15th Canadian Masonry Symposium
Ottawa, Canada
June 2-5, 2025

Designing Stone Dutchman Repairs in Slender Stones

Ellen M. Laase[i]

ABSTRACT

Designing stone dutchman repairs requires a nuanced approach to ensure long-term durability and stability. A successful stone dutchman repair must consider many factors, including material compatibility, precise workmanship, and effective reinforcement. Dutchman repairs in stones within the field of the wall are typically not structurally challenging to design or implement, in that the gravity loads within the load-bearing walls have alternative load paths both around the repair and behind the partial depth. However, through-depth dutchman repairs in slender linear elements such as window mullions and columns present additional challenges that are discussed herein.

This paper will explore stone dutchman repair considerations, including additional considerations when the dutchman repairs are located within slender linear elements such as vertical mullions between windows and must resist gravity loads and magnified wind loads imparted from the adjacent windows. The paper will present how to design an effective repair when the dutchman repair is full-depth with no alternative load path around or behind the repair. By exploring the multiple considerations for dutchman repairs, particularly at slender elements, the paper will explain the complexities of dutchman repairs in historic masonry and offer insights into designing repairs that are capable of resisting both gravity and lateral loading to ensure repairs that are durable, stable, and respectful to the building's history.

KEYWORDS

Restoration, stone, dutchman

[i] Senior Consulting Engineer, Simpson Gumpertz & Heger, Inc., Waltham, Massachusetts, USA, emlaase@sgh.com

INTRODUCTION

Stone spalls – areas where pieces of stone have broken off – are a common form of deterioration in stone buildings. This deterioration not only compromises the appearance of the building but, if unaddressed, can lead to further stone deterioration and potentially water ingress or structural concerns. Repairing spalls effectively is crucial to preserving the integrity and longevity of these stone buildings. One of the methods for repairing stone spalls is a dutchman repair, a technique that involves replacing the damaged section of stone with a new piece of stone. For an effective dutchman repair, that is durable, stable, and respectful to the existing building one must consider both the aesthetic and technical properties of the stone, as well as the anchorage methods to the existing, parent stone.

Often, dutchman repairs are located within a large, parent stone in the field of the wall. With these dutchman repairs, the gravity loads within the load-bearing walls have alternative load paths both around the repair and behind the partial depth of the repair (Fig. 1). However, in some cases, the stone spalls are located within tall, slender stones, such as vertical mullion stones between windows and must support both the gravity loading from the lintel above the window and the lateral loading from wind on the adjacent windows (Fig. 2).

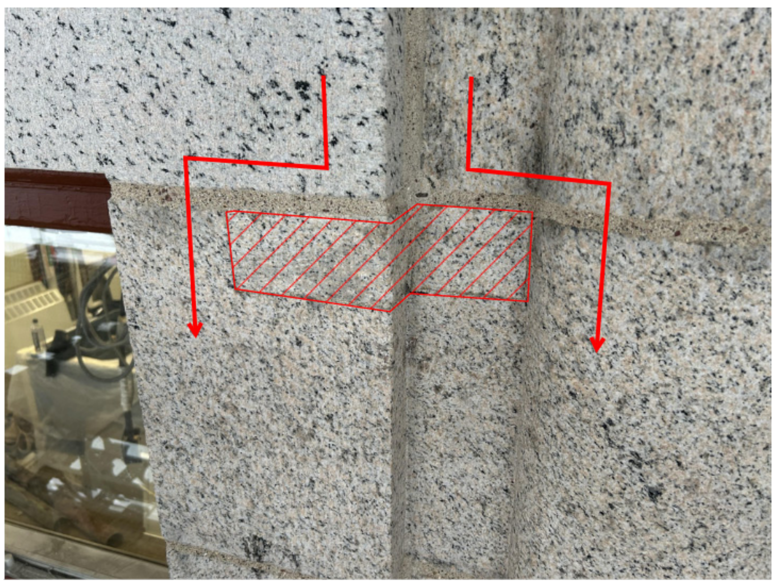

Figure 1: Dutchman repair in field of wall. Red arrows represent alternative gravity load paths around dutchman.

Figure 2: Dutchman repair in slender vertical stone. Red arrows represent gravity loading; blue hatch represents tributary area of wind loading imparted from adjacent windows.

