CAST STONE MASONRY: COMMON PROBLEMS & SOLUTIONS

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ABSTRACT

Cast stone masonry is a form of pre-cast concrete that attempts to replicate the texture and appearance of natural dimension stone. Perhaps one of the oldest of modern building materials, cast stone possesses many unique features inherent with its fabrication and raw material selection that can greatly enhance the beauty of a project in a cost-effective manner. However, without careful attention during installation and stringent quality control during its manufacture, the material can also suffer from problems associated with those very same manufacturing processes and raw material selections that make it desirable architecturally and economically. This presentation will describe problems commonly associated with the material, typical causes of these deficiencies, and their potential solutions. It will also include recommendations for enhanced quality control to limit the risk of problems in the installed product.

SPEAKER

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INTRODUCTION

Cast stone masonry is a form of pre-cast concrete that attempts to replicate the texture, appearance, and workability of natural dimension stone. Cast stone has a rich and successful history of use in construction; it also possesses many unique features inherent with its fabrication and raw material selection that can greatly enhance the beauty of a project in a cost-effective manner.

As with other man-made construction materials, careful attention must be paid during the fabrication and installation processes to avoid defects and deficiencies in the finished product. Through an understanding of the standards governing the industry, careful control of raw materials, and stringent quality control testing, cast stone can be an attractive and durable alternative to natural stone. However, too often inferior cast stone is produced and delivered to a project site, detracting from the appearance of the structure and increasing maintenance requirements to the building owner.

This paper attempts to describe this interesting and unique material that is typically made like concrete but installed like masonry. It will also highlight problems commonly associated with cast stone, typical causes of these deficiencies, and several potential repair solutions. It will also include recommendations for enhanced quality control that can limit the risk of producing and installing inferior material.

WHAT IS CAST STONE?

Cast stone is defined by the Cast Stone Institute (CSI) as "...a highly refined, architectural, pre-cast building stone manufactured to simulate natural cut stone." Properly manufactured cast stone is dense and well consolidated. CSI recommends a compressive strength in excess of 6,500 psi (ASTM C1194) and maximum absorption rates of 6 and 10 percent for cold water and boiling methods respectively (ASTM 1195). The combination of low absorption and high compressive strength makes the material generally durable and resistant to freeze/thaw distress. Compressive strength of cast stone is usually far greater than is necessary for the application; however, it can serve as an indicator of good quality control and future durability. Cast stone with inferior physical properties, though perhaps adequate for the particular application, may not possess the same service life of a higher-quality material whose physical properties are consistent with cast stone industry recommendations.

As a material, cast stone is really a variation of pre-cast concrete. Besides sharing common constituents, cast stone is typically mixed, formed, cured, and stored in a plant environment like pre-cast concrete, which enables rapid, consistent, and controlled fabrication. As with other concrete products, cast stone can be reinforced to increase its ability to withstand flexural and tensile loads. Despite its many similarities, cast stone does differ from precast concrete in a few ways: the mixes integrate finer aggregates to more closely simulate the appearance of natural stone, the method of fabrication can involve very little water, and the product is virtually always used in non-structural applications.

Cast stone can also be subject to similar quality control concerns as those for pre-cast concrete. These can include a lack of consistency in mix design causing variations in appearance; premature cracking as a result of inadequate curing or insufficient strength gain prior to form stripping; damage as a result of impact during storage, transport or erection; and contaminants or reactive aggregates in the raw materials that can cause internal distress.

When properly fabricated, cast stone can be a durable and cost-effective substitute for natural stone, but it may not always look like natural stone. Over time, cast stone can develop characteristics such as cracks, crazing, and discoloration that make it appear less like natural stone as it ages. If quality control is poor, these defects can be more apparent and appear earlier in the service life of the material. Manufacturers should be candid with architects and owners about the potential risks associated with cast stone; in essence it is a good substitute for natural stone, but not an equal.

