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PRESERVATION BRIEFS

42

The Maintenance, Repair and Replacement of Historic Cast Stone

Richard Pieper

Detail of
ornamer
New Yor
Richard

An Imitative Building Material with Many Names

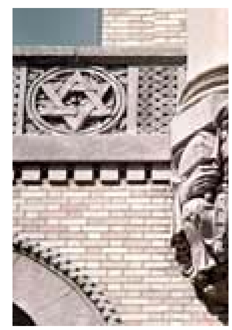
The practice of using cheaper and more common materials on building exteriors in imitation of more expe
materials is by no means a new one. In the eighteenth century, sand impregnated paint was applied to w
quarried stone. Stucco scored to simulate stone ashlar could fool the eye as well. In the 19th century, cas
often detailed to appear like stone. Another such imitative building material was "cast stone" or, more pre
concrete building units.

The prominent Delaware and Hudson Building, Albany, New York, (1916) made extensive use of cast stone as trim combined with a random ashar facing of natural granite. Photo: Richard Pieper.

Cast stone was just one name given to various concrete mixtures that emplo
shapes, decorative aggregates, and masonry pigments to simulate natural st
mixtures included water, sand, coarse aggregate, and cementing agents. Nat
portland cements, oxychloride cements, and sodium silicate based cements w
binding agents. The differences in the resulting products reflected the differe
aggregates, binding agents, methods of manufacture and curing, and system
finishing that were used to produce them. Versatile in representing both intri
ornament and plain blocks of wall ashlar, cast stone could be tooled with a va

During a century and a half of use in the United States, cast stone has been
names. While the term "artificial stone" was commonly used in the 19th cent
stone," "cast stone," and "cut cast stone" replaced it in the early 20th centur
Coignet Stone, Frear Stone, and Ransome Stone were all names of proprieta
-cast concrete building units, which experienced periods of popularity in diffe
United States in the 19th century. These systems may be contrasted with "A
decorative molded concrete construction, both precast and cast-in-place, whi
effort to simulate natural stone.

Having gained popularity in the United States in the 1860s, cast stone had become widely accepted as an economical substitute for natural stone by the early decades of the 20th century. Now, it is considered an important historic material in its own right with unique deterioration problems that require traditional, as well as innovative solutions. This Preservation Brief discusses in detail the maintenance and repair of historic cast stone-precast concrete building units that simulate natural stone. It also covers the conditions that warrant replacement of historic cast stone with appropriate contemporary concrete products and provides guidance on their replication. Many of the issues and techniques discussed here are relevant to the repair and replacement of other precast concrete products, as well.



Sculptural ornament
in cast stone. Repeti
banding course pane
New York City (1926
more economically t
natural stone. Photo

History of Use and Manufacture

Early Patented Systems

While some use of cast stone may be dated to the Middle Ages, more recent efforts to replicate stone wit
materials began in England and France at the end of the 18th century. Coade Stone, one of the best know
English manufactures, was used for architectural ornament and trim, and saw limited use for interior dec
United States as early as 1800. Significant advances in the artificial stone industry in the United States w
production of natural cement or hydraulic lime, which began about 1820.

A large number of patented American, English, and French systems were marketed immediately after the
the earliest American patents for cast stone was awarded to George A. Frear of Chicago in 1868. Frear St
of natural cement and sand, to which a solution of shellac was added to provide initial curing strength. Fr
widely licensed around the country, and the resultant variation in materials and manufacturing methods a
in some significant failures.

Another product which utilized natural cement as its cementing agent was Beton Coignet (literally, "Coign
known as "Coignet Stone"). Francois Coignet was a pioneer of concrete construction in France. He receive

patents in 1869 and 1870 for his system of pre-cast concrete construction, which consisted of portland cement, hydraulic lime, and sand. In the United States the formula was modified to a mix of sand with Rosendale Cement (a high quality natural cement manufactured in Rosendale, Ulster County, New York). In 1870 Coignet's U.S. patent rights were sold to an American, John C. Goodrich, Jr., who formed the New York and Long Island Coignet Stone Company. This company fabricated the cast stone for one of the earliest extant cast stone structures in the United States, the Cleft Ridge Span in Prospect Park, Brooklyn, New York.

