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F 540 - Summary/Abstract

Summary

REASON FOR THE RESEARCH

Cracks may form in plaster for a number of different reasons, and their significance and effect may also vary. Cracks on interior plaster generally represent an aesthetic problem. The functionality of a building's „outer skin" may be impaired considerably by cracks in exterior plaster, depending on the width and extent of the cracks. If relatively wide cracks form (0.2 mm or more), running through to the rendering base, water ingress may cause considerable damage. Needless to say, the primary task is to take effective, reliable steps to prevent cracks of this nature forming. However, as experience has shown, this is not always possible. Consequently, there is a need for lasting, cost-efficient repair systems which are quantified objectively in terms of their effectiveness and which can be selected to suit the crack in question. Cracks differ essentially in terms of the existing crack width and the expected change in crack width following the application of the repair agent. Numerous repair systems are available on the market. However, given the lack of systematic and objective investigations, the effectiveness of these systems has not been quantified to any degree of accuracy up to now. Therefore, users have not been able to confidently choose the best repair system for the crack in question.

OBJECTIVE OF THE RESEARCH

The research study is designed to create the essential preconditions for an accurate, quantitative evaluation of the effectiveness of repair systems for cracked rendering. For this purpose, a suitable testing device has to be developed which enables initial crack widths and changes in crack widths to be set, in adequately large, realistic test pieces, and cyclical long-term stress to be guaranteed with a high degree of accuracy, with reference to the predefined marginal conditions. This testing device should then be used to test selected repair systems which are commonly available on the market and which are evaluated in terms of their effectiveness.

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STUDIES CONDUCTED

The practical marginal conditions for the stress to an exterior repair system were recorded, conducting a detailed examination of literature. The parameters for the laboratory tests were formulated on the basis of this. Measuring techniques used to describe the behaviour and effectiveness of coating systems mathematically, together with testing procedures from technical regulations were shown and assessed. On the basis of this we ascertained which factors contribute most to the effectiveness of these types of repair systems.

An appropriate testing device was developed with a great deal of effort in terms of measuring technology and in extensive preliminary trials. It could be used to apply the cyclical stresses with a changing width of crack with a high degree of accuracy, provided the trial surface was adequately large. This test system was then used to investigate the effectiveness of a total of 4 different makes of crack-bridging repair systems. The stress generally occurred at +20°C, and in a series of tests it also occurred at –10°C; the stress was both cyclical and constant. In the case of cyclical stress, 300 and 400 cycles occurred respectively. The initial crack width was set to 300 µm in all of the series of tests. The change in crack width was set at 50 µm and at 100 µm. In the case of constant stress, the initial crack „quickly“ expanded to the point of failure.

The tests relate to two groups of repair systems: elastic repair systems (with organic bonding agent), called group A below, and repair systems with a reinforced fabric, called group B below. Two systems with different layer thicknesses, 300 µm (system A1) and 1000 µm (system A2), were investigated in group A. The two systems selected in group B were equipped with an alkali-proof textile glass canvas (system B1) or with a fibre glass fabric impregnated with styrene butatine, which is also alkali-proof (system B2).

The rendering base comprised a lightweight concrete building slab in the systems in group A, and a calcium silicate units building slab in the systems in group B. The following types of plaster were used: lightweight plaster PII (group A) and gauged mortar PIII (group B).

The repair systems were applied to the rendered building slabs, with initial cracks in the plaster, in the laboratory by the manufacturers.

In addition to the properties of the mortar rendering, we also tested the abrasion resistance of the repair system following constant stress within the cracked area, the condition of the repair system following cyclical stress and the maximum crack enlargement during constant stress.

FINDINGS OF THE STUDY

The key findings of the study can be summarised as follows:

(1) The developed testing device is adequately accurate for setting the initial crack widths, and for the change in the predefined crack width in particular; and displays long-time stability, i.e. the predefined changes in crack width are maintained exactly over the entire test period. The repair systems can be applied realistically on account of the large test surface. Alternating and expanded climatic stress is possible, however this has not been done in the course of this research work.

(2) In the case of the systems in group A, the tensions required to bring about the change in the crack had already been eased through relaxation during the initial load change cycles; practically no further changes occurred. Consequently, we can assume that the predefined load change times were sufficient to allow the relaxation to take effect. Following a total of 400 cycles and a change in crack width of + 100 µm in each case, neither system displayed any signs of damage and can be classed as fully functioning following the stress.
The maximum crack enlargement achieved with systems 1 and 2 in group A, under constant stress, was between 1500 and 2000 µm.
The maximum stretch values recorded during the tension test on the free film in systems 1 and 2 in group A was about 90 and 12 % respectively. The abrasion resistance values of systems 1 and 2 were very low, which is evidently attributable to the failure in the area of the lightweight plaster.

(3) In the case of systems 1 and 2 in group B, initial hairline cracks appeared under constant stress when the crack had only enlarged to about 230 µm. Further cracks then developed, spaced at intervals which roughly reflected the mesh width of the fabric used.

The abrasion resistance values were about 0.6 and 0.7 N/mm² respectively. The failure occurred each time in the level of the fabric inlay, which acted as a parting layer. Higher abrasion resistance values would appear to be possible by optimising the mesh width.

(4) A crack in the coat at large thickness, which was noticed in other investigations, did not occur during the tests conducted here.
(5) The repair system became clearly embrittled during the series of tests at a temperature of –10°C (systems 1 and 2 in group A).
(6) The coats were found to separate from the edges of the cracks in all of the investigations. The separation depth in some cases was up to 4 mm. A limited separation of this nature may be more beneficial than detrimental to the effectiveness of the repair systems.
(7) With reference to the selected marginal conditions for the investigations, we proved in all cases that the repair systems tested were adequately effective.

The effectiveness of repair systems for cracks in rendering can be described objectively and quantitatively using the testing device which we have developed. It allows the right kind of repair system to be chosen for certain cracks, depending on the type of application. Further research is required in order to quantify the important influence of climatic stress on the lasting effectiveness of the systems.