THE **BRITE** PROJECT

Innovation Case Study No 12

Using Recycled Tyres to Construct an Access Road Over Saturated Terrain

*This series of innovation case studies has been developed by the BRITE Project of the Cooperative Research Centre for **Construction Innovation**. The case studies demonstrate the benefits of innovation and successful implementation strategies in the Australian property and construction industry. Many highlight the strengths of small and medium-sized businesses in regional areas.*

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Using Recycled Tyres to Construct an Access Road Over Saturated Terrain

A new system of road construction has yielded a 15% reduction in project costs compared to the conventional approach, while enabling challenging environmental and social objectives to be met.

E-Pave construction during inclement weather

Selected Project Participants

Client:
Energy Australia

Head Contractor/Project Manager:
Keller Civil Engineers

Environmental Consultant:
Environmental Resources Management Australia

Specialist Sub-Contractor:
Ecoflex Civil Constructions

Design Consultant/Technology Supplier:
Ecoflex Australia

Certifying Engineer:
Snowy Mountains Engineering Company (SMEC)

Tyre Supplier/ Recycler:
C&R Tyre Recycling

This report is based on interviews with Energy Australia, Keller Civil Engineers, Ecoflex Civil Constructions, Ecoflex Australia, and C&R Tyre Recycling.

Cover photo:
Partly filled E-Pave Units laid in diagonal pattern

The Project

The Tomago all-weather access road was a $4m project commissioned by Energy Australia as part of a larger $40-50m project to upgrade electricity supply from Tomago to the Tomaree Peninsula in New South Wales. The Tomago road project called for a 16 km stretch of pavement which:

- required that there be no excavation, compaction or levelling of the ground, to avoid: exposure of acid sulphate soils; disturbance of heritage sites, flora and fauna; and impact on private land
- created a load bearing capacity of 60 tonnes for crane traffic during construction of an electricity transmission line
- was permanent and required little maintenance
- had a low profile to preserve visual amenity
- was water permeable horizontally and vertically, to minimise impact on the ecosystem.

The value-based open tender selection process resulted in the contract being awarded to a team that used patented Ecoflex E-Pave Units in a recycled-tyre reinforced pavement design. This new method offered considerable benefits over conventional macadam pavement. The project was completed in October 2004, after a seven month construction program.

The Achievement

The client consulted the community for four years to determine the most acceptable alignment for the Tomago road. The community's favoured option traversed acid sulphate soils, wetland areas, 190 private properties, 10 archaeological sites and several national park sections. The project was thus environmentally, culturally and politically sensitive.

The winning tender offered an alternative design based on a proprietary construction process that better met the client's requirements and saved 15% over the conventional macadam design. In the bigger picture, the project also absorbed six percent of NSW's annual waste tyre stream, which would otherwise have gone to landfill.

E-Pave filled and capped

The Innovation

The patented tyre-reinforced permeable pavement was developed specifically for water saturated conditions, where the ground has low load bearing capability. The method is one of the few in the world that uses robust engineering systems to take advantage of the structural value of recycled tyres in a quality controlled environment.

The inventor grew up on a cattle property, where he often saw tyres being used to build roads which did not perform well. He later conceived that this performance could be improved by applying engineering principles and quality control processes. The pavement he developed is based on this early idea and his 30 years' experience in the civil construction industry. The pavement is built with Ecoflex units, which comprise:

- an approved recycled tyre
- a sidewall
- free-draining rock fill.

The recycled tyre consists of an approved tyre with the side-wall cut out at a precise location. An approved tyre is one that has a solid rubber tread with even thickness, passes strength and rigidity tests, has no exposed steel, and has not been stripped for re-treading. The cost competitiveness of the technology is underpinned by the adaptation of a $10,000 machine that efficiently and effectively removes the sidewalls. The sidewall is then put inside the tyres on-site to improve their tensile strength.

The tyres are placed on geofabric laid directly on the ground, and arranged in a honeycomb pattern which helps minimise the gaps between the tyres, thus helping to maintain the pavement's structural integrity. Each tyre is butted up to adjoining tyres, again so that fill does not infiltrate gaps and weaken the pavement. A topping layer is then applied to interlock the fill material. When constructed according to quality control procedures, there is no need to fix adjoining tyres to maintain the pavement's trafficability over time. The Tomago road comprises 75,000 truck tyres processed and laid in this way.

On the Tomago project, the client considered alternative pavement methods. Conventional construction methods were rejected for reasons outlined below in the Benefits section. Other new proprietary products from Australia and overseas were also considered. They all provided the fill-containment function offered by the recycled tyres, but the client found the costs much greater and the likely performance lacking.

The Benefits

In the absence of Ecoflex, the Tomago project would probably have used a macadam pavement, which comprises layers of broken stone, compacted into a hard surface. Because much of the terrain is often water saturated, and because excavation was not an option, a macadam pavement would have been very wide and high. To achieve a four metre wide trafficable surface, the pavement would have been seven metres wide and one metre high, while the proprietary pavement is only four metres wide and 300mm high.

