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Thermoelastic responses of calcitic and dolomitic marbles: influence of shape fabric and crystal texture.

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Microstructure-based finite element simulations were used to study the influence of grain shape preferred orientation (SPO) and lattice preferred orientation (LPO) on thermoelastic responses related to degradation phenomena in calcitic and dolomitic marbles. Three SPOs were analyzed: equiaxed grains, elongated grains, and a mixture of equiaxed and elongated grains. Three LPOs were considered: a random orientation distribution function and two degrees of strong directional crystal texture. Results for both minerals show that certain combinations of SPO, LPO, and their directional relationship have significant influence on the thermomechanical behavior of marble. For instance, while there is not a major dependence of the elastic strain energy density and the maximum principal stress on SPO for randomly textured microstructures, there is a strong synergy between LPO and its directional relationship with respect to the SPO direction. Microcracking precursors, elastic strain energy density and maximum principal stress, decrease when the crystalline c-axes have fiber texture perpendicular to the SPO direction, but increase significantly when the c-axes have fiber texture parallel to the SPO direction. Moreover, the microstructural variability increases dramatically for these latter configurations. In general, the influence of LPO was as expected, namely, the strain energy density and the maximum principal stress decreased with more crystal texture, apart from for the exception noted above. Spatial variations of these precursors indicated regions in the microstructure with a propensity for microcracking. Unexpectedly important variables were the microstructural standard deviations of the spatial distributions of the microcracking indicators. These microstructural standard deviations were as large as or larger than the variables themselves. The elastic misfit-strain contributions to the coefficients of thermal expansion were also calculated, but their dependence was as expected. The elastic strain energy values of dolomite were approximately two times smaller than those of calcite. However, the maximum principal stress values of two minerals were approximately the same.