Survey Highlights:
The 2005 NRMCA Industry Data Survey and The 2005 NRMCA Fleet Benchmarking and Costs Survey

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Highlights of the 2005 NRMCA Industry Data Survey

By Mike Forster, CPA, Vice President of Finance & Administration, NRMCA

Background
The Business Administration Committee of the National Ready Mixed Concrete Association annually administers the Industry Data Survey to measure performance as a health check for the ready mixed concrete industry. The survey is confidential and is administered by an independent certified public accounting firm. Individual company details are restricted to the company submitting the survey and the accounting firm. The compiled report provides significant amounts of sales and cost data, both regional and national, that producers may use to measure their performance against averages of other industry participants.

Trends
The 2005 survey includes results for 164 respondents, an increase from the 2004 participation level of 155 respondents and close to the 2003 level of 166 survey responses. The average sales for the 164 companies responding with data for 2004 increased again this year to $50,522,832, after doubling from 2002 to 2003; (the average sales reported for 2002 was $22,062,804 versus $44,215,463 for 2003). This indicates that increasingly larger companies are impacting the survey results.

The average net sales price per cubic yard of concrete for a “Typical NRMCA Member” grew from $68.04/cyd in 2003 to $69.44/cyd in 2004, a net gain of $1.40/cyd. For 2004, “Industry Leaders” that fell into the top 25% of overall performance had an average net sales price of $72.77/cyd, compared to $72.81/cyd in 2003, essentially flat year to year.

Since 1999 when the pre-tax profit peaked at $5.27/cyd, the industry average for the Typical NRMCA Member began declining steadily through 2002, finishing at $1.58/cyd. The pre-tax profit decline was driven by rising costs in all cate-
gories, most notably material costs that increased more rapidly than the net sales price during the period. However, for 2003, the pre-tax profit rebounded to $2.30/cyd, and the climb continues in 2004 to $2.98/cyd. The pre-tax profit for Industry Leaders rebounded from the decline experienced in 2003 when it fell from $4.63/cyd in 2002 to $4.44/cyd in 2003 (down $0.19/cyd); rebounding significantly in 2004 to $6.55/cyd (up $2.11/cyd).

For the Typical NRMCA Member, total variable costs per cubic yard increased $0.48/cyd from 2003 to 2004, growing from $53.93/cyd to $54.41/cyd respectively. The slight gain in variable
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costs (which includes material costs — namely cement) did not increase as much as anticipated, implying that the pricing effects of cement supply should be more prominent in the data for 2005. Subsequently, the contribution margin actually increased nicely $0.92/cyd (from $14.11/cyd in 2003 to $15.03/cyd in 2004). The differential results from the increased net sales price, which is offset slightly by moderate increases for variable and fixed costs.

Summary

While the pre-tax profit continued to rebound and grow from $2.30/cyd in 2003 to $2.98/cyd in 2004, the survey data indicates that the Typical NRMCA Member benefited from economies of scale as the average size of the responding companies continued to grow. Larger scale provides advantages for price-volume purchasing of raw materials; opportunities to spread fixed costs more uniformly across company operations and the opportunity to effect better management control over operations. The survey results appear to support elements of these occurrences.

The Industry Data Survey is a valuable performance measurement tool for benchmarking the ready mixed concrete industry. Although participation levels and company mix vary slightly from year to year, both nationally and regionally, the survey results are deemed statistically valid based on the sample size and grow more statistically valid as increased numbers of producers participate. The National Ready Mixed Concrete Association continues stressing the confidentiality of individual data submitted by participants and encouraging increased participation that is vital to gain the best measure of industry performance. Participants in the survey receive a full detailed copy of the results alongside an individual company profile that makes it easy to evaluate performance against compiled industry averages while also having the distinction of being able to highlight operational areas that might require attention to increase efficiency.

For more information about NRMCA’s Industry Data Survey and other industry benchmarking tools, please contact Forster at mforster@nrmca.org or 240/485-1130.
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Control Charts

An Important Tool in Quality Control to Save Money

By Colin L. Lobo, Ph.D., P.E.,
Vice President of Engineering, NRMCA

When the quality control team at a ready mixed company is not running around putting out fires or generally keeping busy with ensuring that they meet the company’s production targets, there are real opportunities for being proactive with controlling their processes and contributing to the company’s bottom line.

One of the important tools in quality control is a control chart. It is important to note that control charts do not control the process, but are a means of verifying that the process is in control and making changes if it is not. Variability of materials and concrete is unavoidable. The person in charge of QC needs to know what aspect of variability he can control with reasonable resources and what impact that change will have on the company’s bottom line. The net result should have a positive impact to the latter.

Variability of materials or process may be attributed to chance causes or assignable causes.

Chance causes are attributed to the normal variability of the process. Chance causes are inevitable and beyond the control of the persons involved. There is no point investing money to control chance causes.

For example, one low strength result when nothing else has changed may be attributed to a chance cause.

Assignable causes are factors that can be eliminated, thereby reducing the overall variability. Assignable causes may be identified by studying one or more control charts.

For example, a series of low strength tests may be associated with a change in the sand grading during the same period. This is an assignable cause, which can be corrected by either using a different sand stockpile or adjusting the mixture proportions.

Control charts can be useful to distinguish assignable causes from chance causes. It is also important that a chance cause not be misinterpreted as an assignable cause, in which case the reason for the variability will be difficult to establish.

A simple control chart as shown in Figure 1 can be viewed as a statistical normal distribution (bell curve) turned sideways with the vertical axis being the test results and the horizontal axis being the successive test numbers.

Figure 1. A Simple Control Chart

Control Charts can be used for the following:

• Early detection of potential problems
• Identifying assignable causes to decrease variability
• Establishing the process capability
• Reducing price adjustment costs
• Decreasing inspection frequency
• Providing a basis for changing the specification limits
• Providing a basis for product acceptance
• Permanent record of quality
• Instilling quality awareness

Run Charts

The simplest type of quality control chart is the run chart. The individual test results are plotted and checked against some control limits. The control limits might be specification tolerances plotted about a target value. It is, however, better to plot control limits tighter than the specification tolerances so that action can be taken before individual test results fall outside the specification tolerances. The control limits might be arbitrary or statistically based. For example, if the specification calls for air content at 6 ± 1.5%, arbitrary control limits may be set at ± 1%. Statistically-based control limits will be based on the standard deviation (S) calculated from recent data. For example, if the control limits are set at ±2 S, then a change in the process might be identified when more than approximately 1 in 20 tests (5%) fall outside the control limits.

The control limits on a control chart are not to be used to determine if the product is acceptable but to identify a change in the process and to initiate corrective action.

Running Average Charts

Running average of the most recent consecutive test results may be plotted on a control chart. Typically, a running average of 3 or 5 consecutive data points are plotted. The trend of a running average chart is more efficient in detecting changes but may cloud the reason for an individual bad result. It might be worthwhile plotting individual test results along with the running average to identify individual bad results as illustrated in Figure 2.

Figure 2. Control Chart showing Individual Results and Running Average of 3

While not plotted in Figure 2, control limits can be set for this chart. Control limits for running average plot should be tighter than that for individual results. The standard deviation, calculated from individual results, should be modified by dividing by √n, for
causes from assignable causes. The control chart for averages (X-bar Chart) and the control chart for ranges (R-Chart) are used together to identify process changes. The X-bar Chart is useful to detect when the process target or average changes and the R-Chart is used to determine when the process variability changes.

Statistical Control Charts

Statistical Control Charts (or Shewhart Charts) are better for distinguishing chance causes than n is the number of individual results being averaged.

While the positive control limit is not critical for specification conformance on strength, it is useful for determining, for example, that there might be a problem with batching excessive cement.

Statistical Control Charts are always based on the average and range of a subgroup of data where n>1, as opposed to a run chart where individual values (n=1) are plotted. Upper and lower control limits (UCL and LCL) of (±3 Sx) are typically used to identify changes in the process average. Sx is the standard deviation of the averages of each subgroup of data. More than one test result (n>1) in each subgroup is required in order to calculate the ranges for the R-Chart. The disadvantage is that a large amount of historical data is needed before the control limits for the Shewhart Chart can be established.

Figure 3 illustrates the use of a statistical control chart that monitors the minus No. 50 material on sand used at a concrete plant. Two tests are conducted on each shipment. Once sufficient data is collected, the necessary statistics can be developed to establish control limits for the measured quantity.

The point at which action should be taken should also be defined. While interpreting X-bar Charts and R-Charts, it may be decided that a red flag will be raised if one data point (the average of a subset) falls outside the control limits, or if 5 to 8 consecutive subset averages fall on one side of the overall average. In the example in Figure 3, the action might be that the supplier is notified or the loader operator process of working the stockpile is evaluated. Periodically, it may be necessary to update the control limits from more recent data. This could be easily accomplished with spreadsheets or statistical software.

In conclusion, there are tools out there to better monitor the process of quality control. The question is do we have the time and resources to make the process work for controllable variations.

For more information, contact Lobo at clobo@nrmca.org or 240/485-1160.
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Executive Summary of:
2005 NRMCA Fleet Benchmarking and Costs Survey

By Mike Taylor, Lafarge North America
NRMCA OES Committee Chairman
John Carew, Carew Concrete
NRMCA OES Committee Vice Chairman
Jeff Hinkle, Chandler Concrete, Inc.
NRMCA Operations Task Group Chairman
Terry Green, US Concrete Inc.
NRMCA Operation Task Group Co-Chair
Gary M. Mullings, NRMCA
Senior Director of Operations and Compliance

Introduction

The National Ready Mixed Concrete Association Fleet Benchmarking and Costs Survey was established to provide concrete producers with information to evaluate ready mixed concrete fleet maintenance and utilization. This survey form was developed and responses analyzed by the NRMCA Operations, Environmental and Safety (OES) Committee. For the ready mixed concrete industry, those involved in the day-to-day management of a fleet of mixer trucks are confronted with an ever-changing array of business decisions. The competitive nature of the business and long construction seasons makes operating a fleet of trucks very demanding. The industry has witnessed a dramatic shift to one which includes high expectations with no tolerance for unsatisfactory performance, forcing ready mixed concrete fleet managers to attain exceedingly high levels of reliability and cost efficiency for their fleets. Most successful ready mixed concrete producers have always measured themselves in one way or another, relying primarily on financial accounting principles.

These measurements are done to see how they're performing today and to improve their performance for the future. The trick is to know what to measure and to know what constitutes good performance. Benchmarking allows the fleet manager to identify and compare cost and other performance factors with the industry. Once the fleet’s management strategies and performance have been successfully benchmarked, the fleet manager will have a tool to identify the unsatisfactory as well as the excellent performance areas of their fleet.

Benchmarking the fleet allows the manager to identify the areas of the fleet that require change, and it ensures continuous improvement of the fleet. Not having a complete understanding of the fleet’s cost components and lacking an adequate fleet replacement strategy is a significant issue in fleet management.

Confidentiality

The National Ready Mixed Concrete Association keeps all individual company data submitted for the survey strictly confidential. After verification of all data entry and calculations, the association destroys the entry forms and all tabulation records that specifically attribute data to a producer, division and plant. This policy was established to help elevate the level of participation and enhance the statistics through a strong sampling of the industry.

2005 Fleet Benchmarking Survey

The 2005 Fleet Benchmarking Survey Form was sent to NRMCA member companies’ fleet managers and financial officers in February 2005 and placed on NRMCA’s website. An electronic format file of the survey form was distributed via email to the NRMCA membership. The deadline for all survey responses was June 1, 2005. The survey consisted of 59 fill-in-the-blank type questions. The survey represented data for calendar year 2004.

Survey Responses

Responses from 46 companies were received for the 2005 survey. This is compared to the 2004 survey in which 41 companies responded.

Results of the survey
companies participating in the survey. The median number (which may be more typical) for truck mixers in a fleet is 86. This means that about half of the companies who responded to the survey have 86 truck mixers or less.

The average age of a fleet and average age of the individual truck was up slightly over last year’s numbers. The average fleet age for the 43 companies who responded to this question was 7 years, while the average age of individual trucks was calculated to be 6.7 years (exactly the same as 2003 data). Rear discharge mixers still dominate the survey, representing 84% of mixers. Front discharge mixers make up the remaining 16% of the truck mixers.

Chassis Configurations
Over the last several decades, many variations in axle configuration have been developed in response to varying state weight laws. According to the 2005 Fleet Survey, three-axle and four-axle/booster or pusher configurations are most common, accounting for about 79 percent of the operating mixer trucks. In order to meet federal bridge weight restrictions and increase load carrying capacities, more ready mixed concrete trucks are using four or more axles. This data may be biased by the geographical distribution of responses and the pertinent state and local weight restrictions.

Fleet Performance
The survey represents ready mixed concrete trucks that traveled more than 105 million miles in 2004. The average annual mileage on a ready mixed concrete truck was 16,895 miles last year. This figure is down by about 1,500 miles from the 2003 data, when the average annual mileage per truck was 18,437 miles.

