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**ConcreteWorks** is a publication of the [Alabama Concrete Industries Association](http://alconcrete.org) and features articles and photographs pertaining to product applications, educational opportunities, as well as innovative construction techniques impacting the industry.

Please email rlindsay@alconcrete.org with any comments regarding featured articles in ConcreteWorks or to suggest a story idea for a future edition.

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### Solid Ground

At Barber Marina, considerable amounts of concrete are proving once again that it is the go-to material when a project calls for the strength and durability to stand up to harsh environmental elements and severe weather.

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### Don’t Reinvent the Block?

Concrete block is versatile to be sure, but the talented students participating in the ACIA’s annual Student Masonry Competition each year continue to prove this. The 2012 winning project took the top prize for using block in an innovative way without trying to reinvent the material.

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### Perfect Fit

Most architects see their work as more passion than profession, and Hal Gandy’s career path proves that first loves are hard to leave.

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### Rolling Under the River

A project recently completed on the Alabama/Georgia border is using concrete in a truly unique way to create an attraction that has nature lovers, sporting enthusiasts, businesses and local leaders excited. (ON THE COVER)

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### Color Consistency in Masonry Mortar

Color issues in masonry mortar can be avoided, and with some basic guidelines in place, contractors can greatly reduce the chance of having color variability.

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### Acceptance Test Reports for Ready Mixed Concrete

Who should get acceptance test reports for ready mixed concrete? This article highlights industry standards and requirements.
At Barber Marina, considerable amounts of concrete are proving once again that it is the go-to material when a project calls for the strength and durability to stand up to harsh environmental elements and severe weather.

In the spring of 2008, the Barber Marina opened in Elberta, Ala., on Bay La Launch on the Intra-coastal Waterway just north of Orange Beach. It takes its name from its owner, George Barber, the same man who built the Barber Motorsports Park and Barber Vintage Motorsports Museum outside of Birmingham. Anyone who has visited the motorsports park knows how creative and committed Barber is: creative in his use of large-scale modern art pieces at a racetrack and committed to providing guests, race drivers and everyone who enters the park with a “best-of-the-best” experience. It is no different at the marina, a project that was in the works for three years before it was done. A long, winding drive off a county road weaves through stands of pine trees. If you look closely, you’ll see huge, quite lifelike dinosaur sculptures peeking out of the woods, as if they were going about their daily business. A replica of Stonehenge is currently going up in a clearing. And a giant metal spider greets you near the parking lot. These whimsical touches are a Barber signature and evidence of his desire to always get people talking.

“Mr. Barber is a true visionary,” said Matt Ingram, an engineer and the marina’s general manager. “He puts a lot of thought into everything he does; everything he does is top-notch, and is done right.” And doing his marina right called for massive amounts of concrete — well over one million yards — in almost all of its various forms. Poured concrete, concrete beams, concrete block and concrete pavers are all used to great effect in the marina, and Ingram explained why the material is practically everywhere you look. “The reason we went with so much concrete is simple: It is strong, durable and will last,” he said.

In one application, poured concrete helps protect the marina’s main residents. At any given time, it may house up to 375 boats in dry storage, and there are 175 wet slips. Being on the coast, the marina is responsible for keeping its clients’ boats...
THE REASON WE WENT WITH SO MUCH CONCRETE IS SIMPLE: IT IS STRONG, DURABLE AND WILL LAST.
(many of which are worth hundreds of thousands of dollars) safe in the event of a big storm. When a hurricane threatens the area, boats in the boatyard are tightly secured via cables to metal rings attached to a four-feet wide, two-feet thick concrete strip on the ground. “We know that concrete is not going anywhere,” Ingram said.

Across the parking lot from the boatyard, a 79,200-square-foot dry storage building sits on a 14-inch-thick concrete slab with steel reinforced fibers, and its frame is supported by various sizes of concrete beams. “The dry storage is our most heavily used building, so it has to be really strong; it like everything else on property was constructed to withstand a hurricane.”

Ingram is particularly proud of the marina’s floating dock, also made using concrete. “It fluctuates with the tide,” he said. “It is a unique system.” The surface of the dock is made of large concrete form modules filled with foam and then connected with rods. “The concrete here gives a nice, clean look, which is a hallmark of Barber’s projects,” Ingram added.

