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Residual strain and texture analysis on bowed marble building stones by neutron time-of-flight diffraction

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Durability is an essential property to consider when specifying natural rocks for exterior use. Marbles for instance show a bowing of façade panels after a short time of exposure, while the bowing is generally accompanied by a reduction of strength properties with increasing degree of bowing. The Finlandia Hall in Helsinki, the Amoco building in Chicago and the Grand Arc de la defense in Paris are just a few examples that demonstrate the bowing-phenomenon. In order to describe and explain the effect of bowing of marble façade panels, neutron time-of-flight diffraction was applied to determine residual macro- and microstrain on the calcite mineral phase. Specialized texture (SKAT) and strain (EPSILON) goniometers were used to collect experimental data. The strain measurements were combined with investigations of the crystallographic preferred orientation by macroscopic measurements of the panel bowing as well as microfabric analysis.

The research was applied on three calcite marble samples - a fresh broken sample, a good conditioned façade panel and a strongly deformed façade panel. All investigated samples are characterized by a broad grain-size distribution from medium to coarse grained, while grain boundaries are displayed more or less parallel to the foliation plane. The results reveal that an intracrystalline residual strain, which was detected in all samples, differed with the degree of bowing. Additionally, the deformation intensities reflected by residual strains vary significantly in magnitude and direction suggesting a relationship between the preferred orientation of the minerals and the residual strain. Moreover, different Bragg peak widths were detected as indication for

microscopic strain. The observed residual strain values in the samples are related with the grain shape and texture properties. Correlations of spatial strain distributions with preferred orientations are presented and discussed as well.