The construction of these tall, slender stones typically includes ferrous dowels, which, when continually exposed to moisture, can corrode, expand, and spall the surrounding stone (Fig. 3). When designing dutchman repairs in these tall, slender stones, the anchorage methods must be selected to resist the lateral loading imparted from the adjacent windows tributary area, support the full-depth of the repairs, and allow for concealed installation above and below the stone.

Figure 3: Stone spall in tall, slender stone.

TYPICAL CONSIDERATIONS FOR DUTCHMAN REPAIRS

When selecting a new stone for use in a dutchman repair, consideration must be given to both the aesthetic and technical properties, as well as the anchorage to the parent stone. The best aesthetic and technical match to the existing stone will be achieved by using salvaged stone from the building, but, when salvage stone is not a viable option, a new stone must be selected that is compatible with the existing stone in both appearance and performance.

Aesthetic Properties

To provide a dutchman repair that is compatible and blends in with the existing stone, the color, texture, and profile of the existing stone must be considered. Stones like limestone or sandstone generally have a uniform color, but for granite, which consists of many different colors within one stone, the distribution of the color within the stone (i.e. the amount of black, pink, and green on a gray base color in Milford Pink granite) must also be assessed. Note that even stone sourced from the same quarry can have a different appearance if quarried at different times (Fig. 4).

Figure 4: Milford Pink granite quarried in the early 1900s vs. 2000s (arrow).

The finished texture and tooling of the stone can also greatly impact the appearance of the stone. The finish tooling of the dutchman repair should match the finish tooling of the existing stone (i.e. quarry-faced, bush-hammered, honed, etc.). For example, in stones like sandstone or quartzite, the color of the stone will often appear significantly lighter in a bush-hammered finish than in a quarry-faced finish, so when assessing stone for dutchman repairs, samples with the same finish tooling as the existing stone should be reviewed to ensure an appropriate match (Fig. 5).

Figure 5: Bush-hammered (top) and quarry-faced (bottom) profile showing color changes from tooling.

The final aesthetic consideration for dutchman repairs is the profile. The profile of the dutchman stone must match the profile of the existing stone. For dutchman in smooth, ashlar stone blocks, matching the uniform profile is relatively simple, but in quarry-faced or carved stones, matching the existing profile requires skilled workmanship (Fig. 6).

Figure 6: Dutchman repair in quarry-faced (left) and carved stone (right).

Technical Properties

After the stone has been reviewed for its aesthetic properties, the technical properties of the stone for dutchman repairs must also be considered. Stones like sandstone, quartzitic sandstone, and quartzite may have a similar aesthetic appearance but have vastly different technical properties. The key technical properties to consider for dutchman repairs are compressive strength, absorption, and density. These technical properties affect the overall durability of the stone.

Although a lower absorption, higher density, and higher compressive strength generally means the stone will be more durable, if these properties are not compatible with the existing stone, they can cause expedited deterioration of either the existing stone or the new dutchman repair. In addition, a dutchman repair stone with lower absorption and higher density will generally look visibly lighter than the existing stone when wet, as it will not darken at the same rate due to the lower absorption of water.

Unfortunately, the technical properties of the existing stone may not be known. Testing can be performed on the existing stone to determine these technical properties, but it requires removing the stone from the building, and may not be feasible. If existing stone is not available for testing, ASTM International provides standards with compressive strengths, absorptions, and densities of various stone types. However, the ranges of the properties in these standards are large (i.e. compressive strength between 4,000 – 10,000 psi for sandstone) and therefore may not always be reliable for determining the compatibility of a dutchman repair stone with the existing stone. When selecting a stone for a dutchman repair, it is better to select a stone in the middle or on the lower end of the range to mitigate expedited deterioration of the parent stone.

Anchorage to Parent Stone

When an appropriate stone has been selected for the dutchman repair, the final consideration is the anchorage to the parent stone. For dutchman repairs within large stones in the field of the wall, the dutchman repair anchorage only needs to support the dutchman itself.

Mechanical attachment can be achieved using threaded rods, with the diameter, embedment into both the dutchman repair and parent stone, and the number of rods determined by the dutchman repair size. Larger dutchman repairs require more/larger diameter rods and greater embedment. All anchorage should be non-corrosive metals (e.g., stainless steel, titanium, bronze) to prevent additional damage to the stone (Fig. 7).

