The Romance of Cast Stone

by Richard Carey

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Cast stone is about expressing an architectural vision in three dimensions with intricate details that would be impossible to duplicate with any other building material. And are equally applicable to residential and commercial projects, as shown in the photos above. Incorporated here are window and door surrounds, ornamental scrolls, a logo shield and other details, as well as wall banding.

The history of cast stone is well known. It has been used in basically the same technique, except for some enhancements to the design mix, for at least the last 2500 years. The Romans favored it as building material because of its beauty, durability and cost effectiveness. Contemporary cast stone has changed little since that time. Regarding various design mixes, the Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois, 847-966-6200, has the very best data on the subject and should be considered the authority on standards for design mix. Note that it is possible and even desirable to alter the mix design depending on the desired results. More on mix design later.

In short, cast stone is a great bang for the buck. It offers versatility, aesthetic qualities, and favorable economies of scale in relatively low repetitive situations. "You don't have to have a lot before the repetition pays."

Cast stone promotes personal expression at all levels. The owners can fulfill their desire for beauty, durability and still have a maintenance-free product. It frees Architects to define the character of the building through structural and decorative elements because literally anything can be done in cast stone. After initial design, the artisans take over, bringing their skills and touch to complete the production and installation of architect's designs and the owners' vision.

How we almost lost an art

A century ago it was a different time: Industrialization was in full swing, made possible by rapid, reliable transportation, and electricity. It was during this time that much of the American infrastructure was built. Followed by economic depression, war, and population explosion.

Intricate details, such as shown above, are possible in cast stone, promoting personal expression by homeowners, architects and builders.

Our attention and our talents turned to what paid and the next thing you know it's a couple or three generations and the craft of centuries is lost. In addition, not much was written on the subject, further hampering a resurgence of cast stone in the marketplace. As with many things, money is vital to survival; cast stone had none. Labor costs were low and cut stone readily available in low cost labor environment. Little was left to keep the pilot light going. Worse, cement was in short supply with very high demand. Cement cost money.

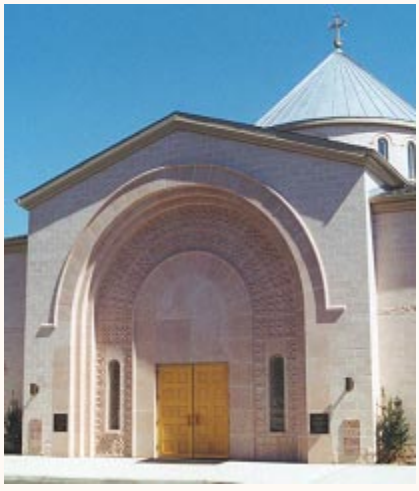
As always times change; labor cost increased, manufacturing of raw materials improved and voila, a stone carver can't compete where he once was king. Cast stone became the vehicle to multiply labor values in a niche market.

In the days of Frank Lloyd Wright, this mom and pop approach fostered innovation on a small scale. Little shops catered to a small, localized need and did so through close contact and limited communication. Over time innovation gave way to a greater need "standards", which allow us all to communicate. For example, what used to be a small order customized at the lumber mill, for each project became a known standard, the bundle of 2x4's, by which to plan. So will the standards of stone be someday. This is not to say cast stone standards will limit new and exciting uses, no more than modular brick standards dictate the building design. It will only serve to enhance an already wide array of options. Cast stone will become yet another.

By the early 1980's, mom and pop organizations began to spring up as demand created awareness. This could have been the direction of the stone industry, but the pace quickens very rapidly in this age, due to transportation and communication.

It's hard to believe, such a fine product with great building qualities, could be lost in the Sea of Time. The Stone Industry must develop a language to better aid the designers and the trades in the use of cast stone or, cut stone for that matter, which are very similar in use. Almost any other field could be used as an example of the importance of standards. Look for them in Part Names or Unit Names or Installation Techniques. "What are the cast stone standards?" and "How will we use them?" All who do will play a role in developing our own language.

The project shown in the photos below would have been extremely difficult, indeed, perhaps cost prohibitive in any other building material than cast stone.



Modern information technology makes it possible for a well-informed labor force to design and produce intricate facades such as the one above. Production methods that size each piece exactly make the precision possible. Individual stones can be inventoried, tracked and staged on location for easier installation by the craftsmen on site.

The Touch of Cast Stone

Many a vision has been dimmed at this phase. The final execution of production and installation.

This is where I would like the story to begin. Call me a hopeless romantic, but I'm going to explain what I see. Each and every step of the cast stone process is hand made. This requires very handy people. It also accounts for the quick response to a versatile array of low yield requirements. People are adaptable. Properly trained, they can do amazing things.

Properly informed, the combined skills transform a mix into specific sizes, designs, carvings, and countless geometric shapes. The result is finely tooled (not readily visible as a casting; no seams) assembly that enhances the building in so many ways. I'm sure the pages of this book could not list the variety of uses: columns, balustrade, entries, walkways, steps, fountains, and much more. The list is endless.

Cast stone is an excellent choice for detailing all sizes of projects. Stone combined with stucco is very popular.

Careful tooling and production techniques result in a finished product that is not readily seen as cast.

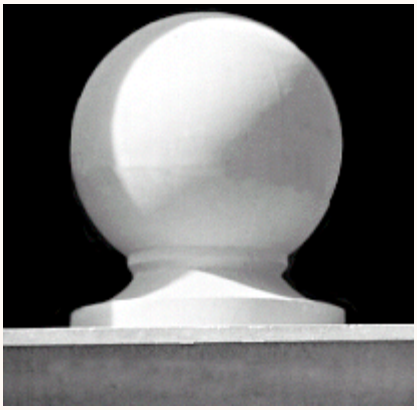
Choosing a Cast Stone Manufacturer

The finest cast stone is hand finished and difficult to identify as molded, particularly true with 360 degree turnings such as balusters, balls or columns. Superior manufacturers use techniques to minimize or prevent unsightly seams and maintain the crisp details. This would be the best indicator of the manufacturer's ability. I have seen buyer's remorse over and over when these types of considerations are ignored by builders and specifiers. This is not strictly a budget decision. All stone is not created equal. Let the buyer beware of poorly executed stone. It is a subtle art with an obvious impact.

