

Laid waste

Years of delving into the properties of pre-loved concrete has laid the foundation of a valuable recycling industry. **Bryony Bennett** outlines the metamorphosis of a monumental waste stream.



One by one the stout red trucks pause by the concrete batcher, slurping their daily dose of aggregate, sand and cement. Bellies churning, they trundle towards the city and suburbs of Melbourne where their sticky mixes will be smoothed into house slabs, drainage channels, pathways and kerbs.

As they exit the gates of the Alex Fraser Group at Laverton North, a line of equally laden vehicles lumbers in. This convoy carries what appears to be demolition waste: jagged chunks of pre-loved concrete, spiked with the odd scrap of twisted steel.

In the eyes of Alex Fraser Recycling Industries general manager, David Bell, this cargo is a precious resource. After a punishing round with loaders, crushers, conveyors, sorters and screening equipment, the concrete chunks are tamed into a neat stack of uniform, cork-sized concrete pieces, as valuable as basalt, and ripe for reincarnation.

Bell can't help sounding satisfied when he says the company, which deals mainly in demolition, has buyers for as much concrete as it can recycle. Reaching this point has entailed a long-term commitment to developing specifications and quality assurance procedures for its products. With the help of scientists from CSIRO Building, Construction and Engineering, the company has found market niches in which recycled concrete performs just as well as its quarried counterparts in certain applications.

Above: Performance-testing the recycled product.

Right: From junk to rejuvenation. Waste concrete from demolition sites across Melbourne is recycled into aggregate by the Alex Fraser Group.



Alex Fraser began recycling concrete in the early 1980s when it bought a crusher to help dispose of demolition waste from an old foundry in the inner Melbourne suburb of Richmond. 'We would have spent as much on transport and disposal fees to get it to the tip,' Bell says. 'At that time we were the only ones doing it; everyone else was still taking it to landfill.'

Foreseeing the potential for recycled concrete, the company established a crushing facility at Port Melbourne. 'We realised that by initially accepting it for no charge at an inner-city location we could get enough concrete in to make it economically viable,' Bell says. 'At first we produced a low-quality road base that was "cheap as



chips”, but with better processes and equipment we worked up to the equivalent of a high-grade quarried product.’

Buyers included civil contractors working on major Victorian projects such as the Western Ring Road and the Grand Prix motor racing circuit at Albert Park. The company also recycled concrete for developers of the Sydney Olympics site at Homebush Bay and in 1994 it crushed a grand total of 340 000 tonnes.

‘Once the market for road base was established we sought to complement it with a higher-value product,’ Bell says. ‘We started to research the use of recycled concrete as an alternative to quarried aggregate in concrete production.’

It was a pioneering move. Until then, the accepted recipes for concrete, those that neatly matched engineers’ specifications, used an aggregate of quarried rock. Change the aggregate and you change the way the concrete performs. A new set of guidelines that categorised the relative properties and performance of the recycled product and its constituents – supported by production and construction protocols – were prerequisites for market acceptance.

Fortunately for the recyclers, the need for such guidelines had been recognised in the early 1990s by a team of concrete specialists at CSIRO Building, Construction and Engineering. The team, led by Dr Kwesi Sagoe-Crentsil, formulates, investigates and troubleshoots concrete, answering all the hard questions posed by the construction industry. It also has an impressive track record of devising useful building materials from the by-products of manufacturing. Notable examples include research and development of cement substitutes from powdered blast furnace slag and from fly ash, a residue of coal burning.

Sagoe-Crentsil says global demand for recycled construction products has increased substantially in the past decade as the sector has moved to embrace ecologically sound practices. He says concrete is perhaps better recycled than most other

The waste concrete is crushed, sorted, sieved and tested to ensure the aggregate produced is of consistent quality. A giant magnet removes fragments of scrap steel (top right).



components of the waste stream, but mostly is used as fill material for road construction and related applications. Development of a higher-value product such as concrete aggregate would improve the economic incentive to recycle.

'Although there is an Australian standard for concrete, it can't be applied directly to the recycled product,' Sagoe-Crentsil says. 'But engineers must be able to specify the quality and quantity of concrete required for a particular job, knowing it will perform as well or better than non-recycled alternatives. We saw that the provision of specifications would be necessary for this to happen.'

Concrete recycling conserves primary resources and reduces the transport cost and volume of solid waste delivered to landfill. The construction industry consumes 40% of Australia's quarried material and concrete use dominates building practices. Construction and demolition waste makes up about 40% of solid waste (estimated at some 14 million tonnes annually) going to landfill and concrete is a major contributor.

