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Examining, Evaluating and Strengthening Masonry Constructions

Examen, évaluation et consolidation de constructions en maçonnerie

Untersuchung, Beurteilung und Sanierung von Mauerwerkskonstruktionen

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SUMMARY

Methods for examining, evaluating and strengthening masonry constructions are investigated in various research projects by the österreichische Gesellschaft zur Erhaltung von Bauten (Austrian Society for the Preservation of Buildings). The pratical results of these investigations are presented in this paper.

RÉSUMÉ

Les méthodes d'analyse, d'évaluation et d'assainissement des maçonneries font l'objet de différents projets de recherches menés par la Société autrichienne pour la conservation de bâtiments (österreichische Gesellschaft zur Erhaltung von Bauten). Les résultats pratiques de ces analyses sont exposés.

ZUSAMMENFASSUNG

Methoden zur Untersuchung, Beurteilung und Sanierung von Mauerwerkskonstruktionen werden im Rahmen der österreichischen Gesellschaft zur Erhaltung von Bauten in einigen Forschungsschwerpunkten behandelt. Im vorliegenden Beitrag werden die praktischen Ergebnisse dieser Untersuchungen präsentiert.

1. BASIC PROBLEMS

In the course of several investigations within the scope of the "Österreichische Gesellschaft zur Erhaltung von Bauten" (Austrian Society for Restoration of Buildings) it turned out that evaluating and restoring of masonry constructions has a cosiderable impact on the sanitizing costs for the whole building.

Among several others the following main aspects have to be considered:

- Analyses and repair of damages caused by humidity
- Evaluation of the actual loadbearing capacity
- Measures for consolidation and reinforcement

Several working groups are dealing with these problems. The results of their investigations are presented within this summary.