HISTORY

Cast stone was developed for use in wall construction as a cost-effective alternative to natural stone, primarily as trim, ornamentation, or ornate building façade elements (see Figure 1). It has also been widely used as wall cladding panels. Its cost advantage is primarily due to reduced cost of the raw materials, the ability to mass produce pieces quickly, and the ability to create complex detailing with formwork and casting as opposed to labor-intensive carving or shaping. An extensive range of colors and textures of cast stone are available through the use of varied aggregates, coloring agents, and modifications to the formwork used for casting. Many designers favor cast stone not only because of the wide range of aesthetic qualities, but also because of the uniformity of appearance that can be achieved with a controlled plant fabrication process.

Cast stone was first used in the year 1138, and was employed extensively in England and France during the 19th century.
Several proprietary systems were developed during this period that utilized unique combinations of natural cements, hydraulic lime, and other binders. These systems were first used in the United States during the middle of the 19th century. Many have since been abandoned in favor of the components we commonly see today: a combination of portland cement and carefully selected aggregate.

**FABRICATION**

There are a relatively small number of cast stone fabricators when compared to pre-cast concrete suppliers. Cast stone fabricators can be large operations that focus on high production and often can produce architectural pre-cast concrete as well. They can also be relatively small operations that may focus on more ornate cast pieces. No matter the size of the operation, each fabricator must have the ability to store and accurately mix bulk cementitious materials, assemble forms, fabricate the cast stone pieces, and strip them from the forms. They must be able to cure the pieces plus perform a final acid etch and cleaning to complete the fabrication process. Fabricators must have adequate provisions for protecting, transporting, and storing pieces prior to delivery. Another critical aspect to every cast stone fabricator’s operation is the ability to perform industry-mandated quality assurance and quality control testing, such as periodic testing for absorption rate, compressive strength, and freeze/thaw durability.

Two processes are typically used to produce cast stone: the “vibratory, dry tamping” (VDT) method, and wet casting. Both have potential advantages and disadvantages.

The VDT method is unique to cast stone fabrication. To achieve the appearance of natural stone, very dry mixes of fine aggregates, cement, and water are poured or compressed into a form on the side that will become exposed in the finished structure. This material is referred to as the “face mix.” Depending upon the depth of face mix required and the complexity or relief of the form, the face mix is placed in layers called “lifts” to ensure full compaction of the material into the form. A “back-up” mix consisting of coarser aggregate, cement, and water is then poured or rammed into place over the face mix to fill the remaining portion of the form. The material is allowed to harden and cure, then the form is stripped and the material stored until it is needed on the project site.

Cast stone produced using the VDT method can replicate stone quite accurately, and is less susceptible to surface disruption as a result of free water against the form. However, quality control is critical to maintain consistency of both the face and back-up mixes. Changes in thickness of the face mix can result in variations in density and appearance of the face mix, as well as cracks due to differential shrinkage between the drier face mix and the wetter back-up mix. Back-up mixes are usually highly variable in content since they are not visible when the finished product is used.

Wet casting of cast stone is virtually identical to the process used for pre-cast concrete: a form is constructed and then filled with a mixture of aggregates, cement, some additives, and water. Some wet-cast methods can involve multiple lifts of material or variations between the face mix and back-up mix. It is allowed to harden and cure for a period of time, and then the form is removed. The formed product is then stored until transported to the building site where it will be used. Its principal advantages include greater consistency in physical properties through the material’s thickness, and better quality control of the material. Its principal disadvantages include lower production rates due to the longer curing time required before stripping, susceptibility to plastic drying shrinkage if not properly cured, and disruption of the finished faces as a result of trapped water at the form/mix interface.

Curing methods for either technique are also highly variable, depending upon the cast stone manufacturer. Some cure their product using water misting, steam, curing compounds, or dam curing. The amount of curing also varies, depending on the fabrication process and storage practices, as well as the demand for the product on the job site. If the cast stone is insufficiently cured, then it can experience excessive shrinkage, causing cracking of the surface and increased water absorption.