The concrete floating dock system does more than just look pretty though. This specific type of concrete dock is renowned for its durability and low life-cycle costs as evidenced by the fact that there are nearly 20 million square feet of them installed over the last half century. Thanks to concrete being the major material, they do not rot, burn or corrode, and they are non-polluting and environmentally friendly, all of which are important attributes for structures down on the Gulf Coast. The concrete surface is safe, as it is finished to be non-skid. Plus, concrete’s natural fire-resistance can lead to lower insurance costs.

Walkways and outdoor areas around the docks and the marina’s office and dock...
shop were constructed with concrete pavers in two contrasting shades of gray, again, to create the clean style that Mr. Barber is always after.

Finally, split-face concrete block is used for several retaining walls around the property. Ingram did some of the wall construction himself. “I love being hands on, but working with concrete block in the South Alabama summer heat can be taxing. It was a labor-intensive process, but well worth it,” he said. “It looks great, and because it is concrete, we know it will stand the test of time and the elements down here, just like the rest of the concrete we used.”

Ingram stressed that Barber marina prides itself on taking care of its customers. “Stellar service is one of our main offerings,” he said. “We live up to what we promise.” Knowing the importance they place on meeting and exceeding expectations, it is a good bet that Ingram, Mr. Barber and everyone at the marina expect the same level of service from anyone and anything they work with.

Yet another reason to choose concrete: Time after time, in myriad situations, it has shown it can deliver. And at Barber Marina, the proof is all around. CW
DON’T REINVENT
THE BLOCK
It’s an old saying, but true nonetheless: The best way to learn is to do. That’s the idea behind The Alabama Concrete Industry Association’s annual Student Masonry Competition. The event challenges third-year students in Auburn University’s school of Architecture, Planning and Landscape Architecture to design a project that makes effective use of masonry block. Thirty-nine third-year architecture students participated in the 2012 competition, and ACIA awarded $2,500 for tuition and/or university fees to the first and second place winners and two honorable mentions.

Each student’s competition project was actually part of a larger studio project they were already working on. They were instructed to select a portion of these projects to submit for judging that exemplified an interior and/or exterior wall condition and then present a detailed design development that included the investigation of concrete masonry unit construction,
assembly processes, structure, finish surface options for both exterior and interior conditions, innovative and traditional construction methods and custom masonry unit design applications.

Each project design was required to be represented with a minimum of three drawings: plan, section and three-dimensional (axonometric, perspective etc.), presented in a 20-foot by 32-foot format oriented vertically.

Sheri Schumacher, Associate Professor at Auburn’s school of Architecture, Planning and Landscape Architecture, is the architecture studio coordinator for third-year undergraduate students, and along with Associate Professor Doug Burleson and Professor Tarik Orgen, helped organize and execute the competition. “We are so happy to have ACIA’s continued support of our program with this competition,” she said.

She pointed to the importance of the very specific submission requirements. “The size limit in particular is very important since all three studios participating in the competition had different types of projects going,” she said. “The size limit means the judges were really comparing apples to apples.”

Schumacher also outlined how the competition benefits her students. “I can see that it allows students to understand more about material resources in direct relation to their studies,” she said. “The competition allows them insight from experts in the industry, which they then apply to their studio projects.”

The judges chosen each year are experts in their fields representing architecture’s academic and professional communities, and this year the panel included Professors Gaines Blackwell and Robert Brooks as well as Alex Krumdieck of A+ I Design Inc. in Birmingham and an Auburn University Adjunct Faculty member. They set the bar high and were looking for some very specific criteria: a design that exemplified tectonic understanding, innovative application and exemplary use of architectural masonry units.

Michael Brudi’s project fit the bill and earned him 1st place and $1,500 for tuition. “His use of concrete masonry units was combined with a transparent bio-resin sheet material, and the judges were really interested in his level of innovation and his clarity, which was shown through his multiple scales,” Schumacher said. “It was apparent that he had a firm understanding of how to realize his project as a whole.”

Brudi’s own words on his presentation best describe the concept and purpose of his block wall. “The thirty-foot high wall serves as a partition between two gallery spaces that are opposites in scale and light condition. The creation of voids between each course of masonry would allow for the transmittance of light and visual interaction between the two galleries.” Various treatments of the edges of the bio-resin used in the voids purposely contrast with the “rough, tactile nature of the masonry” and encourage physical interaction with the wall.