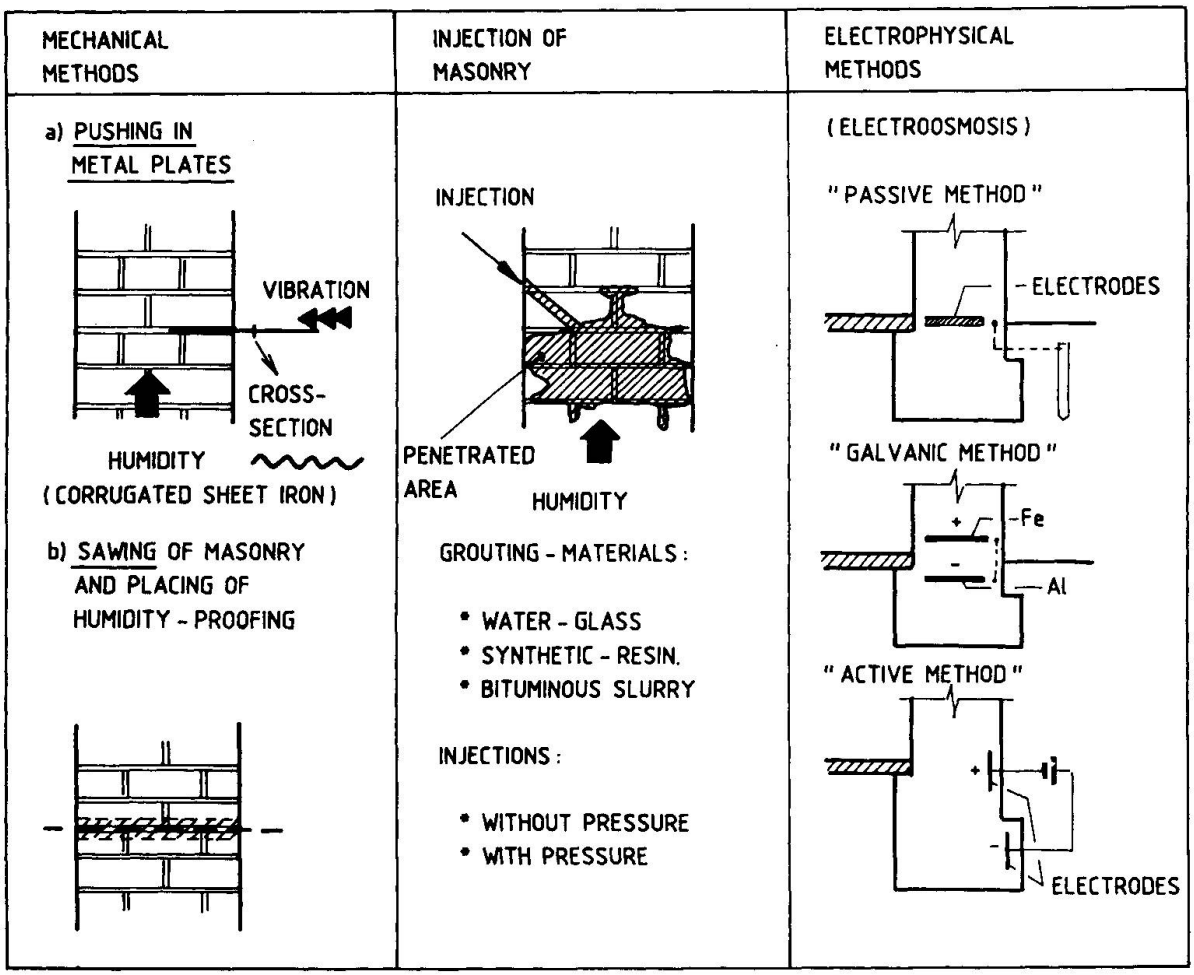


Fig.1 Measures against humidity caused damages

2. DAMAGES CAUSED BY HUMIDITY

Although the influence of humidity on the loadbearing capacity of masonry structures can be neglected in most cases, it turned out that repairing these damages causes a considerable part of overall costs of building consolidation.

In many cases the ground floor of masonry buildings cannot be used for apartments or offices because of damages caused by humidity.

Since the beginning of this century many methods have been invented to insert humidity proofings or water stoppers either chemically or electro- physically. In practical use only a few of them have shown acceptable results.

Within the last 10 years most of these measures have been improved. (Mainly chemical and electro-osmotic methods). Fig. 1 gives a principal outline on these methods. It has to be pointed out that mechanical methods are state of the art, whereas the other methods are still subject to further investigations dealing primarily with the lifecycle- costs of these measures inseparably associated with the durability of the components.

In most cases economic reasons are essential in selecting a particular method.

3. CONSIDERATION OF THE ACTUAL LOADBEARING CAPACITY

At present the characteristic values of actual compressive strength of masonry can be achieved in three different ways, as shown in Fig.2.

