

High-quality circular economy of aerated concrete

Aerated concrete, raw material substitution, recycling, low-CO₂ cements, closed-loop management, LCA

„REPOST“ – Recycling Cluster Porenbeton

Project participants:

Xella Technologie- und Forschungsgesellschaft mbH

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KIT Karlsruhe Institute of Technology - ITC and IIP

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[Link to final report](#)

Aerated concrete (e.g. Ytong®) has been a well-known and proven building material for almost 100 years. In principle, aerated concrete is completely recyclable: During production, there is always breakage and offcuts, which are either further processed into granulate (oil binders, thermal insulation fills, green roof substrates or, in the pet sector, as hygiene litter) or returned to the ongoing production of aerated concrete in ground-up form.

In contrast to these fresh production residues, aerated concrete demolition material usually contains foreign substances, which makes it difficult to recycle this material to a high value from ReziProK Resource-efficient circular economy - innovative product cycles.

Project objectives and approach

The aim of the "REPOST" project was to develop the basis for a resource-efficient, high-quality and economical recycling system for aerated concrete. The existing material cycle for unmixed aerated concrete material was therefore to be opened up for corresponding waste material in the central sub-project of "REPOST".

Building material prototypes (aerated concrete, sand-lime and lightweight concrete blocks) for masonry construction were developed from used aerated concrete of various purity grades, each containing the maximum possible quantities of recycled secondary aerated concrete while complying with standardized property parameters.

Where this waste material cannot be directly recycled, thermal conversion into dicalcium silicate, a main component of cement clinker, was investigated. The aim was to minimize the proportion of aerated concrete going to landfill and to partially replace the primary raw materials cement and burnt lime in aerated concrete production with a recycled product that causes lower energy consumption and therefore lower CO₂ emissions during its production. In addition, it was investigated whether and how the transformation of a conventional, linear use of aerated concrete towards a circular and

sustainable use can succeed. To this end, options for action were to be evaluated on the basis of a techno-economic and ecological analysis as well as optimized site capacity and logistics planning.

Research results and transfer possibilities

During the course of the project, several deliveries of pre-sorted old aerated concrete were delivered by Otto Dörner Entsorgung GmbH to the Xella granulate plant in Rotenburg/Wümme. After training the personnel at Dörner, aerated concrete from demolition work in Hamburg was sorted by hand. The preliminary visual checks for critical foreign matter were positive and the material was sent to Xella for crushing. The resulting aerated concrete powder was free of harmful substances in accordance with LAGA M20, TR-Boden, so that from a chemical point of view there were no restrictions on the use of the crushed waste material.

Following the optimization of process parameters and recipes, a total of over 100 kg of Belit clinker was fired from four different qualities of old pore concrete at the Karlsruhe Institute of Technology, Institute of Technical Chemistry (KIT-ITC) and made available to the project partner Xella. Data on material and energy balances were sent to the Institute of Industrial Management and Production (KIT-IIP) for techno-economic analysis. On a pilot plant scale, up to 50 % of the Portland cement (OPC) normally used in aerated concrete production could be replaced by recycled cement clinker (Belit) from old aerated concrete (Figure 15 shows material from an initial upscaling in the large-scale pilot plant of Xella Technologie und Forschungsgesellschaft mbH with 25 % RC cement clinker). Formulations for aerated concrete have been developed that contain up to 40 % by weight of crushed old porous concrete. Formulations with 20 % by weight (grade PP2 aerated concrete, see Figure 2), 30 % by weight (grade PP4) and 40 % by weight aerated concrete powder (aerated concrete facing board for use as a non-load-bearing interior wall) are currently available.

These three product groups accounted for around 95% of Xella's total aerated concrete production in Germany in 2021. Trial productions based on these new formulations are currently being carried out in Xella plants.

The aim is to release formulations and start production.

The development of a sand-lime brick with crushed old aerated concrete and a lightweight concrete brick using granulated old aerated concrete as a lightweight aggregate was completed on a pilot plant scale. KIT-IIP used modeling to determine the quantities of aerated concrete demolition material that will be produced in Germany by 2050 (at district level). This showed that a significant increase in volumes is to be expected in the coming years and decades, which could rise from 1.2 million m³ in 2020 to over 4 million m³ in 2050 (see Figure 1).

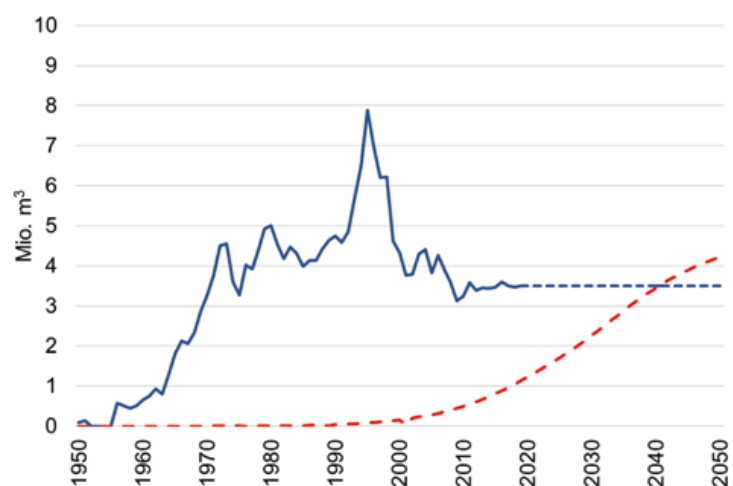


Figure 1: Aerated concrete (AAC) new production and volume of AAC waste in Germany 1950 - 2050

Source: Steins et al.(2021): Assessment of post-demolition autoclaved aerated concrete (ACC) volumes in Germany, Resources, Conservation & Recycling. DOI: 10.1016/j.resconrec.2021.105504

On the one hand, transfer opportunities exist in the expansion of AAC recycling throughout Europe. Significant volumes of old aerated concrete can be expected in the UK and Poland in particular. On the other hand, the methods used could also be used to establish/optimize recycling networks for other building materials from building demolition.

Contribution to resource efficiency and sustainability

A life cycle assessment of various recycling options for old aerated concrete showed that recycling is associated with major CO₂ savings and a significant reduction in other environmental impacts. The best recycling alternative in terms of greenhouse gas emissions is the addition of used porous concrete in ground form in the production of aerated concrete (closed-loop recycling).

This recycling can achieve a saving of almost 0.5 kg of CO₂ per kg of old aerated concrete. A complete change of recipe within Xella Deutschland GmbH would require around 60 kt of old aerated concrete per year. This results in a savings potential for greenhouse gas emissions of up to 30 kt CO₂eq per year.



Figure 2: Production of aerated concrete prototypes in the large-scale technical center of Xella Technologie und Forschungsgesellschaft mbH;

bottom left: Ytong® PP2-0.35 aerated concrete plan block with 20 % proportion of recycled aerated concrete; bottom right: aerated concrete plan block with RC cement clinker (Belit) from recycled aerated concrete

source: Xella Technologie- und Forschungsgesellschaft mbH