The new approach is less costly, has less impact on the environment, and provides greater visual amenity. The recycled tyres contain the rock fill and prevent it from spreading, which is particularly advantageous on projects where excavation is problematic because of water-saturated or environmentally sensitive conditions, such as on the Tomago project.

For the Client

The proprietary system cost approximately 15% less than the conventional approach, significantly reducing the client's project costs, while achieving environmental and social objectives.

For the Environment

The technology supplier estimates that the cost of creating and operating an urban landfill facility in Australia is $100-$150 per tonne of waste. Applying the bottom end of this range, the Tomago project saved the community approximately $400,000 in land fill costs.

Environmental benefit was also provided because the recycled tyre approach required 60% less fill material than a conventional pavement on the project. This meant a reduction in fuel consumption to mine and transport fill. According to the technology supplier, this saved 2,110 tonnes of greenhouse gas emissions.

For the Technology Supplier

The performance record of the proprietary recycled tyre approach, especially on the Tomago project, has impressed the client. This has contributed to their considering development of a 'period contract', which is expected to offer a negotiated fee for unique products used on specified small projects, for a given time period. This arrangement avoids repeated open tendering for work where it is known that there is a unique product offering superior efficiency over available alternatives. For the technology supplier, this preferred status would be a reward for the considerable investment they have made in research and development (R&D), to develop a product that is apparently without peer.

E-Pave road in use before capping

The Implementation Process

Over the past 10 years, the inventor and other stakeholders have invested $4m in R&D and spent seven years obtaining patents in most industrialised countries for a range of recycled tyre innovations, including the tyre-reinforced pavement. Over the past five years, 150 mostly small pavement projects have been undertaken, largely in the civil and mining industries.

One of the key stakeholders in the technology is the tyre recycler on the Tomago project. Their interest has been driven by economic and environmental considerations. Tyre recyclers are usually paid by tyre retailers to dispose of tyres. Roughly 30% are suitable for immediate resale, export, re-treading or crumbing. The remaining 70% are typically buried in landfill after mandatory shredding to reduce volume. The landfill tyres have traditionally had no value, but most of them are suitable for use by the technology supplier.

The tyre recycler on the Tomago Project typically makes 10% profit on landfilled truck tyres, but can make 40% profit on locally sourced, approved and modified truck tyres delivered to site for the technology supplier. This is because it costs more to modify a tyre for landfill and pay the dumping fee, than to modify and deliver it for the technology supplier. Although appropriately modified tyres can be sourced by the technology supplier for nominal cost, the client pays a more substantial fee for the product, based on embedded intellectual property. The fee is priced competitively against next-best alternatives by the technology supplier, who licences the technology to recyclers or contractors.

The client created the opportunity for the proprietary product to be used on the Tomago Project by offering a value-based tender and encouraging alternative submissions. The client was motivated to do this following a pilot test of the product, which they conducted after hearing about the technology and developing a relationship with the inventor.

The pilot test seemed unnecessary to the inventor because 50 proprietary paving projects have already been completed and are operating successfully. He observes that new clients are very interested in the experience of existing clients, however at this point in the technology's development, new clients are still inclined to want their own demonstrator trials conducted.

Relationships were a key part of the implementation process. The key players – the Project Manager for the client, the technology inventor, the tyre recycler's Managing Director, and the head contractor's Managing Director are all very respectful of each other's abilities and have built up robust relationships over time. These are win-win relationships. The technology is a profitable and sustainable business opportunity for the tyre-recycler, a better way of meeting client needs for the head contractor, and it delivers economical/ sustainable project outcomes for the client. Nevertheless, all these parties became involved through a 'leap of faith'. They acknowledge that the adoption of new technology requires judicious risk taking, which in their case appears to be paying off. The client's Project Manager considers that their risks in adopting the new technology were reduced by the level of trust they had in the inventor.

Another type of relationship pursued by the inventor is with universities. He feels that the academic fraternity needs to be convinced of the benefits of the technology because their expert opinion is well regarded. He uses the Commonwealth Government's R&D tax concession to off-set the costs of university research, and has found this scheme 'extraordinarily helpful' in supporting his business.

Chris Montague, Construction Supervisor, Keller Civil Engineers

"it's a two way relationship with Ecoflex – they get demonstrator projects through us and we get innovative solutions for our clients"

Collin Harvey, Managing Director, C & R Tyre Recycling

"we do the R&D work, then sign over the IP to Ecoflex – they claim the tax concession – for smaller firms like us, it is too onerous to claim"

Overcoming Difficulties

The development of the new technology has been very challenging. Firstly, the inventor's team has needed to change damaging **public perceptions** about tyre flammability and leachability, and about the effectiveness of used tyres in structural applications. These issues have been addressed through university research, and through building over 400 successful projects. Such evidence suggests that recycled tyres laid according to the Ecoflex system are largely environmentally benign, and that the technology is robust. Recycled tyres that have been modified and laid according to the Ecoflex engineering system completely outperform the simple application of used tyres for structural purposes.

