In relation to moisture storage in porous materials, it is often assumed that the process dynamics do not affect the moisture retention. There is mounting evidence though that this notion is incorrect: various studies demonstrate that the moisture retention is influenced by the (de)saturation rates of the moisture transfer processes involved. The available evidence primarily stems from imbibition and drainage experiments on soils however, and compared to many other porous media, these tests consider rather permeable materials with relatively dominant liquid transport at comparatively large (de)saturation rates. The current knowledge may thus not be directly transferable to moisture transfer in porous media on the whole, and dedicated further research is required. This paper responds to that need, by reporting on an experimental investigation of the occurrence of dynamic effects on moisture transfer in building materials. Drying and ad-/desorption tests are executed on two building materials, in which moisture contents and moisture potentials are measured simultaneously. These are translated into dynamic retention relations and dynamic storage coefficients, which both distinctly demonstrate that moisture transfer in building materials, similar to moisture transfer in soils, is not free of dynamic effects. The findings imply that the widely accepted static theory for moisture storage in porous media is not generally valid and should be corrected for the occurrences of dynamic effects. Considering that such drying and ad-/desorption processes are dominant features in very many instances of moisture transfer in porous media, the repercussions of these findings may be large.