Cement is a widely known and used hydraulic binding agent which, in contrast to other materials such as polymers, clay or lime, can be used for indoor and outdoor applications. Materials built on cement as the binder, for example concrete or mortar, don't emit considerable amount of Volatile Organic Compounds, don't accumulate allergens, are great for indoor temperature maintenance because of great heating mass and on top of that have widely known and used building capabilities. Standard cement based mixtures require to be compacted after pouring into the formwork and later on cured by use of high amounts of water. This procedures allow for the cured cement based materials to achieve similar properties in every direction for which the materials are highly valued. Unfortunately this procedures and use of formwork requires a lot of time, energy and natural resources such as minerals and drinkable water which will be partially wasted and marked as non recyclable or hard to recycle.

Scientists search for new ways of implementing modified well known materials or using them in different way in order to make them more reliable and sustainable for the future generations. Additive methods of manufacturing offer freedom of form which has never been seen before and in addition to that encourages application of composites which don't require use of formwork. Less use of formwork and better optimization of the amount of used material obtained by computer control of the 3DP machines leads to lower energy and material resources consumption. Nowadays, modern multi-layered composite structures fabricated by use of additive methods or so called 3D printing (3DP), bring new possibilities in creation of more sustainable building technologies. 3D printing can be used as process-efficient way of construction using cement based mixtures.

Unfortunately elements produced by 3DP behave differently than monolithic elements. They should be rather considered as multi-layer composites built on cement binder. The composites contain thin interface layer between main layers of composite. Interface layer has different properties than the rest of the composite. The layer occurs due to chemical process of cement setting which starts at the point of water addition to the mixture. The occurrence of interface layer is further amplified by lack of physical compaction during the process of 3DP. This natural behaviour of the used mixture makes the bonds between the layers worse with longer time intervals between deposition of another layer. Quality of the interface layers determine all of the equivalent properties of these composite. Thus it is desired to describe this phenomenon and its influence for this branch of engineering and material science development.

The main goal of this project is to find, describe and assess relationship between changes in internal structure of the novel multi-layered cement based composites and their response to mechanical loads. Assessment of interface layer cohesion strength is crucial for proper analysis of such composites. Moreover, the appropriate amount of layers and therefore minimal dimensions needed for acquiring proper results should be stated during the course of the tests. Methods standard for testing brittle materials can be used in order to assess knowledge about macro-scale homogenized composite structure and the interface layer mechanical properties. Testing the interface layer by use of modified tests will contribute to deeper description and understanding of novel composite behaviour. This knowledge can be further used for numerical modeling. Description of composite behaviour by use of multi-scale numerical modeling, analysis such as FEM and data acquired during mechanical tests would have great impact on development and optimization of scientific work with smeared composites built on cement matrix.

Chosen approach will help this research to reach the wider audience, because researchers would acquire new tool for cement based composites examination. More information given before mechanical tests and better understanding of constituents' properties from which the composite is fabricated in correlation to standardized testing methods might lower amount of material used during testing phase making them more energy and material efficient. Assessment of the properties should be lead to the point of being able to design and predict most if not all cement based composite's properties. One of the main results of the project will be collection of properties dependent from used material and time intervals between layer laying. A full success in comparison of obtained data and numerical studies will be achieved if properties of tested cement based materials usable in additive methods of fabrication could be translated to composites properties with high accuracy.