Constructed in 1868 of Bet Ridge Span in New York Ci of the earliest extant cast United States. Photo: Rich

Some proprietary systems substituted other cements for the portland cement or hydraulic lime. The British patent process of Frederick Ransome utilized a mixture of sand and sodium silicate, combined with calcium chloride, to form blocks of calcium silicate. The sodium chloride by-product was intended to be removed with water washes during the curing process. The Sorel cement process, developed in 1853 and later applied to the manufacture of grindstones, tiles, and cast stone for combined zinc oxide with zinc chloride, or magnesium oxide and magnesium chloride, to form a hydrated cement mixture that bound together sand or crushed stone. The Union Stone Company in Boston manufa using the Sorel process. Ultimately, however, alternate cementing systems were abandoned in favor of p which proved to be more dependable and less expensive.

Late 19th and 20th Century Development

The use of cast stone grew rapidly with the extraordinary development of the portland cement and concre the end of the 19th century. In the early decades of the 20th century, cast stone became widely accepted substitute for natural stone. It was sometimes used as the only exterior facing material for a building, but used as trim on a rock-faced natural stone or brick wall.

Cast stone was commonly used for molded trim in conjunction with brick or natural stone. This brick building in Rochester, New York, uses cast stone for the entry surround, and natural stone for unornamented windows sills, thresholds, and water table units. Photo: Richard Pieper.

In most early 20th century installations, cast stone was used for exterior win surrounds or lintels, copings, parapets and balustrades, banding courses, cor and sculptural ornament. On occasion, decorative interiors were also finished although elaborate interior cornices and ornaments were more frequently fab

Manufacture

Manufacturers of cast stone used graded mixes of crushed marble, limestone smelting slag to produce a variety of stone effects. A light cement matrix wit crushed marble could replicate limestone, while a mix of marble and small ar slag would give the effect of white granite. Some manufacturers added maso varied colors on the faces of the stone to give a somewhat stylized effect of sandstone. Each manufacturer prepared a variety of stock mixes as well. Not aggregates varied in different localities. In New York State, for example, crus and Tuckahoe marbles were popular facing aggregates; in other areas crushe granite and even silica sand were commonly used.

The two basic cast stone production systems were "dry tamp" and "wet cast. process employed a stiff, low slump concrete mix that was pressed and comp molds. The decorative aggregate mix was frequently distributed only on the the cast units (typically 3/4" to 1 Ω" thick,) while the cores of the units were common concrete. Because

dry tamp units required a relatively short period of time in the molds, which could then be used several ti
removal from the molds, the dry tamp units were often cured in steam rooms to assure proper hydration
The **wet cast** process, on the other hand, used a much more plastic concrete mix that could be poured a
the molds. This system used significantly more water in the mix, assuring proper hydration of the cement
elaborate curing, but requiring that the units be left in the molds for at least a day. Because of this metho
wet cast products necessarily distributed their decorative aggregate mix through the entire unit, rather th
outer facing.

Concrete was cast in molds of wood, plaster, sand and, early in the 20th century, even hide glue or gelati
upon the production method, the intricacy of the piece to be cast, and the number of units to be manufac
were sometimes used for stock ornamental items, less frequently for custom architectural work. When th
adequately hard, finish surfaces were worked to expose the decorative stone aggregate. When removed f
cast units exhibit a surface film of cement paste, which must be removed to expose the aggregate. Partia
could be sprayed with water, rubbed with natural bristle brushes, etched with acid, or sandblasted to rem
layer. The surface of dry tamp products required less finishing.

High quality cast stone was frequently "cut" or tooled with pneumatic chisels and hammers similar to those used to cut natural stone. In some cases, rows of small masonry blades were used to create shallow parallel grooves similar to lineal chisel marks. The results were often strikingly similar in appearance to natural stone. Machine and hand tooling was expensive, however, and simple molded cut cast stone was sometimes only slightly less costly than similar work in limestone. Significant savings could be achieved over the cost of natural stone when repetitive units of ornate carved trim were required.

