SUMMARY

The dissertation concerns physical phenomena occurring in capillary-porous building materials exposed to water freezing, which is characteristic for the climatic conditions in Poland. The purpose of the study is to investigate the durability of cementitious material subjected to cyclic water freezing. The main objective of the investigation is to analyze the ice-induced deterioration of cement-based materials in a accelerated durability tests. Therefore, the application of air-entraining admixtures in prepared materials is deliberately rejected. Questions connected to influence of frost degradation on microstructure and physical properties of water saturated concrete and cement mortars and their resistance to cyclic water freezing are the objectives of research. The aim of the dissertation is specified in tree main arguments described in chapter 1. The main kinds of air pores in the concrete and the process of water absorption and freezing inside the pore structure is described in chapter 2. In the next section a survey of the literature concerning the mechanism of internal damage of concrete structure due to cyclic freezing of water and thawing of ice and description of the internal frost resistance tests is presented.

The durability of cement composites under the conditions of cyclic water freezing is described in the third chapter. Moreover, the influence of concrete microstructure on the frost resistance and permeability is characterized. The relationship between porosity and the permeability of the cement matrix is also taken into account.

To validate the arguments, indicated at the beginning of the dissertation, laboratory tests are conduct. The experiments are divided into two parts. Descriptions of used materials with their characteristics, along with information on the research methods, are provided in the fourth and fifth chapter.

The first part of the experimental research is focused on the examination how the frost-induced damage affects the intrinsic coefficient of concrete permeability. Moreover, the interaction of frost action with permeability and mechanical properties of concrete is discussed. The correlation between the intrinsic permeability and damage parameter, regarded as the relative change of the modulus of elasticity is established (Chapter 6). Subsequently, the relationship between the microstructure and transport properties of cement mortar samples subjected to cyclic water freezing, such as intrinsic coefficient of permeability and the water absorption coefficient, is presented in the seventh chapter. The deterioration of the microstructure is investigated for cement mortars produced on the basis of CEN Standard sand. The relationship between changes of pore size distribution and intrinsic coefficient of permeability is examined for cement mortars made with natural quartz sand, which is also used in concrete mixes.

The laboratory tests confirmed all three arguments of the dissertation and results are described in the conclusions of eighth chapter. The performed tests enabled to estimate that the frost-induced damage has an unfavourable effect on the material microstructure. Furthermore, the destruction of the cement matrix and the range of observed changes depend on the initial pore size distribution and their volume in the cement matrix. It is also established that the increase of transport properties is correlated with

the change of pore size distribution. The modification of pore size distribution with growing number of freeze-thaw cycles allow to analyze the influence of frost induced degradation on gas permeability. Furthermore, the estimated correlations can be used to predict the durability of cement-based materials.

The dissertations is finished with the proposal of further research program. In Annex 1 the results of the preliminary examination are presented. The obtained data allow to propose a scheme of destruction of cement mortar microstructure with different water/cement ratio and with different content of air-entraining admixture. Additionally, in Annex II the analysis of the impact of drying temperature on the microstructure of cement mortar is introduced. All details and results of the test methods described in the chapter six and seven are given in Annexes from III to X.

Wiezorek