

## **Protection and Restoration Analysis of Building Walls Based on Repointing and Mortar Joint Restoration Technology**

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**ABSTRACT:** To improve the durability of building walls and overcome the deficiencies of traditional materials, this paper discussed the wall protection and restoration technology upon the analysis for repointing and mortar joint restoration technology. Before such restoration, marl types, mortar joint types and colors in test board, selection and properties of materials (hardness, water permeability, strength, etc.), preparatory work, technologies in the operation, wall cleanliness after the restoration and others may occur were analyzed by this paper. It follows that, the related hardness permeability of selected mortar joint materials in the repointing and restoration period as well as the information achieved from the visual analysis for building mortar joint could improve the mixing and matching and application technology. Used as a reference for construction, the test board has established the assessment criteria for later stages. This experimental test board has a great referring significance on our country's restoration and protection of building walls.

**KEYWORDS:** Building; Wall; Protection; Restoration.

### **INTRODUCTION**

The mortar joints on the walls may be damaged and fell off due to walls' years of exposing to wind and rain. As the first line of defense, the mortar joint's integrity has something directly to do with the movement of aqueous vapor in the wall and erosion possibility of masonry. Hence, this paper would systematically expound the causes of mortar joint's being damaged, evaluation of the mortar joint before the construction, selection of restoration materials and the requirements of construction technologies.

### **RESTORATION OF MORTAR JOINT IN BUILDINGS**

Bricks, stones, terra cotta and even concrete may be found being used as main materials in almost every historical building. Masonries are not maintained well on a perpetual basis, some of them are suffered from problems of one sort or another after thousand years of wind and rain, especially the connections of masonries, i.e. brickwork joint or mortar joint. New marl should be infused in those places with serious damaged mortar joint. Known as "repointing" or "infusing", this process could be divided into two parts: take out the damaged mortar and repoint the new. If properly disposed, it may restore the visual integrity of buildings. If not properly disposed, it would not only destroy the original visual integrity of buildings, but also cause some damages [1].

#### **Problems that should be concerned before the Repointing**

Further deterioration in buildings may often occur due to the repointing, such as mortar weathering, mortar joint splitting, masonry loosening and wall damping. The repointing is unable to solve all the problems stated above, so some fundamental problems must be found and properly disposed before the repointing, mainly referring to the leaking roofs, fracture and weathering of drainage pipelines and weather effects. If these fundamental problems fail to be effectively resolved, the deterioration would be further deepened and no restoration measure would take effect.

#### **Searching for Suitable Marl**

To ensure the external and visual consistency before and after the restoration, the survey study for building walls is necessary in the early stages of restoration. Hard or water-proof materials suitable can be selected to minimize the damages through the analysis. And during the period of restoration, the analytical investigation on building materials and technologies would be conducive to keep the original appearance of buildings. Even a simple and nontechnical evaluation and analysis related to the masonry and marl would provide some information relevant to the hardness and

permeability of selected marl materials. At the same time, the information got from the visual analysis for building mortar joint could improve the mixing and matching and application technology.

The laboratory data are important in the protection and restoration of building walls. Although this analysis is not indispensable for a successful restoration project, it is still of tremendous assistance by providing information relevant to the original building materials for those buildings with special historic significance. Having its own limitations, this analysis leads to that the specification of marl required for repointing cannot be based on the laboratory analysis results. Analysis needs to explain, but many significant relevant factors affecting marl conditions and properties cannot be achieved from the laboratory analysis [2]. These factors may include the original degree of water saturation, degree of solidification, weather conditions, marl adjusting and repointing way, as well as precision and conditions of the sand. The most important information achieved from the laboratory analysis is the identification of sand levels and colors. Due to its large proportion in the marl, the sand thus enabled the texture structure to be matched to the original marl more accurately (Shown as Figure 1).



**Figure 1.** Mismatched color between repointed and original marl.

The new marl for repointing must be compatible for the masonry and consistent as far as possible with the original. In this way, the new and original marl could be closely connected and co-existed in a good state. The new marl for repointing and restoration should follow several standards:

- (1) The new marl must be consistent with the original in the color, texture structure and processing technology. (If the laboratory data analysis is feasible, the adhesion degree and blend proportion of new marl should be more consistent with the original).
- (2) The sands used for new marl must be consistent with those for the original. (If the sands used for new marl are consistent with those for the original, the color and texture of new marl would be rather clear and consistent with the original).
- (3) The new marl must be provided with good water permeability and should be softer than brick materials under the test of compressive strength.
- (4) The vapor permeability of new marl must be consistent with that of the original and as soft as or softer than the original under the test of compressive strength. (The degree of hardness and softness of marl fails to illustrate its water permeability. To be specific, the original, old and hard limestone mortar still maintains good water permeability).

