Pervious Concrete and ADA Compliance—A Good Combination

Variation in Concrete Performance Due to Aggregates

Part VII of Concrete Quality Series
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In January 1990, the 101st Congress passed the "Americans with Disabilities Act of 1990" (ADA), which was then signed by President George Bush in July. Then as now, anytime there is change to the way we build is mandated, the entire construction industry’s collective response is “It’s going to cost more to build”. The reaction is the same now with today’s greener and sustainable building methods. Nothing in the construction industry changes easily.

Let’s set the record straight on one key issue right from the start: ADA does not approve anything. Well intentioned marketing people would want you to believe that a host of products are ADA approved, but they are not. Properly installed, most will be ADA compliant, but there is no “group” or process that approves or disapproves any material or product.

So what is ADA compliant? Following the ADA Act of 1990, the Department of Justice published the ADA Standards for Accessible Design, a construction document design guide on how accessible construction should be built. The design guide has been updated many times, to cover a number of added applications, but the 1994 update remains the most used reference for building walkway surfaces and is very favorable to pervious concrete-like surfaces.

For example, in Section 4.5 of the guide, the general overall requirements for ground and floor surfaces states: Ground and floor surfaces along accessible routes and in accessible rooms and spaces including floors, walks, ramps, stairs, and curb ramps, shall be stable, firm, slip-resistant. What better way to build a stable, firm, slip-resistance surface than with either broom finish plain concrete or pervious concrete?

In addition, in Section 4.8.8-Outdoor Conditions it states: Outdoor ramps and their approaches shall be designed so that water will not accumulate on walking surfaces. Once again, pervious fits the requirements.

Questions have also been asked about the open voids on the surface of pervious concrete. The closest reference to surface voids is addressed in Section 4.5.4-Gratings, which is very clear on the size and direction of allowable voids in the surface and says the surface should have spaces no greater than 1/2 in (13 mm) wide in one direction. All pervious concrete as we know it would have no problem meeting these requirements.

All other design requirements for ADA compliance, like surface offset, cross slope and incline of surface, apply to pervious concrete placement just as it does to plain concrete and other walking/wheelchair surface material. Those guidelines can be found in Section 4.5.2 and basically say that if you have an offset in the walking surface that is greater than one quarter inch you need to correct the offset as outlined in Section 4.7, which will instruct you on how to construct a transition ramp.

To download a free copy of the current (2010) guide, go to www.ADA.gov.

For the specific sections mentioned in this article, go to http://www.access-board.gov/adaag/html/adaag.htm#4.1.6(3)(a)

From the Author:
I was keenly interested in the ADA movement in 1990 for a couple of reasons. The first was growing up with my cousin Jackie, born with spinal bifida and spent her entire life in a wheelchair. I remember bouncing
Jackie down the three outside steps in my grandparents home where she lived because it was in town and would allow her more community involvement than living on her parents’ farm, to hauling her up the 16 steps on Sunday morning so she could attend church, her only social outing of the week.

The second reason for my interest came with the birth of our daughter in 1983. Ali was born with cerebral palsy, a birth condition that holds many mysteries as a person develops. We didn’t know for many years how “involved” her condition would be, but after an evaluation by an “educated professional” when she was a year old who told us all the things she would not be able to do we decided to focus on what Ali can do, not on what she can’t do.

Ali’s birth in 1983 was 7 years before the ADA act of 1990, and typically, many in the construction industry did not worry about compliant construction until they were forced into it. Remembering the old adage “If you’re not part of the solution, you are part of the problem,” I decided I would try and become an advocate of ADA compliance and a resource to other builders through the local HBA.

Now as we look back on the ADA way of building, we have realized a side benefit not even considered when it began: this is also the way to build for an aging population.
parts I and II of the Concrete Quality series discussed that a good measure and benchmark of concrete quality is the Standard Deviation (SD) of compressive strength test results. The primary factors that impact the SD are variability associated with materials, production and testing. In order to reduce the strength standard deviation the concrete producer needs to manage those aspects of variability that can be controlled. This article discusses concrete strength variability due to variation of aggregate from a single source.

