



Preliminary proposal for an experimental method to measure erosion susceptibility of heritage stones

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Rock erodibility is an intrinsic property defined as the vulnerability of a rock to erosion (Martínez-Martínez et al., 2024; doi: 10.1201/9781003429234-177). Intuitively, erodibility is a key concept in cultural heritage conservation, especially in studies concerning the exposure of building materials to wind, rain, hail, and human activity. However, research on its implications for heritage conservation remains scarce.

Abrasion resistance of rocks is a property routinely measured in geomechanical laboratories and it offers a practical approach to assessing the erosion susceptibility of the material. Two standardized methods, the Böhme abrasion test and the Wide Wheel Abrasion test, are widely used to evaluate abrasion resistance in dimension stones. However, these methods require both large and numerous samples, rendering them unsuitable for cultural heritage studies, where sampling is severely limited. To overcome this limitation, a modified version of the Böhme abrasion test is proposed. This adaption uses a plate grinding machine commonly employed for preparing rock thin sections, making the procedure widely accessible in geoscience laboratories.

The standardized Böhme Abrasion test requires cubic samples of 71 mm size, place on a grinding plate and subjected to an abrasive load of 294N for 16 cycles of 22 turns each. Wear is calculated from the loss in volume and weight. In contrast, the modified procedure uses smaller prismatic samples (20×30×30 mm) and a plate grinding machine operating at 30 cycles per minute under a load of 0.02 N/mm². Sample dimensions and weight are measured at the beginning of the test. Each sample is abraded for 15 minutes on two perpendicular surfaces, and the final dried weight is recorded (Martínez-Martínez et al., 2017; doi: 10.1016/j.buildenv.2017.05.034). Material loss is quantified as the modified Böhme Abrasion Loss (mBAL), calculated using the equation

$$\text{mBAL} = \Delta V = \Delta m / \rho_b$$

where ΔV is the volume loss (in mm³); Δm is the mass difference (in g); and ρ_b is the bulk density of the rock.

This modified procedure was validated using a variety of commercial dimension stones, including limestones, marbles, travertines, tuffs, calcarenites, calcirrudites, sandstones, quartzites and slates. Results were compared to those obtained with the standardized Wide Wheel Abrasion test

on the same rock types. A strong correlation ($R^2=0.87$) was observed between the two methods, expressed by the equation

$$mBAL = 8.9 T_{ww} - 86.5$$

where T_{ww} the wear trace measured in the Wide Wheel Abrasion Test.

This modified approach offers a viable solution for assessing erosion susceptibility in heritage contexts, enabling reliable quantification with minimal material requirements. It offers a valuable tool for developing effective conservation strategies for cultural heritage.

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