The average haul distance a truck mixer must travel will vary depending on locality, type of construction and commitment to customers. The average one-way haul distance for the 39 companies that reported data was 14.3 miles per truck.

In 2004, the average load size was 7.9 cubic yards and the average full load was 9.8 cubic yards, up slightly from a year ago. Important to a ready mixed concrete producer is the “load size coefficient,” which can be calculated by dividing average load size by typical full load size and multiplying times 100 to convert to a percentage. In general, the higher the load size coefficient, the lower the cost of trucking per cubic yard. Of the 37 companies reporting both numbers, the calculated average load size coefficient was 80%, with a high of 95% and a low of 53%.

Fuel Consumption
Certainly one of the major costs in operating a ready mixed concrete fleet is fuel consumption. In 2004 and 2005, we have seen unprecedented price hikes for diesel and

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WINTER 2006
Another major expense to the ready mixed concrete producer is the maintenance cost associated with fleet operations. In years past, data revealed that cost of fleet maintenance is directly related to the average age of the fleet. The total maintenance costs were determined by calculating the sum of parts costs, outside repair services, shop expenses, tire costs and mobile communication costs. The calculated total maintenance costs for a ready mixed concrete fleet in 2001 were $2.59 per cubic yard of concrete delivered. In 2004, the average of the 43 companies reporting has risen to $2.87 per cubic yard delivered, which averages to about a 2.5% increase per year.

Tires

Tires are an essential factor in determining costs associated with ready mixed concrete fleets. Of the 46 companies who reported, only about 7% allow recaps on the steer axle tires while some 86% allow the use of recaps on the drive or trailer axle tires. The maximum number of recaps allowed on a casing ranged from one to five with an average of just over two. And how much does it cost a producer every time there is a breakdown due to tire failure? This number rose again to $147.34 in 2004, up by more than $12 over 2003.

Preventive Maintenance

In order to maintain an efficient ready mixed concrete truck fleet, all producers recognize the need for preventive maintenance (PM). The concept of PM is to carefully service and inspect each truck in the fleet at regular intervals to minimize the number of breakdowns. A good PM program predicts breakdowns and necessary repairs and allows servicing to be scheduled at optimum times before the breakdown occurs. Typical PM drain intervals are calculated in terms of hours of running time on an engine. Historically, manufacturers had recommended PM drain services at about 400 hours. In the past few years of the survey, on average, PM drain intervals are increasing with better performing motor oils. In 1998, the average was approximately 300 hours of engine service. In 2004, the interval was up to 449 engine hours.

Fleet Maintenance Expenses

Gasoline in the U.S. Fuel consumption factors can be measured in many different ways. Typical “miles per gallon” is used as a measure by many “long haul” trucking companies. In the ready mixed concrete industry, although most companies track “mile per gallon” (mpg) data, it does not give us a true picture of fuel usage due to the fact that a mixer truck spends varying amounts of time while at idle or off-road. In this survey, 76% of those companies who reported fuel consumption data reported “miles per gallon,” while 89% reported fuel consumption in “fuel cost per yard.” The price paid per gallon of fuel can also be calculated based on companies that supplied data for both “Gallon per Cubic Yard” and “Fuel Costs per Cubic Yard”, i.e. \[
\text{Price per Gallon} = \frac{\text{Costs yd}^3}{\text{Gallons yd}^3}.
\]

The average fuel cost according to the survey during calendar year 2004, using this calculation, was $2.02 per gallon, up $0.66 or 48% over the previous year. Another statistic of interest is the percentage of fuel usage for off-road energy use. However, this information cannot be determined from the reported data. NRMCA has estimated that Power Takeoff fuel usage is about 30%. It eats nails for breakfast.
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A good PM program is also necessary to ensure long drum life. In the 2004 data, the average service life of a drum was calculated to be nearly 5.7 years, delivering nearly 31,178 yards of concrete.

**Front End Loaders**

Essential to a ready mixed concrete production facility is its front-end loader. This piece of equipment is vital to both production rate and product quality. Keeping the loader in good condition is a must. According to the 2004 data, which represented 758 loaders from 43 companies, the average age of a loader was 10.4 years. Nationally the total maintenance cost for a loader is about $0.24 per cubic yard or $6.38 per engine hour.

**Benchmarking**

This section was added to the survey in 2004 and the data is not included in the “Yearly Comparison” of this report. Of utmost importance to a ready mixed concrete production facility is its ability to measure and monitor key ratios used to quantify productivity. Parked trucks due to low driver availability can be very costly. Driver availability rates are generally calculated daily for each plant and averaged on a monthly or yearly basis. The ready mixed concrete industry measures Fleet Availability to track the efficiency and effectiveness of equipment PM and repair programs. Some factors that affect the Fleet Availability ratios are PM programs, average age of the fleet, parts availability, competency of mechanics and warranties. Fleet Utilization is another key ratio that ready mixed concrete producers monitor. The goal is to match the number of available drivers with available trucks for 100% utilization. This can be quite difficult in markets that experience driver shortages. The OES committee also asked producers for backing and roll-over incidents for 2004. The data revealed an alarming 1.15 rollover per 100 trucks and almost 13 backing accidents per 100 trucks.

**Acknowledgements**

The authors would like to thank all the companies and individuals who spent time to voluntarily participate in the survey. It is due to their efforts that the data can be used by the entire industry to benchmark valuable industry specific fleet information. While the participation level has grown, the reliability of these industry benchmarks can improve by increasing the sample size. Readers of this

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**Survey Summary & Yearly Comparison**

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<td>7.4</td>
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<td>Average Truck Age, years</td>
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The authors would also like to acknowledge and thank NRMCA staff member Nina Stedman for administrative assistance with the survey. An electronic copy of the full report is available upon request to NRMCA’s Gary Mullings via email at gmullinga@nrmca.org.

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Finding the optimum placement technique when delivering concrete is a challenge for both ready mixed concrete producer and contractor alike. It would be nice if a concrete pump was stationed curbside at every job. A ready mixed concrete truck could simply back up to the hopper, unload his precious commodity and head back to the plant for another load. Unfortunately, there are many job sites that don’t use a mobile pump for numerous reasons, including economic, scheduling and availability. In these cases, placement of the concrete can be difficult, requiring the mixer driver to perform the time consuming (and in some cases nearly impossible) task of backing his truck into position to place the concrete. Many concrete producers have found a profitable answer to this problem by incorporating truck mounted conveyors into their fleet.

One such company is Thomas Concrete, located in the Atlanta area. The company has successfully included approximately 40 truck mounted conveyors to their fleet. According to Thomas’s General Manager of Technical Promotion Nick Maloof, they specify that all their conveyors are mounted on 6x all-wheel double frame trucks with standard transmissions and extra water capacity. Nick says a ready mixed concrete producer must also make sure he considers any other truck modifications, operator training (4-6 weeks), training of shop personnel and conveyor maintenance and repairs before he purchases his first unit. If you do your homework, the benefits to a concrete producer can be substantial, including faster and more efficient delivery by using other trucks to deliver concrete over another truck mounted conveyor belt. No need for coordination with special equipment required for placement and better control of costs and scheduling. The use of a conveyor generally does not require a special mix design. The use of a truck mounted conveyor increases the opportunity for profits. The use of truck mounted conveyors increases the opportunity for mixer drivers to increase their earnings. And at Thomas Concrete, the use of truck mounted conveyors has enhanced the company image.

Finally, if your customers are looking for one-stop-shopping, faster and more efficient delivery, placement labor cost savings, lower placing equipment costs on small jobs and no set up fees... then you may want to consider the addition of truck mounted conveyors to your fleet.

For more information, please contact Gary Mullings, senior director of operations and compliance, at gmullings@nrmca.org or 240/485-1161.
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NRMCA Scores a Number of Victories on SAFETEA-LU

By Robert Sullivan and Kevin Voelte
NRMCA Directors of Government Affairs

The National Ready Mixed Concrete Association (NRMCA) chalked up several legislative victories during the first session of the 109th Congress. On the recently enacted Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), NRMCA worked as an active member of the Transportation Construction Coalition (TCC) in achieving a funding level of $286.4 billion over six years. This makes SAFETEA-LU the largest public works legislation passed in the history of the United States. SAFETEA-LU represents a 31 percent increase in funding over its predecessor legislation, the Transportation Equity Act for the 21st Century (TEA-21) and is 16 percent higher than President Bush’s original $247 billion proposal. To put these sums in perspective, each $1 billion in federal surface transportation infrastructure investment means approximately 3 million cubic yards of ready mixed concrete placed.

NRMCA’s government relations team also scored victories on critical ready mixed industry priorities. NRMCA has been working for a decade to achieve tax fairness with respect to the fuel used to turn the mixer drum on ready mixed concrete delivery vehicles. We have argued that when the excise tax was first imposed on diesel fuel, Congress intended that the mixer drum fuel be classified as “off-highway business use” and not subject to federal tax. However, the Internal Revenue Service (IRS) has long ignored the original intent of Congress, contending that it would be too administratively burdensome for the agency to offer a rebate or a credit on taxes paid for our industry’s non-propulsive fuel use. To achieve resolution of this problem NRMCA negotiated language in Section 1144 of SAFETEA-LU, directing the Departments of Treasury and Transportation to study the ready mixed concrete industry’s non-propulsive fuel use and propose options to exempt such use from the federal highway excise tax on fuel. The study is ordered to be completed by January 2007 and could mean as much as $30 million in fuel tax savings to the industry.

NRMCA also showed that it could play defense on Capitol Hill by successfully preventing Senator Frank Lautenberg’s (D-NJ) onerous Safe Highways and Infrastructure Preservation Act (SHIPA) legislation from being included on SAFETEA-LU. SHIPA would extend the truck weight restrictions currently in effect on the Eisenhower Interstate System, including the bridge formula, to all roads designated as part of the National Highway System. Furthermore, it would set a precedent toward further truck weight rollbacks. NRMCA will be on guard against future attempts by Senator Lautenberg to move SHIPA on another legislative vehicle.

As we begin the second session of the 109th Congress, NRMCA will build on its successes in the first session to move other critical industry priorities, such as drivers’ hours of service reform, truck weight liberalization and driver recruitment incentives. NRMCA also intends to ensure that Hurricane Katrina assistance will be used to improve building practices and codes.

For more information concerning NRMCA’s work on SAFETEA-LU, please contact Robert Sullivan (rsullivan@nrmca.org) or Kevin Voelte (kvoelte@nrmca.org) at 1-888-846-7622.
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Inspired by the Proud American Eagle and Built by Proud American Men
n Texas, everything is big — highways, acreage, political squabbles, ready mixed concrete companies — and now hearts too. That’s because one of the Lone Star State’s largest producers, along with its admixture supplier, recently joined forces to build a large suburban home in record time, with proceeds of the sale earmarked for a number of area charities.

The competition was staged October 1 in Tyler, with the placing of a 2,160-square-foot concrete slab home, fully landscaped, with 1,637 square feet of living area, three bedrooms, two baths and a two-car garage being constructed in 2 hours, 52 minutes and 29 seconds. Transit Mix and Degussa Admixtures officials believe the previous record was set in San Diego in 1984 when a home was constructed in 2 hours and 53 minutes. Transit Mix, a division of Dallas-based Trinity Industries, partnered with Degussa Admixtures to design and produce the concrete mix for the project, known as the “Two Hour House.” Thousands of volunteers and several companies, including NRMCA members Transit Mix and Degussa, donated time, knowledge, materials and funding for the project.

Two competing T.E.A.M.s (Together Everyone Achieves More) built the home, which was fully landscaped and ready to move in. City inspectors were on-site to inspect each phase of the construction. Each T.E.A.M., comprised of skilled tradesmen and volunteers, followed a detailed and well-orchestrated plan to achieve the goal. Both “rehearsed” the process by building two practice homes prior to October 1.

“We poured and placed 47 yards of concrete in less than 5 minutes,” explained Dick Schilhab, vice president for Transit Mix in East Texas. “Because it was self-consolidating concrete, all the finishers had to do was screed off the top of the concrete for a perfect finish. The amazing part of all of this was that we were walking on it 20 minutes later.”

To achieve this fast set, Transit Mix worked with Degussa Admixtures and used a slightly modified version of admixtures and concrete materials typically used in rapid setting highway and airport repair applications. The mix allows concrete to be placed, set and open to traffic in four hours. This mix design was modified to achieve a 22-minute set.

The Two Hour House project was organized by the Tyler Area Builders Association, a non-profit coalition of construction industry companies in the Tyler area. With construction complete, the home will be sold and 100 percent of the profits donated to worthy causes in the Tyler area, including Habitat for Humanity of Smith County; the Azleway Charter School, a safe haven for children from abusive situations; Bethesda Health Clinic, a faith-based clinic that provides affordable health care for the working uninsured of Smith County; East Texas Food Bank, a clearinghouse for donating food through a partnership with the food industry; PATH (People Attempting to Help), which serves the economically disadvantaged people of Smith County with emergency assistance and other programs; and the American Red Cross.
When choosing a ready-mix technology solution worthy of your trust, you need to look for three key elements:

**INTELLIGENCE.** A system that delivers accurate, timely information, enabling you to make faster, better decisions.

**INTEGRATION.** A system that truly provides seamless, no-hassle visibility and efficiency across your entire business operations.