Krumdieck explained what stood out in Brudi’s design. “I thought all the projects submitted were pretty good, especially considering the rather short time they had to come up with them,” he said. “But what impressed us in the winning project was
that it understood the idea and the inherent qualities of concrete block. It didn’t try to completely reinvent it.”

Brudi’s project used block in a retaining wall, but by replacing the mortar joints with bio-resin sheet material, he created some transparency in the structure. “That was unique because when most people think of a block wall, they think of heavy and thick and modular, but Brudi’s design challenges these pre-existing ideas. His wall was lighter,” Krumdieck said. “It is really a very simple idea and notion, but it really turned the ideas about what block can do and be on their heads and was very successful in doing that.”

Some of the other projects tried to reinvent concrete masonry units by applying new technology; according the Krumdieck all of the projects fell into two categories. “One included the projects trying to use it and understand it as it is; the other contained the projects trying to use technology to change it,” he said.

While each of the projects had some deficiencies, it was obvious to Krumdieck and the other judges that the students worked hard. “I could tell they all did a lot of research into the material,” he said. He stressed that this is why the competition is so beneficial to the students’ education. “The focused application of using block that comes with participating in the competition helps them have better understanding of the material, and that’s always good,” he said. “Any time you can get more in-depth knowledge of what you are working with, for an architect, that’s a great thing.”

Schumacher agreed; she has been at Auburn for 26 years and involved with the competition in the past. Every time, she’s impressed by how much the students learn. “What I thought was remarkable was that in such a short period of time that students could gain so much knowledge about the concrete industry,” she said. “And it is amazing to watch them investigate innovative ways to use off-the-shelf products.”

"THE COMPETITION ALLOWS THEM INSIGHT FROM EXPERTS IN THE INDUSTRY, WHICH THEY THEN APPLY TO THEIR STUDIO PROJECTS."
Fate can be quite forgiving; even when we take a wrong turn, we can still eventually end up right where we were always meant to be. Growing up with an architect father, Hal Gandy, principal at PH&J Architects in Montgomery, was exposed to the profession early and often. He even considered following in his father’s footsteps throughout his childhood and adolescence. But after high school, he ended up at Auburn University Montgomery (AUM) and earned his degree in business. “I’d always been interested in architecture and had thought that I would end up being an architect, but by the time I got to college, I wasn’t really sure what I wanted,” he said. “I kind of fell into the business degree.”

Not long after graduation though, he realized the job options he was facing were not a good fit, and so he turned back to the aspirations of his younger self and enrolled in the architecture program at Auburn University. “I’d always been interested in architecture and had thought that I would end up being an architect, but by the time I got to college, I wasn’t really sure what I wanted,” he said. “I kind of fell into the business degree.”

Today, 25 years later, it’s clear he made the right decision. The pleasure he takes in his
profession is obvious in his easy manner and smile when he talks about projects he is proud of and the iconic works of architecture that inspire him. “Architecture just drew me back,” he said. “I’d always loved it, and when I realized that I wanted to do something technical and tangible, architecture fit that bill.”

After his second graduation, he worked with an architecture firm in Opelika for four years before coming back home to Montgomery and going to work with this father’s firm, PH&J. “I’ve never left,” he said, proving that once again, he’d made a solid choice. And working with his dad? “I’ve truly enjoyed it,” he said. “I know some sons may not be able to say that, but we really get along and work well together.”

John Gandy just recently retired. “I’ll miss him being here,” Gandy said. Gandy will keep on going without his dad around the corner, mainly because he’s happy doing what he does. “The design process in architecture is a big part of what I love about it,” he said. “I love the problem solving, having a set of parameters and working to come up with a solution that works within those parameters. There is no better reward than when a client is satisfied; when they are happy, the work is all worthwhile.”

PH&J specializes in large-scale public buildings: schools, churches, banks,

SAY HELLO TO HAL

Get to know Montgomery architect Hal Gandy a bit better through his responses to our random Q&A.

CW: What are your hobbies?
HG: I love to travel, particularly out West to the desert states and the Rocky Mountains. I also run with a group of other architects and am looking forward to running a half-marathon in Myrtle Beach soon.

CW: What are your favorite pieces of architecture?
HG: The Guggenheim Museum in New York City, San Chappelle in Paris and the First Christian Church in Columbus, Indiana, by Eliel Saarinen. My taste is very eclectic. I like buildings that are dramatic either in form or technological innovation but that maintain a human scale to them.

