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# Standard Guide for Assessment and Maintenance of Exterior Dimension Stone Masonry Walls and Facades<sup>1</sup>

This standard is issued under the fixed designation C1496; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This guide outlines how to visually assess exterior stone masonry walls and facades to determine their general condition. Examining key features of the construction can help identify and diagnose problems which require repairs or corrective action. Such an examination can expose conditions which may be addressed with maintenance and minor repairs, or may require expert assistance. This guide is not intended to be used for buildings requiring major exterior rehabilitation or structural repairs.

1.1.1 This guide applies to walls of solid stone or dimension stone used as a cladding. Stone cladding is typically connected to a backup material with a variety of anchoring methods, including traditional hand-set masonry anchors such as straps, dowels, cramps, hook-and-eyes, dove-tails, wire ties, and the like. Joints between stones in these types of buildings are usually filled with mortar or sealant. Sealant-filled joints are usually designed to accommodate structural and thermal movements.

1.2 This guide specifically excludes dimension stone used in interior building surfaces, flooring or paving, slate dimension stone used as roofing. Though they share some similar assessment and maintenance concerns, thin stone (less than 2 inches in nominal thickness) exterior cladding, and stone cladding attached to metal frames are also excluded due to their unique design characteristics and performance requirements. Although procedures and cautions listed herein may apply to walls and facades containing semi-dimension, or partially sized, stone in the form of split-face, or rubble and to stone-facade concrete panels, the guide is not specifically directed to such stone use. It does not address removal of small-area stains.

1.3 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

C119 Terminology Relating to Dimension Stone

C1515 ~~Guide for Cleaning of Exterior Dimension Stone, Vertical And Horizontal Surfaces, New or Existing~~ Guide for Cleaning

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee C18 on Dimension Stone and is the direct responsibility of Subcommittee C18.07 on Environmental Properties, Behavior, and Cleaning.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

### 3. Terminology

3.1 Terms used in this guide are defined in Terminology C119.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *crack monitor*—any of the several two-part devices that can be attached to stone masonry in such a way that they can span cracks in order to periodically measure changes in crack width thereby indicating movement.

3.2.2 *dutchman*—repair used to patch stone masonry with a section of new stone. The damaged area within a particular stone element is removed. The remaining void is trimmed to a regular shape. A new piece of stone, or “dutchman,” is cut from matching stone cut slightly smaller than the area to be filled. It is installed using dowels or some other mechanical attachment, then adhered, or mortared into place.

3.2.3 *exfoliation*—deterioration or loss of certain types of stone in the form of flakes, scales, and layers.

3.2.4 *professional assistance*—independent opinions and recommendations provided by persons having expertise in the assessment and repair of stone masonry. Such professionals may include independent consultants such as architects, engineers, material scientists such as mineralogist or geologists, or stone masonry contractors.

3.2.5 *thick*—stones with a nominal bed-depth of 2 in. ~~{5 cm}~~(5 cm) or more.

### 4. Significance and Use

4.1 This guide attempts to provide information to assist building owners and managers with limited knowledge of stone construction to recognize basic problems with performance of facades, and to keep them in good condition through periodic inspections and maintenance. Increased awareness of the behavior of stone masonry facades and associated materials can reduce maintenance and replacement costs by addressing problems and deterioration early.

4.2 The objective of all maintenance should be to limit deterioration through early intervention.

4.3 When it appears damage to stone support elements has occurred, professionals should be consulted to evaluate the support conditions, as well as recommend methods to restore the building’s integrity and preserve public safety.

### 5. Introduction

5.1 An effective maintenance program for exterior stone masonry should incorporate preventive maintenance among its key elements. Early attention to problems, and simple measures to remedy them, will often avoid costly renovation later. This guide is intended to help interested personnel locate such problem areas, better understand potential causes of stone deterioration, and identify appropriate corrective measures for the observed deficiencies.

