

Numerical and Experimental Investigation of Fracture Mechanism in Paintings on Wood

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Abstract : Panel paintings -complex multi-layer structures consisting of wood support and a paint layer composed of a preparatory layer of gesso, paints, and varnishes- are among the category of cultural objects most vulnerable to relative humidity fluctuations and frequently found in museum collections. The current environmental specifications in museums have been derived using the criterion of crack initiation in an undamaged, usually new gesso layer laid on wood. In reality, historical paintings exhibit complex crack patterns called craquelures. The present paper analyses the structural response of a paint layer with a virtual network of rectangular cracks under environmental loadings using a three-dimensional model of a panel painting. Two modes of loading are considered -one induced by one-dimensional moisture response of wood support, termed the tangential loading, and the other isotropic induced by drying shrinkage of the gesso layer. The superposition of the two modes is also analysed. The modelling showed that minimum distances between cracks parallel to the wood grain depended on the gesso stiffness under the tangential loading. In spite of a non-zero Poisson's ratio, gesso cracks perpendicular to the wood grain could not be generated by the moisture response of wood support. The isotropic drying shrinkage of gesso produced cracks that were almost evenly spaced in both directions. The modelling results were cross-checked with crack patterns obtained on a mock-up of a panel painting exposed to a number of extreme environmental variations in an environmental chamber.

Keywords : fracture saturation, surface cracking, paintings on wood, wood panels

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