Investigating the circularity of a demolished concrete bridge

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Abstract

Concrete is known to be the most employed building material in construction. Due to its versatility, it is applied in a wide range of structures and infrastructures, such as residential and commercial buildings, dams, roads, bridges and tunnels. In fact, most bridges in Sweden are built using concrete. At present, closed-loop thinking is paramount concerning the responsible use of concrete as a building material. Residual concrete from construction or demolition concrete waste can be crushed and recycled as aggregates and applied in new concrete or as filler material; the result of this being denoted as Recycled Concrete Aggregates (RCA). Recycled aggregates stemming from construction and demolition waste (CDW) are often applied in e.g. roads, drainage and other construction projects, but it is projected that the application can also be extended to structural applications.

The subject of this investigation is a concrete bridge built in 1935 in Gullspång, Sweden. The transport administration decided in 2016 that this severely corroded bridge had reached the end of its service life and that demolition and replacement were the best alternative. Within this project, funded by InfraSweden 2030: a strategic innovation programme, reinforced concrete edge beams from this demolished bridge were recovered, crushed and processed into recycled aggregate. Relevant physical properties pertaining to the RCA were firstly characterized, e.g. particle density, water absorption, chloride and sulphur content. Moreover, the coarse fractions of this aggregate were used to replace crushed aggregates in a conventional concrete mix typically used for bridges. Three recycled aggregate concrete (RAC) mixes and a benchmark mix with only crushed aggregate were developed. The aggregate replacement ratios investigated were 20%, 50%, and 100% of the crushed aggregate by RCA. Samples of the mother concrete from the demolished bridge were also recovered for comparison purposes with the developed mixes. The mechanical behaviour, in terms of compression and tension properties, was characterized at the material level for the mixes, while the flexural capacity was investigated at the so-called component level (reinforced edge beams).

The outcome of this project indicates the potential of using RCA in a recycled concrete product in structures which is a responsible use of resources and an innovative product development compared to the current use of RCA as a “reused material”.

Keywords: Circularity of concrete, Recycled aggregates, Recycled aggregate concrete, construction materials