**COMMON PROBLEMS**

There are a number of common problems that can occur with cast stone. While some of these occur in cast stone produced using both wet cast and VDT methods, the majority of problems observed in modern construction are associated with the VDT method of manufacture. Unless specifically stated otherwise, these discussions will focus on cast stone created using the VDT method.

These problems range in importance from those that may simply affect appearance or accelerate the need for routine maintenance, to those that impact the structural integrity of the material and put the public at risk. Several of the more commonly observed deficiencies found with cast stone are discussed below.

**EXCESSIVE SOILING**

Excessive soiling of cast-stone surfaces can result from exposure to pollution, soot, and airborne dust. It can also be a result of these materials washing down from other adjacent building surfaces onto the cast stone (see Figure 2). Because cast stone is absorptive as well as somewhat rough in texture, particulates can settle into the cast-stone surface or be deposited there by water. Cast stone with higher absorption and lower surface densities can become soiled more quickly since the surface structure is more open.

**CRAZING**

Crazing or “craze cracking” is a network of interconnected hairline cracks (see Figure 3). In the concrete industry, this type of crack pattern is referred to as “map cracking” because the cracks look like borders between places on a map. These cracks usually extend only a few millimeters into the cast stone; however, severe crazing can
merge together to form deeper cracks that can allow moisture to reach the interior and, in extreme cases, result in loss of strength or instability. At the very least, these cracks take in moisture and dirt, causing them to discolor. Despite their objectionable appearance and potential for more severe damage, crazing is considered a non-structural concern and not cause for rejection of cast stone by CSI.2

Crazing is generally thought to be caused by shrinkage occurring at the outermost surface of the piece. It can be attributed to curing practices, variable cement content at the surface, excessive wetting and drying, or inadequate ventilation behind the cast stone. The process of tamping also contributes to crazing by creating “centers” of high compaction (where the tamper impacted the material) surrounded by rings of lower compaction. Crazing appears to be more concentrated in the areas of lower compaction or density. The amount of crazing is also more prevalent at locations where the face mix is thin. The variations in thickness lead to differential drying shrinkage in the face mix, as well as variations in density that lead to the formation of craze cracking at the surface.

CRACKING

Cracking is probably the most common problem associated with cast stone. CSI recommends that pieces containing cracks in excess of 0.005 inches not be accepted in a quality cast-stone installation.3 Cracking can develop as a result of many different conditions, and range in impact from cosmetic to a loss of structural capacity. Several of these are described below.

Restraint of Volume Change

Often, cast stone is rigidly attached to the back-up structure for support, with no allowance for volume change of the material. Although VDT cast stone is manufactured with a low water content and experiences less shrinkage than wet cast products, shrinkage does occur and continues for several years after fabrication.

The cast stone is also subject to volume changes due to thermal cycling and will typically experience a greater temperature swing than the unexposed back-up structure whose temperature range in service is often moderated by the thermally controlled building interior. If the ends of the cast stone are restrained, the differential volume change between the cast stone and the back-up structure results in cracks forming across the face of the cast stone (see Figure 4).

Some manufacturers will attempt to control cracking resulting from volume changes by introducing reinforcing steel in both directions across the face of the cast-stone piece. Unfortunately, this is often ineffective because of the difficulty in achieving adequate consolidation of the material around the reinforcing steel to control and distribute the cracking. Poor consolidation around reinforcing steel in the transverse direction (perpendicular to its span) actually can form weak planes through the thickness where cracks are more likely to form.

CORROSION

Corrosion of embedded reinforcing steel can lead to cracking at the surface of the cast stone. This type of cracking is often accompanied by delamination of the material at the depth of the reinforcement, leading to further instability of the cast stone in the form of spalls (see Figure 5).