Recent history, particularly the awakening of a consumer hungry for the long life and the exquisite look, has fueled the resurgence of the craft. Ironically it is information technology that will transform the "Mom & Pop" business into an industry, hopefully protecting a craft never to be lost to us again.

Ultimately, a project is judged by the impact of its details. The ball at left clearly shows a seam. The ball on the right does not. Unnecessary scrimping has compromised the integrity of a multi-million dollar estate with shoddy details.

Plastic cast: fast to place. With visible compromises.



The most expensive placement technique. Forged with zero slump. Obviously worth the trouble

The ball on the left, above, is part of this multi-million dollar estate. The owner that built this house would not have agreed with this decision if he had known there was a difference.

Design stone for the building. Steel reinforcements are usually only needed for balconies and large clear span areas, like the dramatic porte cochere at left.

Designing Architecturally with Cast Stone

Cast stone is not about P.S.I. (pounds per square inch), water absorption, or technical information. Although these are important to be sure, cast stone is about shape and designing for ease of installation. After a while, as with anything, experience will be your best teacher. You will begin to understand the detailed methods and techniques of installation.

Design the stone for the building. Focus on the final look. Put cast stone where it pleases the eye. Consider only what meets the primarily objective of the structure. Compromise only after the estimates, if assembly costs prohibit the design. However, you will find that it to be the exception rather than the norm. Superstructure reinforcements are sometimes necessary. Generally these are related to large overhangs on entablature or porticos or balconies that have large spans. Later, consider high traffic areas and insist on cast stone to minimize maintenance on the building. Cast stone is a Class A building product. Ask yourself, "What is the final finished building going to look like?" Leave the details for the budget phase. The details will ultimately impact the cost. After the concept is set in stone begin detailing. This will affect the labor cost of installation and superstructure.

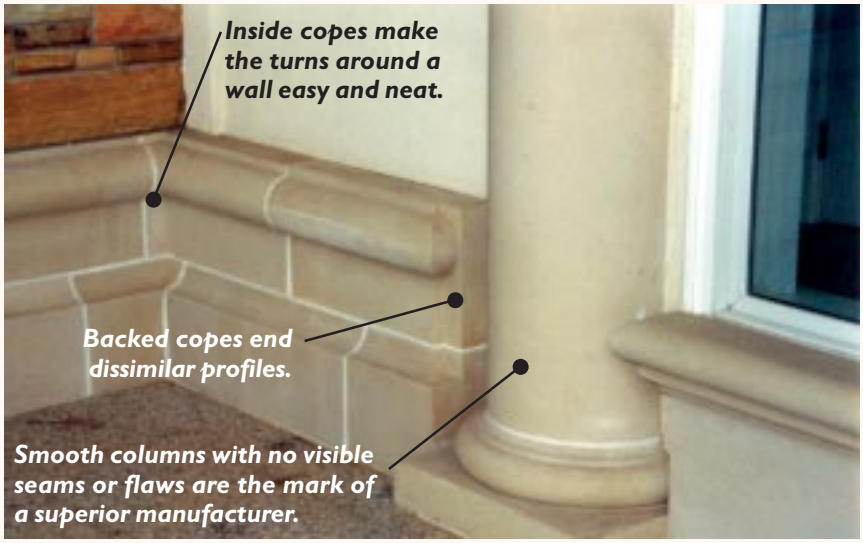
The design is complete. A price is set. You've chosen a manufacturer. Now you are ready to begin the Submittal Phase. This should identify the minimum information required for field dimension verification prior to final drawings. After approval of the submittal package, the manufacturer should supply the installation detail of all parts and their correct setting locations on each unit assembly to the installer.

The use of the joinery is in and of itself an important aspect of the aesthetic design, the charm. Here is where the best designs begin. This determines the ease or difficulty both for the fabricator and the installer. Although saw cuts are common and should be expected, it should not be a license of liberty.

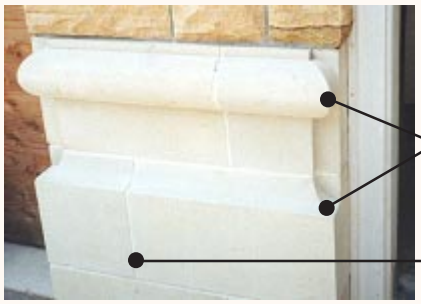
Miters, for example, look best when cast into the product, instead of cut on site and mated with mortar joints. Cast in corners offer a crispness of detail and do not break a cardinal rule: Avoid acute angles and skewed corners. They do not endure well.

Cast in corners on the window header and copes on the sill make the final product look more professional and are easier to install on site.

To say "No Cuts Ever" is also a mistake. Often it is best to field cut versus trying to fit each stone on a horizontal layout. Layout for one stone out of a hundred to be sure the last one fits is not a pleasant task and the masons can be better employed otherwise. However, joinery is an important aesthetic consideration and should be considered part of the design not of the labor. Although the preference is always to make one cut rather than several, a good mason will put in the extra effort to not have odd-sized pieces, even if it means cutting a small amount from each piece to achieve the desired look.



Placement of joint locations are part of the design. Great details are the sign that a good mason was as work here because these lengths were field cut.



Shown at left are a number of specialized pieces that improve the overall look of a finished project. Shown are Backed Copes. They turn the corner, and show a finished side, as well as stopping as shown.

Care must be taken in placement of mortar joints. They add to the finished product.