CW: What is the one tool you can’t live without?
HG: My pocketknife.

CW: What’s the last book you read?
HG: I’m just finishing a science-fiction novel called “REAMDE” about a guy who has invented this online game world and the lines between what’s real and what’s not get blurred. It’s really interesting and timely.

CW: If you could have dinner with anyone, dead or alive, who would it be and why?
HG: Benjamin Franklin. I think it would be interesting to tell him about all the advancements and discoveries in science that have happened since he’s been gone and see his reaction to today’s technology.

CW: What’s your favorite food?
HG: My favorite foods kind of combine with my love of travel. I love any Italian food, but I really love seafood and love the Dungeness crab out in places like San Francisco and Monterey. I also like a good bottle of wine and some cheese.
“THE DESIGN PROCESS IN ARCHITECTURE IS A BIG PART OF WHAT I LOVE ABOUT IT.”
hospitals, government buildings and such. And in these projects, concrete is the material that helps Gandy find those solutions he’s after. “Public buildings need to last and last for a long time, and concrete is an enduring, durable material,” he said. Its inherent fireproof properties also make it stand out. “When dealing with high-rise buildings particularly, its fire-resistance is a huge plus. If you used steel, you’d have to take extra steps.”

Gandy has also used concrete to overcome design challenges, one at a client’s specific request. “We did the RSA headquarters in downtown Montgomery, and that was big foray into post-tensioned concrete,” Gandy said. “The client really wanted us to do some larger spans without columns.”

ACIA helped Gandy figure out the best way to accomplish this, and the result turned out perfect. “We produced 50-foot clear spans on that project,” Gandy said. “I’m proud of that one.” That RSA building also used precast concrete panels on the exterior as well as concrete pavers on the walks in addition to the post-tensioned concrete structural system.

Gandy also likes concrete for its flexibility when it comes to non-structural applications. “We actually do a lot of precast panels and cornices, and use a lot of CMU and concrete pavers for decorative elements on projects, especially in the work we do for the state’s community college system,” he said. “We’ve done many pedestrian walks and paths on community college campuses composed of concrete pavers. Concrete is very versatile in this way, and concrete decorative elements really stand up and hold up.”

“Standing up” and “holding up” are crucial components of a project’s long-term cost and value, as Gandy stressed. “We always want to provide the structure’s owner with a material that will stand up to the environment and not require a lot of maintenance,” he said. “You can use a cheaper material at the outset and get a lower initial cost, but if you have to replace it 10 years later, you have not really saved money. But even for the original cost, precast concrete in particular is usually very reasonable in price and is more cost-effective and better fits budgets than many other materials.”

Gandy also chooses concrete for its sustainability, an aspect that was not really on the radar when he began his career but has grown into a crucial element for many projects.

“Sustainability was almost a non issue when I started, but now it is a big deal and really has become second nature to us,” he said. “Concrete works well in that regard too.”

TOP: Calhoun Community College Health Sciences Building.
Gandy pointed to a project he and his firm just recently completed — a LEED-certified project for Calhoun Community College in North Alabama that was able to re-use concrete components that were more than 50 years old. “It was a simple concrete block and concrete frame building with a pre-stressed concrete roof that had been built in the 60s,” he said. “The concrete bones were still in great shape, so we were able to reuse the existing building and retained the roof structure, which was used to support a new metal roof system. We just refurbished it and repurposed it for its new life as the Alabama Center for Excellence in Clean Energy Technology at the community college.”

Even the existing concrete floor that was soiled with 40 years of dirt and oil was easily transformed by being stained and polished to provide another 40-plus years of service. Other concrete elements included a new, extensive concrete paver system that was part of a pervious system designed to move storm water into the ground and keep it from running off site.

Had the frame been constructed from another material all those decades ago, steel for instance, Gandy may have found some deterioration or a part of the structure that would not work with the new loads. “We didn’t have any of those issues with the old concrete,” he said.

Other sustainable strategies in the building included rainwater harvesting to minimize the amount of water used when flushing toilets; ground source geothermal heat pumps for heating and air conditioning; solar water heating; high efficiency LED light fixtures; recycling of construction and demolition waste materials; and photovoltaic generation of electricity.

An emphasis on sustainability is just one of the changes to come about during Gandy’s career. Another is the quality of concrete available. “Higher-strength concrete is much more attainable that it was 20 years ago,” he said.