INSUFFICIENT STRENGTH

Although cast stone is typically not heavily loaded in most building applications, pieces can develop relatively high flexural stresses if they are spanning across openings, not fully bedded along their length, or in any other orientation with just two points of support. The flexural stresses are exacerbated if the piece is long and slender. Flexural cracking will typically form in the middle third of the span and run from the top to bottom edge of a horizontally oriented piece (see Figure 6), or across a piece that is oriented vertically, such as a window jamb.
the defect a fresh, formable, cementitious material mixed to match the damaged cast stone as closely as possible. It is an inherent part of virtually every cast stone installation, since no matter how careful the cast stone is handled, damage of some sort can occur. Patching is usually performed by the manufacturer of the cast stone after the piece is installed. The manufacturer is most familiar with the components and their proportions that lead to a better color match.

Despite duplicating the cast stone components and their proportions, patches rarely match in all environmental conditions because the density and absorption of the original material cannot be replicated when the patch is installed. The patch material will dry differently when wetted, shrink differently, and fade more rapidly as a result. Because it is so difficult to not be visible from more than 20 feet away.

Patches fail by shrinking excessively or debonding from the substrate. Water can work between the patch and the cast-stone substrate through separations at the bondline resulting from shrinkage. Water can further degrade the patching material, become trapped and freeze, promote efflorescence, or simply make the patch more visible and detract from the overall appearance of the cast stone. Unstable patches that are debonded from the substrate or severely cracked should be removed to prevent them from falling out on their own, particularly where pedestrians or traffic could be impacted (see Figure 9).

**Corrosion of Reinforcing Steel**

While most cast stone is not used in load-bearing applications and does not require reinforcement, reinforcing steel or rebar can be used to increase its strength in flexure or enhance its ability to be handled or transported without damage. Placement of reinforcing steel is of particular concern in VDT cast-stone panels and should be avoided. Usually the face mix is placed first, then the steel is set, and the back-up mix poured around it. Therefore, this process does not allow for the reinforcing steel to engage the face mix. If the back-up mix is dry tamped as well, it is nearly impossible to achieve adequate consolidation around the reinforcing steel that is sufficient to develop its strength.

As with other concrete products, the reinforcing steel is chemically protected from corrosion by the natural alkalinity of the surrounding cementitious materials. However, as the material ages or cracks

**Handling**

Cracks can also develop as a result of mishandling or unintended loading during transportation or erection. Cast stone is usually stripped shortly after forming, moved to a curing facility, then moved for cleaning, and moved again to yard storage. It will often be transported to the project site prior to gaining full strength, making it more susceptible to damage while being loaded onto the truck and unloaded at the project site. Cracks can develop if a piece is picked up or stored in a manner not intended (see Figure 7). Many cast-stone fabricators will furnish lifting hardware cast in larger pieces to avoid damage during lifting operations.

Cracks from handling can occur anywhere within the cast-stone piece. Most often, the piece cracks or is otherwise damaged at corners and edges from impacts or the lifting equipment. Edges and corners are particularly susceptible to damage because these areas are less dense. Compaction of angular corners and edges in the form is difficult due to the shape of the tampers. Cracks can also occur through the body of the cast stone but may remain undetected until after installation.

**Patching Failures**

Patching is the process of repairing a spall or chip in cast stone by placing into

![Figure 6 – This crack was formed as a result of excessive loading in flexure.](image1)

![Figure 7 – Poor storage and handling of cast stone on site can result in improper loading and damage.](image2)

![Figure 8 – A patch relying solely on cementitious bond in an overhead condition. Note the failure of the feathered edge at left.](image3)
develop, carbon dioxide penetrates the materials and reduces its alkalinity, leading to carbonation of the concrete. As the concrete carbonates and the alkalinity is reduced at the level of the reinforcing steel, corrosion (rust) can form in the presence of oxygen and moisture. When the steel is converted to rust scale, it occupies up to several times the volume of the original material. This volume change creates tensile forces in the cast stone that can crack or spall the material. As water and oxygen are allowed to penetrate deeper into the cast stone through the newly formed cracks and spalls, the corrosion accelerates and results in more damage (see Figure 10).