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Creating a high retention workplace has more to do with good managers than anything else. Yes, you have to pay people well. Sure, you have to provide decent benefits. But first it begins with leadership. Whether you are the CEO or the head of the department, creating a great place to work where people have pride in what they do begins with you.

Businesses can improve retention and make their organization a good place to work by following the five-step PRIDE model:

- **P** - Provide a positive working environment
- **R** - Recognize, reinforce and reward individual efforts
- **I** - Involve and engage everyone
- **D** - Develop the potential of your workforce
- **E** - Evaluate and hold managers accountable

**Provide a Positive Working Environment**

Daniel Goleman, in his book, *Primal Leadership*, said, “The climate created by the CEO among their direct reports predicted the business performance of the entire organization. In 75 percent of the cases, climate alone sorted companies into high versus low profits and growth.”

Indeed, a third of the executives surveyed by Robert Half International Inc. say the work environment is the most critical factor in keeping an employee satisfied in today’s business world.

A key aspect is workplace flexibility. First Tennessee National Corporation started making workplace flexibility a top priority. They reshaped the rules they had forced employees to live under, added many family-friendly benefits, and sent managers through three and a half days of intensive management training. Result: Employees stayed twice as long and the bank kept seven percent more of its customers.

**Recognize, Reinforce and Reward Individual Efforts**

Money may attract people to the front door, but something else has to keep them from going out the back. People have a basic human need to feel appreciated and recognition programs help meet that need.

A successful reward and recognition program does not have to be complicated to be effective. An equipment dealership in Louisville, KY, has almost eliminated turnover by its programs. The employees participate in a profit-sharing plan that could possibly mean close to a million dollars upon retirement. Other incentives and benefits provided include:

- Every year, employees celebrate their work anniversary with a cake and receive $100 for each year employed. The check is made out to the Snap-On Tool Company, where employees buy tools for the job.
- Twice a year, employees’ children receive a $50 savings bond when they bring in their “all As” report card.
- Employees are rewarded with a “Safety Bonus Program.” Each employee’s driving record is screened twice a year. Anyone who has a citation is removed from the program. Those employees remaining at the end of the year split $2000.
- To minimize the “we-they” syndrome, every Friday employees rotate jobs for one hour. For example, the person in the parts department becomes a service technician. This builds a stronger team.
During the exposition, scientists and engineers display projects and ideas they are working on. Open only to Sony’s employees, the exposition lets individuals share ideas across each department. This process creates a healthy climate of innovation and creativity at all levels of the organization.

In a study by Linkage, Inc., more than 40 percent of the respondents said they would consider leaving their present employer for another job with the same benefits if that job provided better career development and greater challenges. The National Center on the Educational Quality of the Workforce (EQW) found on an average, a 10 percent increase in workforce education level led to an 8.6 percent gain in total productivity. On the other hand, a 10 percent increase in the value of equipment only increased productivity 3.4 percent.

Evaluate and Hold Managers Accountable

Show me a department with high turnover and I will show you a manager who needs help. As part of your evaluation and analysis process, start measuring the cost of turnover, employee attitudes and which manager or department does the best/worst with employee turnover. Find out why — then reward the good managers and fix the bad managers.

La Rosa’s Company completes a cultural audit once a year, which measures employees’ feelings about pay and benefits, care and recognition, etc. Additionally, all employees evaluate their bosses twice a year using an Internal Customer Satisfaction Index (ICSI). The ICSI has only four questions and asks employees to give their managers a letter grade from A to D in four different categories.

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Greg Smith is the “Retention Expert.” He shows executives and business owners how to attract and keep customers and build organizations that retain and motivate their workforce. He is the author of the book, Here Today Here Tomorrow: Transforming Your Workforce from High-Turnover to High-Retention. He speaks at conferences, conducts management training and is the president of a management consulting firm called Chart Your Course International in Conyers, Ga. Phone him at 770-860-9464. More articles available: http://www.chartcourse.com.
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Overcoming Common Managerial Decision-Making Errors

Amos Hermann has mixed feelings about his promotion to safety director at Ronks Ready Mix because he instinctively knows his decision-making style is different than the man who selected him for the job and who will be his new boss, Jim Lawson, Ronks’ vice president of production. The safety implementation plan was designed by Jim three years ago, but Amos would like to forge ahead with new implementation ideas. Amos also thinks that he might not be seen as a team player if his new plans ruffle the feathers of other veteran plant managers who believe the current safety programs are successful at their facilities.

Amos knows Jim can become frustrated with him because Amos is so deliberative. Amos gathers lots of information, evidence and statistics along the way before he makes a decision. He also waits to process information until it gels as a whole; throughout the process he looks at many alternative solutions; he always recommends a comprehensive, long-term approach though his solutions might be more costly and not as timely.

In comparison, Jim is direct, efficient and logical. His management style serves Ronks’ fast pace and short-term focus because he uses intuition to make decisions quickly with minimal information and few alternatives. His direct reports know Jim has no time for ambiguity and rationality, especially when it comes to safety. In particular, everyone recognizes that Jim’s no-nonsense policy toward driver seat belt compliance not only raised Ronks’ safety record but saved one driver’s life in a rollover accident last winter.

Yet Jim’s business maturity also allowed him to realize that his hard edge could have raised the drivers’ ire when he instituted Ronks’ new seat belt compliance program. Part of Jim’s solution was to tap into Amos’ energy and creativity, asking Amos to design an internal campaign so drivers would buy in to it as fair, equitable and serving the greater good. Jim knows Amos is ready to apply that same effort in all aspects of Ronks’ safety compliance. Amos not only possesses operational skills but also has proven interpersonal skills that can build a stronger safety culture. He has a solid understanding of OSHA regulations. He was frequently called on to work on special safety-related assignments that required problem solving. Most would describe Amos as intelligent, resourceful, motivated and hardworking.

What Jim is hoping for is that Amos can learn to be more flexible, learning that different situations call for different decision-making processes. And when a DOT investigator arrived to discuss the specifics of a driver accident and let Ronks know the company would remain under a watchful eye, Jim gave a clear directive that all safety control measures were to be strictly and immediately followed. Jim reinforced that as safety director, Amos’ job was to monitor safety-related activities to ensure that they were not only accomplished as planned but that any deviations were immediately corrected.

For the two men to work together well, both must understand that their different personality styles can lead them into a common trap of decision-making errors, something neither want.

When individual managers make decisions, they make choices along the way. But by doing so, they must give careful thought to how they execute the process as...
well as how they gather information. Yet complete information for any manager can overload him or her. Consequently, managers often engage in behaviors that speed up the process. That is, in order to avoid information overload, managers naturally make judgmental shortcuts, known as **heuristics**. There are two types and both create biases in a manager’s judgment, something particularly unhealthy when it comes to safety issues.

The first type is called **availability heuristics**, which is defined as the tendency for a manager to base judgments on information that is already available and has created a strong impression. This includes events that have evoked strong emotions, remain vividly ingrained in one’s imagination or have recently occurred. As a result, managers can overestimate the frequency of the occurrence of unlikely events. For instance, many people have a fear of flying though it is documented that it is safer than traveling in a car. For safety managers, **availability heuristics** can also explain why, when conducting performance appraisals or safety audits, research shows that managers tend to give more weight to recent activities or employee behaviors than those earlier in the year.

The second type of a common error in judgment shortcut is called **representative beuristics**, which is the tendency of people to match the likelihood of an occurrence with something they are familiar with. In business organizations, this commonly occurs when decision makers predict the future success of a new process or program by relating it to a previous project’s success. An example is a decision to no longer hire drivers from other ready mixed concrete producers because the last three drivers were poor performers.

The third common managerial decision-making error, called **escalation of commitment**, reflects an increased commitment to a previous decision despite evidence that it is not working. That is, a manager’s tendency to stay the course despite data that suggests he should do otherwise. A common safety example might be sticking with the current PPE enforcement process despite numerous spot checks documenting that drivers are not wearing long sleeves on hot days. So why do managers still stick to the current way despite evidence to the contrary? In most cases, it is an effort to demonstrate that an initial decision was not wrong.

The reality is that managers are typically not born with the intuitive talent to make good decisions all the time. While many, like Amos and Jim, can unconsciously analyze problems and leave an impressive trail of results, managers who understand the process and where the inherent traps are at each stage can make more effective decisions. The seven-step decision-making process** to beware of is:

1. **Identifying the problem.** While many think problems are obvious, the reality is that the most difficult chore is separating the symptoms from the problem. For example, is a five percent decline in cubic yardage delivered a driver-delivery problem or the result of declining sales due to a changing market? Arriving at the true problem sets the stage for success.

2. **Collecting relevant information.** Why has it occurred? How is it affecting productivity? What, if any, company policies are relevant for dealing with this problem? Are there time limitations? What costs are involved?

3. **Developing alternatives.** Creativity is needed to consider alternatives beyond the obvious ones already considered. Generally speaking, the more alternatives generated, the better the final solution. Why? Because the final choice is only as good as the best alternative generated.

4. **Evaluating the strengths and weaknesses of each alternative.** In this step, it is very important to guard against biases. Many managers, in the need to

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**Annual State of Training Recap: Do Your Company’s Efforts Measure Up?**

The American Society for Training and Development, the leading body reporting corporate training statistics and trends in the U.S., released its annual report on the current level of formal training and development. The analysis does not include on-the-job training programs.

In its **State of the Industry**, ASTD found that learning hours received per employee rose from 27.9 in 2002 to a projected 29.8 in 2004, while spending actually decreased by a few dollars from $826 in 2002 to a projected $812 in 2004. The projection for 2004 is that classroom time dropped to about 63 percent, while e-learning, the fastest-growing alternative, climbed to more than 29 percent. Virtual classrooms are quickly being implemented across industry sectors.

Unlike past years where industry specific technical and IT—technology training led the content areas, this year top learning areas were managerial/supervisory training and processes/procedures/business practices (13 percent each). The employee groups receiving the largest percentage of training expenditure were those in management positions, including first-line supervisors, middle and senior managers, and executives (28 percent combined), followed by customer service employees (18 percent).

The report had three general trends that affect our industry. The first shows training hours are up with costs down, due to an increased usage of electronic tools and companies outsourcing internal development and delivery of pricey corporate retreats.

The second trend is a sharper focus on defining problems and matching solutions to needs. That requires training and development professionals to analyze systems and craft custom solutions rather than simply offering standardized classroom training. Allison Rossett, professor of educational technology at San Diego State University and an author and training and development consultant, states that success is not always measured by how many workers can be processed through a seminar but rather how well a particular problem or issue is addressed.

The last key trend noted by ASTD is a combination of old and new training delivery methods, particularly a trend to increase compliance training — knowledge or skills required of workers often by law or regulation. Compliance ranges from diversity training to workplace safety to financial disclosure rules. Standardized content works well as a delivery method, and so does e-learning. And most subjects are available from a variety of vendors, saving companies the cost of creating their own programs.
move quickly, fall back on preconceived notions or past results for other similar problems and make assumptions. They prematurely favor some outcomes over others. Managers who recognize biases and overtly attempt to control them can improve the final outcome.

5. Selecting the best alternative. What is best will reflect any limitations or biases a manager brings to the decision process. It depends on things such as the comprehensiveness and accuracy of the information gathered in Step 2, ingenuity in developing alternatives in Step 3, the degree of risk that a manager is willing to take and the quality of a manager’s analysis in Step 4.

6. Implementing the decision. A manager must convey the decision to those affected and get a commitment to it. A manager specifically wants to assign responsibilities, allocate necessary resources and clarify deadlines.

7. Following up and evaluating. A manager must analyze if his or her choice accomplished the desired result. Did it correct the problem that was originally identified in Step 1? If the follow up and evaluation indicate that the sought-after results were not achieved, a manager should review the decision process to see where he or she went wrong. Essentially, the manager will arrive at a new problem and should go through the decision process again with a fresh perspective.

All NRMCA training courses impart decision-making tools for respective job categories as well as appropriate skills and knowledge. In the case of the three-day Safety Course, attendees practice newly acquired tools by performing an actual Safety Audit at a ready mixed concrete facility on the last morning of the workshop. Afterward, the group reconvenes and assesses their analysis and recommendations, departing with various decision-making tools for immediate application at their companies, aware of common decision-making traps and sound escape mechanisms.


For information about safety compliance as it relates to the ready mixed concrete industry and Safety Course seminar information, contact NRMCA Safety Director Tom Harman at 240-485-1155 or email, tharman@nrmca.org. For information about any NRMCA training seminar, visit NRMCA’s website at www.nrmca.org, call the Education Department at 240-485-1166 or email twaugh@nrmca.org.

