

## SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

**Action number: CA17107**

**STSM title: Development of a smart textile reinforcement of concrete within buildings**

**STSM start and end date: 21/03/2019 to 10/04/2019**

**Grantee name: Laetitia Marrot**

### PURPOSE OF THE STSM:

(max.200 words)

The present STSM is an opportunity for the InnoRenew CoE to strengthen team relationships with its mentor Fraunhofer WKI. "Smart buildings" is a topic of interest at Fraunhofer WKI whose fields of research include the introduction of sensor technology as a way to improve the quality of life. The STSM aims at gaining knowledge in the Smart textiles for building and living applications field (WG4). Specifically, the proposed STSM project focuses on textile reinforced concrete. The key challenges that will be faced are the development of new functional textile materials using multicomponent fibres to create sensors and communication systems with an aim to maximize comfort, well-being and safety. The work accomplished during the STSM will form the foundations of a long-term project (expected to last for 3 years) lead by Fraunhofer WKI. The goal of the project is to develop a new connected construction material that is capable of monitoring physical data (heat, humidity, strength, damage...) to enhance comfort, well-being and safety of buildings. This connected reinforcing material will consist of a smart webbed textile structure made of natural fibers (e.g., flax or hemp) with integrated electrical carbon fibres that has the potential to replace conventional steel reinforcement of concrete.

### DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

(max.500 words)

The STSM was conducted mainly at Fraunhofer WKI in the Hofzet department in Hanover where the team is specialized in textiles, polymers and composites. For this preliminary study, emphasis has been made on the assessment of the natural fibre reinforcement. Several tasks were carried out:

- Meetings with the different key researchers for the project (project coordinator, textile expert, polymer expert, concrete expert and technicians authorized to run the machines) for the organization of the time on site and required training on the testing equipment with the technician assistance.
- Testings at the yarns and roving scales have been performed according to the standard EN ISO 2062 (2009) on natural and synthetic fibres. The influence of several parameters (torsion of the yarn, number of threads per yarn, fibre pretreatment) on the mechanical performances has been studied. The results were compared with the performances of synthetic yarns and rovings.
- Testings at the fabric scale have been performed according to the standard DIN EN ISO 13934-1 (2013) on natural and synthetic fabrics. The influence of several parameters (nature of fibres,

weaving type, number of threads in the warp and weft directions) on the mechanical performances has been studied.

- Testings to measure the alkali resistance of the reinforcement have been initiated
  - By measuring directly the loss of performances of yarns embedded in concrete for different ageing times
  - By performing the alkali resistance test on different fabrics. Fabrics are immersed in an alkaline solution according to the standard ISO 10406-1. The weight of the samples and the mechanical properties are measured before and after the test.
  - Comparison of the performance of natural fibres and synthetic fibres fabrics without sizing regarding the alkali resistance
- Establishment of an action plan to move forward with the project

### **DESCRIPTION OF THE MAIN RESULTS OBTAINED**

- There is a high variability in the performances of the natural fibres rovings and yarns tested during this trial campaign. The study of the different parameters allowed to conclude on recommendations to improve the mechanical performances of natural fibres yarns and rovings, and to manufacture optimized hybrid yarns and fabrics for the next steps of the project
- The analysis of the fabrics is difficult because of the numerous parameters entering into account (nature of fibres, torsion of the yarns, number of yarns per warp or weft width, type of weaving). Some trends have been identified. A correlation between the performances of the yarns and the performance of the fabrics has been developed and will allow to further design an optimized reinforcement using natural fibres.
- Testings to measure the alkali resistance of the reinforcement have been initiated. After 8 days, there is no diminution of the mechanical properties of the flax reinforcement embedded in concrete. More tests will be performed for longer ageing time of concrete (up to one year).

### **FUTURE COLLABORATIONS (if applicable)**

The collaboration is expected to continue on 1) the development of a coating to protect the natural fibres from the alkaline environment and 2) the development of the conductive part of the reinforcement. The results of the STSM allow to design an optimized fabric for the reinforcement in which the conductive fibres will be included. The results of this future collaboration are expected to be presented at the 7<sup>th</sup> edition of the International Conference on Intelligent Textiles and Mass Customization in Marrakech in November 2019. A conference paper will then be issued on this occasion.