Historically, a point finish
pointed chisel. Photo: Fro
Company Catalog. Courte
F. Lynch.

For this column, the appearance of a "pink granite" was simulated by using a pinkish matrix with white and black aggregate. Erosion of a tinted matrix results in a significant lightening of the cast stone surface. Photo: Richard Pieper.

Finally, cast stone is sometimes today used to replace natural stone when the original historic stone is no longer available, or the greater strength of reinforced concrete is desired. Reinforced cast stone columns,
for instance, are frequently used to replace natural stone columns in seismic r
structures. Fine-grained stones, such as sandstones, may be very successfully
cast stone. Coarse-grained granites and marbles with pronounced patterns or
obvious reasons, not so successfully matched with cast stone. The replacemen
with cast stone requires careful attention to selection of fine aggregates and th
the cementing matrix. Coarse aggregate, which is generally used in cast stone
shrinkage and assure adequate compressive strength, can present an aestheti
visible at the surface of cast stone elements which simulate sandstone. Carefu
aggregate sizes in the mix formulation can reduce this problem.

Mechanisms and Modes of Deterioration

The best historic cast stone can rival natural stone in longevity. Many quality c
installations from the first decades of the twentieth century are still in excellent condition, and require litt
other building material, however, cast stone is subject to deterioration, which may occur in several ways:

- Separation of the facing and core layers
- Deterioration of the aggregate

- Deterioration or erosion of the cementing matrix
- Deterioration of the iron or steel reinforcement
- Deterioration of cramps and anchors used in its installation.

Separation of the Facing and Core Layers

Separation of the facing and core layers of dry tamp units is not uncommon, and often reflects fabricatior poor compaction, lengthy fabrication time, or improper curing. Where separation of facing and core layers cast stone units may be "sounded" to establish the extent of delamination.

Deterioration of the Aggregate

Cast stone failure caused by deterioration of the aggregate is uncommon. Granites, marbles, and silica sa durable, although limestone and marble aggregate are subject to the same dissolution problems that affe of these stones. In rare instances, a reaction between the alkalis in the cement matrix and the stone aggı cause deterioration.

Deterioration or Erosion of the Cementing Matrix

Scaling of cast stone units signals problems with the cementing mix and method of manufacture. Serious deterioration of cast stone, such as this, warrants replacement. Photos: Richard Pieper.

While it is relatively uncommon in twentieth century cast stone, serious deteriora cementing matrix can cause extensive damage to cast stone units. A properly pre mix will be durable in most exterior applications, and any flaking of exterior surfa problems in the cementing mix and in the method of manufacture. The use of po improperly stored cement, impure water, or set accelerators can cause cement pı years after a structure is completed. Improper mixing and compaction can also re concrete that is susceptible to frost damage and scaling. Severe cement matrix p impossible to repair properly and often necessitate replacement of the deteriorati units.

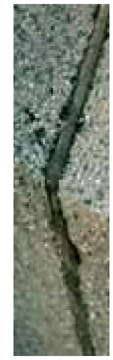
More common and less serious than flaking or scaling caused by deterioration of matrix is the erosion of the surface of the matrix. This usually occurs on surfaces features exposed to water runoff, such as sills, water tables, and window hoods. matrix may erode, leaving small grains of aggregate projecting from the surface. rough surface is not at all the intended original appearance. In some historic cast installations, the thin layer of cement and fine sand at the surface of the cast stor originally tooled from the molded surface, but was finished with patterns of maso stylized imitation of highly figured sandstones or limestones. Erosion of the pigm layer on this type of cast stone results in an even more dramatic change in appea

Deterioration of the Iron or Steel Reinforcement

During their original manufacture, unusually long and thin cast stone units, such as window sills or balust units requiring structural capacity, such as lintels, were generally reinforced with mild steel reinforcing ba sometimes had cable loops or hooks cast into them to facilitate handling and attachment. On occasion, th and wire may be too close (less than 2") to the surface of the piece and rusting will cause spalling of the frequently happens to sills, copings, and water tables where repeated heavy wetting leads to loss of alkal concrete, allowing the reinforcement to rust. If damage from the deteriorating reinforcement is extensive the splitting of a baluster from the rusting of a central reinforcing rod, the cast stone unit may require rep

Deterioration of Cramps and Anchors

Even when reinforcement has not been added to individual cast stone units, mild steel cramps may have been used to anchor a cast stone veneer to backup masonry. Where spalls have occurred primarily at the tops of ashlar or frieze units, this is generally the cause.