Following the national trends, NRMCA currently offers both e-learning and traditional classroom workshops. Compliance training specific to the ready mixed concrete industry remains one of the Association’s key opportunities for producers. E-learning topics include LEED and EPCRA compliance. Instructor-based, in-classroom, compliance-focused seminars by specific knowledge area experts include safety, environmental, technical, legal and financial training. For further information about these ongoing solutions-oriented workshops, please call NRMCA’s Education Department or visit NRMCA’s website at www.nrmca.org.
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The National Ready Mixed Concrete Association (NRMCA) is sponsoring the 2006 Concrete Technology Forum: Focus on Pervious Concrete scheduled for May 24-25, 2006 in Nashville. The forum will bring researchers and practitioners together to discuss the latest advances, technical knowledge, continuing research, tools and solutions for pervious concrete.

Who Should Attend?

Researchers, civil engineers, environmental engineers, landscape architects, architects, contractors, concrete producers, public works officials, material suppliers, concrete industry professionals, and property developers and owners are

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Attendees: Researchers, civil engineers, concrete producers, environmental engineers, landscape architects, architects, public works officials, contractors, material suppliers, concrete industry professionals, and property developers and owners will profit and are invited to attend.

Session Topics: Session topics will cover state-of-the-art developments, new construction techniques and product formulations that optimize performance of pervious concrete including:

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invited to attend. Attendees will earn valuable professional development hours (PDHs) and will receive a copy of the symposium proceedings.

What Topics will be Presented?
With the focus on pervious concrete, the 2006 Concrete Technology Forum will provide a venue for researchers, contractors and product manufacturers to inform the industry about state-of-the-art developments, new construction techniques and product formulations that optimize performance in this important field. Session topics include:

- Hydrological and Environmental Design
- Structural and Site Design
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Although pervious concrete has been used in some areas for decades, recent interest in green building and recognition of pervious pavements by the U.S. EPA as a best practice for stormwater management has heightened interest in its use throughout North America. Its use supports national initiatives such as Cool Communities and Low Impact Development and provides a potential for innovation credit in the LEED rating system for sustainable building construction. The 2006 Concrete Technology Forum: Focus on Pervious Concrete, sponsored by NRMCA, will present state-of-the-art design, materials and construction techniques for pervious concrete.

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Specifying Concrete for Durability

Performance-Based Criteria Offer Best Solutions

By Karthik Obla, Colin Lobo, Lionel Lemay, NRMCA

Introduction

A specification for concrete construction is a set of instructions from the owner, typically written by a design professional as his representative, to the concrete contractor. A specification eventually forms the basis of a contract, a legal agreement, between the owner and the contractor and establishes the joint and separate responsibilities of the various stakeholders in the construction team toward achieving the objectives of the owner. For that reason, the specification should be written in terse mandatory language with clear, measurable and achievable requirements.

Based on numerous concrete specification reviews conducted by the authors, the following points are suggested in developing specifications for concrete construction:

• Compliance with industry reference documents, especially guidance documents written in non-mandatory language, should be avoided. These documents discuss various options and, if a specific option is needed for the project, it should be written in the specification.

• The specification should not include a general statement requiring compliance with the building code. It is the design professional’s responsibility to establish provisions of the code that apply to the project and write them in the specification. Do not apply code provisions to portions of structures for which they are not applicable.

• The specification should avoid outlining details of construction means and methods as the expertise of the contractor is stifled.

• The specification should avoid dictating details of the mixture proportions as the concrete producer’s expertise is stifled. Often the contractor and concrete supplier can work out the requirements of plastic concrete for construction.

• Project requirements “implied” by specification clauses controlling means and methods or mixtures detract from clarity, are not enforceable and should be avoided. State the required performance in measurable terms.

• Requiring the use of specific brands of products or equipment should be avoided when alternative equivalents are available.

• Avoid the adding-on requirements to a set of conditions that currently work as this can cause a different problem. Avoid making acceptance criteria more restrictive than accepted industry practice as that may not be achievable or could cost more for no associated benefit.

• Submittals prior to the start of work should be limited to documenting conformance to the specification requirements. This process can be significantly simplified from the current practice.

The aim of this paper is to help the architect and engineer:

1. Improve the concrete specifications in order to achieve better concrete quality;
2. Choose the right performance criteria in place of prescriptive criteria for concrete subject to harsh environments;
3. Identify and understand the tests and criteria that could be used to satisfy the project performance requirements.

Concrete Strength

Concrete compressive strength is the most common test conducted for acceptance of concrete. Test cylinders are prepared for standard curing in accordance with ASTM C 31 and tested in accordance with ASTM C 39. The ACI 318 Building Code establishes statistically-based acceptance criteria for cylinder tests and criteria for strength tests on cores when the cylinder test criteria are not achieved. The strength test is one of the more precise tests with a single lab coefficient of variation at 2.8% and a multi-lab coefficient of variation of about 5%. Certification programs are in place for field and laboratory technicians to ensure more reliable testing of jobsite concrete samples. ASTM C 31 has historically required 6 x 12-inch cylinders as the standard size test specimen. It also permits 4 x 8-inch specimens when specified. There is considerably greater use of these 4 x 8-inch specimens because they afford ease of handling and more reliable jobsite curing and it is now advisable that the specification allow their use. We recommend including a clause in the specification requiring the use of 4 x 8-inch cylinders for compressive strength tests.

Although strength is not typically a good indicator of concrete durability, most concrete will require a minimum level of strength for structural design purposes regardless of the application. When the structural element is not subject to durability concerns, specified compressive strength is the preferred performance criteria. Do not specify maximum w/cm or minimum cementitious content as this will most likely cause an inherent specification conflict. Concrete can have a wide range of compressive strength for
a given w/cm or total cementitious content. For each set of materials there is a unique relationship between the strength and water-cement ratio. A different set of materials has a different relationship as illustrated in Figure 1. At 0.45 water-cement ratio these three mixtures have strengths of approximately 6000, 5000 and 4000 psi respectively. These differences in strength can occur simply by changing the aggregate size and type used in the mix as described in ACI 211.

ACI 318 establishes a process whereby the concrete producer can document his past test records to establish mixture proportions for the proposed project. When this test record exists, the required average strength of concrete for the proposed work should be established based on the standard deviation of the strength test results from the past work. The submittal should require field or laboratory test records for each class of concrete to demonstrate the concrete will meet the required average compressive strength. The specification should not require the required average strength at a fixed value, say 1200 psi, over the specified strength. The procedure for calculating standard deviation and required average compressive strength based on the specified strength should be derived from the equations in Table 5.3.2.1 of ACI 318. This ensures that producers who maintain low strength variability (standard deviation) can optimize concrete mix designs for a lower average strength. Concrete supplied by producers exercising good quality control will frequently result in fewer problems on a project.

While the traditional testing age for strength tests is 28 days, the design professional has some flexibility to change the test age to suit the project requirements. An early age strength requirement may be appropriate for fast track construction but could detract from the durability of the concrete. If project schedules anticipate later live load applications on the structure, it might be appropriate to specify strength requirements for later test ages, such as 56 or 90 days. This allows the use of higher volumes of supplementary materials such as fly ash, slag and silica fume, which generally result in more durable concrete and support sustainable construction.

Durability

When it comes to concrete durability, engineers should not rely solely on specifying a minimum compressive strength, maximum water-cement ratio, minimum cementitious content and air entrainment. There are better ways to quantify durability. Low permeability and shrinkage are two performance characteristics of concrete that can prolong the service life of a structure that is subjected to severe exposure conditions. But how should these properties be specified and measured? What should the acceptance criteria be? Below we will describe the latest quality assurance and quality control methods used for concrete to withstand corrosion, alkali silica reaction and sulfate attack.

For durability provisions, the ACI 318 Building Code generally relies on the w/cm to reduce the permeation of water or chemical salts into the concrete that impacts its durability and service life. However, along with the w/cm, the code requires a concomitant specified strength level, recognizing that it is difficult to accurately verify the w/cm and that the specified strength (which can be more reliably tested) should be reasonably consistent with the w/cm required for durability.

It should be stated that strength should not be used as a surrogate test to assure durable concrete. It is true that a higher strength concrete will provide more resistance to cracking due to durability mechanisms and will generally have a lower w/cm to beneficially impact permeability. However, it should be ensured that the composition of the mixture is also optimized to resist the relevant exposure conditions that impact concrete’s durability. This means appropriate cementitious materials for sulfate resistance, air void system for freezing and thawing and scaling resistance, adequate protection to prevent corrosion either from carbonation, chloride ingress or depth of cover, a low paste content to minimize drying shrinkage and thermal cracking, and the appropriate combination of aggregates and cementitious materials to minimize the potential for expansive cracking related to alkali silica reactions.

Permeability

Many aspects of concrete durability are improved by reducing the permeability of concrete. The ACI 318 Building Code addresses an exposure condition (Table 4.2.2) for “concrete intended to have a low permeability when exposed to water” by requiring a maximum w/cm of 0.50 and a minimum specified strength of 4000 psi. This recognizes that a lower water-cement ratio is important to control the permeability of concrete.

The problem with the code requirement is that one parameter of w/cm by itself does not assure the owner that compliance with this requirement will not adversely effect other properties of concrete. Figure 2 is an illustration of the volume fractions of the composition of two concrete mixtures at the same w/cm. One mixture has a lower paste (water + cementitious material) content and will likely have different performance than the mixture with the higher paste volume. Some likely problems with the mixture with the higher paste content could be a higher heat of hydration, higher potential for cracking, lower modulus of elasticity, higher creep and different resistance to durability to chemical elements depending on the composition of the cementitious material.

With the extensive use of supplementary cementitious materials and innovative chemical admixtures, a concrete mixture can be optimized for a low permeability in more
Standardized tests exist that can help identify mixtures with low permeability. ASTM C 1202, *Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration*, often called the Rapid Chloride Permeability Test (RCPT), is one method that is increasingly used in performance oriented specifications. The charge passed, in units of coulombs, is used as performance criteria for permeability. Specifications include limits between 1000 and 2500 coulombs for various applications. Figure 3 is an illustration that shows varying levels of charge passed (coulombs) as a measure of permeability for concrete mixtures at the same w/cm depending on the cementitious materials used in the mixture.

The RCP test method is very sensitive to specimen handling and until there is more experience with specimen preparation and care for initial curing in the field, its use as a jobsite acceptance test is not recommended. However, this test could be used as a pre-qualification test in lieu of specifying low w/cm ratio. ASTM C 1202 provides some discussion of the relative potential for chloride ion penetrability based on the charge passed through the concrete specimen. RCP values greater than 4000 coulombs will allow a high level of ion penetrability; values between 2000 and 4000 coulombs are moderate; 1000 to 2000 is considered low and lower values are very low. Values below 2000 to 2500 coulombs afford sufficiently low "permeability" for most applications. Although the RPCT is not a direct measure of permeability, there is a wide body of evidence that concrete with lower coulomb ratings using this test is more resistant to chloride ingress.

Another method that provides a visual indication of the depth of chloride penetration under an electrical field is the rapid migration test, currently a provisional AASHTO standard — AASHTO TP 64. This method is considered more reliable as it provides a quantifiable measure of the depth of penetration of an ionic species and avoids some of the shortcomings of ASTM C 1202. Although this test is not currently in wide use, it may eventually become the basis for pre-qualifying concrete for permeability. However, we do not recommend its use as a jobsite acceptance method at this time.

ASTM C 1556, *Method for Apparent Chloride Diffusion Coefficient of Cementitious Mixtures by Bulk Diffusion*, is a recently standardized method that measures chloride ion concentration at different depths of a test specimen that has been immersed in chloride solution. From the measured chloride ion concentration at different depths the apparent diffusion coefficient can be calculated. This method is rather involved and takes time to obtain results. It should only be used as a pre-
spray from these sources, the ACI 318 Building Code requires a maximum w/cm of 0.40 and a minimum specified compressive strength of 5000 psi (Table 4.2.2). The building code also includes limits for maximum water soluble chloride ions in concrete as a percent by weight of cement. The limits vary from 1.0 for reinforced concrete that will be dry in service to 0.06 for prestressed concrete. A common source of chlorides in the ingredients used for concrete is from chemical admixtures, generally accelerating admixtures. Non-chloride admixtures can be used when these limits apply.

These measures alone may not be adequate to achieve low permeability concrete to protect against corrosion. Use of supplementary cementitious materials such as fly ash, slag, silica fume, etc., is essential. Rather than specifying concrete mixture constituents to achieve low permeability (never a guaranteed step), the engineer can require ASTM C 1202 test data showing a value between 1000 and 2500 coulombs. Other methods discussed under the section of permeability are also applicable to this protection against corrosion.

Cracking due to shrinkage must be minimized. Even though the effect of cracking on rebar corrosion is still a subject of study, the general understanding is that cracks of small width (less than 0.2 mm) perpendicular to the reinforcement may not impact corrosion significantly.

The specification should ensure that the structure as constructed has adequate clear cover from the reinforcing steel. ACI 318 R 7.7.5 recommends minimum cover of 2 to 2.5 inches for concrete exposed to salt water. However, excessive cover in negative moment regions can cause cracking under service loads.