If it must be used, wet-cast methods of fabrication are preferable so that the reinforcement can be fully encapsulated in cementitious material. It is also important to provide adequate cover over the steel to increase the time it takes for carbonation to reach the depth of the steel. Reinforcement that is less susceptible to corrosion, such as galvanized or epoxy-coated bars, also help to reduce the risk of corrosion-induced distress.

**Spalling**

Spalling and incipient spalling can occur for a multitude of reasons. Spalls can develop at anchor points where stresses are high and the cast stone is cut to receive the anchors. It can also occur as a result of setting procedures; often pry bars are used to position the stone, and the weaker edges and corners can break due to the applied pressure (see Figure 11).

**Delamination/ Separation of Lifts**

Cast stone manufactured using the VDT method is compacted into forms as layers called “lifts.” These lifts are intended to bond to each other, with the tamper forcing the layers into intimate contact. However, when the material is spread in the forms, the material being the most highly compacted is that closest to the tamper and furthest away from the layer below. This creates zones of lower compaction at the lift lines that can be more absorptive and break down more quickly if exposed to the environment. Exposed lift lines can take in a substantial amount of water and erode, leaving fissures on the surface that are visually unappealing and increase the amount of water able to reach the interior of the cast stone.

Often, bond at the interface between lifts is lacking. Bond can also be reduced over time if the lift interface is exposed to the environment. Without adequate bond or mechanical engagement, the outer lift (often the face mix) can separate from the back-up mix and become unstable (see Figure 12). This condition, in combination with the presence of cracks in the face mix, can allow portions of the face mix to fragment and spall.

**Solutions**

Over the years, many creative approaches have been developed to restore, repair, and maintain cast stone. The cast-stone industry and professionals engaged to correct deficiencies in building materials have developed repair materials and methods to address many of the problems previously mentioned. Some of the more common repair/maintenance approaches are discussed below.

**Cleaning**

Most soiling can be treated successfully with conventional water rinses, detergents, or chemical cleaners (see Figure 13). The use of more aggressive cleaners, such as those containing acids, should be avoided or used judiciously since they can dissolve...
If cast stone is exhibiting visible crazing, water repellents can be applied after cleaning to help prevent the crazing from becoming more pronounced. It prevents contaminants from being re-deposited in the cracks, and also prevents water from wicking into the body of the cast stone.

To be most effective, we have found that the penetrating water repellent should be applied in two applications, both to refusal. To maintain its effectiveness, it is also necessary to perform re-applications every three to five years, depending upon its climatic exposure. Periodic testing can also be performed to determine its effectiveness and determine appropriate times for re-application.

**Re-etching**

When originally fabricated, a cleaning solution (most often containing muriatic acid) is used to remove the excess paste at the surface and to expose the brighter stone aggregate. Occasionally, if soiling is severe or if crazing is visible and darkened by contaminants filling the surface of the fine cracks, a similar acid-based wash can be used to improve the appearance. The stronger cleaning solution aggressively attacks the material in the cracks and surface irregularities. The author’s experience suggests that the appearance of shallow crazing can be improved with this method and is worth attempting; however, older crazing that penetrates more deeply into the surface is not typically improved by the application.

However, one must also consider that it is far more difficult to apply an acid wash to cast stone once it is in place, particularly if it is oriented in a vertical position. Adjacent surfaces often must be protected from damage by the caustic cleaners, and run-off must be collected and neutralized otherwise controlled. Although feasible, it is not often practical to perform re-etching on larger-scale projects as part of a maintenance program.

**Architectural Coating**

When the cast stone is severely crazed, soiled, discolored, or contains a number of poorly matched patches, an architectural coating or pigmented sealer can be an attractive option. Although the original appearance simulating natural stone is lost, coating and pigmented sealers offer a consistent, fresh appearance (see Figure 14). Coatings will bridge small cracks and surface irregularities, and provide a water-resistant finish for the cast stone, reducing future concerns about absorption.