Perfect batch

The CSIRO team began its research by sampling concrete waste collected by Melbourne recyclers. Its quality was found to vary according to the level of contamination with materials such as brick, masonry, asphalt glass, timber, sand

and steel. 'Cleaner' feedstock has more uniform physical properties, and promised to perform more reliably as the aggregate in a concrete mix.

Concrete design can be a tricky business, even without the complication of impurities. Organic materials can cause instability, glass can cause expansive reactions, and chemicals such as the sulfates in plaster can alter concrete setting and dimensional stability. Information on acceptable contamination levels was needed, as were methods of improving waste separation at the demolition site and removing contamination during the crushing phase.

The researchers graded the feedstocks for characteristics such as bulk density, particle shape and surface texture, strength and moisture absorption. Bulk density is an important measurement because it influences the moisture content and water absorption capacity of aggregate particles. This in turn affects both the accuracy of concrete batching and its workability. Recycled concrete aggregate is generally less dense than basalt because relatively porous mortar particles adhere to the surfaces of original natural aggregate. In some cases these particles may actually improve the bonded strength of the recycled concrete.

When happy with the aggregate specifications, the researchers began mixing test batches in the laboratory. They

Recycled concrete can be substituted for high-grade quarried material in road construction and related applications.

formed hundreds of concrete columns, slightly larger than a jam jar, and rated them for properties such as durability, strength and setting characteristics. The results were compared with concrete made from basalt aggregate.

By 1998, the team was confident that its recycled product could match the original in non-structural uses such as footpaths and driveways. 'It's just as easy as conventional concrete to batch, transport, place and finish,' Sagoe-Crentsil says. He and his colleague Trevor Brown have developed and published guidelines for recycled concrete with the aid of a market development grant from EcoRecycle Victoria.

Meanwhile, Alex Fraser Recycling Industries had been doing some development of its own. It had refurbished a second-hand concrete batcher, set up a laboratory to enable technical sampling of the feedstock and refined its processing procedures and equipment. The improvements enabled production of a higher-grade road base material, and an aggregate good enough to be used in non-structural concrete. Staff had also journeyed overseas to observe recycling operations in Europe and the United States.

Early this year, CSIRO and EcoRecycle Victoria teamed up with Alex Fraser to demonstrate and test recycled aggregate



The recycled product takes shape.

Above: A bike path at Williamstown, one of four recycled-aggregate concrete trial sites in Melbourne.

Top: Kwesi Sagoe-Crentsil (centre) of CSIRO Building Construction and Engineering and Ian Coles of EcoRecycle Victoria (right) inspect the trial sites.

Left: Making samples of the recycled concrete for laboratory testing.

concrete in the field. Four trial projects were established: two bikepaths, a footpath and a kerb and channel. The recycled aggregate concrete has been laid beside conventional concrete so that their long-term durability can be compared.

Mark Kenny of EcoRecycle Victoria says market development is the key to successful recycling. 'This often requires challenging the perception that recycled products are inferior in quality and therefore should be cheaper,' he says.

'In the construction industry, products made from recycled materials must be scientifically validated. With CSIRO, the aim has been to develop a product that is proven to perform equally well if not better than the conventional alternative. We're keen to promote the results to councils and civil engineers.'

If the demand experienced by Alex Fraser is anything to go by, recycled aggregate concrete is set for success. The company now recycles a total of 600 000 tonnes of concrete a year, almost 80% of the Melbourne's market. Bell thinks that might represent a pile of concrete big enough to fill the MCG. About 2% of this pile is made into aggregate – for use by the company and by other concrete manufacturers – and Bell expects this high-value market to grow.

He agrees that this growth will depend on maintaining specified quality standards for the recycled product. 'There'd be nothing worse than having recycled concrete out there cracking up,' he says. 'It could put us back years.'

Alex Fraser's recycled concrete products have edged out quarried materials in some 10% of the Melbourne market for aggregate/road base. 'We couldn't pretend to supply what quarries supply in volume,' Bell says. But by developing a high-quality operation we're extending the use of the recyclable material and the lifetime of the quarried resource.

Abstract: Global demand for recycled construction products has increased substantially in the past decade as the sector has moved to embrace ecologically sound practices. In the absence of engineering specifications outlining its properties and performance when crushed into aggregate, demolished concrete has mostly been reused as road base. After many years of research and development, CSIRO and EcoRecycle Victoria have published guidelines for manufacturing and using recycled aggregate concrete. These are helping to establish a higher-value product that performs as well as the original in non-structural uses such as footpaths and driveways. The recycled concrete is being promoted and tested in field trials.

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