**Corrosion of Reinforcing Steel**

Corrosion of steel is an electrochemical process whereby iron, in the presence of moisture and oxygen, converts to rust that occupies about six times more volume than the original iron. Because of its high alkalinity, concrete creates a passive layer around steel and prevents it from corroding. This breaks down if the concrete carbonates (reacts with carbon dioxide in the air) to the level of the steel, which causes a reduction in the alkalinity. Chloride ions that reach the steel will also break down the passivity provided by concrete. Several steps can be taken to reduce failure due to corrosion of steel reinforcement.

Ensuring that there is adequate clear cover of concrete to the steel delays the onset of corrosion. Another means of delaying the onset of corrosion is by reducing the permeability of the concrete, using epoxy coated reinforcement or corrosion inhibitors, a chemical admixture that is added when concrete is mixed. Non-corrosive reinforcement is probably the best, but not a very cost effective option at this time. Chlorides typically come from sea water or deicing salts.

For corrosion protection of reinforcement in concrete exposed to chlorides from deicing chemicals, salt, brackish water, seawater or...
In addition, epoxy coated reinforcement can be a good choice. However, epoxy coated rebars are not recommended for concrete that will be submerged as in a very moist environment as the epoxy layer has been observed to de-bond. Different types of corrosion inhibitors are also available. Dosages should be used according to manufacturer recommendations. Carbonation of good quality concrete is generally a slow process and is not a concern if adequate cover is provided.

Sulfate Attack

Sulfate ions are found in ground water and soil in some regions of the U.S. For the most part, alumina bearing compounds in cementitious materials react with sulfates forming expansive reaction products. Some sulfate salts also react with the cement hydration products to form gypsum, which also results in a volume expansion. In some cases the cement hydration products are broken down resulting in a loss of cementitious properties. Protecting against sulfate attack requires using the appropriate cementitious materials and reducing the ingress of sulfates into the concrete.

ACI 318 Table 4.3.1 classifies different levels of sulfate exposure based on the concentration of sulfate ions in the soil or water anticipated to be in contact with the concrete. The code requires corresponding levels of maximum w/cm, minimum compressive strengths and cement types.

Portland cements that conform to ASTM Type II and V are used for moderate and severe sulfate conditions, respectively. Type II cements have a maximum limit of 8% on the tricalcium aluminate, C₃A, while Type V cements limit the phase to 5%. A portland cement might optionally be tested for sulfate resistance in accordance with ASTM C 452. Most fly ashes (primarily Class F), slag and silica fume provide resistance against sulfate resistance. These supplementary cementitious materials and blended cements are good options for sulfate resistance. The sulfate resistance of these materials and blended cements can be determined by ASTM C 1012, where mortar bars are immersed in sulfate solutions and expansion measured over time. This provides for a performance-based option for pre-qualifying the cementitious component of a concrete for sulfate resistance.

Table 2.3 of ACI 201.2R-01 has similar w/cm and compressive strength requirements as ACI 318 but addresses the performance alternative for the different cement types. The performance option requires optimizing the cementitious materials and their amounts and is as follows:

• Moderate (Class 1) sulfate exposure – ASTM C 1012 Expansion <0.10% at 6 months
• Severe (Class 2) sulfate exposure – ASTM C 1012 Expansion <0.10% at 12 months
Quality Assurance and Quality Control

Quality assurance and quality control testing for concrete is becoming more complex. In addition to typical concrete tests for strength, slump and air content, there are other performance-based tests that measure such properties as shrinkage, permeability and resistance to chemical attack. Many of these test methods are complicated and sensitive to variability in sampling and procedure. Some tests are best suited for pre-qualifying concrete mixtures while others are better suited for field acceptance.

The following terms are used throughout the discussion:

**Quality Assurance** — actions taken by an owner or representative to provide and document assurance that what is being done and what is being provided are in accordance with the applicable standards of good practice and following the contract document for the work.*

**Quality Control** — actions taken by a producer or contractor to provide and document control over what is being done and what is being provided so that the applicable standards or good practice and the contract documents for the work are followed.*

**Pre-qualification Tests** — tests required in the specification that provide some level of assurance that concrete mixture(s) proposed for use on the project will meet the desired level of performance. For example, field or laboratory test records to demonstrate concrete will meet the required average compressive strength would be considered pre-qualification tests. Many durability tests should be conducted in a controlled laboratory environment or take significant time to obtain results and are better suited as pre-qualification tests. Pre-qualification tests are conducted before concrete is placed and test results are submitted to the project engineer/architect for review and/or approval.

**Acceptance Tests** — tests required in the specification to indicate concrete furnished to the project meets the specified acceptance criteria. For example, tests on concrete cylinders collected in the field during concrete placement and tested at 28 days. Acceptance (pass/fail) criteria should be indicated in the specification. Detailed procedures when concrete does not meet the acceptance criteria should also be provided in the specification. In many cases, alternative identity acceptance tests, such as strength and density, could be used as a means of verifying that the concrete delivered represents the concrete mixture in the submittal, especially when the tests conducted for pre-qualification are not conducive to jobsite schedules or conditions.

**Prescriptive Specification** — a set of instructions that includes clauses for means and methods of construction and composition of the concrete mix rather than defining performance requirements or in addition to some performance requirements. Many times intended performance requirements are not clearly indicated in project specifications and the prescriptive requirements may conflict with the intended or implied performance.

**Performance Specification** — a set of instructions that outlines the functional requirements for hardened concrete depending on the application. The instructions should be clear, achievable, measurable and enforceable. For example, the performance criteria for interior columns in a building might be compressive strength only, since durability is not a concern. Conversely, performance criteria for a bridge deck or parking garage might include, in addition to compressive strength for design loads, limits on permeability and shrinkage since the concrete will be subjected to a harsh environment. Performance specifications should also clearly specify the test methods and the acceptance criteria that will be used to verify and enforce the requirements. Some testing might be required for pre-qualification and some might be for jobsite acceptance. The specifications should provide flexibility to the contractor and producer to provide a mixture that meets the performance criteria in the way they choose. The contractor and producer will also work together to develop a mix design for the plastic concrete that meets additional requirement for placing and finishing, such as flow and set time, while ensuring the performance requirements for the hardened concrete are not compromised. Performance specifications should avoid requirements for means and methods, and should avoid limitations on the ingredients or proportions of the concrete mixture.

* Cement and Concrete Terminology, ACI 116R-00, American Concrete Institute, Farmington Hills, MI, 2000.
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severe test where a mortar bar is exposed to an alkaline solution at a higher temperature. Many aggregates that fail that test have shown to perform satisfactorily in the field. The ASTM C 1293 test is considered to be a more realistic test that is conducted on concrete. But it takes 1 year for the test to be completed as opposed to 16 days for the C 1260 test. So, should an aggregate fail the quick C 1260 test, it is suggested that the C 1293 test be conducted and, if it passes, the aggregate can then be considered as non-reactive. There are some aggregates that may pass the C 1260 and C 1293 tests and yet may fail in the field. These aggregates are very few in number and their behavior is well known in the area where they are typically used. Another alternative is to conduct a petrographic evaluation of the aggregates to identify and quantify the amount of reactive siliceous minerals. Field service history is also a good means of establishing the reactivity of an aggregate provided the mixture composition of the in-place concrete can be established and the structure has been in place for at least 7 to 10 years.

If an aggregate is determined to be potentially reactive in accordance with the above tests, or if the field performance of the aggregate indicates that it is reactive regardless of the results of any of the above tests, then that aggregate can still be used in concrete with appropriate mitigative measures. ASTM C 1567 is a rapid test that uses the aggregate with the test combination of cementitious materials. This test is a modification of ASTM C 1260 that is used to qualify the materials proposed for use on the job. Varying quantities of supplementary cementitious materials can be tested to establish the required quantity that minimizes the potential for deleterious expansions. Expansions less than 0.10% after 14 days exposure will qualify the combination of materials for use. This option is adequate in mitigating ASR. Lithium-based admixtures are also available to reduce the potential for ASR deterioration. Dosage requirements are established by the supplier based on the cementitious materials and the degree of reactivity of the aggregate.

Summary

In conclusion, when specifying concrete

• Very Severe (Class 3) sulfate exposure – ASTM C 1012 Expansion <0.10% at 18 months

The other factor to provide sulfate resistant concrete is to prevent the sulfate salts from permeating into it. ACI 318 controls this by placing a maximum limit on the w/cm. For those structures not governed by the building code, permeability tests will be a performance-based alternative to the w/cm as discussed in the earlier sections.

Alkali Silica Reaction (ASR)

Alkali ions (Na⁺ and K⁺), primarily from the cement, cause a reaction with reactive silica mineral forms present in certain aggregate sources in the presence of moisture. This reaction forms an expansive alkali silicate gel that absorbs water and causes concrete to crack. Alkali salts can also permeate concrete from external sources such as deicing salts or sea water. To prevent ASR, the specifier should avoid requiring the use of a “non-reactive” aggregate because that may not be an option in some regions. Using a low alkali cement (alkali content as Na₂O eq. less than 0.6% by mass of cement) affords some level of protection. But it may not be sufficient if external sources of alkalis are possible or if alkalis could concentrate as the concrete dries out. Generally, combinations of silica fume, fly ash and slag are effective in reducing the potential for deleterious expansions due to alkali silica reactivity. Class F fly ash is more effective at mitigating ASR. Class C fly ash may have to be used at high replacement levels in order to be effective.

Figure 6. Cracking of a concrete bridge substructure due to ASR

Aggregates are expected to be non-reactive if they yield a 14-day expansion lower than 0.10% by ASTM C 1260 test or 1-year expansion lower than 0.04% by the ASTM C 1293 test. The ASTM C 1260 test is a very severe test where a mortar bar is exposed to an alkaline solution at higher temperature.
for durability, use performance-based pre-
qualification and acceptance criteria
whenever possible. Most criteria should focus
on pre-qualifying concrete with some field
acceptance tests that provide some level of
assurance that the concrete proposed (that
met pre-qualification criteria) was the
concrete supplied for the project. Durability
related criteria are only necessary when
concrete will be exposed to a harsh
environment. Most concrete used for
building construction is protected from
exposure and therefore not subject to a harsh
environment. Attempting to improve
durability with prescriptive criteria such as
limits on w/cm or cementitious materials
content should be avoided. In this paper,
guidance was provided to the specifying
engineer on incorporating performance-
based requirements in specifications to
address corrosion, alkali silica reaction and
sulfate attack. This paper will be developed
further to address various other mechanical
and durability properties of concrete.

Current specifications often require
prescriptive elements such as a minimum
cementitious content or a specific dosage of
supplementary cementitious material to
design for durability, generally with not much
assurance that this will be achieved. The ACI
318 Building Code does not require this
prescriptive approach. The engineer could
potentially replace these prescriptive
requirements with performance measures
such as permeability tests as discussed in
detail in this article. The specification will still
have to use a maximum w/cm criterion for
structures governed by the code and, in the
case of sulfate attack, he is also restricted in
his choice of cementitious material. Efforts
continue to revise the building code to more
performance-based provisions. However, the
current code still provides enough
opportunity to design with performance
specifications.

The National Ready Mixed Concrete
Association is spearheading a major shift in
the way concrete is specified — the P2P
Initiative (Prescriptive to Performance
Specifications for Concrete). The goals of the
P2P Initiative include allowing the use of
performance-based specifications as an
alternative to current prescriptive
specifications. Details of the P2P Initiative
can be found at www.nrmca.org/P2P.

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More comfortable using the prescriptive specifications that they have always used and relied upon. And while concrete remains one of the best building materials available, it still has the potential for improvement as advances in technologies help to expand its strength, durability and breadth of applications.

One may wonder why some resist efforts to improve concrete or change the way we do business. Perhaps they feel comfortable with something that has generally worked in the past or their apprehension stems from a concern for compromising overall concrete quality in the long term. However, they need not worry that the concrete industry will be negatively affected through changes in specifications that are designed with the intention of improving concrete and fostering innovation. Importantly, performance specifications that are being advocated by an array of concrete-industry organizations are reviewed by the Prescription-to-Performance (P2P) Steering Committee, spearheaded by the National Ready Mixed Concrete Association (NRMCA). With wide concrete industry representation on the P2P Steering Committee, including concrete companies of all sizes and with support of allied concrete industry groups, it is extremely unlikely that anyone would risk compromising their reputations, and that of the concrete industry, if they did not truly feel that performance-based specifications for concrete is the future of this industry. Indeed, it is because they wholeheartedly feel that the industry would greatly benefit from such a significant shift that they are willing to give of their time and expertise to develop and review work and research related to the adoption of performance-based specifications.

Although the trend toward the use of performance-based specifications is relatively new when compared to the use of prescriptive provisions, the benefits of performance-based specifications are already highly apparent. When a contractor considers the benefit of using a high-strength, high-performance mix that is developed to the project’s construction criteria, it gives the contractor the opportunity to save time without sacrificing quality. The same potential benefits are evident to the owner and design professionals in terms of improved quality with efficient construction schedules for longer service life. Concrete producers will appreciate having improved clarity on what the owner needs with fewer inherent conflicts in specifications as well as having the flexibility to make adjustments to mix designs as material sources and weather conditions vary. Those concrete producers who focus on quality will also benefit from the P2P emphasis on quality control and innovation.