This is especially true of window and door surrounds. For this reason, a good manufacturer takes many of these decisions out of the hands of the masons. For example: divide the stones around a window into even pieces. No cuts required. It makes for great balance in the joints and takes advantage of the ability to easily make identical pieces in cast stone. Joinery again becomes part of the design combined with cast-in corners and turns and the subtle but obvious appearance that skilled craftsmen were at work here. And not just to the trained eye. The owners, and others, may not know exactly what the difference is, but they know instantly there is a difference. Cast in copes, turns and eyebrow joints all add to the flavor that anyone can recognize as quality

To use an old but apropos phrase: Prior Planning Prevents Poor Performance. When this is applied, the results are exceptional. This method is more demanding on the manufacturer, shifting some of the expense and expertise from the installer. Over time, the masons will reflect lower labor costs quoted based on their familiarity with proper manufacturing techniques. It takes them less time

Don't

Compare with this circle top doorway with the leg pieces each the same height and the arch divided into four equal segments with the keystone.

Do!

Forethought and attention to detail would have eliminated that short piece just below the arch on this otherwise graceful door surround.

The window surround at left shows clearly the crisp defined look available with careful casting in of details, including the miters for the eyebrow, the joints for the ear below the eyebrow arch and the outside corners on the sill. A surround like this could not be miter-cut to fit on site.

At right is a miter-cut eyebrow. Although well done, it is not up to the standards of the cast in corners at left.

and less work to install. Therefore, if you choose the right manufacturer, a higher product price should be offset by lower installation costs. Often with price being equal, the loss is what is not cast into the stone. The hidden expense up front.

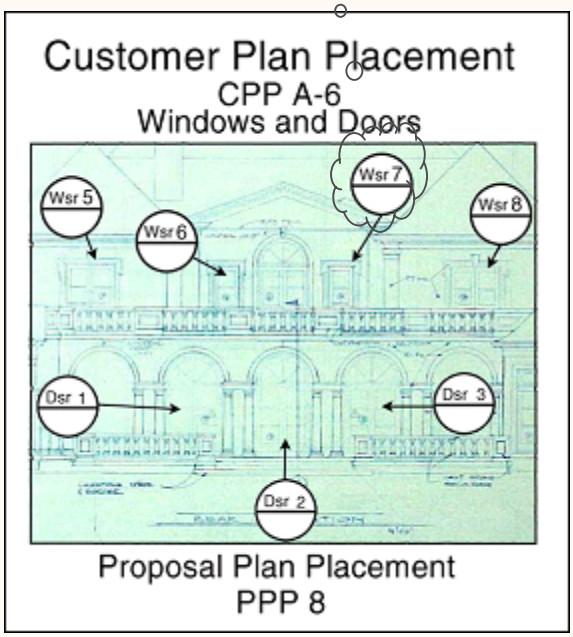
Careful manufacturing, at the very minimum, a superior installation job can be achieved with a lower required skill level. The hard work of determining the number and types of turns, copes and other specialized joints is done in the Shop Drawing Phase of the project.

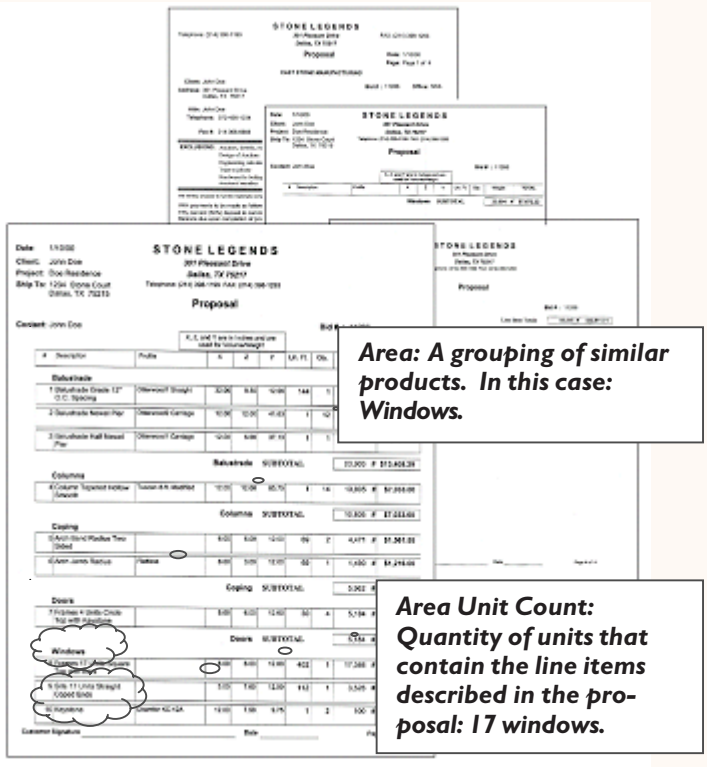
Estimating

The groundwork for good project is laid in the estimating/ bidding stage. The best quotes line item out the stone to be supplied, based on the architect's or builder's drawings. A good estimator will take customer plans and break them down into logical masonry units. This breakdown will vary from project to project but will consist of quantity counts.

Notice the "L" shaped piece of the soffit at the front of the photo. This turn uses a 45^0 angle to follow the line of the roof and was made as a single piece to keep the clean crisp look. The piece toward the back of the photo is a 90^0 turn. These types of special turns give a finished, well-planned look to the final building.

Plan Placement (below) relates the number of units estimated to the original plan. The bubbles call out the product area. In this case, Wsr is the abbreviation for Windows. This window number is Number 7 of a total of 17 Units. See Proposal at lower right.





Line items may be based on multiple elevations or plan views. Area or project groupings of similar types of units quantified by each or by linear foot and profiles. For instance: all linear feet of windows, or each of the columns, or the linear feet of balustrade. Quotes cannot be accurately compared if they are not broken down into quantifiable components. Some questions to ask:

1. What size profiles are being estimated? Dimensions of the cross section of the stone estimated.
2. How can I take advantage of the manufacturers standard sizes and shapes? What does the manufacturer offer as standard?
3. Are the corners of the various units cast in, or does my mason have to cut those on site?
4. What types of attachments, slots, drip edges should be cast into the stone for best installation and performance on site? Often, it is best done in the field. Be open minded, the install can slot, drill, or cut to add attachments to the stone.
5. How will I know when everything I want estimated is accounted for on the quote? Can I relate the quote to the plans?
6. How long will the process take? What can be done to speed it up and what aspects of current design will slow it down?
7. How will I be able to find specific stones on site once the stone is delivered? What are the inventory controls available for storage on site?
8. Installation examples for masons to quote from.
9. Example projects, Samples of the stone, and when called for quality assurances. View the manufacturer's facility. Look at round, or hard to do parts, and finally example detail shop drawings.

