

## Surface Mottling of Mortar Joints

*Understand the science of why surface mottling of mortar joints happens and what can be done to avoid or mitigate the occurrence.*

While masonry mortar makes up only a small percentage of the total surface area of a masonry wall, its finished appearance in a structure complements or contrasts masonry units. When the color of the mortar meets expectations the resulting assemblage completes the designer's vision. When the mortar color does not meet expectations, the designer's vision is compromised.

One undesirable color variation in masonry mortar joints is surface "*mottling*". Similar to mottling in concrete surfaces, mottling on mortar joints is best described as generally darkened or discolored patches or areas that are adjacent to, or within lighter colored mortar on the surface of mortar joints. Mottling generally appears during the construction phase of the project and may or may not be associated with inconsistent mortar composition. Such variation can be so random in a head or bed joint that the mortar would have to be striped or swirled on the mason's mortar board or trowel during installation; a consistency issue easily identified by the trained eye of an experienced mason.



**Surface Mottling of Mortar Joints**

Surface mottling of masonry mortar occurs when on-site conditions and construction practices cause the extension or premature termination of the cement hydration. Densifying of the mortar at the surface of the mortar joint during finishing practices also can cause this surface condition. Hydration of portland cement cannot proceed if water is unavailable making the mortar joint darker than desired. Conversely if additional water is available during the curing process the cement can over hydrate yielding a lighter than expected result. Generally, the higher the water content in the mortar, the lighter the mortar. Mottling can manifest itself across the entire surface of the mortar joint or even in small irregular patches.

This condition of mortar joints is more common when using low initial rate of absorption and/or water repellent masonry units. In general, these units tend to repel water, which forces the water that would normally be absorbed into the masonry unit to stay in or exit through the mortar joint. This can lead to higher water contents in the mortar. To help mitigate these issues, the mortar specified for these types of masonry units should match the density and absorption properties of the masonry units as closely as possible. Mortars used for this application should generally have a low water retention and contain a water repellent admixture to properly match the masonry unit.

If the masonry unit is a polished block or glazed brick, great care should be taken in the removal of any fresh mortar smears as soon as possible. If the mortar smears are removed by rubbing the units with a rag or towel directly after tooling, mortar material adhered to the rag can be transferred to the mortar surface and water can be absorbed or added to the mortar joint contributing to surface mottling. For densified or glazed masonry units, the use of an acrylic finishing tool is generally more successful than using metal finishing tools.

Another contributing factor to this condition is the consistency of the mortar joints and how often they are addressed during the tooling of the wall. The mortar joints should be tooled when thumbprint hard. If the mortar joints are tooled when they are beyond thumbprint hard, more effort is required to achieve the desired finish which densifies the mortar at the surface leading to dark discoloration. This dark discoloration can also be noted in mortar overlays that tend to dry out quickly due to their shallow depth.



**Extended curing times due to grouted cells**



**Leading edge discoloration of a mortar patch – over tooling**

The addition of core fill grout in a concrete masonry unit wall can lead to color variance in the mortar joints by increasing the free water available to the mortar during the curing process. Initially when grout is poured into masonry walls the mortar and block appear to be wet. The moisture absorption from the grout into the block and mortar helps promote a good strong bond between the block, grout, reinforcement and mortar. However, the additional water provided by the grout can result in inhomogeneous paste where some areas hydrate more due to the presence of excess water, while other areas dry out. Excess moisture can migrate through the mortar and pick up soluble salts, such as calcium hydroxide, and deposit them on the surface of the mortar upon drying. Exposure of calcium hydroxide to CO<sub>2</sub> in the atmosphere rapidly converts the calcium hydroxide to calcium carbonate, which leads to light discoloration.

When the appearance of surface mottling occurs, an effective means of removal can be through abrasion. The manual use of a “*rubbing stone*” or a stone drill bit as pictured below followed with washing the joints lightly with a mild cleaning agent has proved successfully in removing surface mottling.

