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CONCRETE SOLUTIONS FOR COAL MINE TAILINGS

The use of coal mine tailings in the production of cement could have significant environmental and economic benefits according to a study funded by ACARP.

The study found that treated coal mine tailings could be a winning formula for both the coal mining and cement/concrete industries.

Researchers Hassan Baji, Zhong Tao, Nariman Saeed, Andrew Hammond, Brendan Donnelly, and Peter Sleep explored the potential of repurposing coal mine tailings from four Queensland and New South Wales mines for use in cement production.

Millions of tonnes of coal tailings are produced in New South Wales and Queensland coal mines annually, which end up in tailings storage facilities (TSFs). Over the past 50 years, Australia's TSFs have accumulated about 500 million tonnes of these tailings.

Repurposing tailings would reduce the volume of tailings stored in TSFs going forward.

The project investigated the feasibility of using coal mine tailings as a raw material for cement clinker production and as a supplementary cementitious material (SCM) in production of concrete.

Every tonne of cement creates about 800 kilos of CO_2 emissions.

About 60 percent of this is chemical reaction emissions, with 40 percent from energy use.

“So even if you use green energy, like solar, you still have that 60 percent of emissions,” said Hassan.

“One of the things you can do to reduce emissions is decrease the amount of cement in the concrete mix through a supplementary cementitious material such as treated coal mine tailings.

"Another consideration is that fly-ash, a byproduct of coal-fired power stations, will be less prevalent as coal-fired generators close down, so there will need to be an alternative.”

The study found that because of their high kaolinite content, when treated, kaolinite is transferred to metakaolin (Figure 1), and these tailings can be used as a SCM in concrete, reducing the need for traditional cement production, which is a significant source of CO_2 emissions.

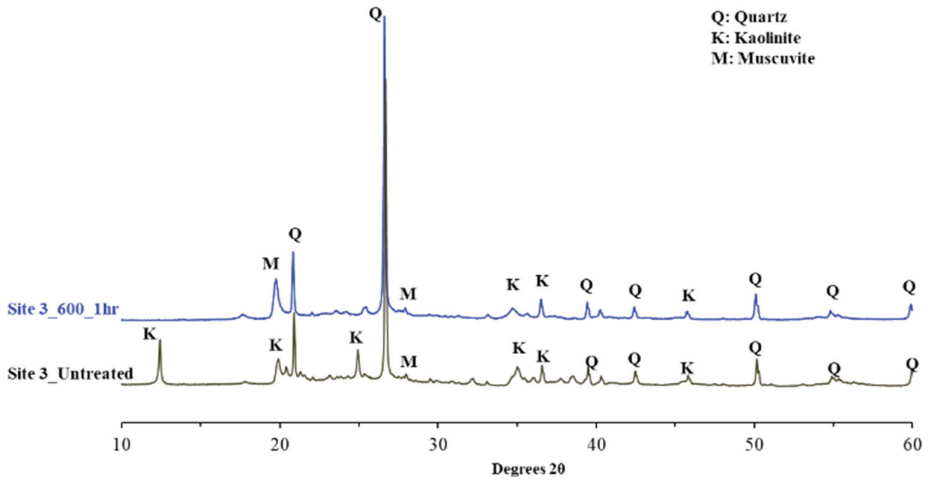

Figure 1. XRD patterns of raw and treated coal tailings for a typical tailings site

"Repurposing coal tailings not only addresses waste management issues for mines, but also offers a sustainable and cost-effective alternative for sustainable cement production," said Hassan.

"Our findings indicate that using treated coal tailings can reduce cement use in concrete by about 20 percent and improve both the strength (Figure 2) and durability of concrete (Figure 3), making it a win-win for both the environment and the industry," he said.

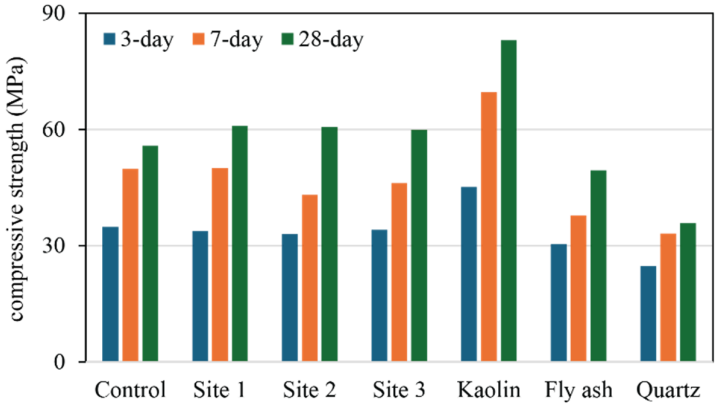

Figure 2. Strength of concrete samples with 20% replacement of cement with treated tailings at different curing ages of 3, 7 and 28-days