Shop Drawings

Some of this will also be shared between the submittal package and the installation package. Marked below are the names of the type of drawings to expect. Submittal drawings are indicated separately from installation drawings. Some are shared from the Submittal to the Installation Packages.

<u>Plan placement:</u> or
Where to place each unit?

<u>Interface Unit Drawing:</u>
When units or profiles are related to one another.

<u>Interface Attachments:</u>
(if required)
The cross section of the associated setting, lines of interfacing unit assembly to the building with recommended attachment methods.

Profile:
A "cross section", of extruded shapes.

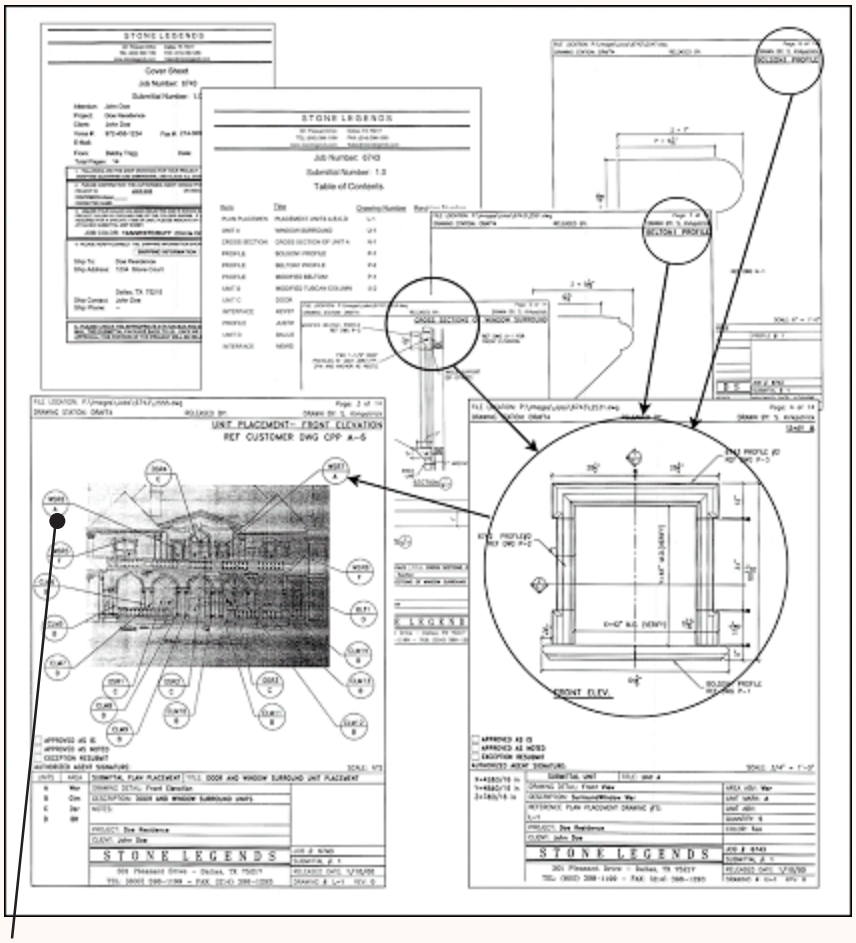
Unit Assembly:
Two or three views of the topside or front of logical masonry assemblies. Minimum dimensions for the Submittal Package. Complete setting dimensions for the Installation Package.

Unit Cross Sections as required to fully describe units.

Unit Part Markings:
Layout the specified parts with appropriate markings. Sometimes combined with unit dimensional drawings. Followed by a parts list for the specific unit. Often called Shop Ticket or Cut List.

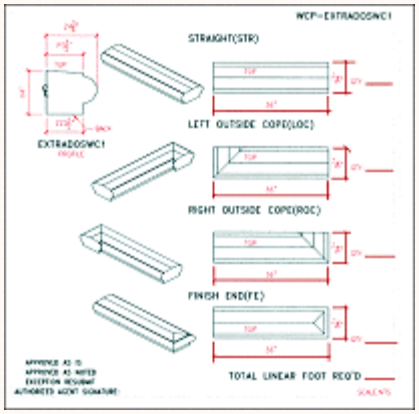
Inventory Control:
Often overlooked, good inventory control to maximize labor efficiency should be supported by the manufacturer with cross references from plan to unit, unit to part, parts to pallets and back again. Critical and essential on big projects, it is helpful even on the smallest jobs.

Map grid on customer plan is helpful. Site map control of pallets is the installer responsibility combined with pallet cross-references from manufacturer will save time and aggravation. Stand at the pallet and know where the stone goes. Stand at the building and know which pallet to go to. Believe me, job site control is a big time saver. It even helps identify manufacturing problems or oversights before a lot of on site labor is involved.



During the Submittal Process, each unit is named and the name added to the bubble with the Unit designation. Similar units will carry the same letter ID.

At right and above are sample Submittal Drawing Packages. At left is a simple, linear foot purchase of Wall Cap.
Above is a combined package with window surrounds, a cross-section and profiles. Note the minimum dimensions on the unit marked "A". The Table of Contents helps navigate through the total package.



Phase 1: Submittal Drawings.

The drafters take the estimate of units each or linear foot units and relate it to the plan by submittal plan placement drawings and name each of the units required for fulfillment so that each piece can be labeled and tracked. The very best submittal (first phase) drawings identify all masonry assemblies and have as few dimensions as possible to be verified in the field. Submittal Drawings control all other dimensions the calculation of which are and should be the manufacturer's responsibility. The more unnecessary field

dimensions required the more confusing the approval processes with no appreciable advantage. Profiles of shapes, cross section interfaces and attachment interfaces will be included as well as plan placements for site direction.

