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Ramachandran, V. S.; Sereda, P. J.

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V.S. Ramachandran and P.J. Sereda

DIVISION OF BUILDING RESEARCH · NATIONAL RESEARCH COUNCIL · OTTAWA · CANADA

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The Division of Building Research has investigated plaster failures occurring in various types of buildings such as offices, hospitals and apartment buildings. In almost all cases studied the failure of white coat plaster could be attributed mainly to the use of Type N hydrated lime. The work also resulted in the development of a new test for determining the potential soundness of limes and of a method of estimating the various constituents in the white coat plaster (1, 2, 3). This note describes white coat plaster, the types and causes of failure, and remedial measures. It does not cover all types of failure.

White Coat Plaster

The final coat of plaster comprises lime, plaster of Paris and water. Plaster may be applied in three coats, viz, 'scratch', 'brown' and 'finish'. The backing for plaster consists of concrete or a dense type of masonry. The plaster is generally coated with paint or sealed with other coatings a few weeks after it has been applied. Specifications for lime and gypsum plaster are covered by Canadian Standards Association and American Society for Testing and Materials (4, 5).

Description of the failure

The terms 'blistering', 'blowing', 'popping' and 'pitting' are used to describe plaster failures.

The blisters or bulges may be observed 5 - 15 years after the plaster is applied, increasing in number and severity with the age of the building. Large blisters or bulges occur as a separation of the smooth or outer coat from the underlying layer of white coat, or as a separation of the white coat from the sanded brown coat or bond

plaster base. Occasionally there is also a weakening of the bond between the sand-lime-plaster and the concrete base. These types of failure are described in greater detail in another publication (6).

Under warm weather and high humidity conditions, the white coat plaster is particularly susceptible to early failure.

Cause of failure

Some of the causes leading to failure are defects in the materials, which may originate in their physical or chemical nature, exposure conditions and/or mistakes in the execution of the job. A common cause of failure is the presence of particles of hard-burned quick-lime or magnesium oxide in the lime used in the plaster mix. These oxides are resistant to easy hydration and hydrate gradually over the years by the moisture provided by high humidity conditions. Water for hydration is also provided by the reaction of atmospheric carbon dioxide with lime in plaster mix. The rate of hydration of MgO or CaO depends, among other factors, upon the temperature at which the lime was originally burnt before it was mixed with the plaster. Figure 1 indicates the effect of calcination temperature on the rate of hydration of MgO in calcined dolomite (7). The hydration was carried out in water in this case but when the material is exposed to ambient conditions of temperature and humidity the rate of hydration of MgO is decreased severalfold.

The magnitude of the solid volume change of calcium oxide and magnesium oxide, when they are converted to hydroxides, is respectively 91% and 117%. These figures, however, do not represent actual expansions in practice because the material is a porous system which tends to accommodate most of these expansions. But these figures do provide a basis to predict the potential over-all expansion, in qualitative terms.

Patching of the walls

The patching or the replastering work after the plaster finish coat has failed, should take into account the severity and extent of failure. If failure is not severe and widespread, trimming should be done around the edges so as to reach the firmly bonded area. Patching should then be done with a well-gauged putty to obtain a hard, well-bonded patch.

One of the most common problems connected with the patching of plaster walls is that water used in the patching mix soaks into the plaster adjacent to the spot being patched. This results in the weakening of the bond at the interface of the white coat plaster and the base and

further expansion due to hydration of the MgO. Excess water thus tends to hasten the failure of the apparently sound plaster.

A technique to prevent water in the patching mix from spreading to adjacent areas has been developed. It involves the application of a bonding compound. The liquid bonding agent is a film-forming, non-oxidizing composition, that can be applied by brush, roller or sprayer. The bonding agent seals off the pores and larger crevices in the sound plaster adjacent to the hole. Thus water ingress into the base of the sound plaster is prevented. It also allows for some expansion without excessive stress. Liquid bonding agents should satisfy the requirements of the CSA standard (8).

