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Study Shows Concrete is Enhanced with Graphene

HIGHLIGHTS

- **New study confirms concrete performance is improved by adding PureGRAPH® graphene**
- **The compressive and flexural strength of cement-based mortars improves by 34.3% and 26.9% respectively**
- **Benefits extend into Recycled Aggregate Concrete (RAC) with an increased compressive and tensile strengths by 43.9% and 24.1%**
- **Significant sustainability benefits with an approximate 40% reduction in water permeability**

First Graphene Limited ("ASX: FGR" or "the Company"), today released a technical update on the application of its proprietary PureGRAPH® graphene as an additive in cement grouts and concrete.

The study shows that graphene admixtures increase strength, reduce materials usage (reducing carbon footprint) and potentially increase longevity of products.

This analysis is noteworthy since cement is estimated to amount to 6% of all CO_2 emissions from human activity.

Cement is the most manufactured and traded product globally after water, which is causing enormous climate change challenges to reduce its carbon footprint.

In 2015, the total mass of cement produced was 4.6 billion tonnes. This is equivalent to about 626 kg per capita, a value higher than the amount of human food consumption.

With population growth, increased urbanisation and improved living standards of the global population, the demand for concrete products continues to grow at an accelerating rate.

First Graphene Managing Director, Craig McGuckin says:

"The initial work demonstrates a low dosage of PureGRAPH® generates an increase in compressive and tensile strengths, when compared to the base product,". Mr. McGuckin further stated

"While there is a considerable amount of further work to be done, this is very encouraging for enhancing the performance of concrete both new and recycled, but equally the sustainability benefits for the environment."

Graphene additives in concrete

The use of graphene admixtures is showing improvements in strength, reduction in materials usage and durability of products. However, further studies are required to fully understand the mechanisms behind these results. Additionally, engagement with the construction industry is needed to ensure that graphene can be used as a viable, cost effective industry enhancement.

Improved strength in cement mortar with PureGRAPH®

In a recent study, the Company's PureGRAPH® graphene products were successfully investigated by the ARC Graphene Research Hub at the University of Adelaide.

The study, led by Professor Dusan Losic, assessed the influence of dosages and particle (platelets) size of PureGRAPH® graphene on physicochemical, microstructural, and mechanical performance of Ordinary Portland Cement (OPC) cement mortars.

The results show the compressive strength increased by 34.3% and tensile strength by 26.9% when PureGRAPH® is added to cement mortar at very low levels of 0.07%w/w in the cement paste (equivalent to ca. 0.01%w/w in concrete), further validating earlier studies by Professor Losic.

Reduced water permeability PureGRAPH®

Further studies completed by Dr. Meini Su the School of Mechanical, Aerospace and Civil Engineering, of the University of Manchester, investigated the impact of PureGRAPH® graphene additives on the performance of concrete systems.

The cement was prepared and tested in accordance with industry standards (BS 1881-108:1983 method for making test cubes from fresh concrete) and the water permeability assessed by a soaking methodology.

A 0.2%w/w loading of PureGRAPH® in cement reduced water permeability by approximately 40%. The reduction in permeability is derived from the enhanced formation of nucleation sites for the C-S-H hydration crystals and the high surface area of graphene, forming a denser network of interlocked cement crystals.

Electrical conductivity with PureGRAPH®

The School of Mechanical, Aerospace and Civil Engineering, of the University of Manchester, also examined the impact of PureGRAPH® concrete additives on the electric conductivity of cement materials.

Sample blocks of 60 mm x 25 mm x 18 mm were cured for 28 days prior to measurement. The inner two electrodes act as a voltage measuring unit and the outer two are used for inducing current.

A significant increase in the electrical conductivity of the cement is observed when the graphene dopant level exceeds ca. 0.05 w/w.

PureGRAPH® concrete additives for recycled aggregate concrete

The production and use of cement-based products, as well as the recycling and effective re-use of demolished concrete aggregate, represent significant environmental and construction challenges for the global industry.

In the United Kingdom alone, more than 50 million tonnes of concrete aggregate are reclaimed every year.

Effective re-use of this material as an aggregate in new concrete is limited by the reduced performance (compressive strength, tensile strength, and Young's modulus) of the composite.

An additional study by the School of Mechanical, Aerospace and Civil Engineering, University of Manchester, investigated the impact of graphene additives upon the performance of Recycled Aggregate Concrete (RAC).

PureGRAPH® graphene concrete additives were dispersed with plasticiser in water to prepare a cement mortar and then RAC concrete prepared.

Researchers identified enhancements in the RAC performance achieved by washing the recycled aggregate and doping the cement mortar with 0.01%w/w of PureGRAPH® graphene additives.

The compressive and tensile strengths of the resulting RAC were enhanced by 43.9% and 24.1% respectively to reach values of 39.14MPa and 3.76MPa which are similar to those of C40 New Aggregate Concrete (NAC) a standard concrete manufactured with fresh materials.

A short summary of these studies is available at https://bit.ly/2Cq5tNN.

Concrete Industry Involvement

First Graphene recently joined the Concrete Institute of Australia (www.concreteinstitute.com.au) and the Concrete Society UK (http://www.concrete.org.uk/). The company is actively seeking industry partners for collaboration on the development of PureGRAPH® additives in the industry. The Company will also be seeking to join similar industry-based organisations in other regions.

-ENDS-

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About First Graphene Ltd (ASX: FGR)

First Graphene Ltd. is the leading supplier of high-performing, graphene products. The company has a robust manufacturing platform based upon captive supply of high-purity raw materials and an established 100 tonne/year graphene production capacity. Commercial applications are now being progressed in composites, elastomers, fire retardancy, construction and energy storage.

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.

PureGRAPH® Range of Products

PureGRAPH® *graphene powders are available in tonnage volumes with lateral platelet sizes of 20µm, 10µm and 5µm. The products are high performing additives, characterised by their high quality and ease of use.*

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With authority of the board, this announcement has been authorised for release, by Peter R. Youd Director, Chief Financial Officer and Company Secretary.