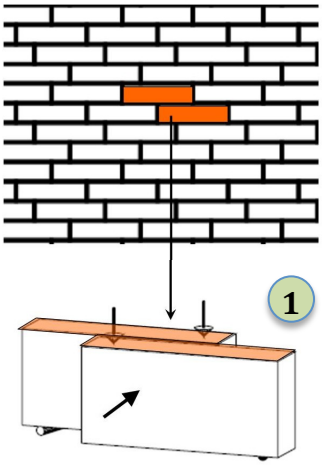
TORSION TESTING OF MASONRY BED JOINTS



At the Danish Building Research Institute (SBi) a method has been developed to measure the flexural strength of masonry bed joints [1].

- The measured values can be used in strength calculations of the masonry with the bricks and mortar, which may be used in a certain building.
- The method can be used to make sure that a mortar will not be so strong that it will tear apart the stones in the case of movements in the brickwork.
- It can be used to optimize the amount of binder and the grain size distribution of the gravel.
- The strength development can be measured from hour 1.

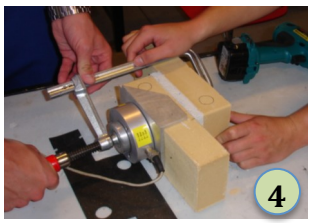
Practice

Two tiles are mortared together. After suitable conditioning they are twisted in relation to each other. The method models the conditions in brickwork bended around the vertical joints (1).

The tools for the method, as described here, are developed at The Dep. of Civil Engineering at the Technical University of Denmark. It is for use with bricks with the Danish normal size, 228 x 108 x 54 mm. Two stones are mortared together over a length of l = 135 mm. The brick laying is done in a gauge to ensure the correct measures (2). A clamp is put on to ensure against damage before testing (3). The specimens are stored in 20 ^{0}C, 65 % RH, until testing.

Before testing a pressure perpendicular to the joint is established by means of a clamp. This corresponds to the load on the joint from the brickwork above the joint. A pressure of σ = 0,1 MPa corresponds to 5 m brickwork above the joint (4).

The test specimen is placed in the testing machine on a roller and a ball. The force from the testing machine is lead to the specimen through a beam and two balls (5).



The load may be applied in a rather simple hydraulic device, where the ultimate load is read on a display (6). In a deformation controlled testing machine (eg. Instron) the connection between the force and the deformation can be drawn. In this way one get an impression of the plasticity of the joint (7).

In [2] it is shown that compared to the 3-stone-method EN 1052-3 this method is easer to use and gives less spread.

Calculations

The *ultimate shear strength*, τ [MPa], is calculated from the following formula

$$\tau = 2M_v/(b^2(a - b/3)) = 2 \cdot 1/2 \cdot P \cdot l/(b^2(a - b/3)) = P \cdot l/(b^2(a - b/3))$$

Here M_v [Nm] is the ultimate moment, P [N] is the ultimate force, which is read on the display, l is the arm for the moment (0,173 m), b is the width of the brick (0,108 m) and a is the length of the joint (0,135 m). a and b can be put into the formula as measured values. If the mentioned standard values are used one get

$$\tau = P \cdot 149{,}8 \cdot 10^{-6}$$

To get the material parameter, *the cohesion, c,* this value must be reduced according to the influence from the pressure perpendicular to the joint, σ. If the so-called *friction angle*, φ, of the mortar is 30^0, one gets

$$c = \tau - \sigma \cdot \tan\varphi = \tau - \sigma \cdot 0{,}577$$

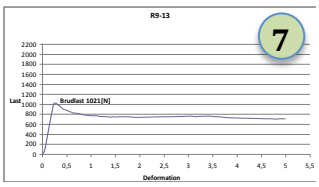
Thus, for bricks with Danish standard measures one gets

$$c = \tau - \sigma \cdot \tan\varphi = P \cdot 149{,}8 \cdot 10^{-6} - \sigma \cdot 0{,}577.$$

Example

With P = *1021 N* and σ = *0,1 MPa* one gets the cohesion

$$c = 1021 \cdot 149{,}8 \cdot 10^{-6} - 0{,}1 \cdot 0{,}577 = 0.095 \text{ MPa}$$



June 2011
Anders Nielsen

DTU
Department of Civil Engineering

References
[1] *Hansen, K.F. & Pedersen, C.M.:*
Torsion testing of bed joints. Masonry Int. 21(1) 2008
[2] *Hansen, K.F. & Petersen, E.S.:*
Shear and Torsion Testing of Brick-mortar Joints.
Masonry Int. 22(2) 2009