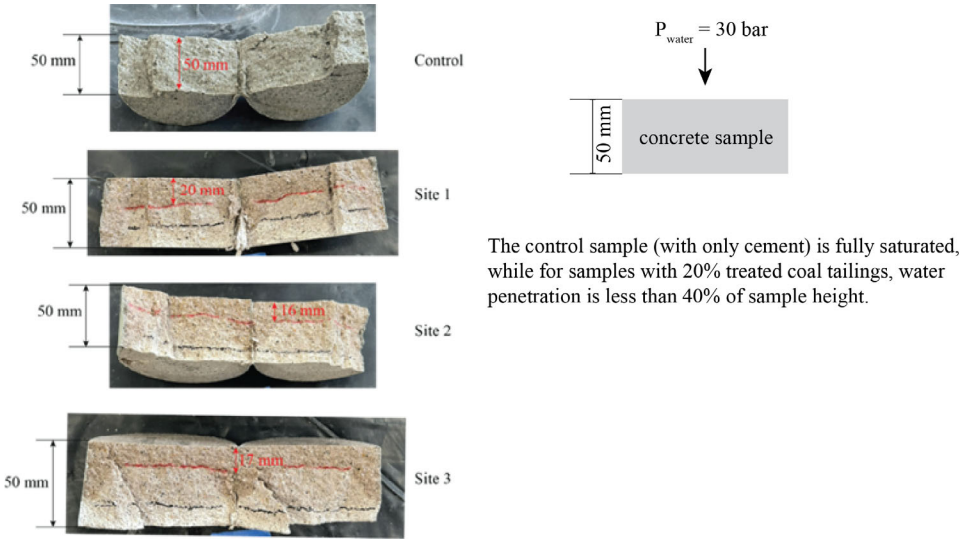

Figure 3. Durability of concrete samples with 20% replacement of cement with treated tailings

The study also found that producing concrete with treated coal tailings was economically competitive with, and sometimes cheaper than, conventional Portland cement. With the assumption of only 50% energy recovery from coal mixed in the coal tailings during the calcination process, the unit cost of blended cement production (80% cement + 20% treated tailings) is less than the ordinary Portland cement (OPC) production (Figure 4).

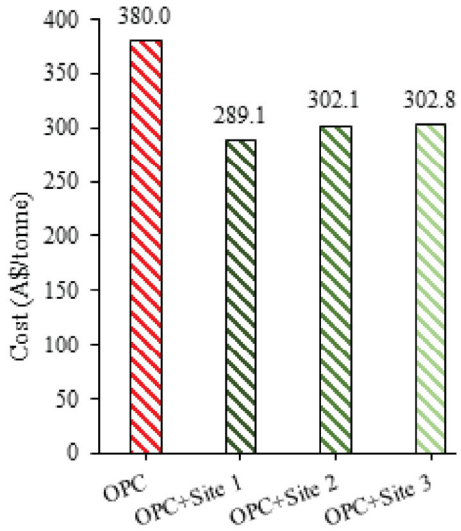

Figure 4. Cost of blended cement with 20% replacement of cement with treated tailings

"The economic viability of using treated coal tailings in concrete production is promising, and with further optimisation, it could become a standard practice in the industry," said Luke Dimech, ACARP Industry Monitor.

“Large-scale pilot testing in real-world construction projects is now necessary to validate laboratory results and identify practical challenges in transport, production and application,” said Luke.

A dual approach of combining coal tailings as both a raw material for clinker production and as a SCM in concrete could maximise the utilisation of coal tailings, reduce the need for additional raw materials, and lower processing costs by optimising the production process for both clinker and SCM applications.

To take the research further, pilot production and real-life testing of the technology is planned, for example in the production of railway sleepers and road infrastructure members. Detailed cost analysis on the logistics of processing and transporting the coal tailings will be included.

Ongoing collaboration with cement companies and research organisations is also crucial for scaling up the processes and to help inform cement companies and their clients of the benefits and reliability of the new material.

MORE INFORMATION
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