

Man Made Vs. Natural Stone

A Study On Cast Stone



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CAST STONE STUDY

Architects and building owners alike are faced with many building material options. For designs or applications that call for stone facades or accents, there are two general paths: natural stone or man-made.

Natural Stone



Man-made



For those considering cast stone, a man-made material that some believe gives the appearance of limestone, it's worth exploring the common uses, limitations, and long-term liabilities associated with this product. While cast stone has been used for well over 100 years in the U.S., the product has some noteworthy shortcomings that are not often discussed until they become apparent on the structure itself.

Cast stone is a common building material that seeks to mimic the appearance of natural, quarried stone like granite and limestone. Although more similar to concrete and other man-made materials, the product is commonly referred to as cast stone, particularly by cast industry advocates, in order to make it seem more closely related to natural material. This terminology is misleading given the fact that cast stone possesses characteristics that are more comparable to concrete than natural stone.

The use of cast stone dates back over 800 years to France, but the product wasn't used in the U.S. until the mid 19th century and gained popularity in 1920.¹ According to the U.S. Department of the Interior, Technical Preservation Services, cast stone was introduced and often used as an economical replacement for natural stone.²

Sometimes cast stone was used as an exterior facing material, but more commonly it was used as trim or ornamentation on buildings or walls.² Today, cast stone is used as a building material to imitate natural Indiana Limestone on schools, churches, government buildings, and other structures from coast to coast.

WHAT IS CAST STONE?

Cast stone is a cementitious product made from fine and coarse aggregates, Portland cement (a combination of calcium, silicon, aluminum, iron, and other ingredients),³ sand, mineral oxide color pigments, chemical admixtures, and water. Two processes are typically used to produce cast stone: the vibratory dry tamping (VDT) method and wet casting.



Vibratory dry tamping (VDT) Casting



Wet Casting

Matthew C. Farmer states, “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 backup 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 backup mix.”⁴



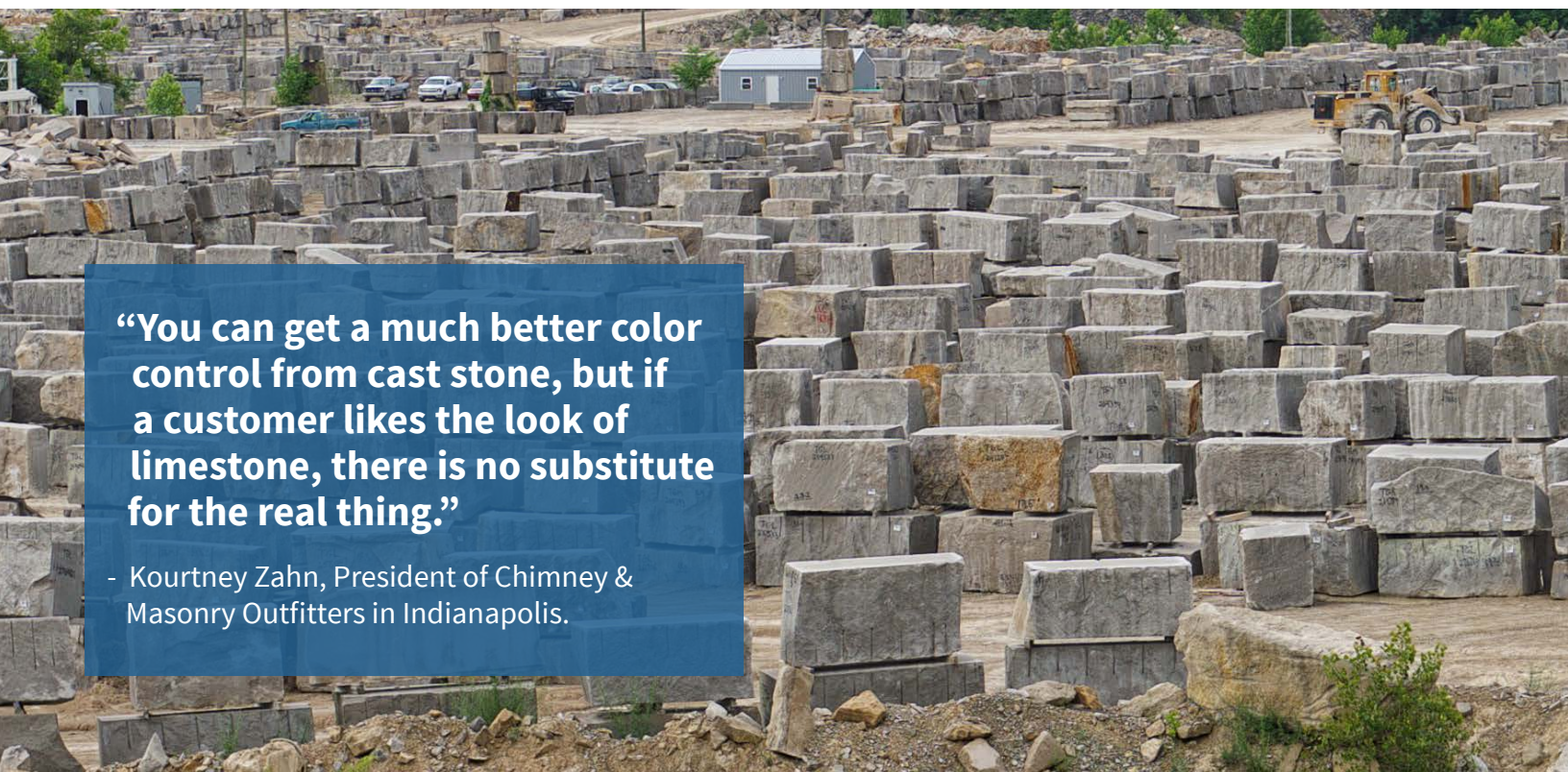
The above illustrates that the inner and outer layer are in essence two separate materials that expand and contract at different rates with temperature changes, inevitably resulting in crazing.

