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Analysis of thermal-moisture regime of the marble plates on the cupola wall of Florence Cathedral

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Degradation of the cultural monuments is strongly influenced by moisture that in combination with temperature, salt and various biofactors, have high impact stone deterioration. Cultural objects are predominantly constructed of porous materials where moisture plays a dominant role in its deterioration. Therefore information regarding moisture-thermal regime of used stone represents the basic assumption for its optimal use or for choice of a suitable preservation procedure of the monuments.

Florence Duomo Cathedral is tilled by plates made of Gioia Marble. A detailed degradation study of the Gioia Marble has been performed within the EU McDUR project in the years 2000 – 2005. Our laboratory was involved in the thermophysical analysis of the stones. Innovative pulse transient method has been used for measuring specific heat, thermal diffusivity and thermal conductivity of the dry and water saturated specimens. Freezing and thawing processes were studied for water saturated marble specimen. Degradation has been studied by measuring thermophysical processes of the water saturated specimen due to freeze/thaw cycle. Changes of thermophysical properties within 2% are found even up to 60 cycles were used. All above mentioned experiments were performed in laboratory.

An experiment has been performed to monitor the moisture processes of the marble plate at the cupola wall of the Florence Cathedral due to measuring thermal conductivity. A special thermal conductivity sensor has been developed that in connection with the RTM monitoring system gives local information on temperature and moisture. The

sensor is based on the hot ball transient method. The monitoring has been performed in a period from February 8 till March 15, 2005. Two rain events and several nights with temperatures below zero occurred within this period. A strong diffusion of the moisture into the plate volume has been found due to temperature increase by sun radiation in day – night cycle. No freezing anomaly has been observed. Data collected at the cupola wall are intercompared with that one measured in laboratory.

Two different measuring techniques are presented, namely the pulse transient method that suits for a detailed thermophysical analysis in laboratory and a hot ball method that is adjusted for portable instruments and the monitoring systems working autonomously