Certainly the best way to sway skeptics is to present them with data and research findings that clearly demonstrate the advantages of using performance-based specifications over prescription specifications. To this end, the RMC Research Foundation is currently

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ost people are uncomfortable with change. Whether this is because they are afraid of the unknown or are simply comfortable in the security of what they know, the fact remains that people often resist change for no particular constructive reason. From this attitude is borne the exclamation “But that’s the way it’s always been done!” This is true for some within the concrete industry as well. Many concrete industry professionals continue to resist change in the way that concrete is specified. Although the trend to specify concrete is moving toward performance-based specifications, there are many who remain more comfortable using the prescriptive specifications that they have always used and relied upon. And while concrete remains one of the best building materials available, it still has the potential for improvement as advances in technologies help to expand its strength, durability and breadth of applications.

One may wonder why some resist efforts to improve concrete or change the way we do business. Perhaps they feel comfortable with something that has generally worked in the past or their apprehension stems from a concern for compromising overall concrete quality in the long term. However, they need not worry that the concrete industry will be negatively affected through changes in specifications that are designed with the intention of improving concrete and fostering innovation.
supporting research efforts for four P2P projects.

Model Performance-based Specification

The first two projects relate to the Preparation of a Model Performance-based Specification — Phase I and Phase II. Phase I of this project includes the development of a comprehensive global review of current requirements for concrete, both in codes and specifications, in an effort to compile a comparative evaluation of prescriptive and performance criteria for concrete, during construction and for its in-service properties. Phase II involves the development of a model specification as performance-oriented as possible, given the present state-of-the-art and current limits on technology. Both projects will assist with the goal of identifying the steps necessary for the development of rapid and reliable means of confirming specified performance. Once both phases are completed, they will provide ready mixed concrete producers with a credible tool for continuing to educate engineers, architects, specifiers and others within the construction community of the benefits of using performance-based specifications.

Quality Management System

The next project focuses specifically on the development of a quality management system (QMS) guideline document specifically for the ready mixed concrete industry. The guideline will assist ready mixed concrete producers in establishing a quality management standard that will allow them to demonstrate that their company has the credentials to bid on and furnish concrete on performance-based criteria. A company's use of these guidelines will also assure a producer's customers that the concrete they are providing has met vigorous quality control standards and will be a uniform and consistent product. The QMS guide will include a review of current industry standard requirements such as from ACI, ASTM, AASHTO, ISO 9000 and NRMCA. International practices will also be noted where applicable. Finally, the guide will also include a complete sample quality management system for a fictitious ready mix company that documents the procedures that support quality. The completed project follows the outline of ISO 9000 Quality Management System and is written specific to the ready mix industry business practice. The document is being reviewed and finalized by a task group of the P2P Steering Committee. Ultimately, these guidelines will serve as the basis for the development of a producer qualification system to support the P2P initiative.

Laboratory-based Experimental Case Study

The fourth project is a laboratory-based experimental case study demonstrating the advantages of performance specifications. The goal of this study is to develop technical data to support changes in codes and specifications and to document a side-by-side comparison of prescriptive concrete mixes and performance-based mixes for two types of applications — warehouse floors and bridges — and a third aspect that evaluates durability provisions in the ACI 318 Building Code. Fresh and hardened concrete properties will be quantified and compared to demonstrate the benefits of concrete mixtures designed using performance-based specifications. This study is almost complete.

The P2P projects supported by the RMC Research Foundation are vital to the P2P Steering Committee's efforts to change the industry's building codes and standards to incorporate performance-based specifications, particularly within ACI's Building Code for Structural Concrete (ACI 318). “The RMC Research Foundation's support on the P2P projects has accelerated the completion of some of the objectives of the P2P initiative that would have taken significantly longer through volunteer effort. This has maintained focus and interest of members of the P2P Steering Committee and the other stakeholders that NRMCA works with,” says Jack Holley, vice president of quality assurance and new product development for Lafarge North America and co-chairman of the P2P Steering Committee. Although lab research and other small scale demonstrations provide solid data of how the P2P initiative may enhance the use of concrete, until codes and standards are adjusted to allow for broader use of performance-based specifications, the concrete industry will not be able to realize its full potential. However, as professionals within the concrete and construction communities become more familiar with the advantages that performance-specified concrete can provide, the industry as a whole is sure to follow. As the P2P movement gains additional momentum, the inevitable widespread use of performance specifications will no doubt foster additional innovation and enhancement of concrete and concrete applications. It is important to note that advancements in technologies have been a tremendous catalyst for the industry to improve the performance of concrete. Many of the innovations in concrete mix design have stemmed from the development of different admixtures and cementitious materials. As the P2P movement continues its advancement, additional innovations are sure to follow.

An important issue to keep in mind is that the use of prescription-based specifications and performance-based specifications is not an “either/or” scenario. Certainly prescription specifications will continue to be appropriate for a variety of projects and some people will likely continue to be more comfortable with their use. However, the emergence of performance-based specifications will undoubtedly offer additional options throughout the industry and will allow the use of concrete to not only improve but to also expand within the construction and infrastructure arenas.
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High Performance Concrete
Enhancement Through Internal Curing

By John Roberts, Chairman, Northeast Solite Corporation

Introduction

Currently, there are several driving forces toward making good concrete better. These are: recognition that durability results from a choice of materials and procedures; the embrace of the concept of high performance concrete (HPC) and the enhancement of these by the innovative concept of the internal curing of concrete. These concepts are simultaneously coming together in 2004 and 2005. They will assure that 50, 75, 100 or 150 year concrete is a valid expectation. Internal curing (IC) in place of, or as an adjunct to, external curing can assure that results contemplated through HPC will be achieved and improved. Problems resulting from low water-cement \((w/c)\) ratio concretes, such as autogenous shrinkage, have been identified, and research and field experience show us how IC will resolve them. Recognizing that external curing is less effective in certain situations, ACI Committee 308 is rewriting the Curing Guide 308R to include Internal Curing as an alternate process to that of external curing of concrete so that the potential properties of the mixture may develop [1]. The result is that the design engineer and the ready mixed concrete (RMC) producer will assume more of the responsibility for curing instead of leaving it to the contractor or his agent to cure the concrete, sometimes under adverse conditions.

High Performance Concrete (HPC)

Recently, the number of projects using HPC has substantially increased because engineers and state departments of transportation have seen that the mechanical and durability properties such as high strength, low permeability, resistance to freeze thaw and resistance to chemical attack are enhanced. Enhanced, yes, but not completely satisfied. Although, through the use of HPC, drying shrinkage is reduced, autogenous shrinkage and self-desiccation, consequences of low water/cement \((w/c)\) ratios, result in cracking not being eliminated, particularly at early ages. Without sufficient water, the cement does not hydrate soon enough, with the result that micro-cracking and autogenous shrinkage occur.

The purpose of HPC is to obtain long term strength, early age strength, low permeability, density and longer life in a severe environment [2]. Internal curing is used for the same purposes and end-results, including durability [3]. It even improves the durability of higher fly-ash concretes [4]. The two concepts have a synergistic effect, and internal curing enhances each of the desired characteristics of HPC and importantly durability.

Internal Curing (IC)

Concrete can be improved by the substitution, for a small amount of natural sand in the mixture, of an equal volume of crushed structural grade absorbent lightweight aggregate sand (LWAS). Most expanded shale lightweight aggregates have the ability to absorb 15% or more by weight of water and this absorbed water is immediately available to hydrate the cement particles deprived of mixing water in low \(w/c\) ratio concretes. This occurs through prompt release of the water as the concrete cures and the mixing water is used up [5].

For the past 50 years coarse lightweight aggregate (usually 3/4 inch) has been used, not for the purpose of supplying the extra water in the mix, but for the economy of its saving weight in bridge decks and multistory buildings. It was observed that its absorbed water supplied the function of internally curing the concrete, with the result that there was a great reduction in expected cracking.

It has been found, in the last five years, that the replacement for natural sand in the mix of as little as 100 lbs. per cubic yard of saturated lightweight aggregate sand will supply the water needed to properly hydrate the cement at a \(w/c\) ratio of 0.43 [6]. The water, which is not included in the water cement ratio calculation, needs to be within capillary distance of the cement particles thirsty for water. This is the process of Internal Curing (IC).

The lower we go from a water-cement \((w/c)\) ratio of 0.43 the autogenous shrinkage problem becomes more noticeable. At 0.43 the problem is measurable and correctable; at 0.40 it becomes a definite concern; at lower numbers its resolution becomes a must. At 0.35, external curing is not effective [7]. The use of strong, crushed LWAS as a replacement of some of the natural sand in the mixture is effective [3, 5, 8, 9].
aggregate and cement are incorporated in the mixture and as the concrete gains its initial set. As the skeleton is formed during the initial hydration of the cement, localized areas become deficient of water. The absorbed water either replaces the conventional mixing water or it directly hydrates cement particles thirsty for water. The “back-up” absorbed water is drawn by capillary force and gravity from the aggregate into the pores formed by the space where the mixing water was. As that water is used up by the further hydration of the cement, it is replaced. Because water is so fluid, capillary action so strong and the thirst of the cement particles so intense, all these actions take place simultaneously [8]. The key is to have the water available and used before the voids, where the mixing water was, become clogged with products of hydration.

Readily available internal water that is within capillary distance of the cement particles hydrates those particles not otherwise hydrated by the mixing water. This provides increased early age (0-72h) strength, eliminates almost all the autogenous shrinkage [6, 9] and further enhances the concrete by reducing the permeability of the concrete. With later age (3-28 days), the absorbed water continues to hydrate the cement (the c of cm) and starts to react with the cementitious material (the m of cm) thus providing increasing strength and other beneficial characteristics. In still later ages (28 days on) the retained water provides higher internal relative humidity and consequently eliminates self-desiccation.

Advantages of Internal Curing

A mixture, with a w/c of 0.434 which contains 100 lbs. of lightweight aggregate sand as a replacement for an equal volume of natural sand, provides 7 day flexural strength in 3 days [9]; improves the 84 day permeability (Coulombs) 25%; the 28 day compressive strength 10%; the 28 day tensile strength 6% and the durability factor 2% or more [3, 5, 6]. At a lower w/c ratio more LWAS will be needed; at a range of 0.38 to 0.40 about 200 lbs. per cubic yard are required [9].

Internal Curing can provide several advantages, depending on the time (hours-days-months) that it takes to provide the reaction with cement or puzzolans. In order to prevent micro-cracking or autogenous shrinkage, the cement needs to be hydrated in the early hours after the water and cement are commingled. Early age (<3 days) is the crucial time for strength gains to be achieved to enable the concrete to be strong enough not to be cracked by the internal and external strains applied to it. This is the period that micro-cracking and autogenous cracking occur. IC is vital to keep that from
occurring. A 20% sand replacement with LWAS enables the almost complete elimination of autogenous shrinkage and reduces the risk of cracking 50% [10].

Eliminate the Risk of Autogenous Cracking

Practitioners (engineers, architects, owners) will decide the margin they feel their particular application can risk against cracking, against corrosion of the reinforcing steel and against all those deficiencies of concrete that can occur because of improper curing. The effects of different amounts of LWAS on autogenous shrinkage were investigated at the National Research Council Canada [10, 11] on large prismatic concrete specimens under fully-restrained autogenous shrinkage (specimens were sealed against external drying). The concrete had a water-cement ratio of 0.34 and a cement-sand-stone ratio of 1:2:2. The sand replacement ratios used in the studies that have been published were 0% (control), 6% and 20%. It was shown that the specimen with 6% LWAS developed slightly less shrinkage and comparable creep than the control specimen. Both the control and 6% LWAS specimens failed after 1.5 days of testing, reflecting a decrease of internal relative humidity (RH) after initially hydrating cement and then absorbing other water from the matrix. The specimen with 20% LWAS, however, demonstrated (i) less internal drying (i.e. enhanced internal curing), (ii) a clear reduction of autogenous shrinkage and (iii) a much reduced tensile stress to strength ratio not higher than 0.5 (i.e. a minimum safety factor of 2). It was also shown that LWAS in the amounts tested in the study did not adversely affect the air content, strength or modulus of elasticity of the concrete.

With cracking eliminated, or largely so, and with permeability reduced, water, salt and other deleterious substances which could adversely affect the reinforcing steel are hindered from entering the concrete. Together, HPC and IC enable the concrete to withstand the attacks, with the result that bridges, pavements, parking structures and walls are essentially repair free for a significant period. The pay off is that they are able to reach service lives of 50, 75, 100 or 150 years.

