

Salt weathering susceptibility of natural limestone and reconstituted stone used in the Orval Abbey, Belgium

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To understand the weathering of the building stones observed at the Orval Abbey, a major monument of southern Wallonia, Belgium, environmental conditions prevailing there and rock properties were investigated and a weathering experiment was performed. The Abbey was partly destroyed and rebuilt several times since the Middle Ages. The older buildings were constructed with two types of natural stones: (1) the Bajocian limestone (BL) with abundant well-preserved calcite shells and (2) the Sinemurian limestone (SL), rich in quartz grains. The materials of the newer buildings constructed during 1932-1948 were mostly reconstituted stones (RS) agglutinated using cement with crushed two types of limestones. Ironically, the new material RS are much more susceptible to salt and frost weathering than the two natural limestones, BL and SL. A measuring station was set up at the newer building to monitor temperature and relative humidity. The temperature fluctuated between ca. -10 and 30. The RH was between 20 and 100%. Rock properties of the three stones were tested: bulk density, porosity and tensile strength. Bulk density of BL, SL and RS are 1.9, 2.39 and 1.79 g/cm³, respectively, whereas porosity values are 29.0, 12.9 and 32.8%, respectively. The dominant pore size is a few μ m for SL, a few tenths of μ m for BL and 0.01-1 μ m for RS. Tensile strength of BL, SL and RS are 3.05, 4.82 and 1.38 MPa, respectively. A capillary rise experiment was also performed using the three rocks and three solutions; saturated Na₂SO₄ solution at 20, 50 %-saturated Na₂SO₄ solution at 20 and distilled water. The results showed that RS had the fastest rates of capillary rise under saturated Na₂SO₄ solution and nearly the same rates of 50 % saturated Na₂SO₄ solution as BL. After the capillary rise test, RS was completely destroyed but BL was not. Thus, it is considered that RS has less durability for salt weathering, even though it has higher strength than BL and SL.