Coatings can range in formulation from acrylic elastomeric to potassium, silicate-based materials. The most critical characteristic is “breathability,” or its ability to allow water vapor to pass from the cast stone to the exterior. Coatings that are not sufficiently breathable will trap moisture, peel, blister, and encourage freeze/thaw deterioration within the cast stone. Coat-

**Figure 13 – Common cleaning methods include washing with low pressure and scrubbing using non-metallic bristle brushes.**

**Figure 14 – Example of architectural coating applied over supplemental anchors.**

tings and sealers do require re-application; our experience suggests re-coating should be anticipated every five to ten years, depending upon the product and its environmental exposure. Most coatings can be easily cleaned with mild detergents.

**Crack Treatments**

Cracks that are non-structural but can allow excessive water penetration to reach the interior of the cast stone should be sealed. Often, cast-stone producers will rub a cementitious slurry or grout into the crack, filling up the surface; however, the crack quickly reforms through the thin,
brilliant application. To more successfully seal cracks, the surface of the crack should be widened and deepened to accept an appropriate amount of material. We have used elastomeric sealant, cementitious grout, and structural adhesives, all with mixed results. The more rigid materials have a more pleasing appearance but can fail even if the crack is considered stable; sealants are more forgiving to movement but can be more visible due to the textural differences between them and the surrounding cast stone. If the crack is not critical from a water penetration standpoint, we favor installing an epoxy-modified grout blended to match the surrounding cast stone.

**PATCHING**

As mentioned previously, patching of cast stone is inevitable. Often, the first priority for the manufacturer is to install a patch that minimizes the impact to the cast stone and matches well. Unfortunately, these patches often fail due to poor surface preparation and reliance on bond strength of the patch material to hold it in place. Since the patch will shrink after its placement in the cast stone, the bond can be broken as a result of the volume change. The manufacturer will also typically taper the patching material out to the edge of the chip or spall, producing a thin, fragile edge. These “feather edges” do not have the integrity to stay bonded, and so they break off, leaving the rest of the patch vulnerable to increased water penetration.

Proper patch installation must make compromises in the appearance. A spall must sometimes be broadened and deepened so that the patch material will be firmly engaged into the surface. The edges must be cut to eliminate feather edging, and mechanical anchoring is necessary to ensure that if the patch does lose bond, it will stay engaged in the substrate (see Figure 15). These practices will produce a patch that is more noticeable, but one that will be far more durable.

**CHEMICAL INJECTION**

Cast stone experiencing cracking but that are still stable or are otherwise reinforced can be successfully injected with structural adhesives such as epoxy-based formulations. The crack surface is typically sealed and ports placed into the crack periodically along its length (see Figure 16). After injection of the chemical adhesives, the ports and surface material are ground off but the crack and port holes can remain visible. This repair detracts from the appearance of the cast stone; therefore, we usually perform this repair in conjunction with application of an architectural coating. This repair is difficult and expensive; therefore, it is only recommended when replacement is not feasible or if the crack poses a structural risk.

**SUPPLEMENTAL ANCHOR INSTALLATION**

When there is instability between the lifts (such as the bond of the face mix to the back-up mix) of a structurally critical or large cast-stone piece that cannot be re-placed or otherwise repaired, supplemental anchoring may be warranted. By installing anchors across the lift interface, the outer unstable lift becomes mechanically engaged with the inner lift. The anchors must be small and spaced closely together to engage the thin lifts and to keep material between anchors from failing (see Figure 17). Anchors are typically 1/4-inch diameter stainless-steel, threaded rods bedded in structural adhesive. They can be field cut to desired lengths, can be recessed below the stone surface, and bond well to the adhesive. Pull-out tests should be conducted periodically to ensure proper installation and engagement in the lifts.

As with chemical injection, this repair should be considered as a last resort, due to its expense and appearance. The repair requires an architectural coating since the anchor holes are visible at the cast-stone surface and will detract from its appearance.