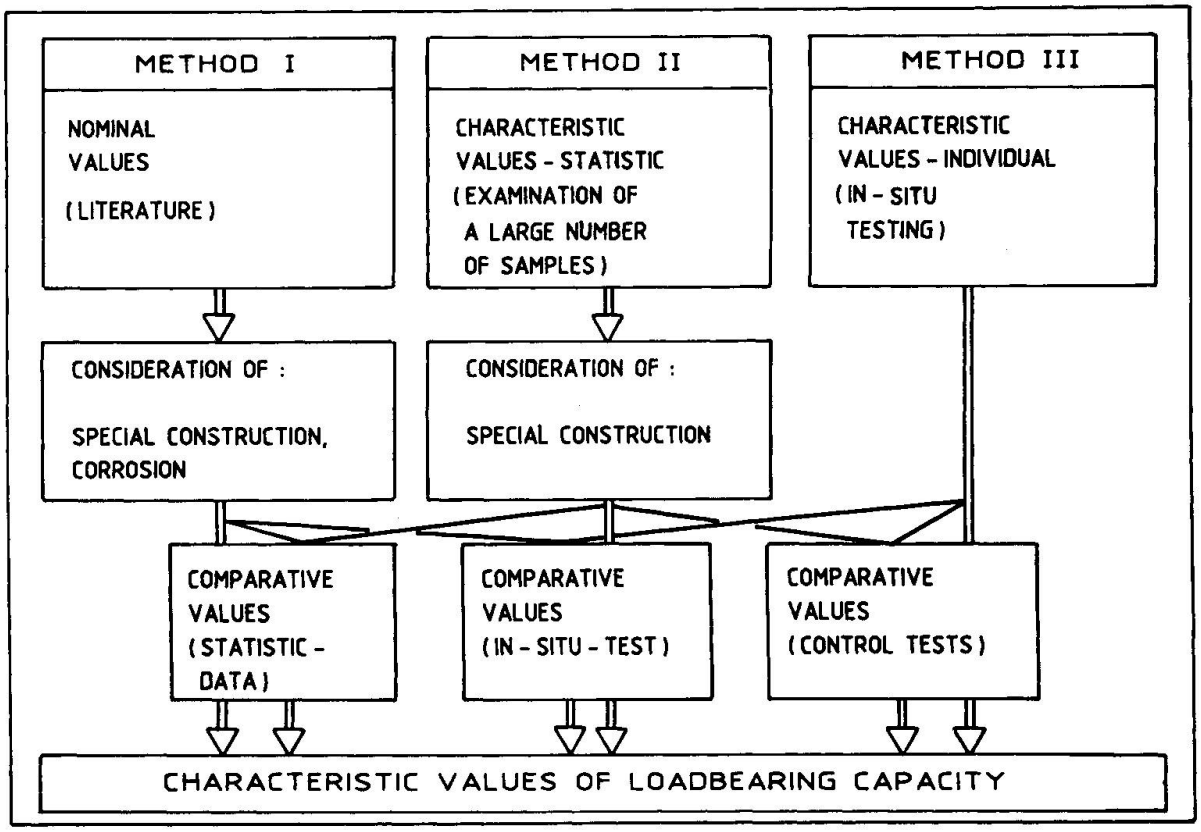


Fig.2 Consideration of actual loadbearing capacity

In any case it is necessary to examine the mechanical uniformity of masonry structures over large areas by non-destructive methods (e.g. Schmidt-Hammer). At the same time random samples should be taken in order to gain secured values for compressive strength.

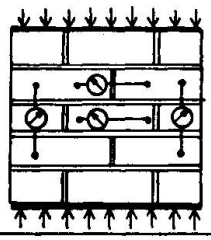
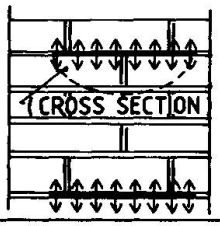
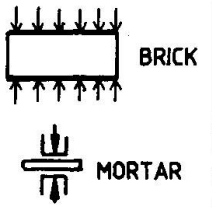
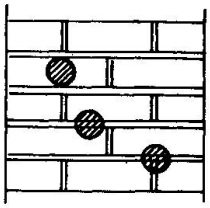
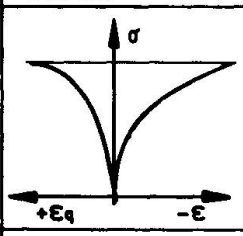
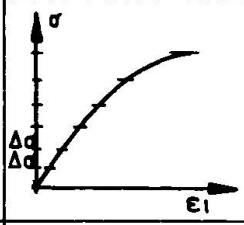
TESTING METHOD				
NAME	(RILEM) WALLETTE TESTING	INSERTING FLAT JACKS	TESTING OF COMPONENTS	TESTING OF DRILLING CORES
RESULTS, (EVALUATION)			SEE FIG. 4	SEE FIG. 5
LIMITS	TAKING OF SAMPLE	EVALUATING THE INFLUENCE OF MASONRY BOND	TAKING OF MORTAR SAMPLES	CONVERSION OF RESULTS TO COMPRESSIVE STRENGTH

Fig.3 Testing methods (loadbearing capacity)