Rusting o
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mortar. P

Maintenance of Cast Stone Installations

Cleaning

Cast stone installations with marble or limestone aggregates may sometimes be cleaned with the same alkaline pre-wash/acid afterwash chemical cleaning systems used to clean limestone and other calcareous natural stones. If no marble or limestone aggregates are present, acidic cleaners, such as those used for natural granites and sandstones, may be used.

Sandblasting and wet grit blasting can seriously erode the surface and should not be used to clean cast stone surfaces. Photo: Richard Pieper.

In either case, dark particulate staining in protected areas may be persistent, however, and require experimentation with other cleaning methods. Some micro-abrasive cleaning techniques used under very controlled ci skilled cleaning personnel can be appropriate for removing tenacious soiling. Ordi or wet grit blasting can seriously damage the surface of the cast stone and shoul

Repointing

Early cast stone installations may have been constructed with natural cement mo nineteenth century and twentieth century installations, cast stone units were gen pointed with mortars composed of portland cement, lime, and sand. When repoin replacement of the historic mortar is required, a Type N mortar (about one part c part lime to six parts of sand) is generally appropriate. When repointing any histo important to match both the character and color of the sand and color of the cem historic mortar. Cement matrix color can often be adjusted by using combination and gray portland cement in the mortar.

Joints in historic cast stone installations can be quite thin and the dense mortar t remove. Unnecessary repointing can cause significant damage to historic cast sto open joints will most often be found on exposed features such as balustrades and copings and, of course, repointing. When a hard and tenacious mortar was used in the original installation or a later repointing, t mortar can easily chip the edges of the cast stone units.

While the careless use of "grinders" to remove mortar has damaged countless historic masonry buildings, may sometimes use a hand held grinder fitted with a thin diamond blade to score the center of a joint, ar the rest of the mortar with a hand chisel. If this method is not done carefully, however, wandering of the or alter joints and cause significant damage to the cast stone. Care must be taken to prevent damage fro vertical joints by stopping blades well short of adjacent units. The use of small pneumatic chisels, such as tool stone, can also work well for mortar removal, but even this method can cause chipping to the edges if it is not done carefully.

Methods of Repair

Much historic cast stone is unnecessarily replaced when it could easily be repaired in situ, or left untreate especially true of areas that exhibit isolated spalls from rusting reinforcement bars or anchorage, or insta erosion of the matrix has left a rough surface of exposed aggregate.

The weathering of cast stone, while different from that of natural stone, produces a patina of age, and do large-scale replacement, unless severe cement matrix problems or rusting reinforcement bars have cause scaling or spalling. Severe rusting of reinforcement bars on small decorative features, such as balusters, r carbonation (loss of alkalinity) of the matrix. Where carbonation of the matrix has occurred, untreated rei continue to rust. Replacement may be an acceptable approach for exposed and severely deteriorated feat hand railings, roof balustrades, or wall copings, where disassembly is unlikely to damage adjacent constru small areas of damage should generally be repaired with mortar "composites," or left alone.

A delaminated layer of ornamental cast stone on the Orpheum Theater, San Francisco, California (1925), was successfully re-attached using epoxy. The multiple delivery ports for the epoxy are removed after treatment and the holes patched. Photo: David P. Wessell.

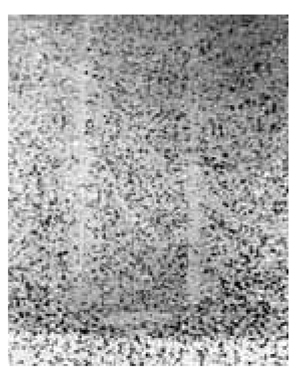
Re-securing Separated Surface Facing

Where the decorative facing of dry tamped cast stone has separate layers, injected grouts may be used to re-secure the facing. Re-att separated facing layer may be time consuming, and should be und conservator, rather than a mason. This technique may be the best, approach for repair of figurative sculpture or unique elements that elsewhere on a building. Theoretically, cementitious grouts are mos re-attaching separated facings, but hairline fissures may require th adhesives. Low-viscosity epoxies have been used for this purpose, applied through small injection ports. Cracks that would allow adhe be repaired prior to injection, of course. Holes made for adhesive ir require patching after re-attachment is complete.