CAST STONE VS. QUARRIED STONE

Cast stone advocates believe that it has several advantages over quarried stone. First is color range and control. Almost any color can be created and reproduced across the entire building design. When a building owner or architect wants a color outside the range of natural stone and demands strict control on color variation, cast stone is often the specified material.

Beyond color, cost is another popular reason to choose this stone. According to cast stone experts, it costs less to create than it does to quarry and cut natural stone.⁵ But there are inconsistencies in this claim.

“For simple pieces like sills or cap stones, I don’t see a cost difference between natural stone and cast stone,” says Kourtney Zahn, President of Chimney & Masonry Outfitters in Indianapolis. “You can get a much better color control from cast stone, but if a customer likes the look of limestone, there is no substitute for the real thing.”



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PREFERRED APPLICATIONS FOR CAST STONE

Applications for cast stone are as wide and varied as quarried stone. From a simple window sill to complex architectural elements, cast stone can meet a variety of design needs. Architects and masons have found many uses for cast stone. But all seek to replicate the use of natural stone.

Overall, cast stone can create the general appearance of natural stone, and to the casual observer, is often confused with natural stone. Structures using cast stone vary as widely as the ways you can use the product itself. These structures include everything from schools, libraries, and office buildings to cultural landmarks like Soldier Field in Chicago.

Although cast stone is often used as a cost-saving substitute for limestone, there are limitations. Cast stone is an acceptable product for applications deemed non-structural or minimally load bearing. But in applications requiring structural support or a combination of structural and decorative, cast stone should not be used.⁵

In addition to structural limitations, the dry tamp method of cast stone does not lend itself to large panels, with a maximum size no larger than 3' x 8'.⁵



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DISADVANTAGES OF CAST STONE

Like any material, there are disadvantages. The most significant disadvantage for cast stone being manufacturing inconsistency. Unlike many other man-made building materials, whose heavily automated manufacturing processes guarantee perfect, piece-to-piece consistency, cast stone can suffer from inconsistencies from manufacturer to manufacturer or even person to person within the same plant.

The mix of aggregates and how it is packed, or “tamped,” into the molds are both variables. Curing methods for either technique differ by manufacturer. These can include water misting, steam, curing compounds, or damp curing. The time it is cured also varies by manufacturer and may be influenced by the demand for the product on the job site. But if the cast stone has not cured sufficiently, then it can undergo excessive shrinkage, causing cracking of the surface and creating issues for increased water absorption.⁴ This mix of variables can create several long-term issues for building owners, including cracking, soiling, and crazing.

In a report created for the Building Envelope Technology Symposium 2007, Matthew C. Farmer states, “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 vibratory dry tamping methods, the majority of problems observed in modern construction are associated with the dry tamp method of manufacture.”



