Research aim

The main aim of the presented project entitled: „Electrical and piezoresistive properties of graphene-based cementitious composites for Structural Health Monitoring applications" is the fabrication of a new generation of self-monitoring cementitious composites. We will develop completely new compositions of conductive and piezoresistive cementitious composites by incorporating graphene or the mix of graphene with carbon fibers. Piezoresistive tests aiming at the measurements of the electrical parameters of a composite during mechanical tests will be conducted under static and cyclic loading. The piezoresistivity tests under bending load will be also performed on notched samples. The results will enable the determination of preliminary correlations between the changes in the composite resistivity and its loading, deformation, cracking or damage. That will allow the monitoring of concrete structural members behavior with concrete being not only a structural material, but also a remarkably durable and inexpensive sensor.

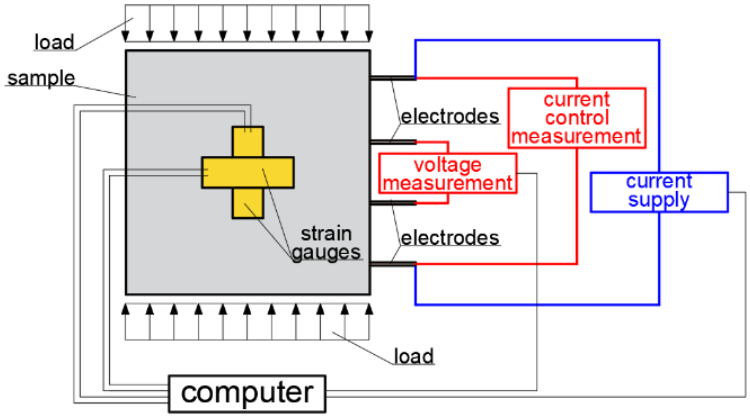

FIGURE 1 A scheme of a piezoresistivity test under compression.

Research methodology

First, we will develop the appropriate methodology of the electrical measurements, which will enable obtaining the stable and repeatable results within further stages of the presented project. Electrical measurements of cementitious composites depend on several factors, namely the material, type and geometry of the electrodes, their layout and fabrication method as well as the type of applied current, i.e. direct or alternating current. The effect of the aforementioned factors on the obtained results will be analyzed during the tests on reference samples. After the determination of the methodology of the electrical measurements, we will fabricate several nano-composites with different loadings of graphene or graphene with the addition of carbon fibers. Fundamental measurements of the composites' resistivity will enable the determination of the percolation threshold, i.e. the minimum dosage of graphene making the cementitious composite conductive. Moreover, the effect of the water content and ambient temperature on the conductivity of the graphene-cement composites will be also determined. Within further stages of the project, we will investigate the basic mechanical properties, composition and microstructure of as produced, conductive composites. Finally, we will perform piezoresistivity tests under static and cyclic loading. That will allow the determination of a preliminary correlations between applied loading, composite's deformation or cracking and the changes in electrical parameters.

Research project impact

The interdisciplinarity of the project as well as the international collaboration between the Faculty of Civil Engineering of the Silesian University of Technology, Centre for Advanced Technologies of Adam Mickiewicz University and Institut de Science et d'Ingénierie Supramoléculaires of University of Strasbourg will allow the development of innovative, conductive, piezoresistive graphene-based cementitious nano-composites. The knowledge gained during the implementation of the presented project will contribute to the understanding of the relationships between the loading, deformation, cracking or damage of conductive cementitious composites and the changes in their electrical resistivity. That will enable the real-time monitoring of structures' technical conditions, thus increasing buildings and users' safety. The conductive composites will significantly simplify the monitoring process, which, in that case, will not require the expensive and ineffective external sensors, thus contributing to the wide range applications of self-sensing concrete in Structural Health Monitoring. Furthermore, it should be highlighted that graphene may be also beneficial for the cathodic protection of steel reinforcement present in concrete structures, thereby remarkably extending their durability and service life.