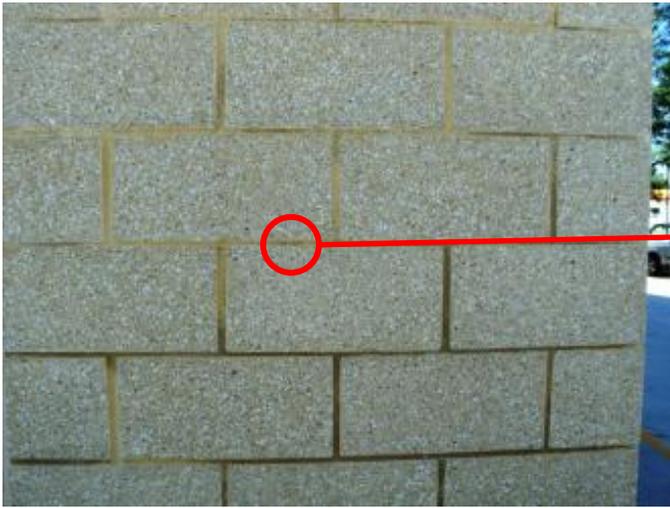


**Removal of mottling by hand abrasion**

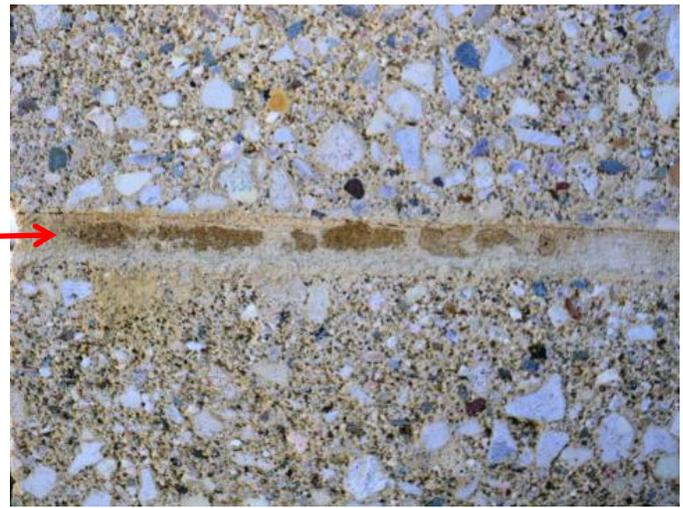


**Mechanical removal of mottling**

Chemical cleaning agents can also be useful to remove this condition. When using chemical cleaning agents it is important to choose the right one. Use the least aggressive cleaning solution and always follow the cleaning agent manufacturer’s recommendations for use. If the masonry unit is a burnished block, great care needs to be taken as the masonry unit itself is polished and smooth. When a cleaning solution is applied to the wall the mortar joints take the brunt of the cleaning solution as the masonry unit itself does not absorb any of the cleaning solution. It should be noted that many manufacturers of burnished masonry units warn against the use of muriatic acid (HCl) when cleaning the wall system. If the mortar joints are washed too aggressively the cementitious paste will become etched, exposing the aggregate. To the eye, the mortar joint will take on the color of the aggregate in the mix only, likely changing the the desired color of the mortar joint.



**Surface mottling due to sealing practices**



**Sealer not fully absorbed into the mortar joints**

When applying a surface sealer to the mortar joints, as is common for burnished block applications, it is extremely important that the mortar has sufficiently cured and that the wall is dry. It is also important that the wall is above 40°F and below 90°F when applying the surface treatment. If the mortar is saturated during installation, the bonding and penetration of the sealing agent can be inhibited which can lead to moisture penetration or flaking of membrane-forming sealers, especially after further cleaning or freeze thaw cycles. This action can lead to “mottling”.

In today’s world of fast-paced construction schedules and the strict demands put upon masonry contractors, it is critically important to understand the basic principles behind the causes of the “mottling” of mortar joints. Mottling can be eliminated or minimized in most instances whereas an aesthetically pleasing finished masonry assemblage is always the result. Work with the designer on matching the mortar type with the properties of the selected masonry unit. Follow proper and consistent cleaning practices and use a reputable branded cleaning product. And remember, aggressive cleaning practices can remove the cement paste off the surface of the mortar joint thereby changing the color. Make certain that consistent tooling procedures and times are put into place. On your next project, take a step back and visualize what you can do to make sure the appearance of the mortar joints will have a true and lasting impact on your project.

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