

EFFECT OF MOISTURE ON APPEARANCE

Some color variation is generally desired in the appearance of brick masonry; however, there can be situations when the appearance of the brickwork is outside the anticipated range. Because it is a natural and absorptive material, fired clay brick can express variability in color depending on its moisture content, which can be more noticeable in light-colored units. Such color variability is often misinterpreted as non-compliance.

This Brick Brief discusses the effect moisture can have on the appearance of masonry and the process of determining whether excess moisture is contributing to perceptions of discoloration. Also discussed are how moisture plays a role in brick masonry construction and how excess moisture can find its way into brick masonry. Users should be aware that the true color of the brickwork will not be apparent until sufficient evaporation of this moisture occurs.

Perception of Brick Color

In general, perception of brickwork color is subjective. Not only does it vary based on lighting conditions, location on the building, and the color of the surrounding elements, such as mortar, brickwork color varies depending on the individual. The presence of moisture also contributes to perceived color in brickwork. Given two brick units that are otherwise the same, a unit with more moisture will be perceived as darker. When the color of the brick units differs, for a given amount of moisture, a perceived color difference will be more noticeable in light-colored units than in dark-colored units. Brick categorized as light-colored units typically include those described as buff, tan, light gray, and white.

Diagnostics

When color variation of brickwork on a project is alleged to be noncompliant, the first step should be to determine whether moisture is affecting the appearance of the brickwork. The brickwork in question should be compared with the project mockup/sample panel. The approved project mockup/sample panel is required to be maintained on-site during construction, as it represents the standard of appearance and workmanship for the project and would be exposed to similar environmental conditions as the completed brickwork.

In cases where the mockup/sample panel has been prematurely removed from the site, photos can provide general guidance but should not be the sole source of

determining the compliance of the brick. This is because photographs do not provide a sufficiently accurate representation for comparison. Not only are the lighting conditions different between the photo and the actual brickwork, but the methods used to view a photo (screen, printed page, etc.) are also known to inaccurately reproduce the color perceived by the eye in person.

For situations where the approved mockup/sample panel is not available, informal testing can be conducted using a heat gun or a torch. If the brick becomes lighter in color under application of direct heat, it indicates that the perceived discoloration is due to moisture. If applying heat is not feasible, ASTM D4263, *Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method*, is a simple procedure that indicates whether elevated moisture is still present in the brickwork.

Handheld moisture meters can indicate the presence of moisture, but the moisture percentage reported by the device can overestimate the true moisture content of the brick in terms of percent of dry weight of the unit.

The brick distributor and the brick manufacturer are typically contacted regarding appearance concerns and may visit the site to observe the conditions in person. They may be able to share other local projects that used the same run of brick. If the brick on these other projects does not exhibit similar discoloration, it is a compelling indication that manufacturing issues are not the cause.

Sources of Moisture

Moisture inherent in construction of brick veneer.

Brick units in masonry veneer are surrounded on four of six sides by mortar. During construction, this mortar is placed in a wet, plastic state such that the water in the mortar is drawn into the pore structure of the brick unit through capillary action. This action is desirable and necessary in order to create bond between the brick and the mortar. Cleaning of brickwork after completion introduces additional moisture from the pre-wetting and rinsing processes.

Moisture from storage practices. As recommended by BIA *Technical Note 7B*, brick cubes, bags of mortar or cement, and sand should be stored off the ground and covered with tarps or other water-resistant materials to protect them from rain, snow, other environmental elements and potential contaminants. Even with protection, the moisture content of individual brick units can vary based on their location within the brick cube.

Staging of brick on the scaffolding can also result in variable moisture content in units prior to laying.

Moisture from unprotected masonry during construction.

Covering masonry at the end of each workday, and especially in times of inclement weather, is essential to keeping excess moisture out of brickwork. This includes protecting all masonry cavities not yet fully enclosed, including but not limited to the top of unfinished masonry; masonry waiting for coping or flashing installation; and unfinished openings in brickwork for windows, doors, movement joints, etc. Otherwise, moisture from rain, ice and snow may enter the masonry, requiring an extended drying period and increasing the risk of persistent efflorescence.