Variability of Aggregate from a Single Source

Aggregate typically occupies about 75% of the volume or weight of a cubic yard of concrete. Even though it is largely inert its large proportion ensures that variation in aggregate properties will have significant impact on concrete performance such as strength, water demand for a given slump, and fresh properties such as cohesiveness, harshness, segregation, bleeding, ease of consolidation, finishability and pumpability; each of which may not always correlate with slump.

Generally, aggregate manufacturers provide concrete producers with test data and certification that their aggregate meets ASTM C33, Specification for Concrete Aggregates. The tests required in ASTM C33 are outlined in Table 1. In addition, tests on Specific Gravity and Absorption, and Bulk Density and Void Content of coarse aggregate are required for concrete mixture proportioning. ACI 301-10 Specification for Structural Concrete states that aggregates used in the project should conform to ASTM C33 and test results showing conformance should not be older than 90 days except for test results for soundness, abrasion and reactivity which should not be older than 1 year. This would require the concrete producer to have current test data of all the above aggregate tests every 90 days except for soundness, abrasion and reactivity which can be conducted on a yearly basis. Typically, these data are provided by the aggregate supplier.
Depending on aggregate production volumes at the quarry for internal QC, aggregate manufacturers conduct daily or weekly testing of certain aggregate property tests. Table 2 adapted from ACI 221R\(^4\) shows a typical quality control program listing the routine control tests to be conducted by both the aggregate and the concrete producers. Only a smaller number of tests as compared to Table 1 are included here. This is due to the following reasons:

1. It is impractical to do all of the tests at the stated frequency.
2. Depending on the source, some of the aggregate properties do not change as much and so it is adequate to do quality control tests more frequently on properties that tend to change more often.

The reader is directed to ACI 221R\(^4\) and ASTM STP 169D (chapters 29, 30 and 31) for a detailed discussion of aggregate tests and effects that the aggregates have on concrete performance. The following section briefly discusses how the aggregate test results affect concrete mixture proportioning and performance.

### Specific Gravity and Absorption of the Aggregate

Specific gravity (SG) and absorption of the aggregate tested according to ASTM C127 and C128 for coarse and fine aggregate, respectively, are unlikely to vary significantly. SG of the aggregate is used in concrete mixture proportioning and changes in SG will change the volumetric composition of the mixture and likely result in discrepancies in yield of concrete batches. Absorption is used to calculate the batch water content of the concrete and using incorrect values can lead to inaccurate mixing water amounts, incorrect w/cm and therefore variations in strength and other concrete properties impacted by water content. High variation in specific gravity speaks to the lack of source control and will need frequent concrete mixture adjustments.

### Aggregate Moisture Content

Aggregate moisture content should be measured and batch water corrected as discussed in Part V of this article series\(^6\). An attempt should be made to maintain a uniform aggregate moisture content when batching concrete. This is accomplished in fine aggregates by adopting good draining storage practices and ensuring that the fine aggregate stockpiles have been inactive long enough. While fine aggregates with a round smooth shape can drain within 12 hours fine aggregate that have angular/flat particles may take up to a week. While wet sand generally contributes more free moisture to a concrete batch, moisture content of coarse aggregate should not be ignored or assumed. Moisture probes that are well calibrated frequently and connected to control systems that allow for automated water adjustment can considerably improve the batch to batch uniformity of concrete for fresh and hardened properties.

### Void Content in Coarse Aggregates

Aggregate bulk density and void content (ASTM C29), also known as the Dry Rodded Unit Weight (DRUW), is recommended for coarse aggregates. The DRUW is used in concrete mixture proportioning to establish the amount of coarse aggregate in a concrete mixture. The void content determined is a function of the aggregate particle shape, texture and grading. If the DRUW test is conducted on a fixed grading the void content will depend on the coarse aggregate shape and texture - with rounded aggregates with smoother texture resulting in lower void contents. The coarse aggregate void content determined in accordance with C29 in as-received grading will not differ much from that determined at a fixed grading as long as there is not an excess amount of aggregates in the finer particles sizes.

