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Hygromechanical behaviour of a wooden panel

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Introduction

Wooden panel paintings from cultural heritage are excellent cases of study for an engineer. They are witness of ancient times and practices, and may provide keys to the understanding of long term behaviour of wooden structures [1,2]. A particularity of these objects is the permanent cupping of the panel. It seems to appear whatever the orientation of the panel cutting (quartersawn or flatsawn) and the position of the paint layer.

Material and Method

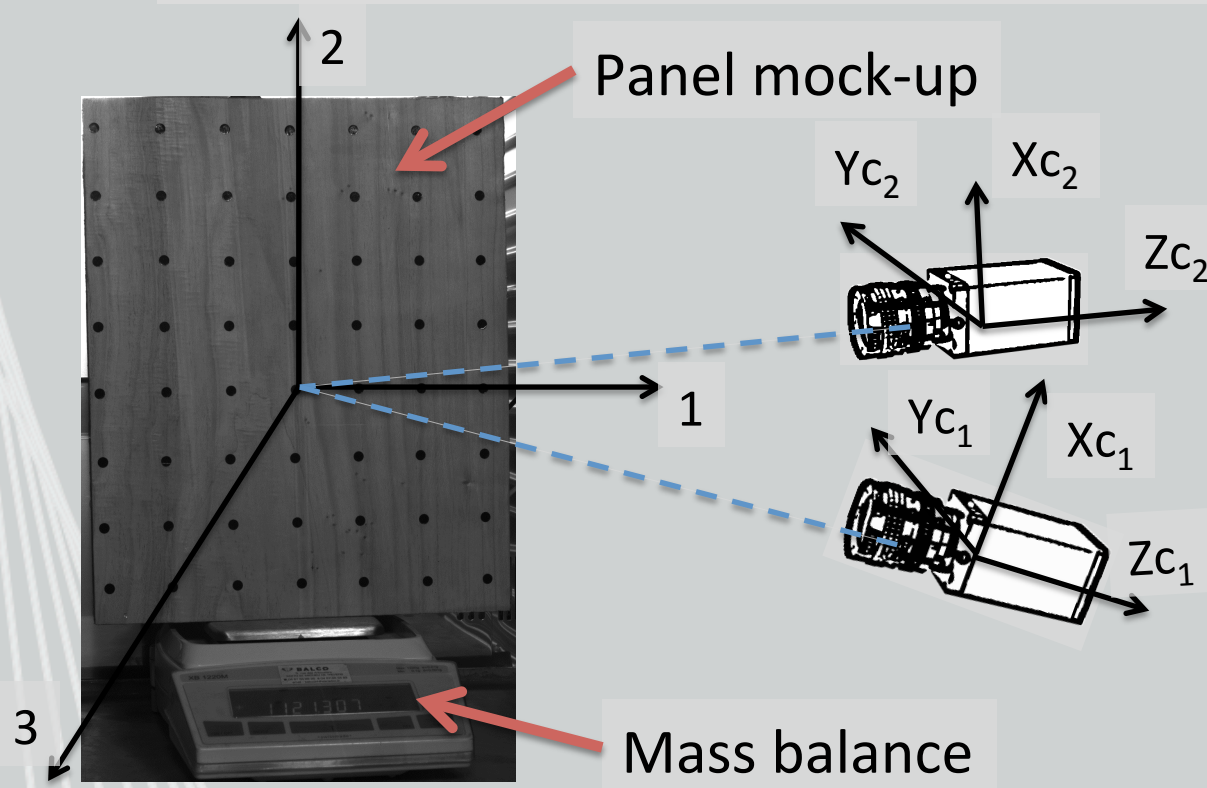


Fig. 1: Digital image correlation technique - Track marking with continuous weighting