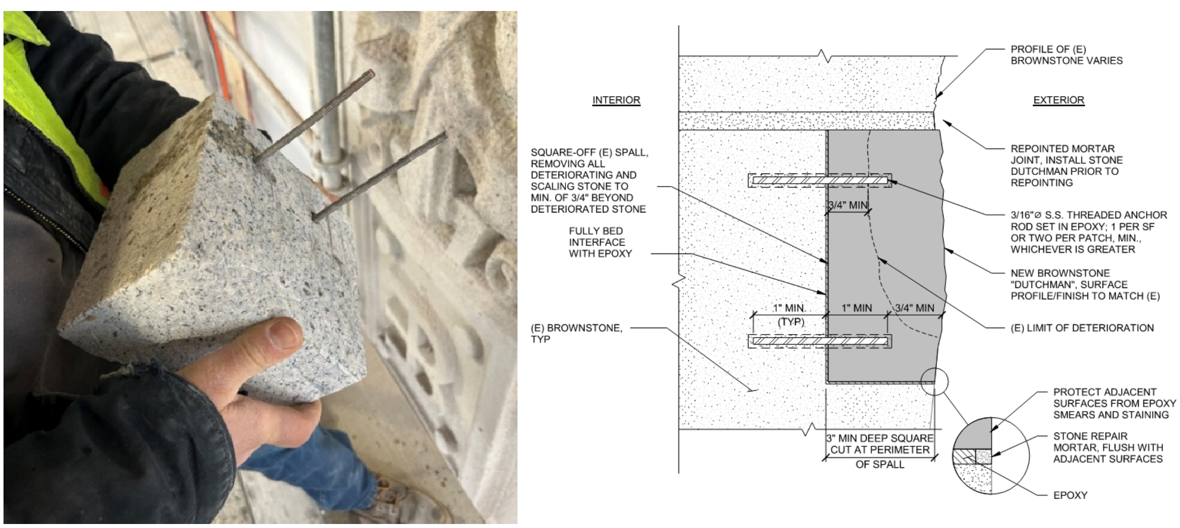

Figure 7: Threaded rods in dutchman repair.

In addition to the mechanical attachment, the dutchman repair should be bed in epoxy to provide an adhesive attachment and to prevent water infiltration into the joint between the dutchman repair and the parent stone. Some epoxy can stain sensitive stone, so care should be taken to mock-up and test the selected epoxy on fragments of the specific stone on the building, to ensure it will not darken or stain the stone.

Additional Considerations for Dutchman Repairs in Slender Stones

When working with a tall, slender stone, such as a vertical column between windows, the same considerations for stone selection apply to both the aesthetic and technical properties. However, unlike a dutchman repair in the field of the wall, a dutchman repair in a tall and slender stone between windows must support both the gravity loading from the lintel above the window and the lateral loading from wind on the adjacent windows imparted through the connections of the windows into the slender stone column or mullion (Fig. 8).

Figure 8: Vertical mullion between windows.

Often, the stone deterioration extends through the majority or the full depth of the stone, and little to no stone backup is available for dutchman repair anchorage (Fig. 9). Therefore, the typical horizontal threaded rod anchorage utilized in dutchman repairs in the field of the wall cannot be implemented. Additionally, with no alternative load paths available around or behind the dutchman, shoring must be provided for the stones until the dutchman repairs are installed.

Figure 9: Wood blocking behind existing stone removed for dutchman repair.

To provide adequate anchorage of the dutchman repair to the parent stone and resist the gravity and lateral loading on the vertical column, the anchorage must be made vertically above and below the dutchman. The configuration of the dutchman repair also does not allow for the installation of fixed threaded rods. To provide concealed anchorage, centered within the repair depth, at both the top and bottom of the dutchman, drop pins can be used to establish an attachment between the dutchman repair and the parent stone, similar to the ferrous dowels present at the mortar joints between stones in the original construction.