Good submittal drawings include logical masonry assemblies, a column or window for example, profiles specified for each portion of the project, accurate cross sections and any special attachments required. Dimensions required for proper assembly will be added after all submittal drawings with minimum dimensions are complete and approved. This is more efficient for all concerned.

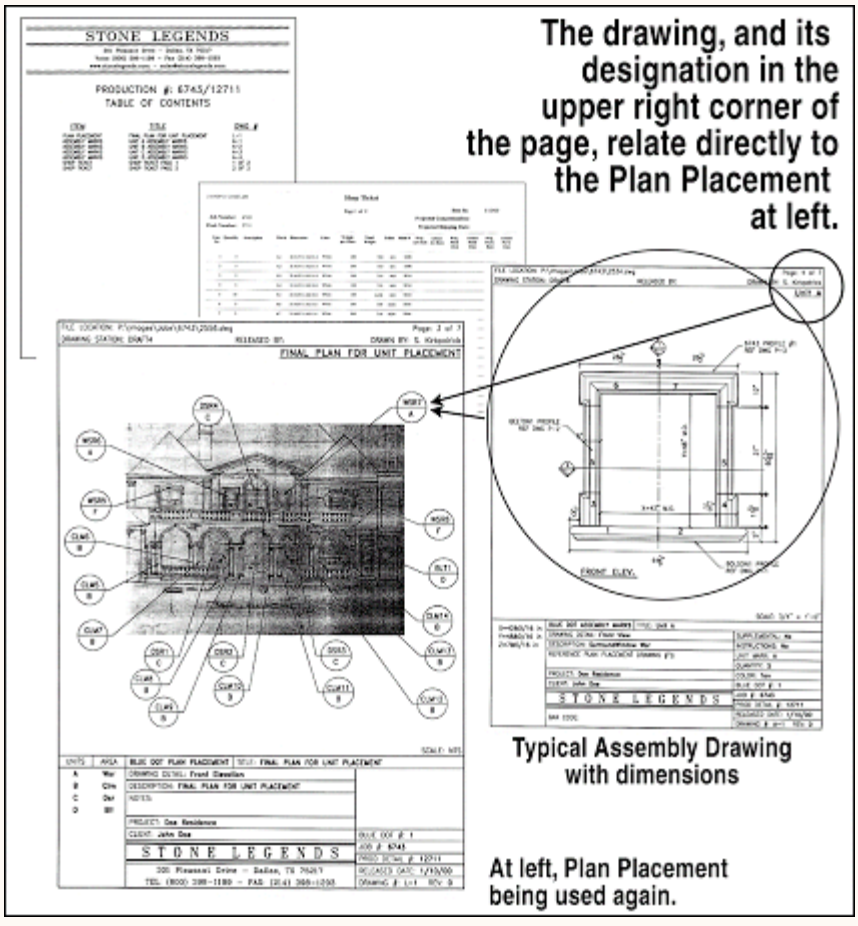
Part details and installation dimensions are all part of the installation detail. Submittal Plan Placement of the units on the structure aids in the verification of all quantities, linear foot and each units, and ensures that the customer is getting everything he thought he was going to get. Sometimes, we find that either something was overlooked by the estimator. Often, at this point, the customer expands the scope of the project to add more stone. Change orders are required in writing for deletions or additions to the original estimate to flush out all of the issues between the structure and the stone. This is the primary purpose of Submittals. Plus they dimensionalize the units identified so that the complete detail can be accomplished in one clean swoop.

At right is sample Installation Package. All of the dimensions needed by the mason have been finalized on the window surround drawing. The unit WSR 7 is clearly marked on the Plan Placement drawing as "A" and the part numbers are shown on the assembly drawing to the right. The parts relate back to the Production Shop Ticket (shown behind).

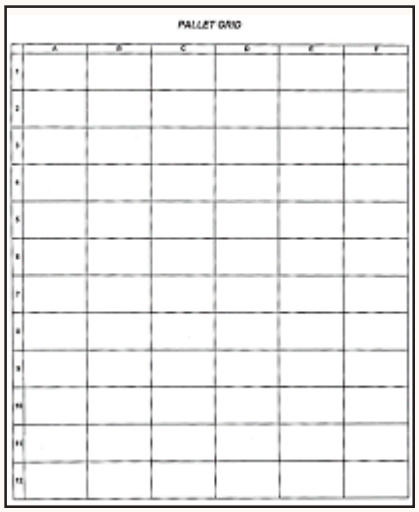
A side note: It is important at the Change Order phase that the client, who often feels vulnerable at this point, understands that the manufacturer is not taking advantage of the situation, but is consistent both in the pricing and the process of manufacturing the stone. In this area of trust, standardization can play an important role in the stability of and consumer confidence in the cast stone industry.

Phase 2: Installation Shop Drawings from the manufacturer

After the submittals are complete and approved, you are ready to move on to the next phase fabrication and installation drawings. The manufacturer takes the primary dimensions that were verified in the field, extrapolates all the part dimensions and part locations. And sets up an inventory tracking control. At that point, not only is the manufacturing process staged to begin production, but also the installation drawings that the mason will need for final setting. This includes more elaborate dimensions at joint spacings. Also all unit assemblies will be located on plan placements. Unit assembly drawings will also show each part mark and the proper dimension location within the unit assembly. Units are marked clearly by part numbers. At the beginning of production, the installer should receive a set of installation drawings…the completion of the Shop Drawing Phase. Shop Tickets and inventory control lists will be delivered with the stone, accompanied by the bill of lading.



Above is a photo of a well-managed inventory control of many intricate designs. Note the variety of stone, and the positions on the building. This was an historic preservation and reconstruction project. Great care was taken to match all of the original artwork and stone emblems.



A grid, such as at right of the photo, can be used to locate each individual pallet.

