Long-term Structural Health Monitoring of the Fortezza fortress: application of damage detection techniques on existing cracks

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ABSTRACT

Structural Health Monitoring (SHM) consists of an elaborated technique, assisting the assessment of existing structures through the detection of active or sudden damages, as well as the diagnosis of possible causes for them. Within the STORM-project (Safeguarding Cultural Heritage through Technical and Organisational Resources Management – "HORIZON2020-DRS-2015 DISASTER - RESILIENCE: SAFEGUARDING AND SECURITY SOCIETY, INCLUDING ADAPTING TO CLIMATE CHANGE / DRS-11-2015 DISASTER RESILIENCE AND CLIMATE CHANGE TOPIC 3: MITIGATING THE IMPACTS OF CLIMATE CHANGE") [1], the SHM strategy selected for the assessment of the Venetian fortress of Fortezza in Rethymno, Greece was the continuous crack monitoring of four different existing cracks of the structure, due to their relatively large width, located at the Bastion of St. Paul's, St. Elias' and St. Lucas as well as the Episcopal mansion.

Besides the crack displacement measurements, several other environmental quantities were monitored at the weather stations, which are known to have a strong influence on the crack width. Considering the fact that the weather fluctuation has reversible effects at the structural integrity, it is of great importance to recognize the environmental and operational variation of the structure, and subsequently identify any separate structural change caused by damage [2], [3]. This was achieved by employing a statistical ARX model (Auto-Regressive model with eXogenous input) [4], calibrated for each case after several months. Once this process was completed it was possible to detect possible active damage on the examined structures and estimate possible causes for them.

The successful application of the methodology at the four monitored cracks provided important information about their state of damage, possible causes and early warnings in case of hazard. Over the evaluated period, it appears that the bastion of St. Elias is in stable condition, while the bastion of St. Lucas and St. Paul are vulnerable to heavy precipitation. Moreover, the Episcopal mansion showed a destabilization response during the rainfall period, which is possible to result in the activation of an overturning mechanism.

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