Mineralogical and chemical characterization of historical mortars from military fortifications in Lisbon harbour (Portugal)

A. Santos Silva[1], T. Cruz[2], M.J. Paiva[1], A. Candeias[3], P. Adriano[1], N. Schiavon[2] & J.A.P. Mirão[2]

[1] Materials Department, National Laboratory for Civil Engineering, Av. Brasil 101, 1700-066 Lisbon, Portugal
[2] HERCULES Laboratory and Evora Geophysics Centre (CGE), University of Evora, Palacio do Vimioso, Largo Marquês de Marialva, 8, 7000-809 Évora, Portugal
[3] HERCULES Laboratory and Evora Chemistry Centre (CQE), University of Évora, Largo Marquês de Marialva, 8, 7000-809 Évora, Portugal

Abstract

Historical mortars from 16th and 17th century military forts located at the mouth of Tagus river in Lisbon have been characterized by Polarized Light Microscopy (PLM), Thermal analysis (TG-DTA), X-ray Diffractometry (XRD) and Scanning Electron Microscopy + Energy Dispersive Spectroscopy (SEM+EDS). The results indicate that the mortars used were all hydraulic lime-based. The presence of well-rounded lime lumps indicates a limited use of water during the lime hydration process. The detection of hydrated calcium chloroaluminate and carboaluminate compounds mostly at binder-aggregate interfaces provides evidence for the onset of pozzolanic reactions during mortar production as further confirmed by the presence of ceramic fragments in the aggregate fractions intentionally added by the forts builders to increase the hydraulic properties of the mortars. The higher mechanical strength and greater resistance to degradation processes imparted by these pozzolanic compounds could explain why, despite the extreme proximity of the investigated sites to the sea, salt weathering processes do not appear to have significantly affected the studied mortars.

Keywords: historical mortars, Lisbon fortifications, petrography, TG-DTA, SEM+EDS, X-ray diffraction