The mason will receive many of the same drawings in the submittal but referenced for installation purposes. For instance the plan placement would be established so that the units could be scattered around the building in a concise manner, a big help to the mason.

A good manufacturer should have an inventory list for each project and a cross-reference for each part from the pallet to the unit and the unit to the building. Very important in larger projects. Ask any mason to try it without them.

Following are some samples of documents needed.

Cross reference list:

Pallets to Parts to Units.
Units to Parts to Pallets.
Total units to Total parts to shipment of pallets.

When required, back ordered parts are noted as incomplete unit assemblies still in production. Not on this shipment. (Only valid with more than one truckload of stone.)

Cast Stone Do's and Don'ts

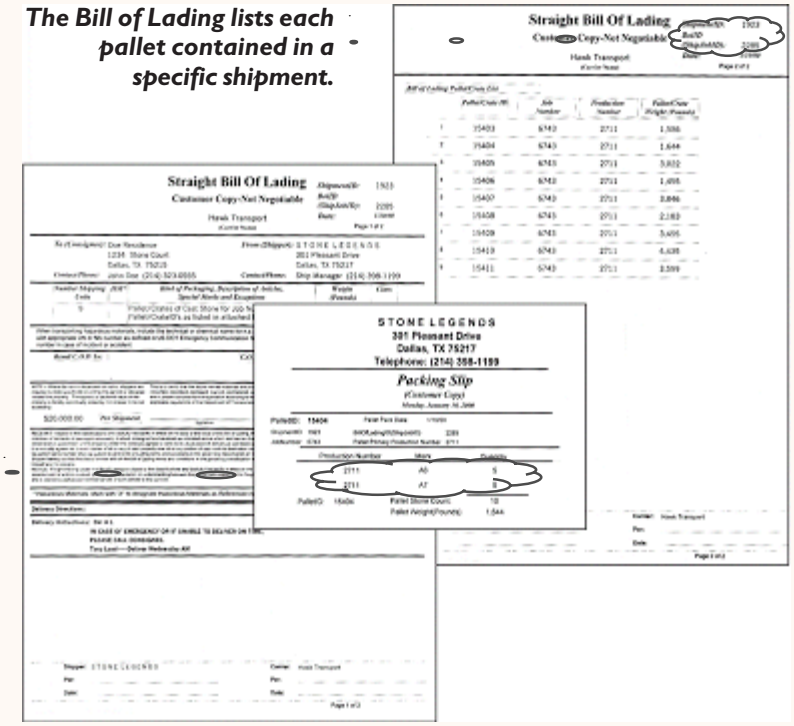
Do! Use profiles that are difficult in natural stone, but easy in cast stone. For instance, a detailed profile face with a lot of intricacy, not a flat face. The added cost is minimal, if any. The look you want is paramount. Instead of using custom profiles, look for opportunities to use existing profiles from the manufacturer.

Don't! Compromise what you want in cast stone for fear of price. Cast stone is not expensive; it is an investment in the future that will be there for centuries.

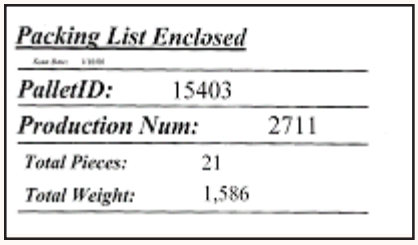
At right is a sample of a bar code tag. Each individual piece of stone should be tagged, as shown on the far right. Each of these tags is scanned as the stone is loaded on a pallet for shipping. The Pallet ID is then cross-referenced to the Bill of Lading.

At right are sample pages from a Bill of Lading and Packing Slip for each individual pallet. Note the Pallet ID is referenced to each Shipment ID so individual parts can be located quickly.

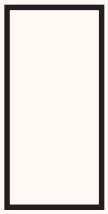
The Bill of Lading lists each pallet contained in a specific shipment.



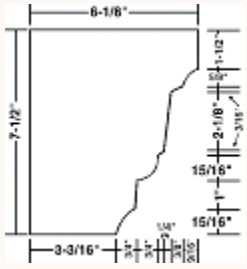
Packing slips list the part number and quantity contained on each pallet.



Each pallet is labeled with its ID number, as listed in the Bill of Lading, the production number, the number of pieces included and the total weight of the pallet and stone.



Don't!



Do!

Do! Pay the price for good design. The result is cleaner and more finished. And installation is simplified. Cast all angles whenever possible.

Don't! Miter-cut. Exceptions should be rare and are generally the result of poor planning. Sometimes it is a cost or time issue. Unavoidable and it shows.

Do! Repeat patterns of doors and windows as much as possible to take advantage of the repetitive capabilities of cast stone.

Do! Expect great shop drawings. They are the key to success.

Don't! Skimp on shop drawings. This is a vital process.

Do! Inventory control both at the manufacturer and especially on the job site. Does the manufacturer help with this?

Don't! Forget inventory control. It begins with good communication standards.

Do! Order early to give the manufacturer time to design and produce the order.

Don't! Delay the submittal process. It's hard to manufacture, even harder if schedules bottleneck. Typically, this delays the process more often than any other issue except for tardy orders.

Do! Take advantage of any and all standard products the manufacturer has.

Don't! Hesitate to make something custom to associate with other products the manufacturer has. Special connector pieces are simple and effective.

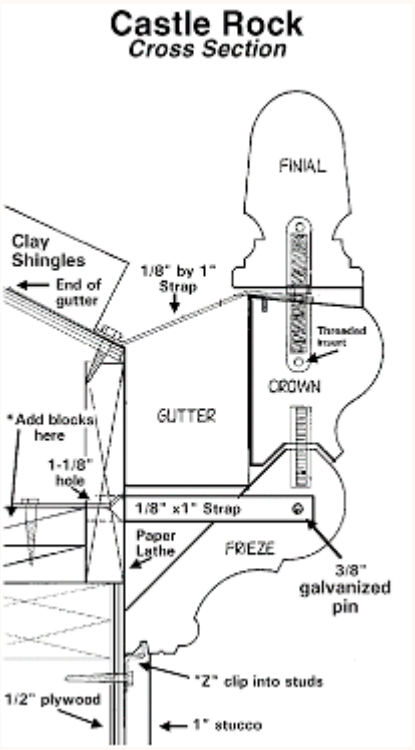
Do! Everything in writing!