Gandy sees the current economy as a challenge to architects, as it is for so many businesses today. Another change that can sometimes be a challenge is the shift in roles when it comes to project management. “We now see contractors trying to play a larger part in project leadership,” he said. “Collaborative models for project delivery are becoming more prevalent. That is not necessarily a bad thing so long as the public health, safety and welfare are protected along with the Owner’s interests. On public works projects the tax payers’ interests must be protected, which is nearly impossible to do unless construction contracts are competitively bid.”

Despite spending more than 20 years as an architect already, Gandy feels that he is only about halfway through his career. “I still enjoy what I do, and I’m looking forward to helping carry the firm into the future and bringing in young architects and mentoring them as they grow in the profession,” he said. Enjoying the mentoring process and camaraderie with fellow architects in all stages of their careers is one reason he serves on the AIA state council’s executive committee.

He expressed his appreciation to those who helped guide him. “My father was certainly a mentor. One important thing he always practiced was that the guiding principle when it comes to design is appropriateness,” he said. “You have to determine what is appropriate for each project; the scale, the materials, articulating the materials and forms in a way that expresses the intent of the design.”

Another mentor was Jim Johnston, the sole practitioner Gandy went to work for in Opelika right out of school. “I learned a lot about the business side of architecture and about construction from him,” he said. “And I have to also mention a senior partner in my firm, Griff Harris; I’ve learned a lot from him, too.”

Just as Gandy ended up in the same profession as his father, it looks like at least one of his two sons will be working in the same industry. “My oldest son Alex has just graduated from Auburn with his degree in building science and is going back to school get his master’s degree in design build,” Gandy said. His younger son Michael is attending AUM. But Gandy is not putting pressure on either to be or do a certain thing. “They’ll figure out where they need to be,” he said. Just like their dad did.
“WE ALWAYS WANT TO PROVIDE THE STRUCTURE’S OWNER WITH A MATERIAL THAT WILL STAND UP TO THE ENVIRONMENT AND NOT REQUIRE A LOT OF MAINTENANCE”
ROLLING UNDER THE RIVER
The thrill of paddling over and through rushing rapids on a fast-flowing river is one that more and more people are looking to experience. Plenty of the Southeast’s abundant rivers provide exciting whitewater opportunities naturally. But now, Scott Bridge Company, on behalf of the Army Corps of Engineers and Uptown Columbus, is creating a manmade whitewater course on a stretch of the Chattahoochee River straddling the Alabama and Georgia state line that is currently moving at a much gentler pace. And they are using concrete to do it.

The whitewater course runs right through downtown Columbus, Ga., and on toward Phenix City, Ala. “It is going to be great for both cities,” Senior Project Manager with Scott Bridge Stephen Summers said. Now completed, the 2.5-mile-long course is the longest “urban whitewater” course in the world, and its class 1 to class 4 rapids provide a truly unique recreational experience for paddlers — whether they are in rafts, canoes or kayaks — from around the country and around the world.

The project also benefits the area’s natural environment by restoring habitat for native plants and animals. And then there are the massive economic impacts, expected to come for both Columbus and Phenix City as visitors increase the cities’ sales and hotel tax revenues and create new jobs. Two whitewater outfitters were recently chosen to provide access to the course, one in Columbus and one in downtown Phenix City.

It all began in 2010 when city leaders in both government and the private sector in Columbus announced the Chattahoochee River Restoration Project. The goal was to return the Chattahoochee River to the place of prominence it once held in the area, back when it provided transportation and power for industry, and this restoration will make it an economic engine for the region once again.
NO ONE HAS EVER DONE ANYTHING LIKE THIS BEFORE, IN AN URBAN, DOWNTOWN AREA
The section of the river that was transformed is dotted with old mills, several of which depended on two area dams to operate. These dams changed the natural course of the river, and the whitewater course project tore them down and returned the flow to its original state for the first time since 1828. “We removed two old dams that were built for local cotton mills,” Summers said. “One is over 130 years old, but it had to go; you cannot whitewater raft over a dam.”

The course also features a wave-shaper device to make it more challenging. A pedestrian bridge from the Columbus Riverwalk onto one of the islands in the river allows the public a spectacular view of the newly created rapids. “We refurbished the 14th Street Bridge and made it a walkway,” Summers said. “It is a great viewing area for folks to watch rafters coming through.”

