POPULAR SCIENCE ABSTRACT

Comprehensive research on the structure of lightweight highly porous cement composites – gel concrete

The aim of the project is to develop **lightweight, highly porous cement based material** obtained by direct gelatinization of starch in cement slurry. The essence of the analysed proposal is to obtain a cement matrix with a very high porosity exceeding 60% by heating mixed fresh cement paste with an admixture of starch to the gelatinisation temperature. The mix can also involve the addition of gypsum and a pozzolan (metakaolin, zeolite, microsilica or fly ash). As a result, a gel-like cement-starch substance with a plastic consistency is formed. The use of the starch gelatinisation process directly in the cement slurry makes it possible to obtain a very homogeneous material, in which the initial, temporary structure is starch gel, around which, after the start of the setting time, the target structure is formed based on cement or other binders.

The main goal of the project is to determine the properties of such cement-based materials, particularly their thermal, strength, microstructural and moisture properties. Based on the preliminary research already carried out, it is hypothesised that it is possible to obtain a group of materials characterised by a relatively high value of compressive strength, while maintaining very good thermal insulation properties in a given range of the volume density of the material. However, the presented hypothesis requires a series of long-term and comprehensive studies on the method of producing these types of materials, the rheological properties of fresh mixtures, methods of conditioning and curing, and the properties of the mature structure of a lightweight cement composite – **gel concrete**.

The project will be divided into several stages. The **first preliminary stage** will answer questions about the basic parameters of fresh mixes, such as: the influence of the composition and types of ingredients on the consistency of the fresh mix and the properties of cured concrete, the influence of the amount of starch used on the gelatinisation process and the resulting consistency of gel concrete, the influence of the gelation temperature on the properties of gel concrete, the influence of the method of mixing the ingredients and the technique of forming specimens. In the **second stage**, the process of curing and conditioning of composites will be tested. The **third stage** provides for the performance of compressive strength, thermal, microstructural and moisture tests in relation to selected mix compositions obtained from the first two stages. In the **fourth stage**, the properties provided for in the third stage will be tested on composites obtained by mixing gel concrete with lightweight fillers with good thermal properties, such as expanded clay aggregate, microspheres or expanded glass aggregate.

The expected **effects of the project** will include:

1) Development and optimisation of high porosity composite formulae obtained by direct gelatinisation of starch in cement slurry.
2) Establishing the correlation between the amount of starch used, its gelatinisation temperature and the basic properties of gel-concrete.
3) Determining the influence of the conditioning method of lightweight composites on their mechanical and thermal properties.
4) Development of the relationship between the density of gel concrete and its properties, such as porosity, thermal, strength and moisture properties.

Thanks to the unique approach to the design of lightweight concrete composites based on the proposed concept, **basic knowledge** on the impact of increasing the porosity of the cement matrix with gelled starch on the properties of this type of concrete will be introduced into the discipline. This project will significantly increase the knowledge of lightweight cement composites in the discipline of civil engineering.