Don't! Assume anything. It costs you money. Cast in stone means exactly what is says.

Screws designed for stone are very strong and easy to use.

Note: these clips were attached to the back of the stone, then to the building.

Many successful methods of installation can be used. At left is a radius window surround attached to the frame with medium-gauge brick ties that will be first covered by the stone and then by the mortar joining the cast stone surround to the stone wall.



The attaching clips in the photo above will be hidden in the joints. On the right side is a drawing of the total installation as it will look when completed. Note that the crown molding is on a radius.

Good flashing details are always an important part and come before the actual cast stone setting. Cast stone should never be considered a vapor barrier. For example, never use one stone that goes from the inside to the outside of a building.

One of the most popular and preferred methods is to use L-brackets and tapcon screws, which are designed to screw into the stone. This is a big hit with the masons. Here are several examples of how they use them.

Attachments

This could be a book all by itself. The best reference I have found on the subject is from the Indiana Limestone Institute. The type of structure, the purpose and the size of the stones will affect this discussion. Even the climate and geographic locations will affect the final system loading/stacking and stiffing/or suspending the stone all offer three basic techniques. Expansion and contraction joints, dead loading, suspended number of connections, weld plates, lintels and even special steel fabrications are all proven and have their place.

Structural versus Veneer Cast Stone

A commonly asked question is: "Can Cast Stone be used structurally?" The answer is yes, but there are many reasons for not doing so.

First let me say, I take exception to the word "structural" as it implies cast stone is not structural at times. Properly designed to meet a purpose is all about structure. To succeed, cast stone must be designed to use its strength, compression loading.

A project is based on so many factors that asking about structural cast stone only brings up more questions. What are the requirements? With steel reinforcements, cast stone can be designed to meet almost any need. It is a highly versatile material and can even be designed in a plastic cast like precast concrete and steel. Only the design mix gives a final product that more closely resembles stone. Normally, cast stone should be considered to have properties similar to natural stone. Cast stone's primary strength is compressive by nature.

The preferred method today is wrapping structural members, whether steel, masonry or wood frame, with stone rather than the stone itself being the building's structural support. The stone is primarily aesthetic. Load bearing versus veneer is situational and more about the building structure than the stone. This decision is impacted by ease of installation, experience levels and even freight charges for the stone versus other items. Properly designed cast stone can be either. But is best suited as an aesthetic veneer with great low maintenance characteristics.

Although it appears to be structural, this is actually a veneer surface around a steel superstructure. And, the cladding is self-supporting, with minimal attachments to the steel superstructure. This is an excellent alternative in many cases.

Above, thin, light-gauge stone panel are being sized and fitted on a wall like a veneer, in place of stucco or brick. This is a well-done, clever installation. This is an excellent approach that will be used more and more in the days to come.

The photo above is an example of masonry to masonry structure with veneer stone going up using adjustable clips. This aids the installer in keeping the wall true and plumb. Slots were cut on the job site.

Below is a shot of the full site still under construction.

These photos are examples of how cast stone can be used as a structural member. Note the crotches underneath have a steel plate on top of them. Which prevents the windowsill from pulling away from the building. However, the load is actually carried diagonally across the stone in compression. The stone is then pinned from the top to prevent it from sliding out. Therefore it becomes reinforcement for the steel or the angle brace. Quite clever. A very good job done by an excellent mason.

Final designs are dictated by what is required of the material. What structural demand will be placed on the cast stone? Just as there are many building codes that vary in different parts of the world, so do the design requirements vary to meet them. For instance, freeze/thaw considerations would not be relevant in southern Florida, but are essential in Colorado where the weather can cycle through freeze/thaw as many as 30 times in a single day. In special situations, the design mix can be altered to ensure the necessary results. However, with good basic formula design, no special exceptions should be necessary. Cast stone is good performer right out of the box.

In much the same way, other factors compel the manufacturer to include steel for safety in handling or to increase load-bearing strength. This would also include adaptations for fasteners cast into the stone. For instance, cast in slots or holes for attachments can greatly lessen installation labor and result in a faster installation. This is mostly relevant to large commercial jobs. Versatility is gained with simple tools. Grinders with diamond blades and drills are the primary attachment tools for slotting, screwing and drilling. This aspect is important. It is not always feasible to produce in concert with structural members of the building. Attachments are sometimes where you can make them rather than where you planned.

In cases where salt-water corrosion is a possibility, the steel may be replaced by fiber-glass reinforcement, which is already common in checking the effects of time and elements in highly corrosive environments such as hardscapes. Earthquake regulations severely affect the structure, attachments (much bigger), and installation systems of cast stone in California and other seismically active areas. Synthetic adhesives absorb the vibration and do not require a change from the manufacturer. Similar conditions are found in some wood structures supporting the stone laterally. Wood moves differently from stone. The adhesives resolve this also. Remember, nothing can make up for inadequate strength in a structural member.

Think about each stone as attached to the superstructure of the building. In residential, it is wood. In commercial buildings steel or masonry is typical. Lateral loading versus the foot print of the surface of each stone resting on another. Remember, stone is about using gravity, mass and compression to your design advantage. Never better demonstrated than Roman arches.