Repairing Reinforcement Spalls and Mechanical

Drilled holes, mechanically damaged corners, and occasional spalls reinforcement bars and anchorage are repairable conditions that do not warrant the replacement of cast s "composite " repairs to damaged masonry units can be made with mortar formulated to visually match th material, and may be successfully undertaken by a competent and sensitive mason. If deterioration appe however, or if large surface areas are spalling or cracking and replacement appears necessary, the owner consult a preservation architect or consultant to determine the cause of deterioration and to specify neces replacement, as appropriate.

The methods of composite repair used for stone masonry are also generally applicable for the repair of historic cast stone. For repairs to damaged cast stone to be successful, however, both the cement matrix color and the aggregate size and coloration must match that of the historic unit. Crushed stone and slag (such as "Black Beauty" abrasive grit), which are similar to many common traditional aggregates, are widely available, although some additional crushing



and/or sieving may be necessary to obtain aggregate of an appropriate size. Remember that half or more of a weathered surface is exposed aggregate, so careful aggregate selection and size grading is extremely important for patching. Even differences in aggregate angularity (rounded

This completed composite repair could have been improved by brushing to remove the matrix residue at the edges of the repair before the surface cured. Photo: Richard Pieper.

The composite mortar is applied to the void with a small spatula or trowel. Photo: Richard Pieper.

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pebbles vs. crushed stone) will be noticeable in the final repair. If more than one aggregate was used in t ratio of the selected aggregates in the mix is, of course, equally important. Variation in coloring of the cer be achieved through the use of either white, "light, " or gray portland cement. If additional tinting is requ inorganic alkali-resistant masonry pigments should be used. Because most historic cast stone was manufa from portland cement and aggregate (with a less than 15% lime/cement ratio), it is not necessary to add hydrated lime to cast stone composite repair mixtures. Small amounts of lime may be added for plasticity mix.

To repair a spall caused by deterioration of a ferrous reinforcement bar or anchorage, it is necessary to re concrete adjacent to the spall; grind and brush the reinforcement to remove all rust and scale; and paint rust-inhibiting primer prior to applying the cast stone composite. If the reinforcement bar is much too clo of the stone, it may be advisable to cut out the deteriorating section of reinforcement after consultation w engineer. If deteriorating cramps are removed, it may be necessary to install new stainless steel anchora

Where spalls have a feather edge, it will be necessary to cut back the repair area to a uniform depth (1/2 with natural stone composite repairs, a bonding agent may assist adhesion of the repair material to the o For unusually large or deep patches, mechanical anchoring of the repair with small nylon or stainless stee required. If the adjacent cast stone is tooled or weathered, it will be necessary to scribe or brush the repa it a matching surface texture. Adding enough coarse aggregate to match adjacent original material will sc with adhesion of the composite, and it may be necessary to press additional aggregate into the applied pa finishing. If this is not skillfully done, however, the surface of the patch may take on a mosaic appearance it is advisable to undertake test composite repairs in an unobtrusive location first.

Surface Refinishing

While re-tooling of deteriorated natural stone may sometimes be appropriate, restoring the original appea stone where surface erosion has occurred is difficult or impossible.

Unlike natural stone, cast stone generally may not be tooled in place to reduce lippage of uneven surfaces at joints. Tooling often exposes coarse aggregate from below the surface. Photo: Richard Pieper.

Tooling or grinding of the surface of the cast stone may expose coarse beneath the surface and will not, in any case, restore original patterne that has weathered away. Silicate paints or masonry stains may be ap to replicate the original appearance, but may not be durable or compl aesthetically. Where matrix has eroded, it is advisable to accept the w appearance of the cast stone, unless extensive replacement is manda factors.