5.2 Maintenance supervisors should understand how their building is constructed to apply this guide and better maintain their buildings. Employing a professional to assist them in interpreting pertinent drawings and documents, and initially inspecting conditions should help them become effective observers of stone performance.

5.3 This guide lists many typical problems that can affect stone masonry, facades. It describes likely causes, and discusses common repair methods. All initial attempts at repairs should be done under the observation of a professional to ensure the use of proper materials and techniques.

5.4 Personnel responsible for stone facade maintenance should be familiar with the systems used in the construction of their buildings on at least an elementary level. Prior to inspections, they should be briefed by personnel knowledgeable about the building and its construction, particularly the stone wall system. This background should help in determining when the engagement of a professional should be considered.

5.5 In cases where the building or its facade has cultural, civic, historic, or architectural significance, consultation with a specialist is recommended.

5.6 When assessing the condition of exterior dimension stone, and particularly any problems requiring action, the appropriate cleaning or repair methods should promote eco-efficiency, avoid any adverse impacts on humans present or involved, avoid any adverse impacts on the building structure, and reduce stress on the environment. See Guide E1971. Choices must be made on cleaning products and processes, and building repair materials and method.

5.6.1 Certain pertinent questions should be considered here: (1) how is the building used? (2) what type of dimension stone and what finish was used? (3) is the dimension stone load-bearing or is the load carried by other materials such as steel or concrete? (4) are there any issues relating to building age or architecture? (5) what criteria or measures will be used to evaluate the quality of cleaning and repairs?

### 6. Guidelines for Inspections

6.1 *Schedule Inspections*—Schedule and perform semi-annual inspections of stone wall elements. Inspect all elevations of the building. A walk-around visual survey with a camera and binoculars should be a minimum procedure. Use adjacent buildings’ roofs and windows to gain same-level access, to examine building facades and associated elements. Use building windows and set-backs where possible for additional vantage points. If the available access is not sufficient to perform the inspections, then consider methods, as outlined in 6.3. Photograph any observed distress or problem areas for later reference in determining appropriate repairs.

6.2 *Condition Documentation/Monitoring*—Keep accurate and cumulative records of inspection findings. Buildings constructed of thick dimension stone with mortar or sealant-filled joints react slowly to environmental forces. Knowledge of the timing of a condition’s onset and understanding its progress aid in assessing the distressed condition. Monitor critical or deteriorated areas between scheduled inspections. Use measurements or crack monitors to measure changes in cracks, increasing lippage between stones (stones projecting or retreating in plane from the adjacent stones), or other changes and displacements in stone position. Well-kept records will aid in the diagnosis of the specific causes of the conditions observed, should more experienced professionals be required.

6.3 *Tall Buildings*—Inspections of buildings with heights that exceed those readily observable with binoculars, or with limited vantage points require more detailed planning. It will be necessary to view representative areas of the facades from suspended or fixed scaffolding, mobile work platforms, or personnel lifts to adequately observe existing conditions.

## 7. Procedure for Evaluation of Stone Conditions

7.1 At a minimum, the following procedure should be used as a guide to decide an appropriate course of action for observed deficiencies as part of an inspection and maintenance program for stone masonry facades.

7.1.1 Identify and document the defects.

7.1.2 Note the extent of the defects, patterns or concentrations of distress.

7.1.3 Postulate the likely causes.

7.1.4 Perform necessary maintenance or obtain assistance with repairs:

7.1.4.1 If the condition is stable and does not appear to be progressive, perform appropriate maintenance, and simple or temporary repairs.

7.1.4.2 If the cause is not apparent, and the condition appears stable and not progressive, monitor the condition and consult with professionals to determine the cause and appropriate repairs.

7.1.4.3 If the observed conditions are considered dangerous or progressive, obtain professional assistance immediately.

## 8. Maintenance

8.1 *Routine Maintenance*—Many problems can begin or worsen due to neglect of routine maintenance. Stone masonry itself, when used in an exterior application, requires periodic joint repairs, such as sealant replacement, tuck pointing, and cleaning. Stone facade components can also be affected by a lack of maintenance of other building systems, such as roofs, parapets, windows, and flashing.