Secondly, the inventor's team considers that the **regulatory/specification environment** is complex and confusing, and that public procurement policies are excessively risk-averse. These factors are seen to constrain the uptake of their technology. Indeed, these themes are commonly raised by industry commentators.

Thirdly, as the technology is new, the inventor's team is very keen to ensure that all their projects perform well. This is particularly important as the technology seems deceptively simple, yet lack of attention to detail in the implementation phase can have a dramatic negative impact on performance. Hence, there is a strong focus on robust design by engineers and **expert supervision of site activities**. Every project is submitted for development application approval through the relevant government authority and hence complies with their requirements. Quality is also assured through certification of all projects by independent engineers and specialist supervision on-site.

Fourthly, the inventor's team conducts research to assess **unauthorised use of their patented system**. This is done mainly to avoid any project disasters perpetrated by unrelated organisations reflecting badly on the inventor's technology. There have been several instances discovered to date, and on each occasion a solution has been found that ensures the integrity of the project. Any disasters with recycled-tyre pavements, perpetrated by firms ineffectively copying the Ecoflex system or using other systems, could confuse the market and result in rejection of the inventor's technology.

Fifthly, the inventor's team feels that the technology has reached a level of development and market penetration where they can successfully seek a **partnership with a large established firm** in the industry. This is expected to provide additional capital to more effectively defend patents, the resources to more vigorously promote the technology, and the relationships to win more projects.

Finally, there were challenges in **project procurement**. The client's primary relationship was with the inventor, rather than with the head contractor. In this respect, the client would have been happy to receive a submission from the inventor's contracting company as head contractor, through the open tender process. However, the pre-qualification criteria precluded this. Instead, the inventor licensed Keller Civil Engineers, a larger and more experienced firm, to use the technology, and submit a bid as the head contractor. Keller's Managing Director is a long-time colleague of the inventor's.

Tam Niven, Project Manager, Energy Australia

"we used a value-based assessment of tenders – which Ecoflex won based on the benefits of its unique technology"

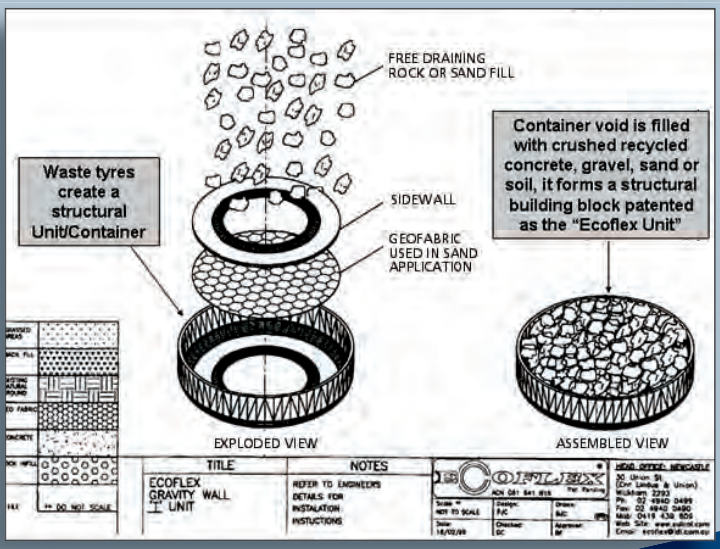
Garry Callinan, Inventor; CEO, Ecoflex Australia; Managing Director, Ecoflex Civil Constructions

"we are nearly at the point now where new clients will accept the evidence of benefits provided by existing projects, without needing their own demonstrator trials"

Lessons Learned

- Patience and effective industry networking underpin the commercial potential of new technology ventures undertaken by small businesses.
- Successful market acceptance of new products requires careful monitoring and management of imitators, to avoid damage to the product's reputation.
- Clients play a key role in promoting innovation, particularly via value-based tender selection and encouraging alternative tender submissions.
- Expert supervision and quality control is required to effectively implement new technological systems and maintain a good reputation.
- Small new technology businesses may achieve greater commercial success through partnerships with larger, more established businesses, particularly through improved market penetration and protection of patents.
- Small new technology businesses can benefit from relationships with universities, particularly where research is undertaken to validate claims, and where the Commonwealth Government's R&D tax concession can be used.
- Regulatory complexity and risk-averse public procurement policies constrain industry innovation.

E-Pave road construction



Exploded view of Ecoflex E-Pave Unit

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CRC *Construction Innovation* Vision … *'to lead the Australian property and construction industry in collaboration and innovation'*