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The Influence of Prague Winter Climatic Conditions on Sandstone Weathering

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Sandstones were often used, mainly as building materials, due to their easy workability and availability in the Czech Republic. There are many historical monuments in Prague built from this material (e.g. The National Museum, The National Theatre and Charles bridge). Weathering processes lead to damage of these stones, to the loss of their original chemical, mechanical and physical properties, and consequently to changes in their durability. The study of weathering processes is very important to understand the rate of decay and also to estimate reparation possibilities and costs to reconstruct these heritage buildings. The range of the deterioration depends on petrography, including internal structure, the mineral composition and cementation type, and also on the changes initiated. The stone's properties are negatively influenced especially during the winter frost, and the presence of salt can exacerbate this process. The national standardized testing methods for natural stone, such as determination of frost resistance and determination of resistance to salt crystallisation may not take into consideration the actual conditions in the stone's locality. Road salts, mainly composed of sodium chlorite, are used to de-ice streets in Prague during winter season. Although they are not applied directly to historical monuments, these salts affect building stones through traffic action. Water spattering from car wheels and sticking to pedestrians' shoes contains salt solutions, which can get to contact with buildings and can penetrate and rise throughout the building masonry. Samples of snow/water mixtures from Prague city centre were chemically analyzed and the average NaCl concentration was determined. To simulate the weathering processes typical in Prague's winter climatic conditions, seasonal data from 1999 to 2008 was statistically analyzed. Based on this analysis, a simulation program containing 56 freeze/thaw cycles in the temperature range of – 14°C to 14°C was developed. The weathering simulation program was divided into four stages, each consisting of 14 freeze/thaw cycles. The sandstone samples were soaked for 24 hours in distilled water and in a 2.5% solution of NaCl before each stage. Each cycle lasted seven hours and the samples were maintained at minimal and maximal temperatures for two hours. The three types of cretaceous sandstone of Hořice, Božanov and Kocbeře, which are often used in the Czech Republic, were tested during this experiment. Changes developing in the internal structure were studied by Hg porosimetry, He pycnometry and microscopical methods. Geotechnical properties such as water absorption at atmospheric pressure, uniaxial compressive strength, apparent density and open porosity were also studied.