

4 October 2023

# World-leading cement production trials validate PureGRAPH® as a means to reduce carbon emissions

## Highlights

- Initial early-stage compressive strength gain data indicates up to 10% increase which meets performance expectations
- First stage results demonstrate route to a 15% reduction in carbon emissions, providing the cement and concrete industry a solution to meet environmental sustainability targets
- Viability of producing industrial-scale graphene enhanced quantities confirmed, further validating PureGRAPH® benefits to the cement and concrete industry
- Further trials (Phase 2) planned, aiming at optimising dosage rates and addition methodology

First Graphene Limited (“ASX: FGR”; “First Graphene” or “the Company”) is pleased to announce positive results from the first phase of the Company’s world-leading graphene enhanced cement trials in the United Kingdom.

Approximately 600 tonnes of graphene enhanced cement was produced at the UK’s largest cement processing facility, operated by Breedon Cement Ltd. Graphene was consistently dosed and dispersed into a cement grinding mill using standard process equipment.

During the production trials, the PureGRAPH® enhanced grinding aid performed adeptly, maintaining a consistent and highly stable feed. The operating conditions remained unchanged during the dispersion of graphene, and the cement produced conformed with Breedon’s strict quality control parameters.

Initial results show up to a 10% increase in early-stage cement compressive strength compared to an equivalent control. The trials were conducted on a CEM II cement, which has a reduced clinker factor compared to CEM I. The lower clinker factor is an enabler to an approximately 15% reduction in CO<sub>2</sub> emissions associated with cement production.

These initial results validate the scientific theory underpinning the improvements associated with the use of graphene as a value-adding additive in the cement industry, whilst also demonstrating the viability of producing industrial scale volumes with minimal disruption and costs associated with modifications at a live production facility.

The trial also demonstrates graphene enhanced cement can be supplied using existing infrastructure and facilities and, when used in construction settings, no additional equipment or training is required for the applicators.

The graphene enhanced cement was used to create a temporary wheel washing facility at a major infrastructure project that is being delivered by project partner, Morgan Sindall Infrastructure, on behalf of a UK Government Company.

This provides an optimal and challenging environment to test the strength and permeability of the graphene-enhanced concrete slab, as it will be subject to constant heavy vehicle traffic, high water loadings from washed wheels and high dust loadings from incoming vehicles.

Morgan Sindall will continue to monitor the performance of the installation, providing First Graphene with valuable real-world data in a harsh testing environment.

As announced in June<sup>1</sup>, the focus of the trials was to validate and showcase the CO<sub>2</sub> reduction capabilities and concrete performance of graphene-enhanced cement, in a bid to create stronger and 'greener' infrastructure.

Having delivered significant results in the very first trials clearly demonstrates the Company's R&D capability to produce and supply high quality graphene at a commercial scale and the enormous potential for First Graphene's PureGRAPH range. This is a significant strategic milestone in commercialising graphene at a large scale.

First Graphene will continue to work closely with Breedon Cement Ltd, Morgan Sindall and the University of Manchester as the next phase of the commercialisation process begins later this year, initially aiming to further refine the addition method and optimise graphene dosing rates.

**First Graphene Managing Director and CEO Michael Bell said:** *"Completion of phase one trials is a significant milestone towards the adoption of graphene-enhanced cement as a tool to help drive emissions down in the construction industry. This initial test of applying PureGRAPH®-enhanced cement at an industrial scale has produced very encouraging and positive results. These results provide a route for the construction industry to meet environmental sustainability targets, and First Graphene is optimistic about the role our product can play in that journey."*

*"We look forward to continuing this collaboration with project partners as we embark on the next phase of trials, which is set to revolutionise the global construction sector."*

**Jude Lagan, Breedon Cement Managing Director said:** *"I am pleased that the trial was safely and efficiently delivered through the great level of collaboration between all partners. We've already seen some promising early results and, while there is clearly more to do, it's a significant step in the right direction as the industry moves towards Net-Zero in 2050."*

*"I am looking forward to continuing further trials to see how we can optimise the use of graphene and help to decarbonise the cement industry, whilst continuing to develop environmental benefits."*

**Sarah Reid, Morgan Sindall Infrastructure, Highways team Managing Director said:** *"We are delighted to be involved in this full-scale production trial from the beginning. The work undertaken provides an opportunity for cement carbon reduction."*

*"Concrete is one of the most common materials we use, and it won't be one single change that makes it Net Zero, it will be a number of things. Graphene is just one element that will contribute to our responsible business strategy on improving the environment."*

**Dr Akilu Yunusa-Kaltungo, from the School of Engineering at the University of Manchester, said:** *"We were pleased to work with our industrial partners on this project, seeing it through from the laboratory scale to a full-scale demonstrator."*

*This is a good example of how we can collaborate to transfer our world-class scientific and engineering knowledge to the real world. We look forward to continuing to work with our partners on future projects.”*

A joint announcement by the project partners is attached below.