Scott Bridge got started on this project in September 2011, and Summers explained the role concrete is playing. “We have reconfigured the placement of existing boulders to re-contour the bottom of the river and create the rapids, and we used concrete to grout the rocks together and hold them in place,” he said. “Concrete was by far the best choice due to its durability and its flowability.”

Summers said his company has never worked on a project like this before, and it took a few tries to get the concrete mix just right. “We’ve never done anything like this before; it is really special,” he said. “We used several different mixes and settled on using a fiber mix to get it flowable. Some of the grout has gone eight to ten feet deep, and some we had to do in layers.”

One challenge has been working on the project with water still in the riverbed. “No one has ever done anything like this before, in an urban, downtown area,” Summers said. “Other projects like this have had the luxury of dams that can cut the flow of the water off. But here, we are dealing with a constant river flow. There are three states fighting over the water this river provides, so there is always at least some water coming through, and that has been a real hurdle, but one we have overcome.”

The project opened Memorial Day weekend. “Everyone involved is really excited about it,” Summers said. “And concrete has done the job well. It has definitely performed up to our expectations.”

TOP: Group gathers to experience and watch the newly completed urban whitewater coarse near Phenix City, Alabama.
"WE HAVE RECONFIGURED THE PLACEMENT OF EXISTING BOULDERS TO RE-CONTOUR THE BOTTOM OF THE RIVER AND CREATE THE RAPIDS"
It does not matter how expensive or elaborate the project is, it can be ruined if the masonry mortar has variability in color. Even slight differences in the color can stand out, and may be the first thing a person notices when they see the project for the first time. Correcting these issues can be very expensive, and sometimes the only solution may be to tear it out and start over. Color issues can be avoided, however. There are some basic guidelines that masonry contractors can follow that will greatly reduce the chances of having color variability in the masonry mortar.
THE SAMPLE PANEL IS CRITICAL, BECAUSE IT WILL BE MUCH MORE REPRESENTATIVE OF THE MASONRY WORK
**PROJECT SPOTLIGHT**

**PRIOR TO CONSTRUCTION**

Colors for the masonry units and the masonry mortar will be selected prior to construction by the owner and/or architect. They may be selected by viewing sample products, color charts, or existing structures. However, they are selected, it is recommended that new sample panels be constructed prior to the start of the job with the actual job site materials that will be used on the project. It should be constructed by the same masonry contractor that will be actually performing the work for the structure. The mortar should be mixed in the same manner and batch size that will be used for the project. The mortar joints for the sample panel should be the same types that are planned for the project. Timing of the tooling of the sample panel should be performed carefully. Sample panels are small, and it may be tempting to tool the joints too quickly. The sample panel is critical, because it will be much more representative of the masonry work than anything else that may be seen prior to construction. The brick and mortar samples in a showroom may look quite different once they are in an actual wall. This is not necessarily anyone’s fault, it is just a fact that materials and workmanship may vary.

**DELIVERY OF MATERIALS**

If it is possible, all masonry units and mortar material should be purchased and delivered to the project at once. This will help ensure that materials are all from the same run and are consistent. This may not be possible on large projects, due to time and storage constraints. If this is the case, the manufacturer of the masonry units and masonry cement may be able to store the same run of products at their site. You want to be able to avoid a situation such as needing 10 more bags of colored masonry cement to go with 500 bags that were produced three months before. Materials manufacturers obviously try to keep their products consistent within reasonable tolerances, but their sources and processes may change over time.

**STORAGE OF MATERIALS**

Masonry units should be kept on pallets and should be covered. This will help in keeping the moisture content of the units consistent. Variability in moisture content of masonry units is a common cause of color variations in the mortar. Unless a masonry unit is 100% saturated, it will draw water out of the mortar into the unit. This loss of water in the mortar will affect the color. If there is significant variability in unit moisture, then there may be noticeable color differences in the mortar.

Masonry sand should also be kept covered. This will help maintain consistent moisture content and also keep out debris. Sand for masonry mortar is added to the batch by volume and moisture content affects the volume. This change in volume due to moisture content is known as bulking. A given amount of dry sand will occupy more volume than the same amount of sand will when it is wet. Maintaining consistent moisture will help to keep the sand content per batch consistent. Variations in the sand content will affect water demand of the mortar and this may affect color.