Although incorporated into most specifications, such weather protection recommendations are not consistently enforced on the jobsite. In such cases, weather events and coordination issues delaying trades from installing adjacent work can all result in excessive moisture entering the brick veneer and the cavity behind it. As an example, in one project, mineral wool insulation in the cavity became saturated due to inadequate protection during construction. This negatively affected the appearance of the brickwork due to the excessive moisture needing to evaporate through the brick units.

Addressing Moisture in Brickwork

All brickwork, components and adjacent work should be completed including all flashings, copings, sealants and other adjacent features that serve to protect or direct moisture away. If these are not completed, moisture will continue to influence the brickwork's appearance.

Certain details can allow more moisture into the brick wall assembly than others, even if not intended. Skyward-facing conditions such as copings, caps, rowlock sills and transitions to other cladding materials are most susceptible to moisture entry. As a result, BIA *Technical Note 7* recommends the installation of drip edges at flashings and flexible membrane flashing under copings, caps and rowlock assemblies to provide additional protection for the top of the cavity and any blocking that is present, since these elements are not necessarily watertight.



Photo 1: Reported color variation of brickwork in courtyard (mid-April)

After verifying that the brickwork and its surrounding construction are completed, the most effective manner to address moisture in brick veneer and the cavity behind it is to provide adequate time for the moisture in the assembly to naturally evaporate. During this time, conducting periodic assessments of the brickwork appearance is recommended.

Evaporation is non-uniform, depending on the orientation of wall relative to sunlight and wind. The amount of direct sunlight and the amount of wind a brick veneer is exposed to will affect the rate at which moisture evaporates from the veneer. The orientation of the wall and shadows cast by other elements or adjacent buildings affect the amount of direct sunlight received by the veneer. Brick veneer facing north will naturally experience less time in direct sunlight than veneer facing south, east or west. In BIA's experience, it can take months for a very wet assembly to dry sufficiently, as shown in Photo 1 and Photo 2.

Be advised that proceeding with corrective action before sufficient moisture has evaporated can have unintended consequences. Repeated cleaning only serves to add more moisture to the brickwork. For brickwork already experiencing units that appear darker than intended because adequate time has not been allowed for the evaporation of moisture, an additional cleaning process can cause the brick to appear even darker and require even more time for moisture to evaporate. It is not advised to apply brick stain to units perceived to be discolored because the stain color will be matched to adjacent brickwork that also contains moisture. After the moisture evaporates, the stained brickwork may not match the surrounding brickwork, which can be irreversible and would require further work on both the stained and surrounding brickwork to correct.

Prevention

The most effective means of preventing discoloration due to moisture is consistently implementing protection procedures for stored materials and brickwork under construction. BIA also recommends educating the project stakeholders so they understand the duration of the evaporation process and that the appearance of the brickwork may vary as the moisture evaporates. Section X10.2.1 in the appendix of ASTM C216 includes language that helps to explain this condition:

As a natural and absorptive material, fired clay brick may appear to vary in color depending on its moisture content. This variability can result in claims of non-compliance with approved samples. However, moisture is ever-present in the construction of brick masonry and cannot be avoided, from on-site storage and staging through bricklaying to final cleaning. In many cases, perceived discoloration resolves when sufficient evaporation of this moisture occurs. Conditions that factor into the drying time include, but are not limited to, orientation of the face of the masonry surface, temperature, precipitation, humidity, and wind. Remedial actions to “correct” assumed variations in color, such as additional cleaning or brick staining, are not recommended during this evaporation period, as these actions will either introduce more moisture into the brickwork or result in irreversible changes that may not match the surrounding brickwork after drying.

