JSPS Postdoctoral Fellowship

Fellow: Dr Riccardo Maddalena (PE19722), Cardiff University, School of Engineering, CF24 3AA, Cardiff, UK, MaddalenaR@cardiff.ac.uk

Host: Prof Tomoya Nishiwaki, Tohoku University, Graduate School of Architecture and Engineering, Sendai.

Period: 9/05/2019 – 08/08/2019

Fellowship Title: Fibre-reinforced **S**elf-**H**ealing (FISH) concrete

In 2019 I was awarded a short-term fellowship to conduct research at **Tohoku University**. During that time, I worked with a world-recognised research group active in the field of self-healing concrete.

Self-healing concrete represents nowadays an environmentally friendly alternative solution to conventional building materials, i.e. Portland cement concrete. Self-healing concrete not only increases the service life of a structure but also reduces its overall maintenance and subsequent usage of concrete.

Formation of cracks represents one of the major causes of concrete deterioration, due to air and water entrainment, chloride ingress, and subsequent corrosion and carbonation, and can compromise the safety and stability.

Prof Tomoya **Nishiwaki** is an expert in high-performance fibre-reinforced concrete, especially using polymeric fibres. Together we designed a novel concrete mix which include plastic fibres and have the potential of promoting self-healing and crack-closure, named **FISH** (Fibre-reinforced self-healing concrete). In addition, we partial replaced Portland cement by waste materials and by-products up to 50% by mass.

Replacing **Portland cement** with by-product **waste** materials to enhance concrete **autogenous healing** potential not only benefit the environment in terms of Portland cement reduction but also provides a means to shift waste materials from landfill to construction.

Visit of the Taihaku Concrete factory, Nishiwaki, Sendai, Miyagi with Prof. Nishiwaki

During the time of the **fellowship**, I investigated the mechanical properties and healing potential of concrete specimens using different mixes of waste materials and plastic fibres. We demonstrated that cement replacement could enhance crack-closure by almost 100% and improve the overall performance of concrete. We engaged with another research group within the University and we pioneered a novel non-destructive technique to detect self-healing in concrete using Tera-hertz wave spectroscopy imaging. Additionally, I conducted a carbon footprint analysis on all the mixes, expressed as greenhouse gas emission equivalent, and compared it against the use of conventional concrete.

During the fellowship I delivered a special lecture to graduate students and other academic colleagues, I organised visits to other universities and I had the fantastic opportunity to join the research group in field trips (cement and concrete plants and construction sites) and visited the Dai-Ichi Fukushima Nuclear Plant.

The JSPS fellowship has been an excellent opportunity to boost my CV and create new collaborations. The academic members of staff and students of Tohoku University have been very supportive in helping me before my arrival and during my stay.

Prof Nishiwaki provided me with a great research environment and opportunities to socialise after working hours. We started a solid collaboration and we are aiming to work closer in seeking further funding and collaborations.

On my return, I joined the JSPS UK & Ireland Alumni Association to maintain and create academics links with Japan and help new Fellows.

Visit to the Geibikei Gorge, Ichinoseki, Iwate with the Tohoku University research group.