Drop pins are smooth, concealed dowels designed to “drop” into the lower stone to engage both the dutchman and parent stones. For installation, an elongated hole must be drilled in the upper stone so the drop pin can be pushed up to allow the lower stone to slide into place (Fig. 10). As the dutchman is installed, the drop pins at the top and bottom can be held in place using putty knives, or strings threaded around the drop pin within the hole. Once the dutchman is in place, the putty knives are removed or the strings pulled, to allow the pin to drop into the holes in the lower stone (Fig. 11).

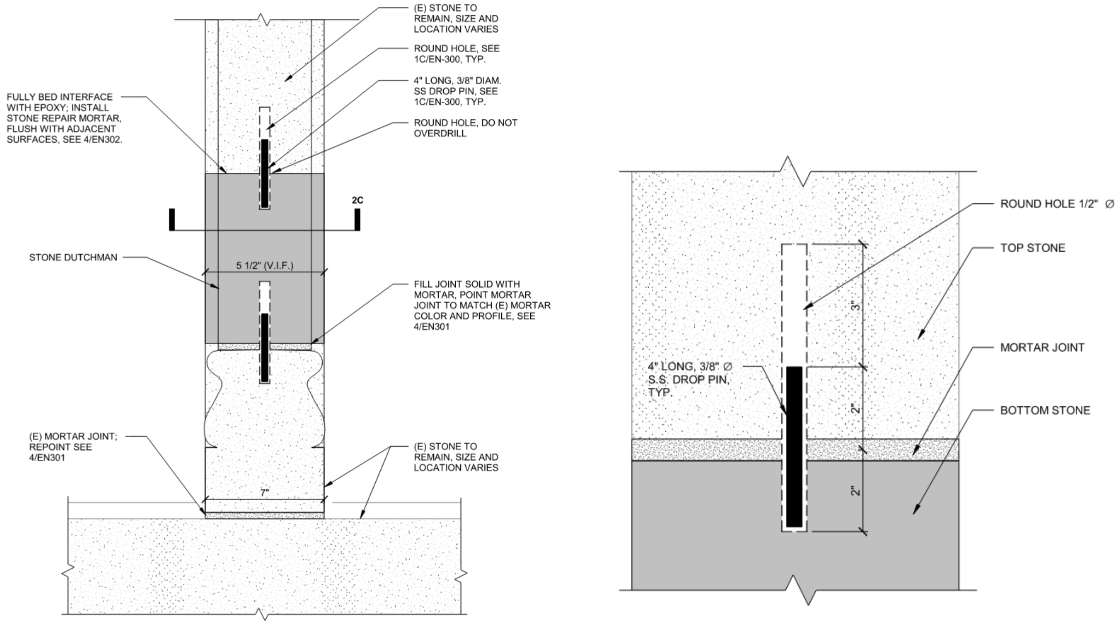

Figure 10: Detail of drop pin installation.

Figure 11: Completed dutchman repair using drop pins. Yellow lines indicate the location of concealed drop pins within the completed repair.

Like the dutchman repairs in the field of the wall, the diameter, number, and embedment of the drop pins can be determined based on the size of the dutchman, but given the need for the dutchman repairs to support both the gravity loads from the lintel and wall above and the lateral loading imparted from the adjacent window tributary area, the anchorage should be designed by an Engineer on a case-by-case basis.

CONCLUSIONS

Dutchman repairs are a well-established method of repairing spalls in stone buildings. However, many factors must be considered to provide a dutchman repair that is both aesthetically and technically compatible with the existing stone. To select an appropriate stone for dutchman repairs, one must consider the aesthetic properties, including the color, texture, and profile of the existing stone. Additionally, one must consider the technical properties, including compressive strength, absorption, and density, to provide a dutchman repair that is compatible both visually and technically with the existing stone.

The complexity of dutchman repairs increases when they are located within tall, slender stones that must support both gravity and lateral loads. To implement an effective dutchman repair in slender stones, consideration must be given to the need for shoring since the repairs often extend through the full depth of the stone, and the sequencing and type of anchorage to provide concealed anchors that engage both the parent stone and the dutchman.

Proper selection of a compatible stone, coupled with adequate anchorage, is essential for an effective and durable dutchman repair that maintains the integrity of the existing building.

ACKNOWLEDGMENTS

I thank my colleagues at Simpson Gumpertz & Heger Inc. for their encouragement in writing this paper and the building owners who entrusted me to work on their stone buildings.