8.2 *Cleaning*—Regular cleaning is also critical to the long term durability of natural stone facades, as well as their appearance. Cleaning methods should be selected that do not damage the stone. Cleaning methods and materials should be first tested, from the least to the most aggressive, to determine the mildest treatment that provides satisfactory results. Prior to implementing a cleaning technique building-wide, test areas should be cleaned using the proposed methods. The areas should be evaluated for a minimum period of six weeks to assess the results. Improper selection of cleaning chemicals and procedures will produce unsightly and irreversible damage to the appearance, and potentially the structural integrity, of the stone facade components. Refer to Guide C1515 for procedures for cleaning exterior stone.

## 9. Areas of Focus for Inspection

9.1 *Moisture or Water Staining*—Look for signs of moisture on interior and exterior surfaces, as well as throughout the stone wall system. Water penetration can lead not only to deterioration of interior finishes, but also to stone and joint material degradation and corrosion of anchor system components if the water is trapped behind or within the wall or facade system for prolonged periods. Water absorbed into stone and joint materials can cause dimensional changes, potentially reducing clearances and creating stress concentrations. Trapped water can freeze and expand, causing the stone to weaken, and eventually spall or crack. Joint materials may also deteriorate as a result.

9.1.1 Water can also carry minerals, chemicals, or other contaminants that can be deposited on or within the stone and joints, causing discoloration, staining, or deterioration.

9.1.2 Wetness, staining, or darkening may be due to trapped moisture. Discoloration or deposition of efflorescence (a powdery white or gray accretion on stone faces) may also be evidence of moisture entry, or “rising damp.” Rising damp is a condition in which the stones appear darker due to water wicking into the stone by capillary action from a water source along one or more edges of the stone, such as at the base of a building.

9.2 *Joints*—Every inspection should include a review of each joint between stones. Document anomalous and suspect conditions photographically, especially in areas of accelerated deterioration. Where a problem is suspected, it is useful to compare photographs taken at various times to establish the progression and rate of deterioration.

9.2.1 Look for missing mortar and sealant, for cracks in mortar, for partings between mortar or sealant and the stone, for non-uniform joint sizes due to tight, closed or opening joints, and for lipped stones. Connections between stones and non-stone materials such as windows and other openings are often particularly susceptible to racking and eccentric movement. Check for plugged weep holes throughout the wall system. Compare the width of expansion, control, and construction joints. Look for wider or narrower tops and bottoms of such joints.

9.3 *Stone*—Cracks and spalled areas at or near joints may indicate excessive compression loading, anchor failure, and

environmental deterioration, among other things. Misalignment of stone across a series of joints may indicate local or structural building movements.

9.3.1 Surface deterioration may take the form of exfoliation (where the surface is lost in thin layers), spalling, powdering, or chipping. These conditions can be particularly prevalent where chloride-based de-icing products used on paving systems aggravate the effects of freeze-thaw cycling. Both calcium chloride (CaCl<sub>2</sub>) and sodium chloride (NaCl) are commonly used. Both will cause damage to stone surfaces.

9.4 *Facades*—Sight along walls for bulging areas, particularly in those containing smaller stones. Look for areas of different, or changing, colors. Compare colors before and after rains; a continuing damp appearance for some time after a rain may suggest a leak. Cracks across stones, or diagonally along mortar joints, may suggest unaccommodated expansion and contraction or structural movements.

9.5 *Unique Details and Fenestration of the Building*—Look particularly at parapets, copings, building returns and corners, and projecting or corbeled courses, for dampness and misalignment. Check all facades at their bases for the appearance of rising damp. Compare the appearance of joints and stones at and near openings. Due to the typical uniqueness of their installation, soffit stones deserve special attention to their alignment, color retention, and joint conditions.