Cracking

Cracking is probably the most common problem associated with cast stone. The Cast Stone Institute (CSI) recommends that pieces containing cracks in excess of 0.005 inches be rejected upon delivery.⁶

Cast stone can be reinforced with steel to help reduce cracking,⁴ but the introduction of reinforcing steel also presents an issue. Cast stone is a permeable product, allowing water to pass through it. If water makes contact with the steel, it will rust and expand. This causes the product to crack and split, compounding the very problem the steel was meant to prevent.⁴



The above illustrates cracking which is probably the most common problem associated with cast stone

Soiling

Soiling is caused by exposure to pollution, soot, and dust. It can collect directly onto a surface or can be washed from other parts of the building or even neighboring buildings. According to Farmer for the Building Envelope Technology Symposium 2007, cast stone is porous and somewhat rough in texture, which allows dirt or other material to settle on the surface.⁴

Cleaning these materials off of cast stone can be as frustrating as the soiling itself, as each manufacturer has its own recommended cleaning practices. In order to clean cast stone properly, it is also important to know the composition of the cast stone, which helps determine the best cleaning solution to use. For example, if the cast stone is made from marble or limestone aggregates, an alkaline pre-wash and acid post wash is acceptable.²

On the other hand, if there is no marble or limestone, then acidic cleaners, much like

those used for granite, may be used.² If the composition of the product or manufacturer is unknown, the Cast Stone Institute recommends using a mild detergent and water and to avoid power washing, sandblasting, or metal brushes.⁷ Additionally, unusual stains can be handled in the same manner as cleaning traditional concrete, taking care not to scar the surface with abrasive chemicals or brushes.



The above illustrates soiling which is caused by exposure to pollution, soot, and dust.

Crazing

Crazing, or craze cracking, is a network of interconnected hairline cracks. In the concrete industry, this type of crack pattern is referred to as “map cracking” because the cracks look like borders on a map. These cracks are typically not severe and only a few millimeters deep, but can sometimes merge and form deeper crevices that allow moisture to penetrate, ultimately affecting the strength and stability of your product.⁴ At a minimum, these crazing cracks can become unsightly due to discoloration or excessive soiling. According to the CSI, crazing is a nonstructural concern and not cause for rejection of cast stone.⁸ But many see these effects as undesirable.

CSI also notes that “crazing can be caused by any factor which causes surface tension in excess of interior tension,” in addition to being influenced during manufacturing by improper curing, variables in material mixing/ proportions, or plastic shrinkage cracking.⁸ It is also common to occur depending on how it is used within a structure. Applications that include high amounts of vapor, excessive wet/ dry cycles, or lack of proper ventilation behind the stone promote crazing.⁸

To the right illustrates crazing, or craze cracking, a network of interconnected hairline cracks.

Managing moisture is the key to reducing the occurrence of crazing, as installations that fail to limit water penetration promote crazing. Some common issues include improper flashing, lack of weep holes, no ventilated wythe, the use of below grade or planters without sufficient moisture barriers, failure of joint materials, the use of hard mortar joints instead of sealant joints, and lack of sufficient control joints.⁸

Unfortunately, there is no way to prevent what is considered normal crazing and it is considered an accepted attribute of the product. If, for your project, the idea of map cracking isn’t favorable, natural stone is a recommended alternative.



Cast Stone Repair

Even when cast stone is manufactured, handled, and applied within all proper specifications, it can become cracked or chipped during installation, and a certain amount of repair is common and expected.⁹ According to the CSI, any chip visible from a 20' distance should be repaired with material supplied by the original manufacturer to ensure consistency. This would include chips measuring larger than 1/4" across the cast stone face and chips larger than 8" square, which should actually be repaired immediately and replaced entirely. Chips that measure 1/4" or smaller usually do not need any type of repair.

The process of repairs include mending the damage itself and blending the repair into the surrounding stone. Sometimes the entire section or piece needs to be replaced, but occasionally the damaged portion can be salvaged and simply epoxied back into place.⁹



ADVANTAGES OF INDIANA LIMESTONE

The most popular alternative to cast stone is quarried Indiana Limestone, the material cast stone tries to replicate. Quarried and cut to architectural specifications, Indiana Limestone is among the best known, oldest, and most widely used natural building products. From national monuments to modest homes, Indiana Limestone offers a broad range of applications. From simple ornamentation to intricate and ornate details, it has helped create and shape modern architecture.