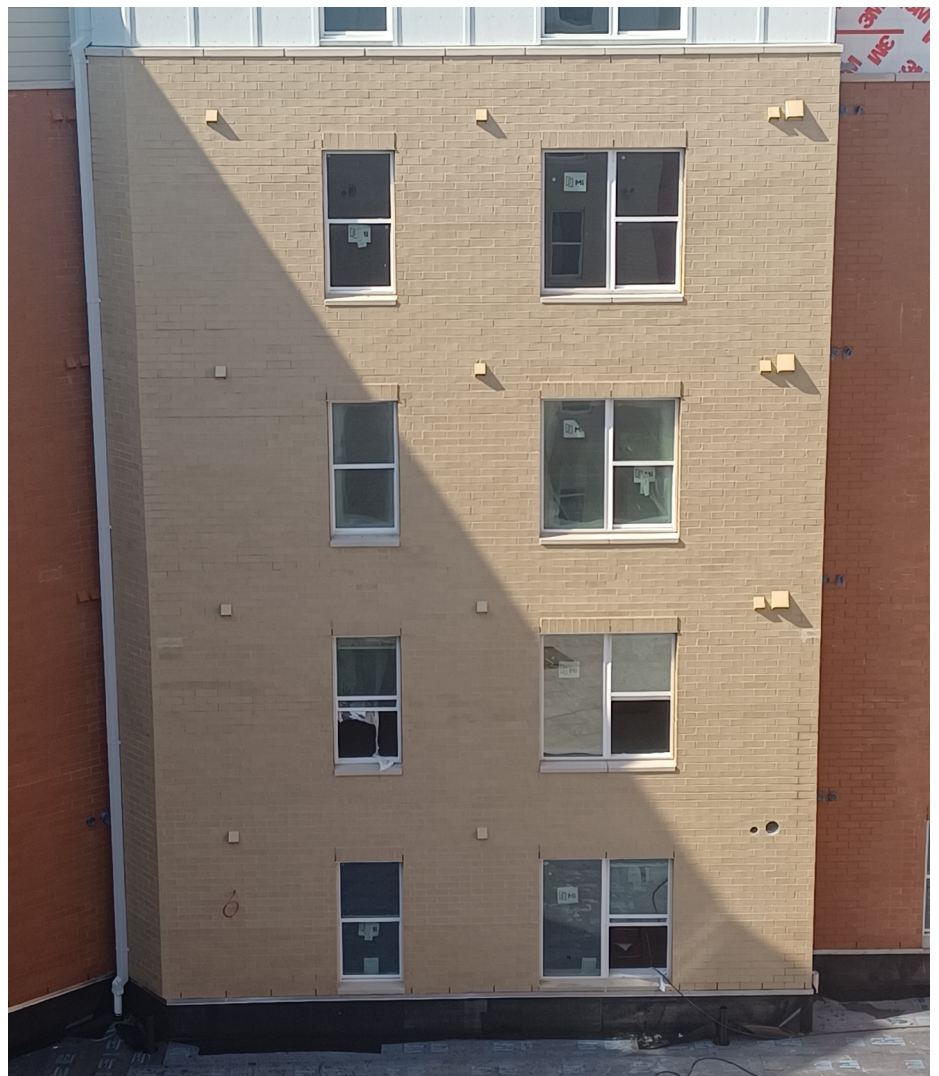


Photo 2: Difference in appearance after drying (early August)

Conclusion

When evaluating the appearance of completed brickwork, it is important to account for the amount of moisture that may be present in some brick units or areas of brickwork relative to other units or portions of brickwork. Where the color appears different, it is critical to assess and determine whether moisture present in the unit(s) is affecting the perceived color of the brick. When it is determined that moisture is present to the extent that the brick appears discolored, the evaluation should be discontinued until adequate time elapses to dissipate the moisture. Only then should evaluation of the color of the brick and brickwork proceed to determine compliance with the project mockup/sample panel. Not taking these steps can result in remediation attempts that worsen the original conditions.

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