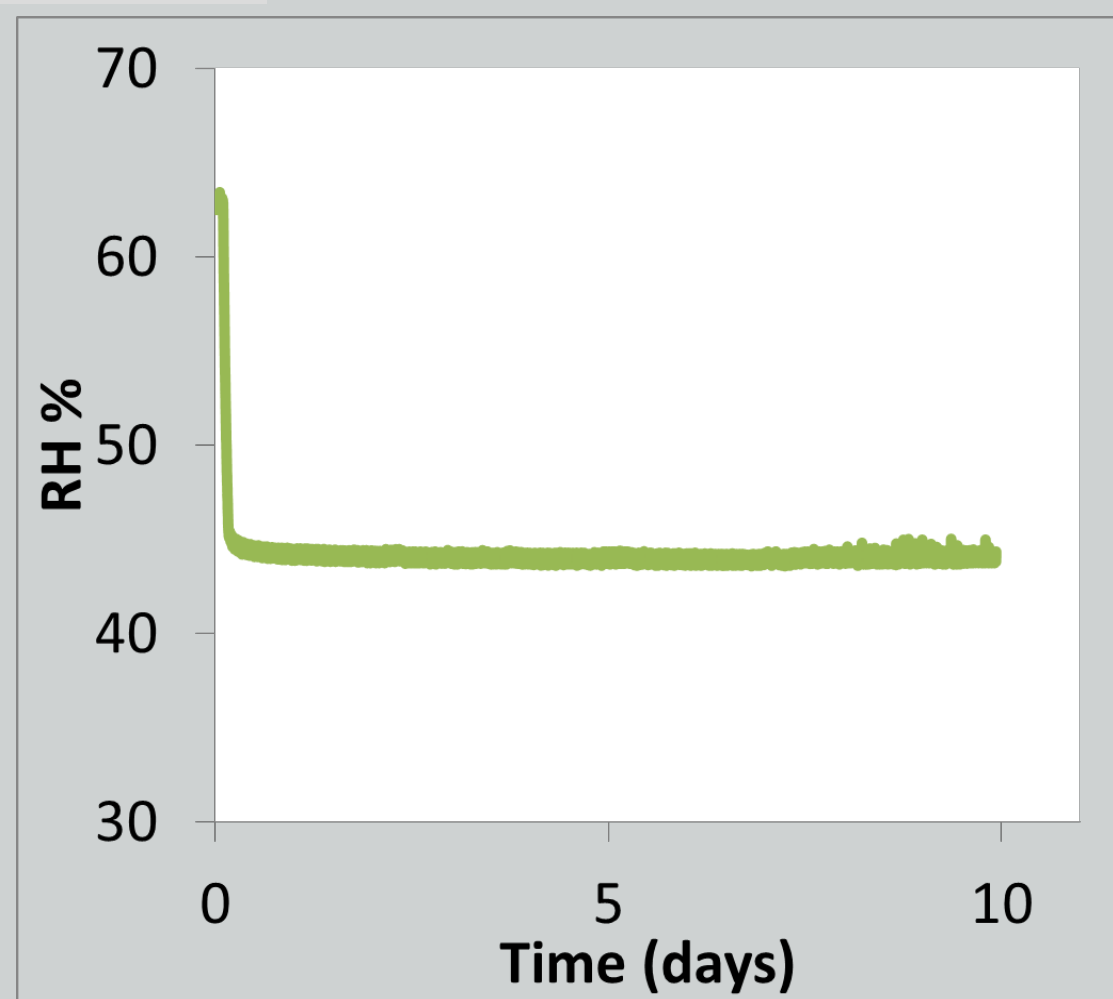


Fig. 2: Relative Humidity (RH) set over the time

Mechanical simulation : wetting

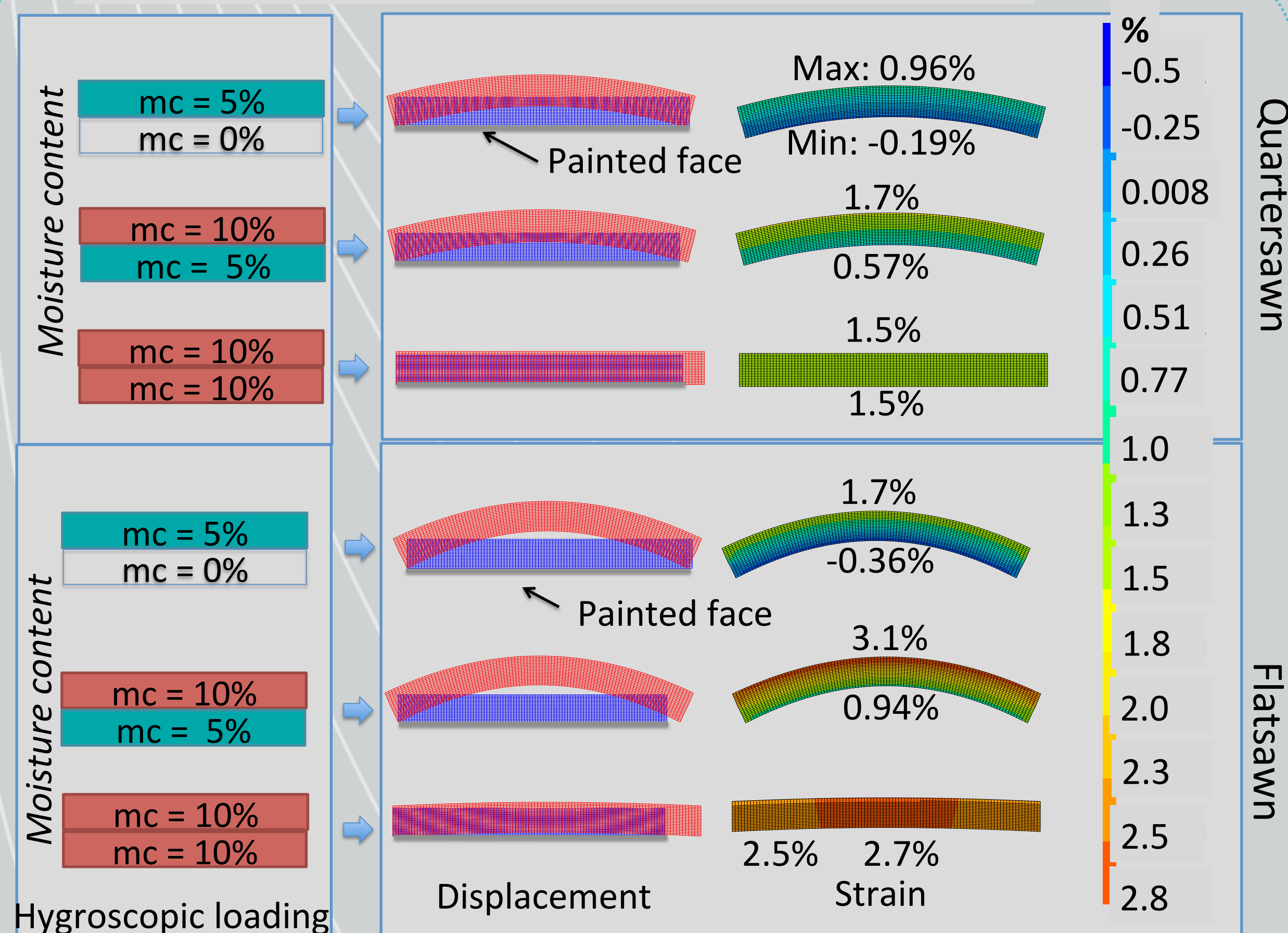


Fig. 6: Board with one painted face submitted to an increase of moisture content. Displacement and strain of the cross section

➤ Drastic wetting:

- ➔ compressive strain on the painted face
- ➔ Tension strain on the back face

Experimental results

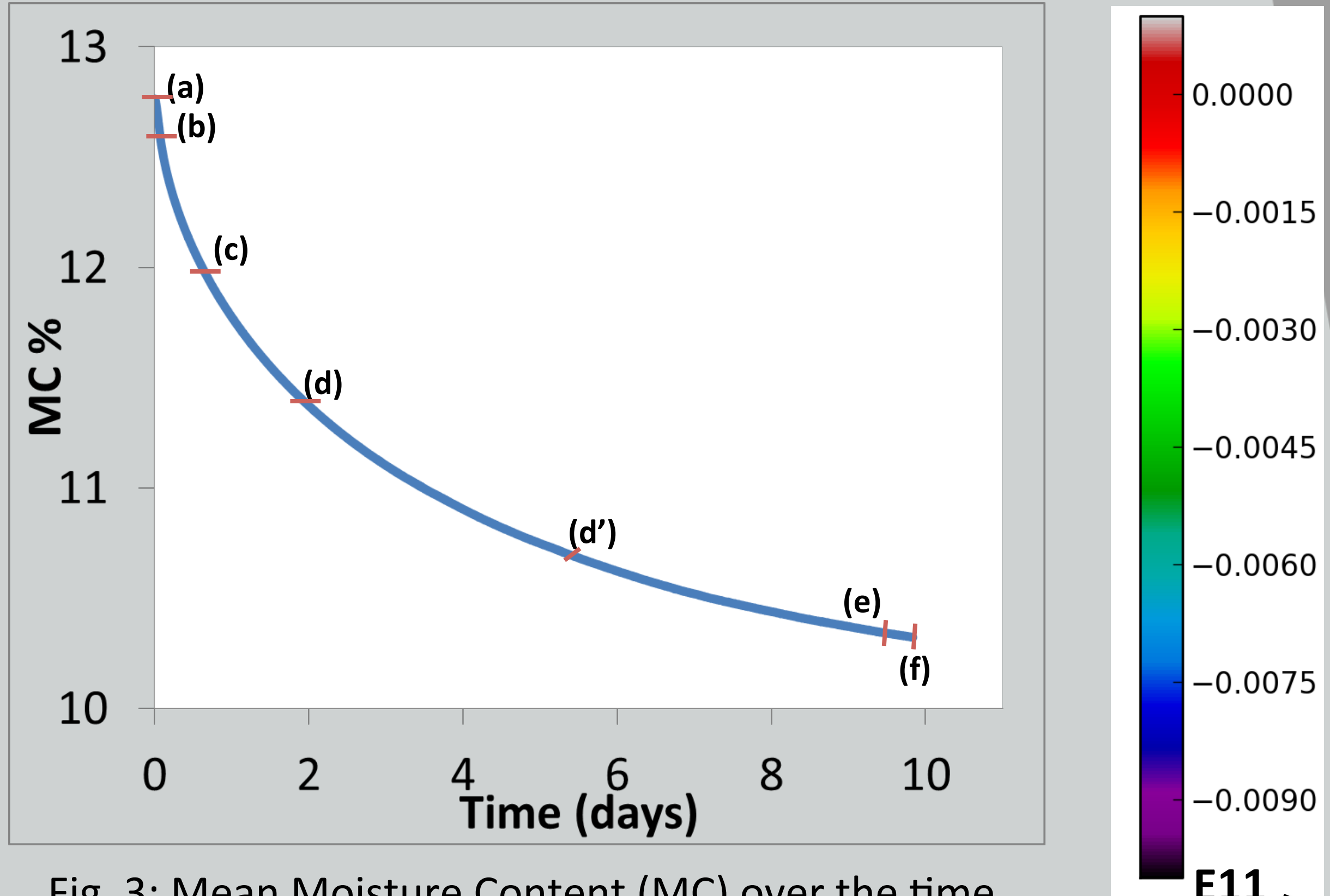


Fig. 3: Mean Moisture Content (MC) over the time (%) due to Fig. 2 hygro-loading

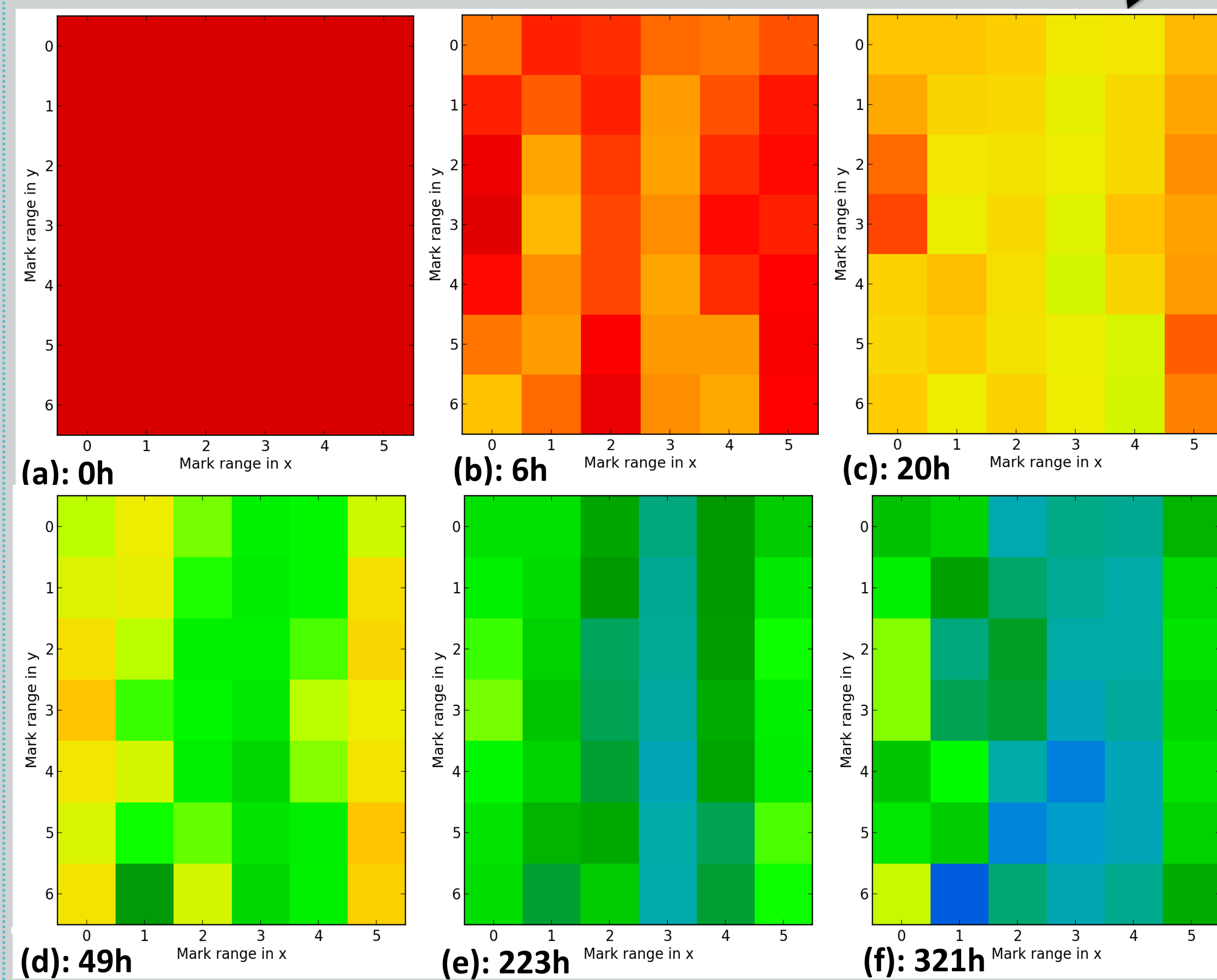


Fig. 4: Horizontal strain (E11) of the surface of the panel with four coated lateral faces, over the time, corresponding to Fig. 3 points

- Vertical strain (E22) and shear (E12) are negligible compared to the horizontal strain (E11)

