Contribution ID: **39** Type: **Abstract TEC2ZERO**

Optimization of cement stone recovery in concrete recycling by thermal-mechanical treatment

In view of the high CO2-emissions of the cement industry and the growing demand for mineral aggregates, maximum recovery of cement stone and original aggregates in concrete waste must be aimed at. For example, recycled coarse aggregates can be reused in ready-mix concrete, while the separated and ground cement stone can be returned into the clinker burning process, opening the possibility to saves a significant amount of CO2-emissions, but also conserves resources by partially replacing the limestone with the secondary raw meal.

To increase the degree of recovery especially of cement stone, a processing technology combining cyclic heating and grinding was investigated. To determine the optimum combination of cyclic heating and subsequent grinding, extensive test series were performed using a conventional concrete mixture. After initial crushing, the concrete waste was thermally pre-damaged at different temperature levels with different numbers of cycles. To evaluate degree of recovery, different variations of mechanical energies were tested in a grinding process using a ball mill. To vary the crushing energy e.g. the drop height of the steel balls, their diameter and duration of grinding were changed.

It has been shown, that combined thermal-mechanical treatment increases the degree of recovery of cement stone. Recovery of fine aggregates increases with increasing temperature, steel ball size and duration of grinding. The temperature treatment alone not only increases the crushability of the coarse agglomerates, but helps to improve elemental composition of the recycled cement stone for reuse in the clinker burning process. Mechanical grinding energy alone, has no significant effect on the elemental composition of the recycled fine cement stone. In addition, increased CaO content was observed with increasing fineness of the recycled material. At high mechanical grinding energies, the quality of the coarser recycled aggregates (≥ 0.5 mm) is almost comparable to the properties of geogenic aggregates.

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Track Classification: Materials Flow: Urban Mining & Secondary Raw Materials