**This release has been approved for release by the board.**

**For further information please contact:**

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## **About First Graphene Ltd (ASX: FGR)**

*First Graphene Limited is focused on the development of advanced materials to help industry improve. The Company is a leading supplier of graphitic materials and product formulations with a specific commercial focus on large, high-growth global markets including cement and concrete; composites and plastics; coatings, adhesives, sealants and elastomers (CASE); and energy storage applications.*

*One of the key outcomes these advanced materials offer is the reduction of carbon dioxide emissions, whether directly through a reduction in output of these harmful greenhouse gases or lower energy usage requirements in manufacturing, or indirectly due to enhanced performance characteristics and extending the usable life of products.*

*First Graphene has a robust manufacturing platform based on captive and abundant supply of high-purity raw materials, and readily scalable technologies to meet growing market demand. As well as being the world's leading supplier of its own high performance PureGRAPH® graphene product range, the Company works with multiple industry partners around the world as a supplier of graphitic materials and partner to research, develop, test and facilitate the commercial marketing of a wide range of sector-specific chemical solutions.*

*First Graphene Ltd is publicly listed in Australia (ASX:FGR) and has a primary manufacturing base in Henderson, near Perth, WA. The company is incorporated in the UK as First Graphene (UK) Ltd and is a Tier 1 partner at the Graphene Engineering and Innovation Centre (GEIC), Manchester, UK, where it has a strong marketing and R&D capability.*

## Joint Announcement from Project Partners

### Successful trials and implementation of graphene-enhanced cement

The first full-scale production trials of graphene-enhanced cement have been successfully completed. The trials provided an opportunity to validate and showcase the CO<sub>2</sub> reduction and concrete performance benefits achievable by adding graphene into a live cement production process on an industrial scale.

The trials are aligned with the Global Cement and Concrete Association's (GCCA's) roadmap to Net Zero<sup>1</sup> by 2050. As a member of the GCCA, Breedon is committed to achieving Net Zero by 2050 and has a target to achieve a 30% reduction in the gross carbon intensity per tonne of cementitious product<sup>2</sup> by 2030. The adoption of graphene-enhanced cement could be one of the opportunities that will enable Breedon to achieve its target, by contributing to a reduction in the clinker content of its cement products.

The trials were safely conducted in late June, with the team producing 600 tonnes of graphene-enhanced cement. A graphene-enhanced grinding aid, produced by Fosroc Constructive Solutions<sup>3</sup>, was successfully added to a grinding mill at Breedon Group's Cement Processing facility. The graphene-enhanced grinding aid performed well; processing conditions were largely unaffected, and the graphene-based dispersion gave a consistent and highly stable feed into the mill.

The cement conformed with Breedon's strict quality control parameters and initial results are encouraging. We have seen an improvement of up to 10% in the early-stage compressive strength, as compared to a product using an equivalent grinding aid that did not contain graphene. This is consistent with previously reported studies and aligned with published theories regarding graphene reinforcement mechanisms in cementitious systems.

Following the trial, a batch of graphene-enhanced cement was supplied to Morgan Sindall Infrastructure and has now been used in the production of a C32/40 concrete approach for a temporary off-network wheel washing facility at a major infrastructure project that is being delivered by Morgan Sindall.

The graphene-enhanced concrete was successfully poured on site and the initial results indicate a good level of strength gain and a high level of consistency between the concrete batches. The concrete slab has met its performance targets and, through careful selection of the cement used, it has delivered a 15% reduction in CO<sub>2</sub> emissions over ordinary Portland Cement, providing a route to the construction industry meeting their Environmental Sustainability Targets. The graphene-enhanced concrete was batched using "industry-standard" processes and equipment.

Morgan Sindall will continue to monitor the performance of the installation, providing Breedon with valuable real-world data in a harsh off network environment.

This first set of trials is a significant milestone towards the adoption of graphene-enhanced cement as a tool that can support delivery of a net zero construction industry. This trial has shown how the industry can make significant quantities of graphene-enhanced cement with minimal disruption or changes at a live production facility. It has also demonstrated that the product can be supplied and

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<sup>1</sup> <https://gccassociation.org/concretefuture/wp-content/uploads/2021/10/GCCA-Concrete-Future-Roadmap-Document-AW.pdf>

<sup>2</sup> <https://www.breedongroup.com/sustainability/planet/carbon-and-energy>

<sup>3</sup> <https://fosroc.com/english/news/roadmap-to-net-zero/>

processed into concrete using existing infrastructure and processing facilities and that, when used at a live construction site, no additional equipment or training is required.

The success of this trial is a clear step in the right direction. There will be significant optimisation work before the full benefits of the graphene in cement and concrete systems can be realised; the project partners will continue to collaborate closely to ensure these benefits can be delivered.

**First Graphene Managing Director and CEO Michael Bell said:**

*“The completion of these phase one trials is a significant milestone towards the adoption of graphene-enhanced cement as a tool to help deliver a net zero construction industry. This initial test of producing PureGRAPH® enhanced cement at an industrial scale has resulted in very encouraging and positive headway, and we are optimistic about the role graphene can play in the cement and concrete industry.*

*“We look forward to continuing this close collaboration with our project partners as we embark on the next phase of these trials, which is set to revolutionise the global construction sector.”*

**Jude Lagan, Breedon Cement Managing Director said:**

*“I am pleased that the trial was safely and efficiently delivered through the great level of collaboration between all partners. We’ve already seen some promising early results and, while there is clearly more to do, it’s a significant step in the right direction as the industry moves towards Net-Zero in 2050.*

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*“We are delighted to be involved in this full-scale production trial from the beginning. The work undertaken provides an opportunity for cement carbon reduction.*

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**Dr Neelam Mughal, Innovation Lead – Transforming Foundation Industries at UK Research and Innovation said:**

*“In a world where the construction sector’s impact on energy consumption and carbon emissions cannot be ignored, “high-performance graphene enhanced cement” (GR-CEM) represents a game changer for cement as it enhances energy efficiency, optimises raw materials, and reduces CO2 emissions from the cement production process.*

*This has been a very successful project under the Transforming Foundation Industries Challenge and is a great example of what can be achieved when industrial and academic partners work collaboratively, supported by Innovate UK. I’m very excited to follow the journey of this advanced material-enabled innovation - an important stepping-stone towards delivering and growing a sustainable future for Construction and the Foundation Industries.”*