

concrete

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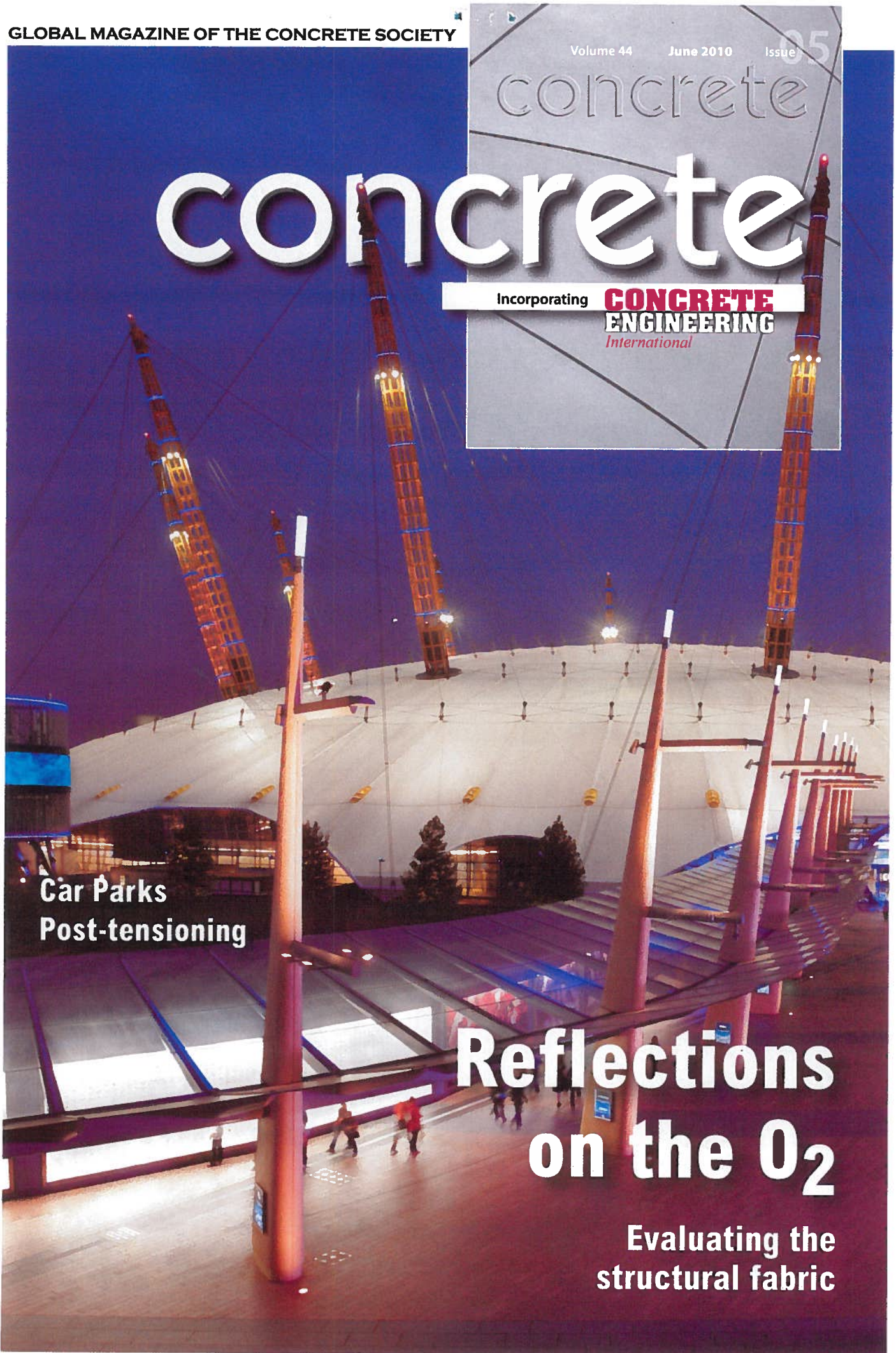
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Recycled glass granules provide key to lightweight concrete versatility

Granules made from 100% recycled glass form versatile lightweight aggregates for concrete, offering increased flexibility for house-building design. **Phillip Brdlík** of **Dennert Poraver** reports.

Recycling of used materials can do more than help save the environment when the new material produced turns out to have substantial benefits of its own. This is the case with Poraver, an inorganic lightweight aggregate manufactured from 100% recycled glass. The product, which was developed by Dennert Poraver of Germany, has high-quality technical performance characteristics. Post-consumer glass, typically collected through municipal box programmes, is crushed and refined to create lightweight pellets that expand and generate a fine-pored granulate.

Research found that spherical granules in diameters that range from 0.04 to 16mm, made entirely from glass unsuitable for recycling as glassware, could be used as a lightweight aggregate that enhanced the performance of many building products including lightweight concrete, construction chemicals, dry mortars and panel systems.

The first and most obvious improvement concerned weight reduction. It quickly became apparent that there were additional benefits, with the granules providing an odour-free and non-allergenic material. Additionally, unlike organic aggregates, the expanded glass granulates are chemically resistant, non-flammable and absorb only small amounts of water.

Due to its very light but strong glass spheres, Poraver extends the possibilities of modern structural concretes by reducing the density while still maintaining high strength levels. The aggregate can be used in both precast and ready-mixed concretes. The ball-bearing effect of the spherical grains improves the characteristics of the wet concrete, for example the flow when filling moulds.

As the material can be used to produce high-quality

precast panels as well as concrete blocks, it allows for great flexibility in house building. Being lighter in weight, there are savings to be made in transportation, with more square metres of panels or blocks per truck being delivered to the site.