Because cast stone depends on exposed aggregate to achieve its aest use of an applied cementitious surface coating dramatically alters the material and is inappropriate as a cast stone repair technique. A ceme coating can also trap moisture in the cast units and cause surface spa

Replacement of Historic Cast Stone Installations

Individual cast stone units, which are subject to repeated wetting (such as copings, railings and balusters
severe failure due to spalling or reinforcement deterioration, may require replacement with new cast ston
replicate deteriorated units in existing buildings.

After removal from the mold, the new cast stone units are scrubbed to remove surface paste and expose underlying aggregate. End cast pieces, such as this sculpture, may have numberous air bubbles at the suface.Photo: Richard Pieper.

Fortunately, a number of companies custom manufacture precast concrete units. T
involved in manufacture are considerable, and it is wise to use a firm with experier
and custom work rather than a precast concrete firm which manufactures stock str
concrete pipe, or the like. Several trade organizations, including the Cast Stone Ins
National Precast Concrete Association, and the Architectural Precast Association, ha
recommendations and/or guide specifications for the manufacture of cast stone an
concrete. These specifications set standards for characteristics such as compressiv
water absorptivity, and discuss additives such as air entraining agents and water r
which influence the longevity of new cast stone. Trade references and guide specifi
consulted before contracting for replacement of historic cast stone.

Fabrication defects in new cast stone. While the cement matrix coloration and aggregate considerations previously mentioned require the most careful attention, project staff should also look for defects which are common to cast stone fabrication:

The holes on
casting (see
filled with a r
concrete mix
element. Pho

Air bubbles. Small pits on the surface of the stone may form if the unit is not given adequate vibration to release trapped air during pouring. Bubbles can also be a problem when end casting long items such as columns or railings, where it is difficult to vibrate bubbles away from the finish surface of the unit.

Surface cracking or checking. Overly wet mixes and insufficient moisture during curing can result in surface cracking of large castings, such as columns. Such cracking dramatically reduces the durability of new cast stone. Small reinforced elements, such as balusters, also f
thin "necks" in the castings.

Aggregate segregation. Cast stone formulations generally include a range of coarse aggregates (crushe
aggregates (sand). When units are vibrated to assure compaction of the mix and liberate trapped air bubl
aggregates may begin to settle and separate from the paste of cement and sand. Aggregate segregation
concentration of coarse aggregate at one end of the casting. Segregation is more problematic when end c
such as columns.

Surface rippling or irregularity. Production molds for fabricatior
of rubber mold facings encased in larger "mother molds" of plaster
Vibration can loosen the rubber facing from the outer mold and res
irregularities on the surface of the finished casting. Even when ripp
noticeable, irregularity caused by mold movement can make it diffi
surfaces of adjacent units when assembling cast stone installations

Mold lines. Freestanding elements, such as columns, must be cast
molds, which are separated to release the completed cast piece. If

Surface cracking may reduce the durability of cast stone units. Cracking is often problematic on reinforced elements with thin "necks," such as balusters, unless curing is carefully controlled. Photo: Richard Pieper.

not join tightly, some leakage of cement paste will occur at the mo in a projecting line on the surface of the casting. This is generally t the casting completely cures. A mold line will be visible on the com projecting material is not completely removed, or if the tooling at t not match the adjacent surface of the casting. Tooling at mold lines contrasting coarse aggregate beneath the surface of the casting.

Other Considerations for Replacement of Cast Stone

Several other considerations are worth noting when it is necessary to replace historic cast stone elements new cast stone.

Reinforcement. The alkalinity of new concrete generally provides adequate protection to steel reinforcer areas where deterioration due to rusting of reinforcement has previously been a problem, however, the u steel reinforcement is recommended.

Surface finishing. Post-fabrication surface tooling of new cast stone is not currently common. Sandblasting is typically used to remove the surface film of cement and expose the aggregate. For replacement units replicating historic cast stone pieces in highly visible locations, it is sometimes possible to make a mold of a sound or repaired existing piece to incorporate the original tooling in the casting process. If the historic unit is too deteriorated to use as a pattern, a plaster model may be made to replicate the damaged piece. This is tooled to replicate the desired surface treatment or appearance, and a production mold is then made from the plaster model.