**INDUSTRY QUALITY CONTROL**

The document most referenced by architectural specifications today with respect to the design, use, and manufacture of cast stone is the CSI Technical Manual (Ref. No. 1); it has become the most widely accepted...
standard for the industry. Most specifications will defer to the requirements for cast stone expressed in its standard specifications. This document in turn references ASTM C 1364 (Ref. No. 2), “Standard Specification for Architectural Cast Stone,” which is maintained by ASTM Committee C-27 on Pre-cast Concrete Products, and the direct responsibility of Subcommittee C27.20 on Architectural and Structural Products. The language between these two documents is quite similar, with the CSI specification inclusive of the ASTM requirements.

Although many improvements have been made recently regarding the quality of cast stone as a result of more stringent requirements for quality control in the industry, we believe there are still some areas where the standard specification and industry requirements could be improved to better ensure a quality product will be delivered and the material’s end user will be satisfied.

**Sampling for Quality Control Testing**

Until recently, CSI specifications did not require samples for quality assurance testing to be taken from the material delivered to the jobsite. Moreover, samples for testing would be individually cast, not cut from fabricated pieces. This process did not adequately evaluate the impact of consolidation practices on physical properties. While this represents a significant step forward, we recommend that all samples taken for testing, including at the plant and at the jobsite, be taken from finished pieces.

CSI recommends sampling every 500 cf of cast stone produced. If the project is small or the pieces are being used as architectural accents, far less than 500 cf may be produced for an entire project. We recommend that the sampling rate be a function of fabrication time (such as once per day of production) and a minimum percentage of overall product (we recommend a minimum of one test series and 2 percent of the total product produced). This more fairly captures the variability that can occur in production and applies the same sampling rate, regardless of project size.

**Material Warranty**

CSI and the industry in general have developed relatively stringent criteria as a basis for acceptance or rejection of cast stone. Given the industry’s promotion of cast stone as a durable substitute for natural stone, we suggest that the suppliers of cast stone should offer warranties in excess of the traditional one year against material defects, and guarantee that the material will still comply with the established acceptance criteria at the end of the warranty period. This is particularly critical since many of the more common problems associated with cast stone do not develop until later in its service life.

**Enhanced Inspection and Acceptance Criteria**

While the acceptance criteria presented by CSI is thorough and fair in its breadth, we suggest enhancing their requirements in two ways. First, the acceptance criteria should be evaluated under both wet and dry conditions; often irregularities are most objectionable or only visible under damp conditions. Secondly, we believe that crazing should be evaluated in the same manner as other visual defects. Currently, the industry specifically states, “The occurrence of crazing or efflorescence shall not constitute a cause for rejection.” As with other material defects that are evaluated for acceptance, crazing is also typically visually objectionable to owners.

CSI Bulletin #32, “Crazing,” (Ref. No. 1) states, “...A manufacturer careful in proportioning of designs and watchful of compaction techniques and curing methods will minimize the likelihood of crazing as a result of manufacturing causes.” While we must realize that all crazing cannot be eliminated by good quality control, we also must understand that its frequency and severity can be impacted by manufacturing practices. Since it is in the control of the manufacturer, it would seem reasonable to evaluate it in the same manner as other visible defects in their control, such as color and texture.

**Conclusion**

Cast stone is a unique material that offers modern designers the appearance of natural stone, but with all the advantages of a manufactured product. Conversely, proper manufacturing processes and quality control are critical to providing a good cast-stone product. A better understanding of the material’s advantages and limitations is essential to make certain that all parties involved in the cast-stone application are pleased with the final installation.

**Bibliography**


**References**

1 The Cast Stone Institute is an organization composed primarily of cast stone fabricators and other construction professionals involved in the specification, manufacture and use of cast stone. According to the Cast Stone Institute Technical Manual with Case Histories, Fourth Edition, “The purpose of the Cast Stone Institute is to improve the quality of cast stone and to disseminate information regarding its use.”


3 Ref. No. 1, CSI Bulletin #36, “Inspection and Acceptance.”

4 Ref. No. 1, CSI Technical Bulletin #38, “Patching.”

5 Ref. No. 1, CSI Bulletin #36, “Inspection and Acceptance.”