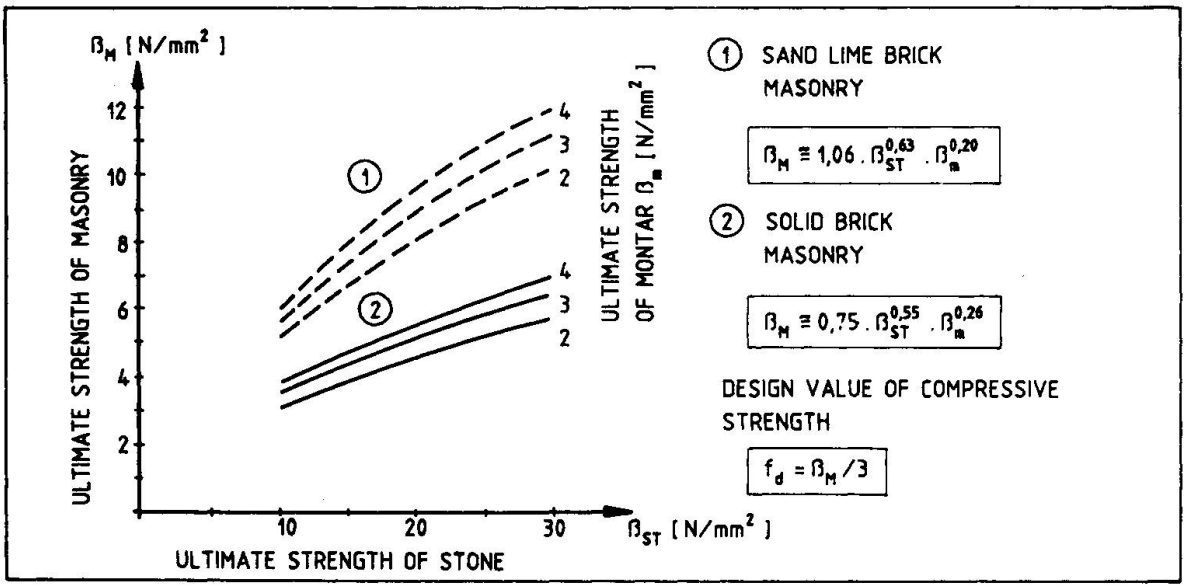


Fig.4 Testing of components - superposition formulas

The testing methods are shown in Fig. 3. Taking and Testing of wallettes (specimen of several layers of brick masonry) has considerable drawbacks connected with extraction and transport of the specimen to a laboratory. (The wallettes should be at least five layers high, so that the results can be compared to those of RILEM-test, on which most national standards are based.)

The other methods are subject to recent investigations. Testing of components (brick and mortar) - as shown in Fig. 3 - is based on the knowledge of superposition formulas as pointed out in Fig. 4.

Testing of drilling cores was first researched by Berger [2]. At present the correlation of the shown test methods is analysed in various research projects by ÖGEB.

Fig. 4 evaluates the superposition formula for pure sand lime brick or brick masonry and mortars with ultimate strengths of 2, 3 and 4 N/mm^2. Using the proposed formulas superposition curves have been drawn.
The design value of compressive strength of masonry is estimated as 1/3 of ultimate strength.

Fig. 5 shows the prininciples for evaluating compressive strength of pure brick constructions by testing drilling cores (diameter 5 to 6cm).In some cases this method poses problems during the extraction of joint drilling cores. After superposition of the shear stress and transverse stress for pure brick and joint drilling cores the results have to be converted to the compressive strength of the masonry. In order to find acceptable conversion factors, several tests are recently investigated.

