Experimental evaluation of the effect of perforating the composite profiles on the load-bearing behavior of concrete elements

The intensive development of materials engineering, which can be observed in recent years, has significantly contributed to the development of civil engineering. More and more often, modern engineering structures do not consist of homogeneous materials, and various combinations are used for their construction. Composite structures - made of a combination of at least two materials, often with different mechanical properties - are often characterized by high load-bearing capacity, stability and resistance to dynamic impacts, as well as high quality and durability. There is also at least one key advantage associated with this type of structures - compared to classic ones, they are faster to build - which may make them attractive in terms of cost.

Fiber-reinforced polymers - FRP (Fibre-Reinforced Polymer) composites, have been widely used in civil engineering for many years. The fibers most commonly used in this technology include: carbon, glass, basalt and aramid, while epoxy resin is most often used as the matrix. FRP materials are used to strengthen structural elements as well as design new structures. This is due to the many advantages of these materials, which include: high strength-to-weight ratio, significant stiffness, good fatigue properties, resistance to aggressive environments and low thermal conductivity. It is worth emphasizing that in recent decades, the most frequently used materials from the FRP composite group are carbon fiber reinforced polymers (CFRP), which have been widely used in engineering due to the best strength parameters. However, these materials, despite their numerous advantages, have a significant drawback - low resistance to elevated temperatures. The epoxy resin used in the installation of FRP mats and tapes plasticizes already at a temperature of about 60°C, which means that this composite may lose its properties due to excessive heating (caused, for example, by intense exposure to sunlight), which may ultimately lead to structural failure.

Concrete samples strengthened using CFRP composites are characterized by increased load-bearing capacity and stiffness. In this research, the use of composite profiles in the form of pipes made of CFRP was proposed. These pipes were used inside the cross-section of the concrete elements and as external reinforcement. A key role in the project is the analysis of the impact of perforation holes in the internal composite pipe on the load-bearing capacity of concrete elements. Making holes in the internal composite pipe ensures cooperation between the individual components of the composite samples. In conditions of elevated temperatures, the location of composite pipes inside the concrete cross-section reduces the risk of plasticization of the composite through the outer concrete layer. The proposed laboratory tests include an analysis of the influence of the thickness and diameter of composite pipes, the size of holes in perforated pipes and their location, and the slenderness of samples on the load-bearing capacity of composite samples. The aim of the project is to determine how the simultaneous use of properly prepared composite pipes outside and inside the cross-section affects the stress-strain characteristics and load-bearing capacity of the samples.