Bags of masonry cement should be delivered to the project on pallets, and they should remain on the pallets. The pallets should be carefully covered with plastic to keep the bags completely dry. Mortar Proportions and Mixing

Once construction begins, the name of the game is consistency. Do every thing you do the same, batch to batch, day to day. The mortar batch size that is used should always be based on full bags of masonry cement. Do not use a batch size that requires you to try and split bags. The bags never get evenly split, and the left over portion may get wet or contaminated. The amount of masonry sand used for the mortar should be in accordance with ASTM C 270 “Standard Specification for Mortar for Unit Masonry”. Sand should be measured in a one cubic foot box to ensure accuracy from batch to batch. A common, but inappropriate, method for measuring the sand is to simply count shovel fulls as they go into the mixer.

The amount of water required for the right mortar consistency will be apparent after the first few batches. The water should be measured out in a five gallon bucket or some other container that can be marked. Adjustments to the water may have to be made depending on the weather and/or how well the moisture content of the sand is maintained. It is extremely important to try and maintain the mortar consistency from batch to batch. Try and have the same person do all of the proportioning and mixing for each batch. Have that person train one or more other people to do it when he or she is not available. Remember, consistency is the name of the game to avoid color problems.

An option that can help eliminate variances in mixture proportions is to use pre-blended dry masonry mortar that is available from a number of suppliers. The product is proportioned according to ASTM C 270 and all that has to be added is water. It is usually available in bags or 3000 lb bulk sacks.
TOOLING OF JOINTS
The final tooling, or striking, of joints, can have a huge impact on the resulting color of the mortar. As with everything else mentioned, consistency is the key. The timing of this procedure is what is so important. If the joints are tooled too early, when the mortar is still very plastic, a high water content paste may be pulled to the joint surface. This can result in a porous, light-colored surface. If the joint is tooled too late when the mortar is stiff, the mortar is not compacted, and there is friction between the metal jointer and mortar, and this can cause the color to be too dark. The joint should be tooled when the mortar is “thumbprint hard.” That is, hard enough to allow an impression, but not too soft to push the mortar out of the joint.

The masons have to be very careful with their joint timing. One common problem is at the end of the day. The masons may want to strike the last remaining courses of work all at one time and go home, rather than waiting for the proper jointing time. This is why you can sometimes tell where one days work ends and another starts. The end of the previous days joints are lighter in color because they were struck too early.

CLEANING OF MASONRY
When it comes to cleaning masonry units, the less you have to do the better. If the masons are careful during construction, they can reduce the need for excessive cleaning. As mentioned above, tooling the joints at the proper time is critical to achieving the correct color. It also has an impact on how much mortar gets on the masonry units. When joints are tooled too early, mortar can get smeared and splattered all over the units. The less they get on the units, the less they have to clean.

There are numerous methods for cleaning masonry units. The main interest here is on color consistency, so the details of each method will not be discussed. The key point regarding color is that any cleaning solution that is to be used on the masonry units and mortar should be done so in strict accordance with the manufacturer’s recommendations. Cleaning products that contain acid can damage the mortar and affect the color, sometimes drastically, if not used properly. Most of these products are mixed and diluted, so close attention must be paid to the proper proportions. The use of muriatic acid should be avoided. Only used products specifically made for cleaning masonry. CW

SUMMARY OF KEY POINTS
- Prepare sample panels
- Order enough materials for the job
- Safely store sand and masonry cement
- Be consistent in batching
- Tool joints at the proper time
- Use extreme caution with cleaning solutions
The process of testing concrete is reasonably well established for quality assurance of ready mixed concrete delivered to projects. The owner or his representative hires an independent testing and/or inspection agency to perform quality assurance functions during the construction of the Work. Industry standards provide requirements for the following:

- Qualification of testing agencies and testing technicians;
- Frequency of testing;
- Standardized procedures for obtaining samples and performing tests;
- Acceptance criteria for fresh and hardened concrete tests; and
- Referee testing and criteria for tests that fail to meet the acceptance criteria.

Standards require the concrete supplier to maintain a quality control plan and to take steps to respond to situations when test results are trending towards potential noncompliance. Prior to a project, the supplier is required to use a complete test record from previous projects as a basis for establishing their concrete mixture proportions and properties for new work and to provide this documentation in a submittal to the engineer of record.

