ESECMaSE
Enhanced Safety and Efficient Construction of Masonry Structures in Europe

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Technical University of Munich
Department of civil engineering and geodesy
Chair of Structural Concrete
80290 Munich

TECHNISCHE
UNIVERSITÄT
MÜNCHEN

Institut für Baustoffe und Konstruktion

MPA BAU

Lehrstuhl für Massivbau
Univ.-Prof.
Dr.-Ing. K. Zilch

Arbeitsgruppe 4
Mauerwerk

ESECMASE

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Person in charge: Dr.-Ing. Detleff Schermer

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MAILING ADDRESS:	D-80290 MUENCHEN	PHONE +49 / 89 / 289 - 23038/39	FAX +49 / 89 / 289 - 23046
ADDRESS:	BUILDING N6	THERESIENSTR. 90	D-80333 MUENCHEN
BANK DATA:	BAYER. LANDESBANK MUENCHEN	ACCOUNT NO: 24 866	BANK CODE: 700 500 00
CONTACT PERSON:	DIPL.-ING. S. GRABOWSKI	E-MAIL:esecmase@mb.bv.tum.de	PHONE +49 / 89 / 289-23071

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1. Introduction

Within the reports of the work-packages 5.1 [1], 5.2 [2] and 5.3 [3] several test methods concerning the tensile strength of masonry units have been investigated and corresponding tests on units have been performed. The results are presented in the report of work-package 5.5 [4].
Within this report the suitability of the several test methods is given in dependency of the kind of masonry units.

The part of the report dealing with the bond between unit and mortar is found in a separate report from the TNO.

2. Solid units

Units without perforation and without any relevant openings can be described as solid units. Here the results of the several test methods don't show any significant difference except of local varying material strength. In general the results of the several tests (flexural-, splitting- and uniaxial-tension-tests) on solid calcium-silicate-units showed a small coefficient of variation.
Nevertheless during the production process of CS-units caused by the compression of the press and the friction of the material with the surface of the formwork a non-uniform distribution of the density can be observed. Therefore also a different tension strength is found locally.
That means, for CS-units in regions next to the surface a higher tension strength results compared to the regions inside the unit next to the centre.

For AAC-units similar effects in dependency of the location relative to the expanding process can be supposed.

As during the flexural tensile tests the maximum stress is found next to the surface of the CS-units here the maximum strength values were found. During the splitting tensile tests the relevant tension stress is distributed uniform along the thickness of the units. In consequence the appeared maximum strength is a smeared value of the strength inside the unit and next to the surface.

Therefore for solid units the splitting tensile strength with the load application perpendicular to the bed joints is proposed for the determination of the tensile strength of masonry units concerning in-plane shear failure (s. chapter 2.1 in the report of the work-package 5.3 [3]).

3. Perforated units

The mechanical behavior of perforated units under combined tensions stresses is ruled by their geometry of the perforation pattern. Especially for clay bricks voids, like shrinking cracks can dominate and superpose these effects.
The mentioned kind of shrinking and firing cracks appear generally next to the bed joint surface but also inside the units at the connection between the web shells in cross and longitudinal direction. In consequence, even if the relevant mechanical parameter of the clay material (e.g. tension strength) is known exactly, the expected tension strength of the whole unit can not be predicted at all.

Therefore several types of test methods have been investigated. The following statements refer to vertically perforated clay bricks but can also be applied to other vertically perforated masonry units.

Regarding the flexural tension tests the coefficient of variation was even higher than those from the uniaxial tension tests parallel to the bed joints. As for clay bricks the effect of initial cracks next to the bed surface and the activation of a quasi brittle failure behavior under in-plane bending is critical, this kind of tests was omitted. Also the so called single-shear shearing test (see chapter 2.4 of work-package 5.3 [3]) was found not be not suitable, as the stress distribution in the units under the mentioned combined loadings was significantly different to the stress state in real shear walls.

Regarding the splitting tensions tests and the uniaxial tension tests at the HLZ B 12-unit contrariwise results were found. The uniaxial tension strength perpendicular to the bed joints was found to 1.19 N/mm² and parallel to the bed joints to 0.21 N/mm².
The corresponding splitting tension strength was found to 0.31N/mm² (failure surface parallel to the bed joints, i.e. angle of the load application 90°), to 0.49 N/mm² at the angle of 40° (error in Table 11 of the report 5.5 [4]), to 0.59 N/mm² at the angle of 20° and to 0.61 N/mm²

(failure surface perpendicular to the bed joint, i.e. angle of the load application 0°), in contrary to the developing of the net cross section area.

As the angle of observed cracks in shear walls is in general about 30°, it can be assumed, that the results at the angle of the load application of 20° and 40° covers this failure mode in general well. In the splitting tension tests close values were found from 0.49 N/mm² (angle 40°) up to 0.61N/mm² (angle 0°). A simplification can be realized by the determination of the test with an angle of 0°.

Therefore for vertically perforated units the splitting tensile strength with the load application perpendicular to the bed joints in the area with the minimum cross section is proposed for the determination of the tensile strength of masonry units concerning in-plane shear failure (s. chapter 2.1 in the report of the work-package 5.3 [3]).

Bibliography

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