Monitoring moisture regimes on limestone walls: the use of a test wall, Wytham Woods, near Oxford

Heather Viles, Barbara Emery, Wesley Fraser
Oxford University School of Geography and the Environment

As part of the EPSRC-funded ‘Limestone Project’ a test wall was built within the University of Oxford experimental site at Wytham Woods, a few miles NNW of the city of Oxford.

The wall was built from Elm Park stone (from the Cotswolds), using ashlar blocks 40 x 40 x 20 cm in size, with lime mortar. The wall was constructed on a concrete plinth sunk some 5 -10 cm below the ground surface, in order to encourage moisture movements into the wall from the surrounding soil. Facing approximately west, it is 1.8 m high, 2 m long and 40 cm thick, and has a shed attached to the rear (to simulate a closed internal environment on one side of the wall). Two recessed blocks were created in the front face of the wall (by using blocks cut to 40 x 30 x 20 cm). Similar recessed blocks were created in the rear of the wall. A block of older limestone was built into the upper part of the wall.

Front and back of the test wall in Wytham Woods.
The wall was built in Summer 2007 and moisture and temperature probes were installed at the end of November 2007. We monitored temperature and RH conditions within the four recessed blocks (two recessed at the front, and two at the back) - at 24cm, 13.5 and 4 cm from the front face. The shed at the rear of the wall housed the dataloggers for the probes (we used Rotronic Hygrolog probes to monitor RH and temperature conditions within stone blocks). Data was collected over a year, with some more intensive shorter term monitoring campaigns, using iButton Hygrochrons to monitor RH and temperature at the surface. Surface hardness measurements were taken at the start of the period using an Equotip rebound device, and surface temperature and moisture were measured monthly using 2D IR thermometry and a Protimeter.

Dataloggers and Hygrolog probes installed in the shed at the rear of the test wall.

Protimeter % Wood moisture equivalent values for each month from October 2007 to December 2008. During the first winter the recessed blocks (7Br and 3Br) recorded wetter conditions than the other blocks.
The two graphs below show Hygrolog temperature data from December 2007 for the upper control vs recessed block, showing the cooler and less variable temperature regimes within the recessed block. Probes 1C and 2C are located 4cm behind the front face, probes 1B and 2B 13.5 cm behind, and probes 1A and 2A are located 26 cm behind the front face.

The graphs below illustrate the difference in surface temperature regimes between flat and recessed blocks - a) illustrates the daily temperature ranges from the upper flat and recessed blocks (7Br = recessed, 7D = flat) for a month and a half period from September 19th to October 27th 2008 whilst b) illustrates the same thing for the lower recessed block (3Br) and its flat counterpart (3D). Warmer minimum surface temperatures are found on the recessed blocks.

Relative humidity trends are much less clear - for most of the year all the Hygrolog probes within the stones record 100%, whilst the iButtons show no significant difference in surface RH ranges between upper flat and recessed blocks, and higher RH on lower flat vs recessed block (as illustrated in the graphs on the following page).
Surface temperatures recorded on a grid using an IR thermometer in Summer 2008 as shown above illustrate the cooler conditions during the heat of the day experienced within the recessed blocks.

The data collected from the test wall help to elucidate the microclimatic conditions on and within recessed and flat blocks in limestone walls, and thus contribute to understanding the moisture regimes that develop once rapid decay produces recessed areas within the stonework.