To meet these requirements, it is essential that the concrete supplier be provided ALL reports of acceptance tests performed on the concrete mixtures delivered during the progress of a project. These test reports should be provided in a timely manner so that proactive action can be taken to ensure that specified requirements for concrete, especially strength, are not violated. When low-strength problems occur, considerable time and money is expended to evaluate the cause and to take corrective action. It is thereby beneficial to all parties to minimize the risk of low-strength concrete.

Why is the distribution of test reports an issue? Some testing agencies do not provide test reports to concrete suppliers because they believe these reports should only go to the entity that contracted with them for the testing services. Some believe that distribution of test reports to several entities increases their cost, although this concern should be less of an issue with the widespread availability of electronic communication. Some testing agencies only provide failing strength test results to concrete suppliers to notify them that a problem exists. Clearly, this is undesirable because if previous tests were provided and a trend was observed, the failing test result could have likely been avoided.

Many concrete producers have established relationships with local testing agencies to ensure that test reports of all tests performed on their concrete are distributed to them. Web-based test reporting systems also exist whereby test reports posted can be accessed by pertinent project team members.

Important revisions were approved in the ACI 318-11 Building Code for Structural Concrete to address issues related to testing of concrete and reporting of results. Section 5.6.1 of ACI 318-11 has been revised to address distribution of test results. The following is the excerpt from the code:
MANY CONCRETE PRODUCERS HAVE ESTABLISHED RELATIONSHIPS WITH LOCAL TESTING AGENCIES TO ENSURE THAT TEST REPORTS OF ALL TESTS PERFORMED ON THEIR CONCRETE ARE DISTRIBUTED TO THEM.
All reports of acceptance tests shall be provided to the licensed design professional, contractor, concrete producer, and, when requested, to the owner and the building official.

The following is the discussion in the commentary to this code provision:

The code requires testing reports to be distributed to the parties responsible for the design, construction, and approval of the work. Such distribution of test reports should be indicated in contracts for inspection and testing services. Prompt distribution of testing reports allows for timely identification of either compliance or the need for corrective action. A complete record of testing allows the concrete producer to reliably establish the required average strength $f_{c'}$ for future work.

This commentary highlights the fact that distribution of test results is important not only to the current project, but also to quantify the level of quality control (measured by the standard deviation of strength test results) of the concrete supplier. While a component of this variability is attributed to testing, a measure of standard deviation allows for continuous improvement and facilitates better optimization of concrete mixtures at reduced cost for future projects. A complete test record from past projects is required for use as the basis of a submittal for future work.

The engineer of record or other owner’s representative should ensure that the distribution list of test reports includes the entities listed in ACI 318. ACI Committee 311 publishes ACI 311.6, Specification for Ready Mixed Concrete Testing Services, which can be used by the owner as part of the contract for testing and inspection on projects. One of the mandatory checklist items that needs to be completed to make this a complete specification is on the agency’s responsibility for submittal of reports to include timelines, methods of delivery, and the distribution list. The distribution list defined in the contract with the testing agency should include the concrete supplier and all the other parties listed in ACI 318-11.

Another revision to ACI 318-11 regarding testing is that it now requires testing agencies to comply with ASTM C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation. This has been a requirement in ACI 301, Specification for Structural Concrete, and ASTM C94, Specification for Ready Mixed Concrete. It is now a code requirement. ASTM C1077 establishes quality systems for testing agencies, requiring labs to have periodic inspections of their procedures and equipment, verifies qualifications of testing technicians and requires laboratories to participate in proficiency sample testing. Proficiency sample testing allows labs to compare their results to those of other labs when the same material is tested. The validation that a laboratory complies with ASTM C1077 is obtained through an accreditation program provided by several national and local entities. ACI 318 does not require the testing agency to be accredited. ACI 311.6 goes this extra step to require testing agencies to be accredited and lists acceptable accreditation programs.

If someone manufactures a product, it is imperative that information on the evaluation of the product be provided to the manufacturer. This is not only in the interest of the manufacturer but also to the owner who uses the product. Avoiding problems with test results will save time, money and prevent delays in project schedules due to these evaluations.

Colin Lobo, Ph.D., P.E., is senior vice president, engineering, at NRMCA.

REFERENCES
ACI 301-10, Specifications for Structural Concrete. Farmington Hills, MI: American Concrete Institute (www.concrete.org).

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