Internal Curing Saves Dollars

Moreover, external curing costs money and is subject to procedures not being followed. The most important part of good concreting practice is often the most abused and overlooked in the field. The cost of external, after-the-fact, curing, repair cost and earlier replacement of the concrete exceed the relatively low initial cost of IC. The value added properties provide the RMC producer with an additional promotion tool. In addition, there is the obvious advantage of eliminating much of the uncertainty of external curing.

The cost of the IC agent (the lightweight aggregate sand used) that is incorporated in the concrete depends on the amount needed. Not only is the cost of the IC agent (LWAS) of interest to the designer who uses it to reduce cracking but also the characteristics of the aggregate itself are important: its absorption, its particle...
strength, particle shape, gradation and its ability to not detract from mixing, placing and finishing. Consequently, it is well to make comparative tests, using ASTM C 109/C 109 M [3, 6], to test the LWAS to be sure the mortar compressive strength is not compromised.

How Much LWAS to Use

The February 2005 issue of Concrete International had an article authored by Bentz, Lura and Roberts on how much IC agent to use [12, 13]. The rationale is based on the chemical shrinkage (autogenous shrinkage) and the desorption of the readily available water as it migrates to the hydrating cement. The maximum expected degree of hydration of the cement depends on the water available. The rate depends on the ability of the lightweight aggregate to desorb the water quickly.

A less than optimum lightweight aggregate will have inadequacy of water or desorb it at a lower rate such that the maximum amount of hydration of the cement is not achieved. The ASTM C128 test for absorption has a time of 24 hours and this test is an indicator of the water available internally for the hydration of the cement not hydrated by the mixing water. Since desorption is especially important in the initial and final setting stages, an absorption at 30 minutes has been accepted as a measure of early availability of absorbed water. As far as the absorption of the lightweight aggregate is concerned, each shale, clay or slate out of which the aggregate is made has its own characteristic expansion with resulting void or pore configuration. Some voids are large, some infinitesimally small, some are interconnecting, some are not. The result is that 24 hour absorptions vary from 5% or less to 25% or more. Consequently, with different lightweight aggregates, the same mass of lightweight aggregate might have widely varying ability to provide water for the hydration of the cement.

The formula is designed for computing the amount of LWAS to use by knowing the degree of saturation of the water in the aggregate, the w/c ratio, the degree of hydration of the cement and the amount of cement [9].

Procedure for Using LWAS

The procedure for best results is within standard practices of ready mixed concrete plants. In addition to replacing some of the natural sand with an equal volume of structural grade LWAS, care should be exercised to batch the LWAS saturated surface dry (SSD). Your lightweight aggregate supplier can provide you with specific procedures.

Summary

There are many opportunities to make good concrete better through the use of HPC and IC. Applications needing the benefits have been identified. In the case of bridges, Anthony E. Fiorato, past president of ACI said, “Durability is a driving force on the choice of materials in bridge construction.” He said we could “…accomplish this through materials, selection and design.” Concrete in the 21st Century is being improved through choice of...
ingredients and engineered systems and practices, rather than relying on methods that are affected by on-the-job practices and the weather. Instead of external curing with water after-the-fact, water will be engineered into the concrete through the use of water absorbent materials.

Acknowledgements

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Water, Water Everywhere
Maybe Not? Maybe $$$$$$

By Edward Herbert, III, Director of Environmental Compliance, NRMCA

Water for ready mixed concrete production has always been readily available in virtually limitless amounts in most parts of our country. We have long been blessed with a seemingly limitless water supply to use in the production of ready mixed concrete. The thought of having to conserve water may seem foreign to us. USA TODAY reported two years ago that the current shortage of water in the United States is unprecedented and may get worse. While the East Coast has received a great deal of attention, the problem exists throughout many parts of the U.S. While government intervention has been limited, imposed restrictions on water use and higher costs for consumption can potentially have a great effect on ready mixed concrete producers.

There were several seminars and discussions on water use and cost at the recent OES Forum & Expo in San Antonio. Information presented gives the impression that most producers consider water expenses a simple cost of doing business without considering ways to reduce water usage and increase profits. Producers diligently follow the process of cement and aggregate, but do not consider water in their list of costs for materials. The industry has faced several challenges over the last year with soaring cement prices and other material shortages. Looking at ways to reduce water use and encourage recycling could help to ease the pain caused by the increased cost of other materials.

In the more arid areas of the United States, ready mixed concrete producers realize the need to conserve and recycle water, whether it is from a municipal source or from a well. Producers in California, for example, are not permitted to discharge any process waters from their plants. Stormwater regulations are also very stringent. This limitation has driven innovation and encouraged ready mixed concrete producers to implement water recycling programs and limit the use of potable water. New standards such as ASTM C 1602, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete, and ASTM C 1603, Standard Test Method for the Measurement of Solids in Water, provide explicit instructions...
on how to recycle water and assure the production of the highest quality concrete.

Other producers are constructing high-pressure spray wash systems that use reduced volumes of water with greater efficiency. The costs are further reduced if recycled process water or stormwater is used for truck washing. These systems clean the trucks effectively and help to present your company in a positive light. It will only take a cursory cost/benefit analysis to see how quickly such a system will pay for itself and will continue to be a benefit with reduced water use and associated expenditures.

In his presentation on the “Cost of Water” at the OES Forum & Expo, Greg Vickers of Schwing America provided some very interesting information on water use, price variability and ways to reduce costs. Greg believes that at most plants, a lot of money could be saved via water conservation and recycling programs. The main point of Greg's presentation was that water is never free; there is always an expenditure involved for the producer, demonstrated in the following points:

• U.S. city water usage rates average $4+ per 1,000 gallons.
• Water and sewer line tapping rates are based on per-home usage (EDUs or "equivalent dwelling units"), frequently @ <6,000 gal/month.
• Industrial water users are often assessed fresh water and sewerage fees based on the same criteria.

Greg also presented some statistics on the accomplishments of Lafarge North America at its Alpharetta plant. The Alpharetta plant is the only Performance Track-certified concrete plant in the United States. This high-volume plant uses both city and well water. Prior to conducting monitoring for the Performance Track program (mid-2004), water costs per cubic yard were roughly 17¢. A focus on water usage and the implementation of best management practices at the plant resulted in reduced water costs that are between 3.5¢-7.5¢ per cubic yard.

Greg conducted a survey of 34 plants and found that water costs ranged between 2¢ and 52¢ per cubic yard. Of the 34 plants, he found that “city water” plants tend to have much higher water costs per yard (25¢, 34¢, 47¢) and that well water plants typically spent less than 7¢ per cubic yard. The average cost of water at all 34 plants was 15¢ per cubic yard.

Ready mixed concrete producers have the ability to take steps to implement devices and management practices that will reduce water costs. Finally, Greg made a great point by stressing that the ready mixed concrete industry could and should promote itself as conservation-minded, NOT as a high consumer of water.

You may want to take steps now to find measures to conserve water use, prevent waste and save money. Making these efforts now may help when any regulatory effort transpires to show how you already have a conservation plan in place. Conservation efforts can also serve a company well in its public relations endeavors. Take action now to show your commitment to reduce water waste and save money for your company.

For more information, contact Herbert at eherbert@nrma.org or 240/485-1154.
Concrete Roofs are Green

By A. Vance Pool, National Resource Director, NRMCA

Sustainable construction is reaching a point where many architects are beginning to see it as the mainstream, no longer an emerging trend. That is both good and bad news. The good news is that the perception will likely increase the number of sustainable buildings built, which is good for us all. The bad news is that there are many significant, simple to deploy technologies that involve concrete that are neither well understood nor used as often as their economic benefits would predict. In previous editions of Concrete Infocus, we have talked about the numerous ways concrete parking lots are green. We reported on the many attributes that make walls that include concrete green. It is only logical we keep moving up the structure to talk about the roof. Green roofs, which are just beginning to get some traction in the U.S., have been successfully deployed around the world. They provide a number of benefits, which can provide not only environmental benefits but also economic benefits.

Sustainable construction and environmental benefits of green roofs are numerous. They impact urban heat islands, stormwater management, overall air quality and provide a habitat for specific types of wildlife. Each of these qualities deserves a smattering of more detail.

Urban heat islands are a well-documented phenomenon. As mentioned in earlier articles, visit www.nasa.gov to find out how science has proven that they exist and that light colored rigid pavements like concrete outperform petroleum based flexible pavements in this area of growing concern. Just as light colored pavements add value to a project, so do light colored roof materials. But the reflecting of the light and heat is only one portion of the problem. When land is undeveloped, the moisture in the soils provides a cooling effect and this is not addressed by using light colored roofing. A green roof with a soil medium and plants on it provides some relief in this area. It also can provide shade depending on the type of green roof developed. That is why a number of airports in Europe have started to employ green roofs — the large buildings create significant green space.

Stormwater management is an increasingly important and expensive part of most development plans. Stormwater systems cost local governments significantly more and more money to build, maintain and upgrade capacity levels. Developers carry the cost burden of building retention ponds and more complex water management systems. Green roofs can play a role in a good overall stormwater management plan. Green roofs will hold an amount of water based on their type and size and the runoff will be slower than with a conventional roofing system. The water quality is generally enhanced due to the filtering effects of the plants and soil media. There are studies that have documented the filtering effect.

Air quality improvement is another positive effect of green roofs. By using plants instead of a conventional roofing system, photosynthesis can occur. This means oxygen is being created and this can help offset some of the losses from deforestation during development. There are some types of green roofs that have plants as large as trees, so this effect can be enhanced based on the type and amount of foliage planted.

Green roofs can provide a habitat for wildlife. Small animals and birds can utilize green roofs as a part of their environment. While this is in no way a substitute for a native habitat, green roofs can be an oasis in a large metropolitan area. Birds will find and utilize these areas as a portion of their habitat.

The potential economic benefits can include a reduction in pervious cover as recognized in some municipal, county or state regulations. Overall building energy costs can be reduced due to the green roofs’ natural thermal insulation properties. Acoustic insulation properties also exist with green roofs, and many have been placed near airports, yielding great results in noise reduction. When green roofs are applied, often-wasted rooftop space can be turned into usable space. When the savings associated with deferred repair and maintenance as well as reduced energy consumption are taken into account, the lifetime cost of green roofs can be comparable to the cost of conventional flat roofs.

A significant trend in the use of green roofs includes using "waterproof concrete.” Waterproof concrete can allow the removal of
a waterproofing membrane layer in the system. Since failure of the membrane can require a costly repair during the lifecycle of the project, this is a significant step forward in the evolution of the green roof movement. Waterproof concrete is nothing new; it has been used in floating bridges in Seattle for decades. It can be accomplished through a variety of admixtures and mix designs. For those naysayers reading this, imagine a leak in the concrete and you can see that doing the repair from the underside of the roof is much easier and less costly than removing everything above a membrane and replacing it.

Green roofs are a growing construction method in the rest of the world. The U.S. is lagging behind many countries in its acceptance of this proven technology. By using the many significant, simple to deploy technologies that involve concrete, owners, specifiers and end users of projects can provide sustainable construction that is also economically viable. Green roofs, concrete wall systems like insulating concrete forms and tilt wall, as well as concrete parking areas, roads and streets, all meet the criteria. As life cycle cost of development becomes the norm instead of bid cost, all these systems will see more rapid rates of adoption.

For more information on green roofs, visit www.greenrooftops.org. For information on concrete parking areas, visit www.concreteparking.org.
Throughout 2005, NRMCA is celebrating a notable milestone... our Diamond Anniversary. Founded in 1930, NRMCA continues to be the leading industry advocate working to expand, improve and promote the ready mixed concrete industry through leadership, education and partnering... helping keep America strong. To celebrate our 75th Anniversary, we’re proud to introduce a new logo, projecting confident leadership as we accelerate into an exciting future.

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early two years ago, NRMCA released version 1.0 of the Concrete Pavement Analyst (CPA) parking area design and costing software. This tool was born out of the necessity for the concrete industry to better quantify the differences between concrete and asphalt pavements for parking areas. These differences are quantified in two main categories: comparative design differences and ownership costing, where ownership costing combines initial cost with long-term maintenance costs.

Since CPA’s release, over 500 industry promotion professionals have been trained in the use of CPA. Of these promotion professionals, approximately one dozen of these people have gone on to conduct their own CPA software training sessions with others. All these trained promotion professionals has led to the training of over 1,000 specifiers, owners and contractors. Although not all project successes have been documented, NRMCA knows that over 50,000 cubic yards of concrete have been sold as a direct result of utilizing CPA as a key part of the promotion strategy. It is believed that this documented 50,000 cubic yards is a mere fraction of the true success of CPA. Originally, most of the success was centered on the upper Midwest, but as the saying goes, “success breeds success” and NRMCA is now fielding inquiries about the use of CPA for promoting concrete parking areas throughout the country on a weekly basis.

