components of concrete varies considerably (see Figure 1). In view of this variation, the grinding process is designed so that only the cement stone is comminuted and the remaining components retain their original shapes and sizes. In the Loesche mill, the crushed concrete rubble is fed centrally onto the rotating grinding table and conveyed under the grinding rollers by centrifugal forces. A material bed is formed between the rollers and the grinding table, limited by the dam ring at the overflow. This is controlled by the appropriate setting of parameters such as grinding table rotation speed, as well as inclination and pressure of the grinding rollers. The material then undergoes a combined shearing and rubbing pressure on the grinding bed.

The Loesche mill for concrete recycling is a further development based on original technology developed by Loesche. One difference is that due to the lower grinding pressure needed, the hydraulic system can be considerably simplified. Another advantage is that this mill type weighs less due to the lighter mill body and force-transmitting structure.

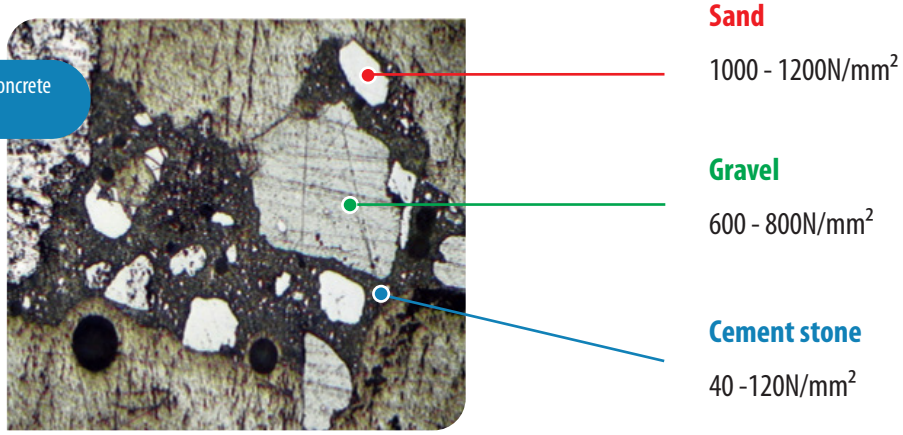

Figure 1: Varying hardnesses of concrete compounds.

Figure 2: Using concrete recycling materials.

