Recycling of concrete in new structural concrete

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Abstract

Urbanization causes growth in construction and infrastructure sectors resulting in rapid production of concrete and related waste. Recycled aggregates from construction waste used in concrete is advantageous for ecological preservation of natural aggregates, reduction of waste and landfill. This study focuses on the production of structural concrete from prefabricated concrete waste.

This thesis investigates crushed concrete aggregates (CCA) as aggregate replacements in an industrial reference concrete recipe. Overall CCA replacement addresses closed-loop recycling feasible for continuous waste supply. Even a partial aggregate replacement is considered given the likelihood of discontinuous waste supply where fine fractions of natural aggregates are replaced by CCA. Both replacement ratios address technical and practical concerns in Sweden and exhibit novelty and potential of CCA replacement in high-utility recycling.

CCA concrete shows lower compressive strength and workability than reference concrete due to the adhered mortar and flakiness of CCA fractions, different from reference concrete aggregates. This leads to lower aggregate packing density and higher water absorption, crucial for concrete strength and workability. To improve concrete properties, this research firstly conducts mechanical pre-processing to enhance CCA quality by adhered mortar removal. Secondly, investigates paste densification by the addition of secondary cementitious materials (SCM) such as blast furnace slag. Besides the paste densification, SCM also strengthens the unremoved adhered mortar.

Concrete with CCA as overall aggregate replacement achieves reference concrete strength and workability with SCM addition, resulting in a climate-optimized concrete due to reduced carbon dioxide emissions from cement replacement. Concrete with CCA as fine aggregates fulfils the reference concrete requirements as a climate optimized concrete by the combination of mechanical pre-processing and SCM addition. These results give statistically significant improvements on the compressive strength of the concrete.

Keywords: concrete recycling; sustainability; closed-loop recycling; recycled aggregates; green concrete; climate-optimized concrete