As glass is non-porous, lightweight concrete made with Poraver granules is extremely effective at regulating moisture. Only a limited and defined amount of moisture is absorbed by the pores of the tiny glass spheres and quickly released. The formation of uniform air voids enhances the 'breathing effect' and the climate control of lightweight concrete housing.

Insulation

Lightweight concrete made with Poraver aggregate has high insulating properties, a great advantage when designing energy-efficient buildings. Poraver walls and blocks can achieve λ -values of 0.11W/mK without using any external additional thermal insulation system or any internal organic filling: all that is needed is the purely monolithic mineral material.

The Poraver granules also meet the requirements for low dry density of the concrete as well as the required compressive strengths. Those properties are demonstrated in precast wall systems such as poraFORM; these lightweight concrete panels are efficient insulating structural elements.

The multi-cellular structural wall panels are effective for both winter and summer thermal insulation. Good structural performance is achieved due to the load-bearing qualities that range from LAC2 to LAC8. The Poraver-based system reduces weight by as much as 450kg/m³ and therefore large panels are easier to transport and lift.

Sound absorption

In addition to thermal insulation, the material provides effective sound absorption properties. Acoustic panel systems such as StoSilent Panel from StoVerotec owe much of their performance figures and flexible application possibilities to the use of Poraver aggregate, which helps to absorb environmental noise from outside



Poraver extends the possibilities of modern structural concretes by reducing the density while still maintaining high strength levels.



Below: Poraver glass granules.

Right: Lightweight concrete panels made with Poraver glass granules used for house building.





and to dampen internal sound transmission from one room to another. In a special production process, a binding agent is added to the expanded glass granulate and the mixture pressed to make panels. Mounted on walls and ceilings of any area, the seamless 'silent panels' can produce precisely definable room acoustics by the sound waves being absorbed or reflected in a tightly focused manner. Reverberation times and background noise can be effectively reduced.

A typical aggregate dosage used for insulating concrete would be around 200kg of Poraver bonded with 100kg of cement, leading to densities of 270–300kg/m³ at approximately 0.5MPa. This dosage can be used as an insulation layer on the outer faces of concrete precast panels, using higher-strength concrete for the inner load-bearing layer, resulting in values that can reduce to 0.07W/mK.

Concrete blocks

The glass granules can also be used to improve concrete blocks, as demonstrated by the Calimax product line. Produced to German Technical Approvals, the blocks are made from lightweight concrete with 1–8mm Poraver granules. These blocks achieve excellent λ -values of 0.11W/mK at low densities (450kg/m³) but have an effectual strength class of 2.5MPa.

Atlas Block Co in Canada uses up to 30% Poraver in its PCR Block, the company's new lightweight environmentally friendly concrete block.

After three years of testing, the PCR Block was introduced into the market in small quantities last year. Some were used for the construction of a school in Barrie, Ontario, and for a new media centre at

Huntsville, which will be used for a G8 summit this year.

Atlas has also developed a prototype block with Poraver that is substantially lighter than the lightest block currently on the market. The block could weigh as little as 10lb (4.5kg), about 20–22lb (9–10kg) lighter than other lightweight blocks (including PCR Block) currently produced. The lightweight prototype has received favourable reviews from architects, and is now undergoing extensive testing to determine load tables and other criteria.

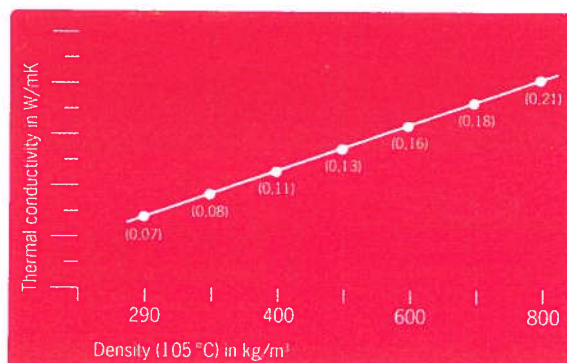
Visual qualities

Due to the weight reduction from using Poraver, complete prefabricated rooms can be inserted into unfinished buildings. The ex-factory prefabricated modules, fully wired and with all fixtures and fittings, are simply lifted into place by crane.

These can offer pleasing design possibilities. With the addition of different minerals, glass granules and colour pigments, a unique stone can be created with endless artistic options available. With the mineral aggregate content, further enhanced by Poraver's creamy white colour, the visual and tactile qualities can mimic natural stone. ●

Above left: Lightweight concrete blocks made with Poraver glass granules.

Above: poraFORM lightweight concrete panels used for house building.



Thermal conductivity of Poraver insulating concrete.

Table 1 – External walls: Technical data

Wall thickness* in mm	375	315	275	375	315	375	315
Compressive strength class	LAC2	LAC2	LAC2	LAC4	LAC4	LAC8	LAC8
Lightweight concrete apparent density in kg/m ³	450	450	450	700	700	800	800
Thermal conductivity λ_R in W/mK	0.11	0.11	0.11	0.18	0.18	0.21	0.21
U value (previously k value) in W/m ² K	0.28	0.33	0.39	0.42	0.49	0.48	0.56
Sound Insulation R'_w in dB	45	43	41	48	46	50	48
Factory undercoat plaster	External: lightweight mineral undercoat plaster as per DIN 18550-4. Internal: mineral thin-layer plaster						
Fire-resistance grading period	F120						
Vapour diffusion resistance coefficient** μ	5/10						

* Plus 20mm of lightweight plaster in the factory ($\lambda_R = 0.16W/mK$) on the external wall

** According to DIN 52615