

Pore Structure of Concrete with Recycling Aggregates

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Introduction

Processed building rubble containing about 90 % of crushed concrete can be used as recycling aggregates. The reuse for the production of new high-grade concrete requires a knowledge of the engineering properties as well as the pore structure of these materials. Two recycling aggregates and the concretes made with them were studied.



Concrete made with recycling aggregates W

Experimental

Materials

- recycling aggregates X and W
- concretes with CEM I 32.5 R, X- and W-aggregates for all fractions from 2 to 32 mm, natural river sand for 0/2 mm, $(w/c)_{eff} = 0.5$
- reference concrete with same composition, but only natural sand and gravel

Methods

- examination of various engineering characteristics (compressive strength test of 150 mm cubes at the age of 28 days e.g.)
- density, mercury intrusion and nitrogen sorption measurements at crushed samples (4-8 mm granules, drying at 22 °C and 4 kPa above cold trap, sampling by rotary sample divider)

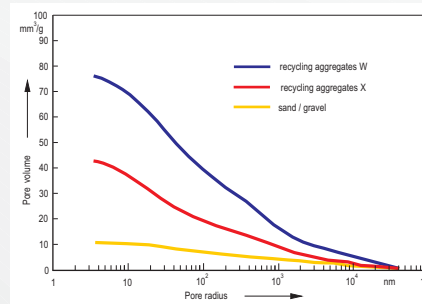
Characteristics of recycling aggregates

Aggregates	X	W
Content of concrete (%)	94	89
Other constituents	mortar, masonry, asphalt	
Bulk density (g/cm ³)	2.16	2.07
Water absorption (%)	3.5	6.6

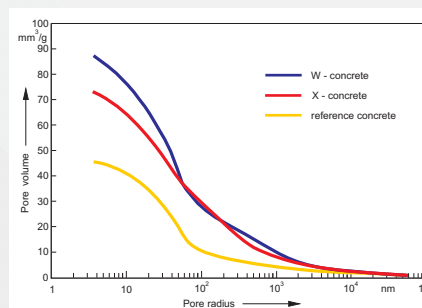
Conclusions

- The porous matrix of the recycling aggregates affects the pore volume and the pore size distribution of the concretes.
- But the porosity of the X- and W-concretes is, in general, higher than the sum of the pore volume of the old cement paste matrix of the recycling aggregates and that of the new formed matrix of the concrete.
- This discrepancy points to some additional effects of the recycling material on the pore structure, which are subject of further studies.

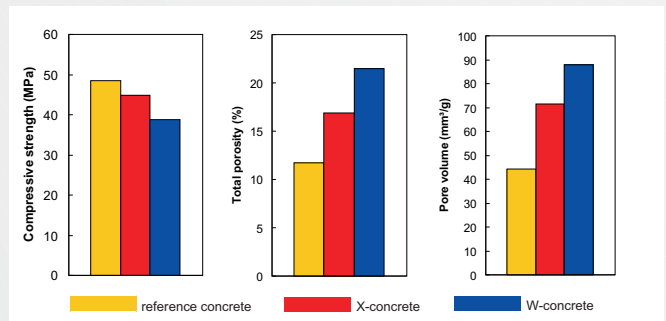
Results



Pore size distribution of natural and recycling aggregates from mercury porosimetry. The recycling aggregates are porous materials showing the typical pore structure of an old concrete.



Pore size distribution of concretes with natural and recycling aggregates from mercury porosimetry. X- and W-concretes have much higher porosities than the reference concrete.



Strength and porosity characteristics of concretes with natural and recycling aggregates. The results from pore structure studies confirm the engineering properties.

Comparison of measured and calculated porosity parameters of concretes with recycling aggregates. The calculated values are obtained by summing up the porosities of each constituent equivalent to its proportion in the concrete.

Parameter	X-concrete		W-concrete	
	measured	calculated	measured	calculated
Total porosity (%) (bulk density/density)	16.9	16.9	21.5	18.6
Pore volume (mm ³ /g) (mercury intrusion)	71.5	59.2	88.0	73.6
Pore volume (mm ³ /g) (N ₂ -sorption, BJH)	31.0	31.6	38.5	36.5
Surface area (m ² /g) (N ₂ -adsorption, BET)	6.5	4.4	7.4	6.0