The patching of a failed spot involves the following steps:

(1) Remove all loose plaster from in and around the area that has been affected.

(2) Apply the bonding compound on the failed area ensuring that it is covered well. Pay particular attention to the edges and corners.

(3) Let it dry for about 1 to 3 days or according to the manufacturer's recommendations.

(4) Patch the spot with well mixed, white coat plaster containing, preferably, a pressure hydrated lime; in other words the plaster, before its application on the wall should contain minimal amounts of unhydrated MgO and CaO.

(5) Allow two weeks or more before subjecting the wall to painting or other decorative finish.

(6) If blistering or failure occurs over a large area it should be serously considered whether it would not be economical to remove the entire finish coat and refinish the wall with a new putty coat.

(7) Failure of the brown coat is also possible. This can be checked for firmness by scratching it with a trowel or any sharp tool. A hard, sound brown coat would need considerable pressure for an impression to be made. If the brown coat shows signs of deterioration it may require removal down to lathing before the refilling operation.

Conclusions

A few precautions taken before the application of white coat plaster ensure good long-term performance.

The lime used in the plaster mix should preferably contain minimal amounts of free calcium oxide and magnesium oxide. Type S hydrated lime satisfies this requirement.

The plaster mix should contain higher proportions of plaster of Paris.

Plaster that gives a good bond strength should be used.

After application of white coat adequate curing should be allowed before paint is applied.

If a plaster has failed locally a bonding compound should be used before patching.

If a plaster has failed, it is easy to test whether it is due to hydration of free MgO by carrying out comparative tests using compacts of the plaster that is still sound and located elsewhere on the same wall (1, 2, 3).

If the plaster failure spreads over a large area it may be judged more economical to peel off the entire coat and replaster with a sound plaster.

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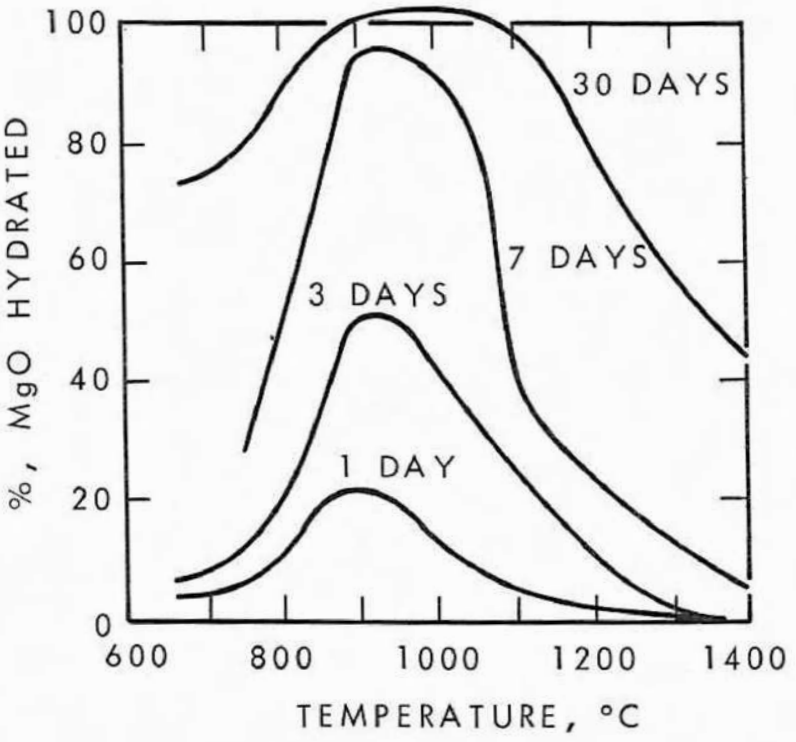

FIGURE 1 HYDRATION OF MAGNESIA IN CALCINED DOLOMITE