Unlike cast stone, Indiana Limestone is virtually maintenance-free and has fewer surface imperfection risks, such as cracking or crazing, as well as reduced weathering risks, such as freezing and thawing. Although Indiana Limestone is still affected by slight weathering over time, this creates a pleasing blend of natural colors.

With no artificial coloring agents to fade and no supportive rods to rust, the appearance of Indiana Limestone actually tends to improve with age.¹⁰ This is a different story to that of cast stone, with a change in coloring expected but not preferred. It is important to note that the impact of such a change is dependent on the quality of cast stone used.

The durability of natural stone is never in question. It remains strong, stable, and aesthetically pleasing, as illustrated by countless structures featuring Indiana Limestone including Washington National Cathedral, Château Laurier, and Tribune Tower. Cast stone lacks the same guarantee.

Kathy Baker-Heckard, President of Indiana Cut Stone in Bedford, Indiana, is well aware of the differences between Indiana Limestone and cast stone. She said, “natural stone possesses many benefits, but the most notable is durability.”



“There is a reason Indiana Limestone has long been recognized as ‘America’s Building Stone.’”

- Kathy Baker-Heckard, President of Indiana Cut Stone

Approximately ten years ago our fabrication shop collaborated with a restoration company in Pennsylvania to replace all of the cast stone materials with Indiana Limestone on a high school building. The cast materials were only nine years old.

“Finished cast stone product looks similar to Indiana Limestone but it will deteriorate so quickly, whereas the natural stone will remain for many years. There is a reason Indiana Limestone has long been recognized as ‘America’s Building Stone.’”

Although cast stone manufacturers have invested considerable time and money to amplify claims that their materials possess the same maintenance features as natural stone, the durability of cast stone continues to fall short with the eventual breakdown of materials a frequent occurrence.¹¹

The disparities in durability between natural stone and cast stone can have significant implications on the long-term cost of a project. While cast stone is available at a lower initial cost, Indiana Limestone requires less cumulative investment as the natural product is far more enduring than its man-made counterpart.¹² This is due to the fact that Indiana Limestone, and indeed any natural stone, requires minimal maintenance. This consideration is often overlooked as the immediate cost is often perceived as the be-all and end-all, when in actuality the permanent structure will demand future investment, the level of which depends on the building product used.

Furthermore, natural stone is suited to elaborate, complex projects. Quarried Indiana Limestone can be cut, finished, and ready for a specified project. In contrast, cast stone is not economically viable for such projects as it is repetitively produced in standard sizes. As a result, producers will be unable to reuse and recycle their molds, meaning any required changes would have to be made during the building process.¹²

Indiana Limestone products are the outcome of thorough design and development procedures allowing for the required stone to arrive already cut to fit the project. The preparation and installation of this stone is carried out by highly skilled professionals. While this can increase the length of time required, the crafting capabilities of Indiana Limestone and outcome of this process more than compensate for this.

Many government buildings, religious facilities, museums, and office buildings are constructed of Indiana Limestone. The genuine beauty, combined with guaranteed durability, versatility, and long-term affordability, make this natural stone a straightforward choice for those looking to build a structure for current and future generations to enjoy.¹²

Lastly, Indiana Limestone bonds better with mortar because of its porosity.¹³ Cast stone may have issues with this type of bonding if the stone is cut with a saw prior to installation or if the manufacturer adds stripping or de-bonding agents. Compared to Indiana Limestone, these chemicals conflict with the bonding agents in mortar.⁹



SUMMARY

With cost an influential factor on architects' purchasing decisions, cast stone has grown in popularity. However, while cast stone can reduce short-term building costs, maintenance costs can accumulate, although this is often not acknowledged at the time the decision to use cast stone is made. Indiana Limestone has a track record of less deterioration and therefore lower maintenance cost over the span of a building's existence.

There are proven benefits and drawbacks of each product. Indiana Limestone and other natural stone products guarantee an attractive, carefully-designed, and enduring structure, while cast stone can satisfy flexible product specifications for those with a restricted budget.

Ultimately, it's worth contemplating the long-term factors when considering both products. What is the plan for the building in 10, 15, or 20 years? For structures built with longevity in mind, quarried material such as Indiana Limestone represent the logical choice.

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