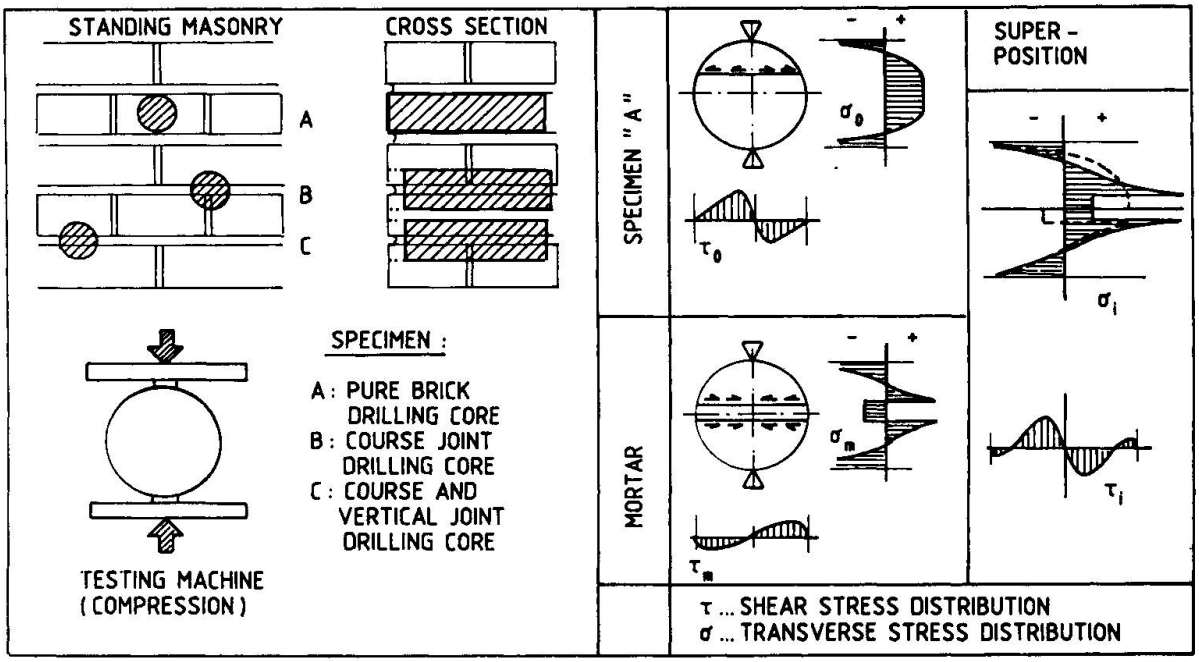


Fig.5 Testing drilling cores

4. STRENGTHENING OF MASONRY

Techniques of strengthening existing masonry structures are investigated within a special working committee. Five methods have been analysed so far. (See Fig. 6)

Each measure has both advantages and drawbacks in technical as well as in economic respect. Some of these are pointed out in Fig. 6.

In most cases the first two methods are put into practice. Reinforcing or prestressing local areas is used for historical buildings, where economic aspects play a minor role.

Evaluating shrinkage and creep of old masonry structures turned out to be the main problem in the application of these methods. Another problem is connected with the protection of reinforcing rods and prestressing cables against corrosion [5].

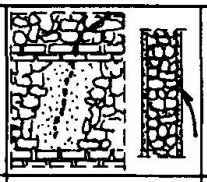
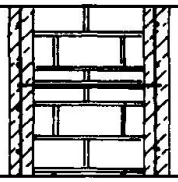
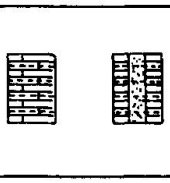
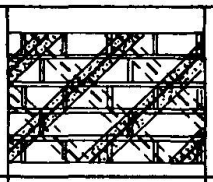
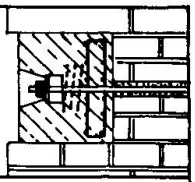
STRENGTHENING METHOD					
NAME	INJECTION	JACKETING (SHOTCRETE)	INSERTING REINFORCEMENT RODS	REINFORCING	PRESTRESSING
FIELD OF APPLICATION	LOCAL FAILURE	INCREASING SHEAR RESISTANCE, STRENGTH	SANDWICH MASONRY	LOCAL STRENGTHENING	REHABILITATION AFTER DEFORMATIONS
LIMITS	AREA OF APPLICATION	PLASTERING OF SURFACE	SANDWICH MASONRY	ACCESSIBILITY OF DRILLING LOCATION	CREEP AND SHRINKAGE
NECESSARY INVESTIGATIONS	CHARACTERISTIC VALUES OF MATERIALS (MORTAR, BRICK), GEOMETRICAL PARAMETERS CHEMICAL ANALYSIS OF MATERIALS				

Fig.6 Techniques of strengthening existing masonry structures

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