

Using recycled concrete in the construction of new buildings

State of Berlin (Germany)

Background

The construction industry is heavily dependent on resources, in particular concrete. The extraction of primary resources used in concrete production, such as open pit mining for sand and gravel, can lead to environmental damage including soil loss, habitat loss, and water, air and noise pollution. In addition, the energy used to transport aggregates and process these into concrete can contribute to greenhouse gas emissions and air pollution.

It is possible, however, to reduce the environmental impact of concrete by replacing some of these primary materials with recycled materials, without impacting the performance of the end product.

In 2013, Berlin was already using more than 1,000,000 tonnes of recycled concrete per year in road construction. However, demand for recycled concrete was still lower than its potential, and uptake in building construction was particularly slow.

As such, in 2013 the [State of Berlin](#) decided to address this by initiating a pilot project. The project aimed to overcome prejudices against the use of recycled concrete in building construction, and stimulate demand for recycled concrete in the building materials market. This pilot used the construction of the research and laboratory building for Life Sciences at the Humboldt University (worth a total €33.8 million) as an opportunity to include recycled concrete as a requirement. Extensive monitoring of the use and performance of the recycled material was conducted by the [Brandenburg Technical University Cottbus-Senftenberg](#) group (Faculty of Environmental Sciences and Process Engineering).

Procurement objectives

Following the successful completion of this initial pilot project (from 2013), similar requirements were included in a further research and laboratory building at Humboldt University. This time for the Berlin Institute for Medical Systems at the Max-Delbrück-Centre for Molecular Medicine.

The building will include high-tech laboratories and flexible working spaces, housing up to 25 research groups. When complete, the new research building will provide around 4,570m² (or 10,435m² in gross floor space), split between two interconnected buildings of three and six floors, as well as a basement. All supporting components of the structure including walls, ceilings, columns and the basement are made from concrete.

During the planning phase, extensive specialist discussions were held with all actors, after which an 'open' public procurement procedure was used, and building works commenced in February 2015. The concrete structure was completed in December 2016, and the building will be finished and ready to use from 2018.



Criteria used

Subject matter of the contract:

Berlin Institute for Medical Systems Biology Structural Works

Technical specifications:

Concrete cast on-site up to a concrete strength class of C30/37 must include recycled aggregate from crushed concrete, which meets aggregate for concrete standards DIN EN 12620: 2008-07 and the guidelines from the [German Committee for Structural Concrete](#) on using recycled aggregate.

Requirements for recycled aggregates were set as follows:

- delivery type 1 (concrete slab) according to DIN EN 12620: 2008-07, section 5.8
- Environmental compatibility: LAGA class: Z1.2
- Grain group: 2/8mm and/or 8/16mm
- Grain bulk density: 2,350kg/m³
- Mass fraction RC injection: max 45% according to formula (for XC 2)

Submission of a report documenting previous experience in the use of recycled concrete (with input from the manufacturer), particularly regarding water resistance, was also required.

Award criteria:

The contract was awarded to the lowest price bid which met the technical specifications.

Results

The total cost of the building is around €33.5 million. While using recycled concrete is currently more expensive than virgin aggregate, the State of Berlin is assuming that cost neutrality will be achieved in future as demand becomes more regular and the retrieval of aggregate for reuse is improved.

Tenders were submitted at the end of 2014 and construction began in 2015. The second phase of construction, which included the concrete structure, was completed in December 2016.

12 bids were received, and all bidders were able to meet the technical requirements for recycled concrete.

During the works, no difficulties in the use of recycled concrete were reported by the contractors.

Environmental impacts

Recycled concrete is an opportunity to close the loop in building materials, and create a more circular lifecycle for buildings. It provides a means to avoid environmental impacts associated with gravel mining. In addition, it reduces the environmental impact associated with the transportation and production of recycled aggregates - particularly when construction rubble, which is located close to or on the same site that a new construction will take place, is used.

In comparison with traditional concrete using primary aggregates, using recycled concrete in the pilot project at Humboldt University saved 880m² of virgin gravel, 66% of the energy required for production and transport (or 225 megajoule (MJ) per tonne of recycled concrete), and 7% of the associated CO₂ (0.6kg CO₂ per tonne of recycled concrete). Thus, the scientific monitoring of the pilot project proved that recycling firms are able to produce concrete at a high enough quality to meet all the requirements of building works (that is, strength class and consistency) without requiring any additional or special treatment during installation. This was also confirmed in the subsequent building of the Berlin Institute for Medical Systems.

"This procurement and the earlier pilot (from 2013) demonstrates that recyclers are able to produce high quality aggregates which can be used in concrete, and are not of inferior quality compared to virgin aggregate. Moreover, this aggregate can be easily used to make concrete which meets all necessary standards (such as strength, class and consistency), and requires no special or additional handling during installation in comparison to primary aggregate concrete."

The quality of recycled concrete aggregates significantly determines the quality and properties of the recycled concrete. In particular, it has to be kept free from contamination of wood chips and certain chemicals. If, however, improvements are made to the retrieval and sorting of demolition material, the additional costs for increased inspection (as occurred in the pilot project) would be reduced. Berlin's administrative regulations on '[Purchasing and Environment](#)' (which came into force in January 2013), offers a suitable instrument to require the separation of concrete from building demolition and the use of recycled concrete for new buildings by means of setting minimum criteria into procurement procedures.

Lessons learned

This procurement and the earlier pilot (from 2013) demonstrates that recyclers are able to produce high quality aggregates which can be used in concrete, and are not of inferior quality compared to virgin aggregate. Moreover, this aggregate can be easily used to make concrete which meets all necessary standards (such as strength, class and consistency), and requires no special or additional handling during installation in comparison to primary aggregate concrete.

Results from the earlier pilot project also confirmed that early announcement and communication can be useful. This gives recycling companies the necessary lead time to prepare tenders, including assessing environmental impact of the aggregate used, and altering and testing concrete formulations against normal concrete.

As a result of the success of the pilot project and subsequent uses, the State of Berlin now requires that recycled concrete is used in all future public high-rise construction projects. This will result in the replacement of around 100,000m³ of standard concrete per year.

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For related information, please see European GPP criteria for [Office Building Design, Construction and Management](#), the [Technical Background Report](#) and the [Procurement Practice Guidance document](#)