TURNING WASTE INTO LOW CARBON MARINE CONCRETE

PROJECT FACTSHEET

LOW CARBON LIVING CRC

KEY POINTS

- **The manufacture of Portland cement in Australia produces eight million tonnes of carbon emissions per year.**
- **Australia generates 14 million tonnes of fly ash (from coal fired power generation) and 3 million tonnes of slag (from steel manufacture) as industrial by-products.**
- **Significant energy reduction can be achieved by using the slag and fly ash in Geopolymer Concrete.**
- **The higher density of Geopolymer is ideal for coastal defences, and can provide a major material and cost reductions.**

CRC for Low Carbon Living

The CRC for Low Carbon Living (CRCLCL) is a national research and innovation hub that seeks to enable a globally competitive low carbon built environment sector and is supported by the Commonwealth Government's Cooperative Research Centres programme.

With a focus on collaborative innovation, the CRCLCL brings together property, planning, engineering and policy organisations with leading Australian researchers. It develops new social, technological and policy tools for facilitating the development of low carbon products and services to reduce greenhouse gas emissions in the built environment. For more information visit www.lowcarbonlivingcrc.com.au/

THE CHALLENGE

The production of one tonne of Portland cement produces nearly one tonne of CO_2 emissions, and it is estimated that the manufacture of Portland cement in Australia produces around eight million tonnes of carbon emissions per year. During the same period, Australia generates 14 million tonnes of fly ash (from coal fired power generation) and 3 million tonnes of slag (from steel manufacture) as industrial by-products. These waste products are not fully utilised, but can potentially replace a significant amount of Portland cement.

A potential solution to both problems is to replace ordinary Portland concrete with Geopolymer Concrete (GPC). GPC uses industrial waste products to generate high quality concrete.

While GPC is promising there are many challenges, both in developing a concrete design, and in batching the concrete in real-world concrete plants.

OUR RESEARCH

We are working with the concrete industry to perfect GPC and make it useable in construction.

GPC has many superior qualities, including higher tensile strength and improved resistance to chemical deterioration in the marine environment. However there have been many challenges in making GPC behave like traditional concrete in terms of such things as ease of pumping, setting time, and curing requirements.

Making GPC is further complicated by the need to ensure that there is no contamination between concrete types, so batching the concrete in standard concrete facilities is difficult.

APPLICATIONS

One of the unique properties of GPC is its high density. This is especially important for maritime applications.

Coastal structures are often exposed to heavy seas and require very large armour units (typically 8-60 tonnes in NSW) to remain stable. While rock is often the preferred material for use on structures due to its low cost, it can be virtually impossible to get quality rock of sufficient size, so concrete units are required.

Density is a key parameter in the stability of coastal armour units. It is significant because the armour stability increases with the density cubed, so small increases in density have a significant impact on a structures stability. This has dramatic impacts on both new structures and the maintenance of existing infrastructure.

We have commenced a trial at NSW Ports' Port Kembla Harbor to validate GPC in the marine environment. A small batch of 18-tonne Hanbar units made from high density GPC have been cast and placed on the north breakwater. These units will be monitored for stability and integrity, and will provide a valuable benchmark for future use of geopolymer concrete.

Batching the concrete requires a unique supply chain, and has involved the supply of specialist materials from Australian Steel Mill Services, the Australasian (iron and steel) Slag Association and ICL Construction. Batching has been performed by MKD Machinery in a specialised mobile batching rig that allows the concrete to be made on site, to tight tolerances.

VALUE PROPOSITION OF OUR RESEARCH

- Lower carbon footprint for the construction industry.
- Improved use of industrial waste.
- More resilient coastal infrastructure.
- Simpler and more efficient repairs and adaptive measures for breakwaters and seawalls.

LESSONS

This project has been an excellent example of the collaborative effort between research and industry needed to bring novel technologies to market.

It has required vision and financial contribution from us and NSW Ports, cutting edge research on a construction driven timeframe, world class knowledge of marine infrastructure, and time, materials and industry leading know-how from concrete and material suppliers.

NEXT STEPS

Further research on the concrete technology will improve concrete ease of use and applicability to other areas of construction.

Monitoring of the GPC hanbars will be ongoing, providing coastal engineering with the confidence to use GPC in future repairs and construction.

PROJECT TEAM

The trial has taken a massive collaborative effort across industry and research. It has required innovation, coastal expertise, industry know-how and real commitment from all parties to make it happen.

The following organisations and companies have contributed to the project:

- CRC for Low Carbon Living
- NSW Ports
- UNSW Centre for Infrastructure Engineering and Safety
- UNSW Water Research Laboratory
- Australian Steel Mill Services
- Australasian (iron & steel) Slag Association
- ICL Construction
- MKD Machinery Australia

PROJECT REPORTS

This project applies the learnings from our project RP1020. That project has a broad suite of publications which are listed in our project catalogue and available on our website: lowcarbonlivingcrc.com.au

FURTHER INFORMATION

For more information about this project, please contact:

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