



## **Assesment of Cleaning Methods On Küfeki Stones Used In Historical Monuments In İstanbul**

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Historical monuments are one of the most precious elements of world cultural heritage. Many historical monuments in İstanbul were constructed using natural stones widely named in the region as Küfeki stones which are originally composed of limestones, fosilliferous limestones and clayey limestones. These rocks exhibit different deterioration types due to varying atmospheric conditions, lithological and micro-textural characteristics, biological effects, and other man-induced effects. For these reasons, change in color, crust formation, abrasion, biological colonization, karstification, cracking and spalling of different scale are widely observed on these building stones.

During the research three types of Küfeki stones were investigated. Samples obtained in fresh state were tested to define physical and mechanical properties including porosities, unit weights, specific gravities P-wave velocities and uniaxial compressive strength. Additionally, X-Ray Diffraction analysis and microscopic studies were utilized to determine the mineralogical and petrographic properties of studied rocks. Besides binocular microscopes and Scanning Electron Microscope (SEM) analyses was used to determine the surface conditions. Afterwards same rocks were subjected to the accelerated artifical aging tests including freeze-thaw cycles, sulfur dioxide deposition velocity on limestone surfaces and sodium sulphate crystallisation test. In the next step these artificially degraded stones were subjected to widely used cleaning methods (e.g. laser, high pressure water jet and blast cleaning with sand, chemical solutions, dry ice). Finally, physical, mechanical, petrographic and mineralogical properties of these cleaned stones were also determined including binocular microscope studies and SEM analysis for evaluating the surface condition. The results were than compared to understand the physical, mechanical, petrographic and mineralogical changes between fresh and artificaly degraded and cleaned stones.

The results revealed that physical and chemical cleaning techniques can cause unexpected additional micro-damage to studied rocks. On the other hand laser cleaning is found to be the most appropriate technique for cleaning the studied rocks. It is strongly recommended that during the cleaning procedure of natural building stones rock type, major deterioration effect and type of cleaning must be considered together in order to avoid unexpected damage on the stones.