DISSERTATION ABSTRACT

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The subject of the doctoral dissertation: **Modification of concrete composites in terms of thermal conductivity, heat accumulation and strength**

Stricter Technical Requirements, in force since 1 January 2018, have resulted in energy-saving measures being more stringent for buildings, which in the near future are to be designed in the near-zero energy standard. The measures taken result from the need to reduce energy consumption of buildings and the construction industry. On one hand, there is a need to minimize heat loss (by using building envelopes with excellent thermal performance), and on the other, there is a need to improve the heat-accumulation capacity (by using materials with high specific heat in the envelopes). These requirements are generally considered to be divergent, especially because additional strength requirements are imposed on building components.

The research carried out for the doctoral thesis was devoted to the search for effective methods of modifying composites in order to improve their thermal capacity and thermal performance and to ensure the required strength. It was assumed that the research programme would include three basic groups of concrete composites made from three different coarse aggregates. The first group of mixtures was made with natural silica aggregate. In the second group of mixtures, lightweight sintered fly-ash aggregate was used. Mixtures in the third group were made on the basis of expanded clay aggregate.

The doctoral dissertation provides for testing of a wide range of concrete composites of extremely diverse composition and preparation technology. Therefore, the programme consists of the introduction of dry and saturated with water aggregate and lightweight aggregate with grains internally saturated with water and dry near their surface (specific moisture preparation) to be penetrated by the cement paste, which ensures good bonding of these two components.

In the case of natural aggregate and both kinds of lightweight aggregates, the aim was to test different mixture variants. One of them was an unaerated matrix, the other a matrix aerated by

introducing a suitable air-entraining admixture or an aluminium powder. Furthermore, mixtures based on natural aggregate were compacted with silica fume. Moreover, it was planned to test the mixture with the addition of flake graphite, which is characterized, by good heat accumulation properties and high thermal conductivity.

In turn, for composites based on lightweight aggregates, it was decided to increase their porosity by adding an aerogel granulate, which shows very low thermal conductivity.

As a result, the testing programme covered twenty one concrete composites, differentiated by the type of aggregate used, the method of its preparation for tests, alternative admixtures (air-entraining and liquefying) and additives used (silica dust, aerogel granulate, graphite and aluminium powder). However, the type of cement was not differentiated due to its small impact on heat accumulation and thermal performance of a concrete composite.

The dissertation included preliminary diagnostic and preparatory works to be systematically conducted during the first year of curing (and drying), that is, measurements of the thermal conductivity, volumetric heat capacity and compression strength and testing of microstructural parameters, in which various techniques were used – optical porosimetry, mercury porosimetry, SEM and EDS analysis.

Additionally, non-stationary thermal processes were examined, indicating a wide span of results (both qualitative and quantitative) in dynamic responses of the 21 tested composites to step change in ambient temperatures. The laboratory tests were crowned with calculations of dynamic thermal characteristics related to specific envelopes, modelled in such a way that the structural layer was made of each composite with previously tested parameters. A part of the dissertation plan was also to identify relations between the individual parameters being tested.

The aim of this research project was to collect extensive sets of data on individual properties, demonstrating that modification of the internal structure of composites being designed resulted in high differentiation of thermal conductivity, specific heat and compression strength, giving the possibility to choose the most favourable solution due to the expected application of a given composite.

The results will be used to more effectively determine the type, quantity and proportions of individual components of a concrete composite, which must meet specific thermal and strength requirements, taking into account the specificity of the expected operating conditions.

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