Mass transfer simulation: drying

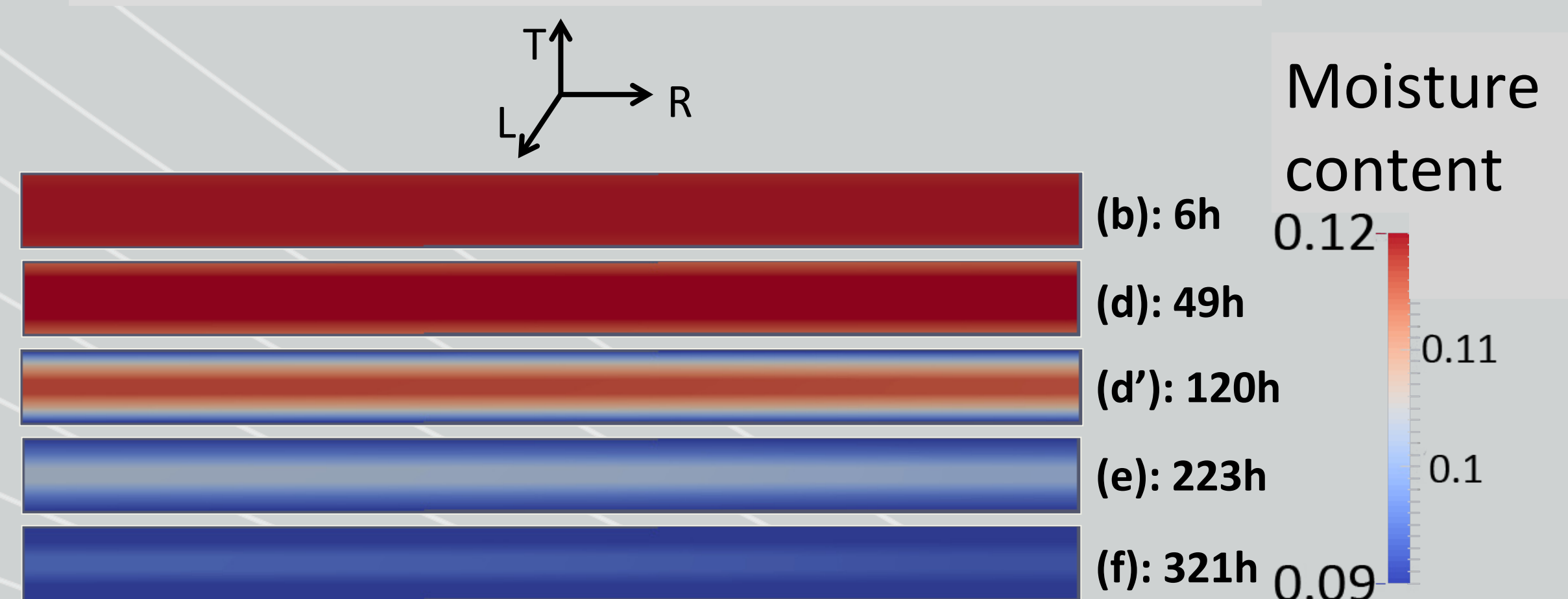


Fig. 5: Moisture content distribution into the cross section of a panel with four coated lateral faces, obtained by mass transfer simulation using the software *Transpore* [3], corresponding to Fig. 3 points

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Art Conservation and Research

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- [1] Colmars, J., (2011) *Hygromécanique du matériau bois appliquée à la conservation du patrimoine culturel: étude sur la courbure des panneaux peints*. PhD thesis, Montpellier 2 University (in French).
 - [2] Marcon, B., (2009) *Hygromécanique des panneaux en bois et conservation du patrimoine culturel*. PhD thesis, Montpellier 2 University, Università degli studi di Firenze (in French).
 - [3] Perré P. and Turner I. W. (1999) A 3-D version of TransPore: a comprehensive heat and mass transfer computational model for simulating the drying of porous media, *International Journal of Heat and Mass Transfer*, vol. 42, no. 24, pp. 4501-4521.