#### Marl Properties

No matter in the U.S. or other areas, marl used for repointing would have softer property and better water permeability than bricks and original, otherwise damages to bricks may occur. People often assume falsely that the hardness or high strength is the method to measure the properness of marl, especially those based on the lime. The pressures in the walls generated by expansion, contraction or vapor movement needs to achieve the mutual equilibrium and in gun walls, such pressures shall be reduced by the marl, other than blocks. If the compressive strength of marl is stronger than that of

brickwork and cannot be given out, these pressures would be released through the brickwork, so causing the permanent and unrepaired destruction of buildings, like the wall cracks and abscission (as shown in Figure 2) [3].



**Figure 2.** Wall cracks and abscission.

At the same time, these pressures would destroy the connections between the marl and brickworks, causing the water to be penetrated in the mortar joint at connections. It is much easier to restore the destroyed connections by repointing than restore the damaged walls. It is also hard on be strict with the permeability or vapor transmission rate. The soluble salts would be deposited and weathered on their surface or formed as sub-weathering underneath the surface after the evaporation of water in the marl [4]. The soluble salts deposited on the surface are relatively harmless and those salt crystals in the walls would produce pressure and thus causes the cracks and abscission on the surface. If the water or vapor in the marl cannot be completely moved out of the wall and evaporated, then the brickwork would be damaged.

#### Implementation of Restoration Work

Before the implementation of restoration work, contractors would use the technological mean same to the original as the construction tips. The test board should include marl types, mortar joint types and colors and problems may be encountered in other construction periods. Generally speaking, for brick buildings, the size based on feet is enough and for gun buildings, larger area is needed [5]. So these test boards have been used as a reference for construction and established assessment criteria for later stages. This experimental test board exerts a great referring significance on the restoration and protection of building walls in our country.

#### Mortar Joint Preparatory Work

Before the repointing, construction personnel should clear away the old marl, whose depth should be 2-2.5 times of its mortar joint width. In this way, the adhesive force of new marl can be ensured and the “vesicular eye” after the drying of marl can be prevented. For most of brickwork joints, the mortar joint depth needing to be cleared up should be approximately 0.5-1 inches. For those brick buildings with wider mortar joint, the mortar joint depth needing to be cleared up should be several inches. In case of any looseness or disintegration of marl over that depth, the complete clearness should be carried out as well (as shown in Figure 3) [6].

#### Marl Preparatory Work

The blending compositions of marl should be carefully measured and mixed during the protection and restoration of building walls to guarantee the unified appearance and physical properties. The dry ingredients should be measured based on the volume and completely and evenly mixed before adding any water. The sands should be kept in a moist and loose condition when added. The marl used for repointing should be the typical prehydration marl, which could be condensed together by adding the water. For this ground, it could be placed for a period before adding the water [7]. After mixing the raw materials for several minutes, half of the water should be added at first to achieve the required standard by adding the water in steps.



**Figure 3.** Marl depth remained after the clearness.

of mortar joint should be repeatedly repointed with marl of inches and tightly with back corners. This process would continue for inches on the wall. Once the repointed marl reaches to the hardness born by the thumb extrusion, the new layer of marl shall be repointed. The vast majority of marl is contracted in the period of hardness and if the hardening is not sufficient, the new repointed marl layers would cause the insufficient integral contraction of marl [8].

If the bricks or stone masonry in walls have been damaged to lose the edges and corners, then the best way is to compress the marl to the inner space. In this way, the visual effect that mortar joint is wider than the actual would be avoided (as shown in Figure 4). This action would avoid producing numerous thin edges, which are easily to be damaged to allow the water in [9]. The supernumerary marl should be cleared from the edges of mortar joint when disposing. The clearness work shall be made with natural bristle brushes or nylon brushes, wherein the metal brushes are prevented.



**Figure 4.** Comparison of cupped and uncupped mortar joint.

#### Cleared and Repointed Wall

If the restoration work has been meticulously completed, both the supernumerary marl on edges of marls and the whole restoration area should be worked off. The construction personnel usually use natural bristle brushes or nylon brushes for clearing (after the hardening of marl), but should carry out one hour before the complete solidification of marl. The wooden paddle-tumbler may be used for clearing the hardened marl or if necessary, the chisel would also be adopted [10].

## CONCLUSION

It should be noted that the restoration is a time-consuming and arduous long-term course during the protection and restoration of building walls. Firstly, plenty of time must be guaranteed to assess the buildings and make a detailed investigation for causes of various problems. Secondly, the time for preparing the contract document should be reserved. The restoration is a strict and time-consuming task with noise generated, so scaffolds sometimes should be set up around the buildings for a long time. For these two reasons, the building owners or managers must prepare detailed plans to avoid numerous problems. The restoration must be inter coordinated with other tasks to avoid conflicts. If the building owners or managers intend to completely maintain different properties of the original by one restoration, they should not hasten construction process. Due to the long period, the corner cutting should not be adopted neither.

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