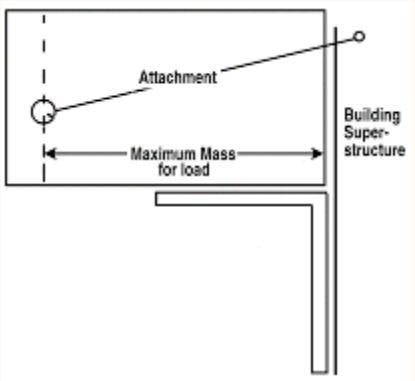
Structurally, cast stone is high in compressive strength, and low in flexural strength. Typically, the higher the one, the lower the other. Most favored and best method is to modulate the stone into smaller, manageable pieces and tie it to the building. Whether using a steel lintel or suspending the stone from above, the rules are always the same. Stone is heavy, so let gravity work for you. And since compression loading is favored, always maximize the mass suspended behind the load.

Because of the enormous number of panels found on this VA Hospital, a clip system was designed into the panels themselves, along with slots for final attachment. See the detail photo below of the overall photo. Note that one side is finished and the edge on to the camera has a cast-in slot for attaching to the building.

Finished edge.

Cast-in slot for attaching to the building.

For the engineers, steel can be embedded with good planning and provided the stones are large enough to offer ample room to place the steel. Odd shapes or too much steel make the practice unfeasible from a placement perspective. A cast stone manufacturer should be consulted in the design of engineering specifications regarding the feasibility of structural castings. Steel and stone expand and contract similarly. They go well together, but most often this is not the best solution.

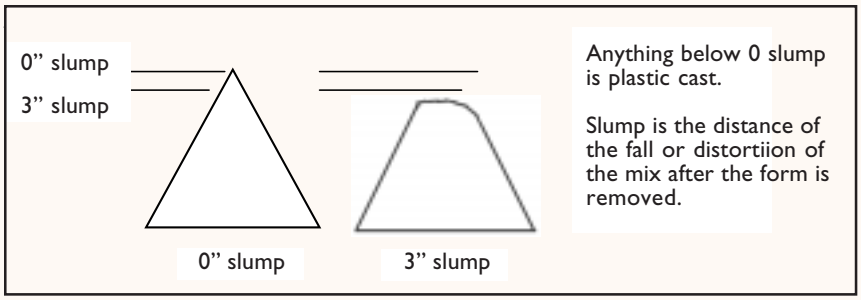


When necessary, attachments can be embedded, cast into the stone to help with the assembly process on the structure. It is not the preferred method because it involves another trade to do the task. It is not a pleasant task for the one responsible to coordinate.

Production Specifications and Mix Design

I'm not sure where the term VDT (Vibrant Dry Tamp) came from, but it is being used to describe the old-fashioned hand forging placement technique that only works with zero slump mix designs. I think the term "vibrant" refers to the pneumatic hammers used in the process. "D" Dry to the zero slump mix design. The "T" refers to tamping, and the people who hand forge the stone are called "tampers". Hand forging is, obviously, the most desired placement technique for a cast stone mix design that is moist but not liquid and packs nicely into virtually any shape enabling a refined finishing system. Much the same as building sand castles as children. We packed our buckets good and firm, and voila, we turned the bucket over and had the start of a sandcastle.

This is also the most difficult placement technique. During the manufacturing phase, the mix is literally pounded into stone. The result closely resembles natural limestone with high compressive strength and very low water absorption. Forging actually changes the silica quartz fines total contact surface area. The heat generated by friction forges the mix into a granular structure. The formal name for the mix design is "0" (zero) slump.



An alternative method is plastic casting (often referred to as "wet casting"). In plastic casting, the mix is placed as a liquid. It cannot be forged or compacted into place due to the viscosity. The plastic mix moves aside instead of compacting like the zero slump mix. This is done by adding more H_2O, which affects the strength of the final material. Sometimes the mix design is altered to compensate for loss of strength or water absorption. However, flaws, such as "bug holes" (trapped air pockets that leave small pits in the surface) are common in plastic cast material.

The final step in making the best cast stone is the drying process, called curing. Often overlooked, it is probably the most important aspect of the chemical reaction. At the first phase, because the stone is made very dry mix to accomplish the zero slump, the humidity must be raised to 100% to thoroughly hydrate the new stones. Which completes the catalyst process. Then it must be continued for a period of time, depending on the temperature in order to slow down the curing process. So the stone cures through and through, from the inside out. The secret is to cure the product slowly. This allows the molecular structure of the portland cement, the bonding agent, to align via magnetic polarity, a molecular principle in all glues. The longer the glue remains malleable, the more of those molecules align magnetically as they harden, like sticking a chain of magnets together, north to south; south to north and so on. This is the real magic of the chemical process which makes cast stone such a durable product.

The final step in making great cast stone…Hydrating the stone to slow down drying and increase overall strength. Note: the fog developing as the humidity is raised to 100%.

Cast Stone in the Information Age

Cast stone may be a product with ancient roots, but the information age and the advent of the computer have profoundly affected it. In today's economy, speed is always an issue. And speed is directly related to a manufacturer's ability to communicate at all levels. The complexity of the manufacturing process is a lesson in hydro dynamics only with information. On one scale of information management, "mom & pop", the steps are the same as on a large scale. The required volume of information increased exponentially with each option of shape, quickly burdening the communication for both customers and the manufacturer's employees. Formalizing standards will enable cast stone to be manufactured on an unprecedented scale and computers will undoubtedly play a major role in bringing this about. When all involved, especially the manufacturers employees, are well informed, it creates a trickle down of efficiencies for the project and results in quicker installations that are better done. Look at the organization of any manufacturer as a whole. Good communications will make the difference overall.

In Closing

I hope I have simplified your understanding of cast stone. It is a very complicated subject. I also hope I have given you valuable information that will help in future building design and making future choices of your manufacturers and your masons. But most of all a better understanding of what a great building component cast stone is and how much it can really affect what you do. I have no doubt that any effort or time you spend developing, researching cast stone for use in any project will be well worth the time. Your reward will be self-evident and a testament to generations yet unborn.

I am humbled and thankful just to have a chance to be a part of something so important to our culture. I've always been told to finish how you start. Cast stone provokes a certain aristocratic passion that touches us all and makes us feel a romantic part of our past.

Using cast stone is building for generations to come.
This helical exterior staircase is not only beautiful, it is virtually maintenance-free.