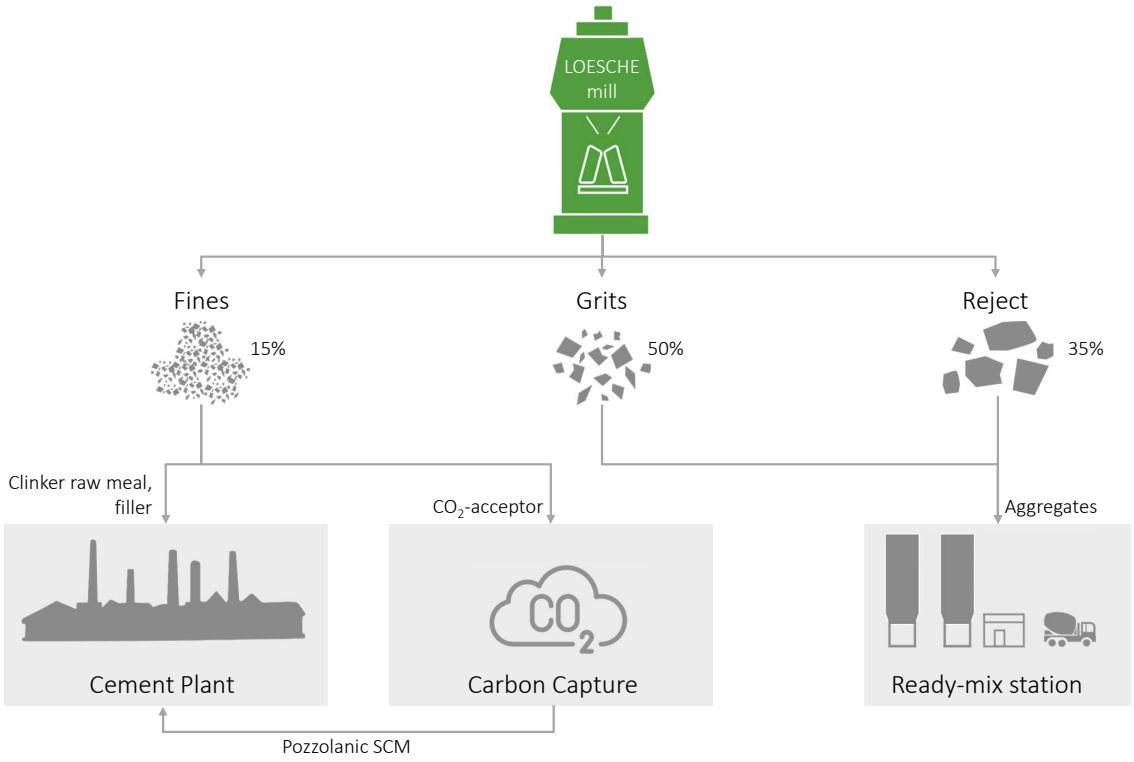

Figure 3: Semi-scale mill in the Loesche Test Center.

Stages of the process

The mill is operated simultaneously in gas flow and overflow mode so that a significant material flow is discharged through the louvre ring, specially designed for counter flow screening. At this point, an initial sorting and classification takes place, by discharging coarse goods downwards through the 'reject' chute.

The feed particle size of the concrete rubble can be up to 100mm. These particle sizes roughly correspond to those usually produced in a crushing plant. The concrete rubble is released from the steel reinforcement by upstream sorting steps before being fed to the mill.

The gas flow takes the finer material upwards to the second classification stage, the dynamic classifier. The

classifier separates the cement stone from the sand and aggregates. These are returned to the grinding process through the grit funnel. The sand is ejected via the funnel before it returns to the grinding table. This is particularly recommended for large quantities of organic and other impurities, as they accumulate in this stage of the process.

Further stages can be added after the selective grinding to increase the purity of the fine and coarse materials, such as density sorting and screening. The necessary tests are carried out in LOESCHE's Test Center and laboratory mills (see Figure 3).

Using the resulting products

Selective grinding generates three types of products: Coarse aggregates (>4mm), fine aggregates (0-4mm) and fines (<125µm) (see below).

The coarse aggregates, also known as gravel, have been used for many decades as an alternative for concrete production. Selective grinding can achieve gravel purities of up to 95% with no detrimental effect on the quality of concrete. The fine material, mostly cement stone, can substitute up to 35% of the clinker content if appropriate boundary conditions such as sulphate content and chloride content are met (DIN EN 197-6:2023). In cement, fines are inert and have a predominantly filler effect, but can also contribute to reactivity, especially when made of concretes with dehydrated clinker. Alternatively, fines can be used as a CO_2-acceptor, because the mineralogical phases in the cement stone, mainly portlandite $Ca(OH)_2$ and C-S-H-phases, tend to form calcium carbonate $CaCO_3$ in the presence of CO_2. This is a natural process that can be accelerated by using CO_2-enriched exhaust streams in external devices. Cement stone can also be a substitute for clinker raw meal, lending this fine material huge potential for sustainable cement production.

Conclusion

The patented process of selective grinding in a LOESCHE vertical roller mill proves that it is possible to fully recycle concrete on an industrial scale. The advantages of the S/CRETE technology are:

1. No water consumption;
2. Low energy requirement;
3. Low carbon footprint of the plant;
4. Scalable to all sizes (including mobile plants);
5. Applicable to all types of concrete.

The applicability of the materials produced is versatile and can achieve CO_2 reduction beyond conventional use as aggregates in fresh concrete. The goal of concrete recycling must be a closed circular economy. However, this can only be achieved if all involved parties understand sustainability as a maxim for action.

Figure 4: Operating principle of the LOESCHE mill for concrete processing.