9.6 *Building Components Not Fabricated from Stone*—Many problems on buildings occur in the roof/parapet areas, near openings, and at grade. Look carefully at the inside surfaces of parapets; check the flashing and counter-flashing; the cant-strip and blocking; the mortar of masonry, back-up or under the coping; the coping head joints; expansion joints; and the roof membrane. Inspect roof valleys, particularly at their ends, where they terminate into drains and down spouts. Check for functioning drain leaders and down spouts. Also note any cracks and open joints at and near windows and doors.

## 10. Common Problems and Typically Recommended Repairs

10.1 The following section lists a number of common problems that can occur with exterior stone wall construction which can be identified and addressed, at least in early stages, by a maintenance staff with some specific training. The conditions are listed from least to most serious. Table 1 is a brief summary of common stone problems, their repairs, and the consequences of delaying corrective action. However, complex distressed conditions and advanced stages of any stone masonry problem may need the attention of experienced professionals.

~~10.1.1 *Rising Damp*—Stone masonry at or extending below grade, will absorb moisture from its surrounding environment, transferring that moisture upwards, and release it at evaporative surfaces. Any chemicals or minerals dissolved in the water will remain within the stone during this process.~~

~~10.1.1.1 Water repellents and clear sealers are sometimes inappropriately recommended to limit water entry into the stone. Application of a sealer above grade will usually not prevent water entry, but will serve to reduce the ability, of the water to evaporate from the stone elements. A more appropriate repair would be to expose the below-grade stone areas, allow them to dry out, and apply damp proofing before recovering the stone. Where this stone condition exists adjacent to concrete at grade, professional help is recommended. Where rising damp occurs, especially in frost zones, surface loss in the form of chips or exfoliation may also occur due to freezing of the trapped water or accumulation of water-borne crystalline minerals within the body of the stone. This condition can ultimately cause structural damage.—Stone masonry at or extending below grade, will absorb~~

**TABLE 1 Summary of Common Stone Distress and Repairs**

Stone Problem	Common Minor Repair Or Maintenance	Consequence To Delaying Repairs
Cracked/missing mortar, separations between mortar and stone.	Monitor joints for continued movement. Remove mortar in joints to a minimum depth of 2 times the joint width. Tuck point the cracks with mortar compatible to the original material.	Cracks progress and widen, resulting in water infiltration through wall system.
Compressed or split sealant in stone joints; sealant not bonded to substrate.	Remove existing sealant and bond break material, clean and prime joint, install new bond break and sealant. Match original sealant material (i.e. use silicone with silicone, polyurethane with polyurethane). Monitor joints for excessive movement.	Water infiltration, stone anchorage damage, stone deterioration, interior wall damage, increase sealant failure.
Continual Dampness at grade level, even in dry weather (rising damp). Dampness or efflorescence in upper building areas.	Expose stones' lower surfaces, allow to dry; damp proof and provide additional drainage. Reseal flashings, roof, clean out gutters drain leaders, and down spouts; check parapets, window sills, and flashings; examine all stone and other types of masonry for cracks.	Potential stone and joint deterioration; structural instability, water infiltration. Water infiltration, interior leakage, deterioration of stone anchorage.
Surface loss by powdering, "sugaring," or exfoliation. Cracked, broken stones.	Limit surface deterioration and water infiltration into stone. Check for leaks; eliminate chloride based chemicals from snow-removal procedures. Seek assistance with stone replacement; if fragments are stable and secure, tuck point or caulk crack with sealant; monitor closely for additional cracking or movement.	Continuing surface loss, structural instability. Water infiltration, deterioration of stone anchorage, structural instability.
Numerous cracked, missing, or spalling stones.	Monitor condition closely and seek professional assistance.	Deterioration of stone anchorage; structural instability, water infiltration; safety concern.
Failed expansion joint material, stone spalling adjacent to expansion joints, or non-moving expansion joints.	Monitor expansion joint movement. Obtain professional assistance.	Water infiltration, structural instability, damage to stone anchorage, excessive building movements, inability to accommodate stone or structure movements.