Offshore floating foundations using self-sensing carbon fibre textile-reinforced concretes

Dr Shanshan Cheng, Lecturer in Civil Engineering, University of Plymouth University

Project period: Jan 2020 – Sep 2021

Summary

This project targets the use of carbon-fibre textile reinforced concrete (CTRC) for floating platforms. Carbon fibre textile (Fig. 1) for reinforcing concrete usually has a mesh size between 5mm and 80mm, and is a new reinforcing technology for lightweight concretes. In this project, we proposed a novel self-sensing technique that utilises the contact resistance at the connections of the carbon fibre tows in the mesh. Preliminary tests have been carried out on the off-the-shelf carbon fibre textiles to test the feasibility of this method.

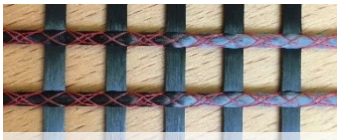

Fig. 1 Carbon fibre textile

Program of work

This project aims to demonstrate the feasibility of using self-sensory carbon fibre textile reinforced concrete for floating foundations. Four tasks have been carried out through the project:

Task 1 – Fibre tow electrical resistance measurement

Electrical resistance of various lengths of carbon fibre tows have been measured to obtain a statistics of the electrical resistance per unit length.

Task 2 – End point contact resistance measurement

The end point contact resistance would be noises in this sensing technology, so minimising it is a target. Different treatment have been tried, using surface polishing, silver epoxy coating, and silver pain coating technologies.

Task 3 – Fibre mesh connection contact resistance measurement

Fibre mesh connection contact resistance is the key for this technology. The electrical resistance of various mesh containing single or multiple contact points have been measured.

Task 4 – Electrical resistance sensitivity to external loading

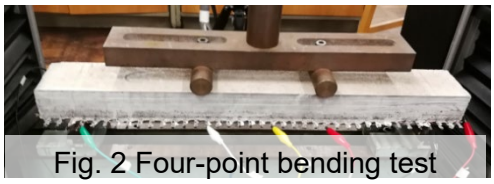

Fig. 2 Four-point bending test

The electrical resistance change of both pure carbon fibre textile mesh, and the textile embedded in concrete matrix (textile reinforced concrete), under external loading, have been measured to test the sensitivity of the resistance to external loading. Both seawater concrete and fresh water concrete have been used. Effect of sand coating on the carbon fibre mesh has been tested as well.

Results and Conclusions

Results have shown that the fibre tow electrical resistance is roughly 0.025Ω/mm. The end point contact resistance is roughly 1Ω, and it does not vary much by using different conductive coating materials. The mesh connection contact resistance is roughly 10Ω, which is one magnitude higher than the end point contact resistance, and thus made this proposed method valid for use. The pure fibre mesh is highly sensitive to external loading, and change of loading positions, but further studies are needed to calibrate the change of voltage to the strain/deformation. However, when the mesh is embedded in concrete matrix (textile reinforced concrete samples), the voltage change is less distinct, and sand coating using epoxy reduces the sensitivity even further. Using fresh water or seawater in concrete does not affect the test results significantly, thus the use of this technology in marine environment is feasible.

Deliverables

The results have been presented on the 8th PRIMaRE conference held on 29th – 30th June 2021.