Production molds rubbers backed v supports are use stone. Photo: Ric

Moist curing. Surface crystallization of soluble salts (efflorescence) during curing may lighten the surface of some precast units, especially those simulating darker stone. Some manufacturers use a series of wet/dry curing cycles or washing with acetic acid to remove soluble salts that might otherwise discolor finished surfaces. For most wet cast products, simple moist curing under a plastic cover is sufficient.

Appropriateness of Glass Fiber Reinforced Concrete as Replacement Material

Light-Weight Alternative

Glass fiber reinforced concrete (GFRC) is more and more frequently encountered in building restoration and is used to replicate deteriorated stone and cast stone, and even architectural terra cotta. This is a relatively new material that uses short chopped strands of glass fiber to reinforce a matrix of sand and cement. GFRC has become a popular low cost alternative to traditional precast concrete or stone masonry for some applications. Fabricators use a spray gun to spray the mortar-like mix into a mold of the shape desired. The resulting concrete unit, typically only æ" thick, is quite rigid, but requires a metal frame or armature to secure it to the building substrate. The metal frame is joined to the GFRC unit with small "bonding pads" of GFRC.

The attachment hardware inside this GFRC cartouche (left) will not be visible when the

(t e g

GFRC has a dramatic advantage over traditional precast concrete where the weight of the installation is a concern, such as with cornices or window hoods. Many cast stone mixes can successfully be replicated with GFRC. Where it is used to simulate natural stone, GFRC, like cast stone, is most appropriate for simulation of fine-grained sandstones or limestones.

unit is installed (armature visible at right). Photos: Towne House Restorations, Inc

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Not for Use in Load Bearing Applications

Because the GFRC system is in effect a "skin," GFRC cannot be used for load bearing applications without additional support. This makes it unsuitable for some tasks such as replacement of individual ashlar units appropriate for small freestanding elements such as balusters, or for most columns, unless they are enga surrounding masonry or can be vertically seamed, which may significantly alter the historic appearance. (also allow for expansion and contraction, and are generally separated by sealant joints, not by mortar. A be unacceptable for some historic applications; however, substitution of GFRC for cast stone may be appr entire assembly, such as a cornice, roof dormer, or window hood, requires replacement. Great care must detailing a GFRC replacement for existing cast stone.

Deterioration of GFRC

Because it is a relatively new material, the long term durability of GFRC is still untested. When GFRC was some installations experienced deterioration caused by alkaline sensitivity of the glass fiber reinforcemen glass is now used for GFRC manufacture. Even when the GFRC skin is well manufactured, however, the st bonding pad system used to mount the material is vulnerable to damage from leakage at sealant joints o wash surfaces. The use of galvanized or stainless steel armatures, and stainless steel fasteners and bondi advisable.

Summary and References

Cast stone-a mixture of water, sand, coarse aggregate, and cementing agents—has proven over time to b and durable building material, when properly manufactured. It gained popularity in the 1860s and, by the the 20th century, became widely accepted as an economical substitute for natural stone. Unfortunately, r stone is unnecessarily replaced when it could easily be repaired and preserved in situ, or left untreated. A of damaged units can extend the life of any cast stone installation. Because of the necessity of matching l and aggregate size and ratio, conservation projects which involve repair or replication of cast stone shoul lead time for the assembly of materials and the preparation of test samples. Understanding which conditi which warrant replacement, and which should be accepted as normal weathering is key to selecting the m approach to the protection and care of historic cast stone.

Helpful Organizations

Cast Stone Institute

10 West Kimball Street

Winder, GA 30680-2535

National Precast Concrete Association

10333 North Meridian Street, Suite 272

Indianapolis, IN 46290

Architectural Precast Association

P.O. Box 08669

Fort Myers, FL 33908-0669

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This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amende the Secretary of the Interior to develop and make available information concerning historic properties. Te Preservation Services (TPS), National Park Service prepares standards, guidelines, and other educational responsible historic preservation treatments for a broad public.

September 2001

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