As a result of feedback received, NRMCA has created and released version 1.1 of CPA. This newer version addressed a few cosmetic changes, the addition of a 6” curb section, the inclusion of R-Values for soils in the help screens and, most importantly, added structural number (SN) values to several of the CPA outputs. The SN for a given pavement is a relative value that allows the program user to draw comparisons in load carrying capacity between different pavement types and thicknesses. The higher the SN is for a given pavement, the greater the load carrying capacity is as well. Designing structurally equivalent concrete and asphalt pavements is our first line of defense in the promotion battle. Needless to say, 1 inch of concrete is not equal to 1 inch of asphalt. The Design Summary Graph shows three structurally equivalent pavements showing the same 2.25 SN.

When competing concrete and asphalt pavements have the same SN, the initial cost for each pavement is surprisingly close, + or – 5%. The asphalt industry is keenly aware of this and that is why its frequently promoted lighter duty pavement is nowhere close to the...
performance of the specified concrete pavement for the same project. This allows it to sell at a significantly lower initial cost. It is not usually the cheap price of asphalt per ton that causes us problems; it is the cheap light duty asphalt design that makes initial cost comparisons difficult. In fact, you will frequently find the asphalt design sold is thinner than the Asphalt Institute’s minimum recommended thickness of 4 inches.

Although we can’t always count on the specifier accepting our equal design comparisons, he should always be our first point of discussion. Our next compelling argument should be Ownership Costing, which combines initial cost and anticipated maintenance costs over a given period of time called the service life. The Cost Summary Graph tells a very compelling story about Total Ownership Costs. First, the ACI-330 Concrete Design and the Asphalt Institute Design are roughly equal on initial cost, but this asphalt design has far higher ownership over a similar service life. Second, and more noteworthy, is the fact that the light duty Specified Asphalt Design, while having the lowest initial cost, is also the most expensive to own.

Another valuable output of the CPA software is the Break Even Analysis Graph. This view of ownership cost over time allows the decision maker to see at what point in time the ownership cost of an asphalt design will exceed that of the recommended concrete design. This point in time is referred to as the break even point, which on most projects will happen within 8-12 years. In fact, the ownership cost for asphalt eclipses the corresponding cost of the recommended concrete with the addition of one seal coat and one overlay to the asphalt design.

This methodology of using these CPA outputs has allowed numerous promotion professionals to convert asphalt pavement to concrete. NRMCA has had first-hand involvement with several national accounts in using CPA to sell more concrete parking areas. The first such example was with a Menards store in Ottumwa, IA, by working with an aggressive concrete contractor who had a strong desire to expand his company’s work with Menards to include more than the interior floors. This one project led to at least one other success in Spirit Lake, IA, where not only was a parking lot constructed in concrete, but the surrounding commercial development incorporated concrete streets as well. In Owatonna, MN, a Lowe’s home improvement store utilized concrete pavement in the distribution side of its building despite significant efforts from the asphalt industry to do otherwise. Recently in Chicago, United Parcel Service (UPS) received extensive training on CPA for all field engineers overseeing more than 2,000 distribution facilities. The head of UPS’s engineering department was quoted as saying, “We need to utilize this tool (CPA) in each and every pavement decision we make.” NRMCA national resource directors have also supported many members and local promoters in using CPA in the promotion of local projects leading to numerous conversions, including a Super Wal-Mart in Great Bend, KS.

The Nebraska Concrete and Aggregates Association was the first state to conduct CPA training for its membership. So it should be no surprise that there have been more conversions in Nebraska than any other state, yielding an excess of 30,000 cubic yards of concrete sold, including a Super Wal-Mart, a couple of car dealerships, an ethanol plant and a parking area for the Nebraska DOT. Travis Mumford of Arps Red-E-Mix in Fremont, NE, has been an exceptional promoter using the CPA software. He says, “This has been a great tool for us to educate decision makers on the difference between concrete and asphalt.” Not only has Travis been able to successfully use this tool to sell more concrete for Arps Red-E-Mix, but his involvement with a local design/build contractor has led to concrete parking lots being sold outside of Arp’s market.

Cenex Harvest States used concrete roadways throughout its soybean processing plant.
Another strong advocate of the CPA software has been Mitch Voehl of the Bosshart Company based in Truman, MN. Mitch has more than 15 project success stories in using CPA, which has led to the sale of more than 8,000 cubic yards of concrete. Agricultural co-operative giant, Cenex Harvest States used concrete roadways throughout its soybean processing plant, which resulted in the sale of 4,700 cubic yards of concrete for Bosshart. Cenex was convinced that concrete was “the best buy” and would stand up to the 200-300 loaded trucks per day.

Projects the size of this Cenex plant don’t happen all that often for Bosshart. So Mitch has had most of his success in promoting the 300 cubic yard projects, including churches, funeral homes, a nursing home and a couple of other specific projects that are worthy of special attention. One of these projects of special mention is the sale of a large concrete driveway to a retired farmer. Anyone who has ever tried selling anything to a farmer, let alone one who is retired, can understand the challenge Mitch overcame in this situation.

Another noteworthy success for Mitch was a concrete parking lot for the non-profit Knights of Columbus. Even though it chose an inexpensive metal building for the structure, it insisted on the long-term durability and low maintenance of concrete for the parking area. Mitch feels that, “CPA is the strongest selling tool the industry has to offer and I consider it unfortunate that it is not more widely utilized.”

When we quantify the differences between concrete and asphalt by using CPA many people have learned that they truly can compete with asphalt and you can too.

For those interested in learning more about concrete parking lots or CPA, contact NRMCA at (888) 846-7622 or visit our website at www.nrmca.org or www.concreteparking.org.
The Consequences of ‘No Consequences’

By Thomas Harman, M.S., CSP, Director of Safety Compliance, NRMCA

A progressive disciplinary schedule is arguably essential to successful safety and compliance program management. Employees must know what is expected of them in accomplishing their jobs safely, as well as be knowledgeable in the regulations that govern their work. To ensure both the safety of individual employees and the company’s compliance with regulatory standards, employers must educate workers. Regulatory compliance instruction is easier than teaching employees to work safely since the latter requires varying degrees of behavioral modification.

Ready mixed concrete producers should establish non-negotiable safety standards. Remembering that the standard you set is the standard you get, producers can choose just a few safety policies to create a foundation for safe work. In the ready mixed concrete production environment, policies regarding seat belt use, lock out/tag out procedures, confined space work with respiratory protection and fall protection provide a firm basis on which to build a positive, proactive safety program. With these basic protections in place, producers can be assured that their employees are minimally protected against injury and illness.

What can managers do to engage development and execution of a disciplinary program? Some line managers do not like to be seen or even perceived as disciplinarians, but to effectively manage employee safety, managers must practice some form of discipline in dealing with individual protection issues. Meeting the challenge of employee compliance with safety policies sometimes requires managers to take an autocratic approach, meaning that, “You must follow these safety rules if you work here.” Though not an ideal management posture that fosters belief and buy-in to the safety culture, the dictatorial method is often times an organizational necessity in preventing injuries, illnesses and fatalities. An obvious pitfall to this style lies in minimizing the character of the organization.

An additional consideration has to do with how the organization perceives safety relative to production. For example, are line managers held accountable for safety as well as for production? Businesses can take the step to evaluate managerial safety performance when assessing whether a manager meets production objectives. There are generally consequences to not meeting production goals. Does the same hold true for failing to meet safety goals?

Accountability for safety is at all levels in an organization. From the driver to the plant manager to the vice president to the CEO, each has safety activities in which to engage. Safety’s success in an organization depends on how well rules are followed. Setting a standard for excellence in safety requires consequences for not engaging safety at all levels. What is your organization’s safety standard?

For more information about NRMCA’s safety program, contact Harman at tharman@nrmca.org or 240/485-1155.
Best Sellers from the NRMCA Bookstore

1. 2PCP100 — Concrete In Practice Package — Concrete in Practice Sheets are short 1-page discussions on various concrete topics and are written in a “What? Why? And How” scheme intended to provide information in a non-technical format. The CIP topics are researched and written by members of NRMCA’s Research, Engineering and Standards Committee. These are a great resource to give to your contractors and customers. English CIP Full Set 2PCP100 — contains 20 sets of each CIP topic 1-38. Spanish CIP Full Set 2PCP100s — contains 20 sets of each CIP topic 1-36. ($180 members, $720 non-members); English Single Set 2PCPS & Spanish Single Set 2PCPSSes ($20 members, $80 non-members)

2. 2PCCRT — Pervious Concrete Contractor Certification (Reference Textbook) — This text reference serves as the content for the NRMCA Pervious Contractor Certification program. It includes information on What the Concrete Craftsman needs to know about Pervious Concrete; Pervious Concrete Mixtures and Production; Tools and Equipment; General Design Principles; Pervious Concrete Construction; and Maintenance and Troubleshooting. The text was developed with support from the RMC Research Foundation. ($50 members, $50 non-members)

3. 2P159 — Concrete Plant Operator’s Manual — Jointly prepared by the Concrete Plant Manufacturers Bureau and NRMCA, this manual is a comprehensive guide for the batch plant operator. It includes valuable information on materials, batch tolerance and aggregate moisture, calculations, plant maintenance, safety and more. ($20 members, $80 non-members)

4. 2PCPB50 — Concrete Parking Promotion Brochure (Pkg. of 50) — This attractive brochure describes the economic, environmental and aesthetic advantages of concrete parking. Printed on high-quality gloss stock, and built around a “Money in the bank” theme, the brochure should be left behind on every promotion and sales call. ($50 members, $50 non-member)

5. 2PRV036 — Shut Down & Save (Video) — Allowing RM trucks to idle needlessly costs our industry millions of dollars in wasted fuel, increased maintenance costs, shortened engine life, not to mention the added pollutants to the air we breathe. A new, very timely video lesson titled “Shut Down & Save” highlights the costs associated with prolonged engine idling and offers tips on how to properly shut down a diesel engine. ($70 members, $90 non-members)

6. 2P188 — Truck Mixer Driver’s Manual — This manual educates truck mixer drivers about concrete and customer relations. Completely updated for 2004, it also highlights driver duties, safety precautions, equipment inspection and maintenance procedures, and what the driver should do in case of an accident. This 64-page manual is easy to understand and contains common sense information every driver should know. ($10 members, $40 non-members); (20 or more copies $8 members, $32 non-members)

7. Performance — Based Specifications for Concrete (Pkg. of 50) — This 4-page reprint of an article featured in the April 2005 issue of STRUCTURE magazine is an ideal introduction to performance-based specifications for concrete. It provides details on the NRMCA P2P Initiative (Prescriptive to Performance) and describes how moving toward performance-based specifications is the next logical step in the evolution of the concrete construction industry. The article concludes that performance-based specifications can result in innovative products and construction processes, higher quality, reduced cost and satisfied customers. This reprint is ideal as a handout during presentations or as an insert for direct mail campaigns. Coauthored by Colin Lobo, Ph.D., P.E., Lionel Lemay, P.E., S.E., and Karthik Obla, Ph.D., P.E. ($25 members, $50 non-members)

8. 2187 — Compilation of ASTM Standards Relating to Concrete — Contains 43 ASTM specifications, practices and test methods relating to cement, fly ash, slag, silica fume, admixtures, aggregates and concrete. Included in the ASTM Manual of Aggregates and Concrete Testing. Reprinted by NRMCA in January 2005, it contains the most recent versions of the ASTM standards at that date. ($40 members, $60 non-members)

9. 2PBPS0 — Pervious Concrete: When It Rains, It Drains (Pkg. of 50) — As customers and influencers in every part of the country are under increasing pressure to move toward increased sustainability, the many “green” and economic advantages of pervious concrete are attracting more and more attention. This promotional brochure, developed through the NRMCA-sponsored Concrete Collateral Working Group, and targeted to owners and architects, clearly makes the case for pervious. As interest in the pervious continues to grow, these brochures should be left behind on every promotion and sales call. ($50 members, $50 non-member)

10. 2PRW037 — The Pressure’s On Parts 1 & 2 (Video) — A driver’s lack of understanding the mechanics of a ready mixed truck water system has been cited as the reason for reported driver injuries in water tank explosions. In a two-part proactive response, The Pressure’s On’s preventive focus first explains the function and safe operation of the 10 main components in a typical water system. The second lesson builds on that functional understanding so the delivery professional can recognize when the system is not working properly. Basic winterizing is also covered. ($99 members, $120 non-members)
Question:

I employ a driver who also serves as a firefighter. He carries a pager and suspends his driving activities with my company when called to a fire. How should his time spent on these activities be logged on the record of duty status?

Answer:

It depends on whether he serves as a volunteer or compensated firefighter. Drivers who are allowed by the motor carrier to leave their normal activities to perform a voluntary activity such as fighting fires are considered off-duty. Compensated firefighters may record time during which they have the opportunity to rest on the job as off-duty time. However, all time that the compensated firefighter is required to perform work (e.g. equipment maintenance, administrative work, etc.) would be considered on-duty, not driving time.

For more information, contact NRMCA’s Kevin Voelte at 888/846-7622, ext. 1152 or at kvoelte@nrmca.org.

Please note: The column contained here should in no way be considered a substitute for competent legal counsel. It is only meant as a guide to help employers know when it is necessary to consult an attorney on issues pertaining to labor-management relations and other workplace issues.
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