

2014/15 Undergraduate Research Grant Scheme

Project title: Investigation of methods to enhance the strength and stiffness of concrete with a small quantity of graphene oxide flakes

University: Plymouth University

Supervisor: Boksun Kim

Student: tba

Aims of research:

This project aims to explore and develop methods to improve the strength and stiffness of concrete with a small quantity of graphene oxide flakes. The application of graphene to concrete is very new and innovative. It has been suggested (Monash University, 2013) that the exceptional strength and stiffness of graphene can enhance the poor tensile properties and durability of concrete when graphene oxide is added. However in practice the use of graphene oxide in a large amount of concrete may be limited due to its high price.

Monash University (2013). Graphene oxide reinforced cement and concrete, US Patent WO2013096990A1.

Description of method:

This project requires two students and will be carried out in two phases.

Firstly, to investigate the effect of graphene oxide (GO) flakes on the strength and stiffness of concrete, a total of 30 cubes (150mm) and 6 cylinders (150mm diameter and 300mm long) will be cast and tested in the Materials Laboratory at Plymouth University. Three sets of specimens will be prepared with a) ordinary Portland cement, b) 0.5% of GO flakes, c) 1.0% of GO flakes. For cases b) and c) the specimens will be finished with a 10mm top up with cement paste with GO flakes. The modulus of elasticity of the concrete will be measured and determined using Pundit Lab Plus during the early hydration process (for the first 24 hours), after 1 day, 2 days, 3 days, 7 days and 28 days. After the measurement of the modulus at each date, the concrete cubes will be crushed to determine the compressive strength of the concrete. For cubes with GO flakes the effect of the location of the GO layer in the cube on its compressive strength and elastic modulus will be studied. The six cylinders will be prepared and tested to determine the tensile strength of the concrete at 28 days old.

Secondly, a total of 30 core samples will be obtained from the local reinforced concrete car park, which is about to be demolished. The core samples will have the following added: a) 10mm GO cement paste on one end only and b) 10mm GO cement paste on both ends. 0.5% and 1.0% of GO flakes will be used. The strength and stiffness of the samples with the GO cement paste will be measured and compared with those without GO cement paste.

Benefits to structural engineering:

- The outcome of this project will improve the understanding of ways to improve the strength and stiffness of concrete using relatively small amounts of graphene oxide (GO) flakes.
- If the improvement is significant, GO flakes in practice do not need to be mixed with concrete and hence a small amount of GO cement paste could lead to a cost effective option.
- Cement paste with GO flakes could be easily sprayed onto existing reinforced concrete structures to strengthen them and also be used for a new building, where in-situ topping is required on top of precast units.

Proposed finish date: May 2015