Based on a large experimental study, Bloem and Gaynor (1963)\(^7\) reported that when different coarse aggregate sources were used with a single source of fine aggregate to make concrete every 1 percent increase in coarse aggregate void content determined according to ASTM C29 (fixed grading) led to an average increase in mixing water content of 0.5 gal/yd\(^3\) for a concrete slump of 2 to 3 in. Wills (1967)\(^8\) tested nine gravels and found the coarse aggregate void contents determined according to ASTM C29 (fixed grading) correlated very well with the mixing water demand (i.e. mixing water quantity required for a fixed slump). The void contents varied from 33 to 42 percent and the corresponding water demand for concrete with a control fine aggregate ranged by about 35 lb/yd\(^3\). Large amounts of flat and elongated particles as measured according to ASTM D4791\(^9\) can make concrete mixtures too harsh for some placement methods resulting in voids, honeycombing or pump blockages.

### Void Content of Fine Aggregates

ASTM C1252 describes the determination of the uncompacted void content of fine aggregate. If the test is conducted on an as-received aggregate grading (Method C), the void content is influenced by particle shape, surface texture and grading. If the test is conducted on a standard aggregate grading...
(Method A), the void content depends on the aggregate shape and texture – with rounded aggregates with smoother texture giving lower void contents. Fine aggregate shape and texture influences the water demand and concrete workability more than coarse aggregate.

Wills (1967) tested 9 fine aggregates and found that the void content measured using a fixed grading – similar to ASTM C1252 (Method A) – correlated very well with the mixing water demand. The void contents of sands varied from 39 to 50 percent; the corresponding water demand for concrete with a control gravel at a target slump ranged by about 50 lb/yd$^3$ (Figure 1); and the compressive strength ranged by about 2000 psi (Figure 2). Gray and Bell (1964) recommended a maximum void content in manufactured fine aggregate of 53 percent (Method B in C1252) and noted that this value restricts the use of screenings that almost invariably have poor particle shape, uncontrolled grading and are usually troublesome.

After reviewing various studies Gaynor and Meininger (1983) reported that every 1 percent increase in fine aggregate void content (measured at a fixed grading) resulted in an increase in mixing water content of 3 to 8 lb/yd$^3$ for a target slump – the higher value would apply when different aggregate sources are compared and the smaller value would apply when changes in processing changes particle shape at a single source.

**Aggregate Grading**

The aggregate sieve analysis, conducted in accordance with ASTM C136, and the fineness modulus (FM) must be determined for both coarse and fine aggregates. The fineness modulus (FM) is an empirical number related to the aggregate grading with higher FMs corresponding to aggregates that are coarser. However, aggregates with the same FM can have different grading. ASTM C33 has requirements on the grading of coarse and fine aggregates and places limits on the FM of fine aggregates. ASTM C33 requires concrete fine aggregate to have an FM between 2.3 and 3.1. As a control on same source uniformity, it indicates that the FM should not vary by more than 0.20 from the base FM. In the ACI 211 mixture proportioning procedure, the FM of the fine aggregate is used in conjunction with the DRUW of the coarse aggregate to determine the aggregate proportions in concrete mixtures. Finer sands (lower FM) result in increased coarse aggregate content at the same nominal maximum size of coarse aggregates. Changes in fine aggregate FM over a range as much as 1.0 have been noted in a day’s production.$^1$

If the fine aggregate FM changes more than 0.20 then the relative proportions of coarse and fine aggregate amounts must be adjusted, as recommended by ACI 211. An increase in the sand FM by 0.20 will reduce the coarse aggregate quantity by about 60 lb/yd$^3$ with similar increase in the weight of fine aggregate. Another option is to change the coarse and fine aggregate amounts such that the FM of the combined aggregate stays the same even though the FM of the coarse or fine aggregate has changed.

Fine aggregate grading influences concrete performance more than coarse aggregate. Apart from FM it is useful to track the percent retained on each (or selected) sieve size, particularly for the fine aggregate, on a control chart for the following reasons:

1. In fine aggregate the amount of material passing the 300-μm (No. 50) sieve should be 15 to 30% for good pumpability.$^4$
2. Gaynor (1977) has reported that increased minus 75-μm (No. 200) or 150-μm (No. 100) sieve size material in fine aggregate material require an increased dosage of air entraining admixture to obtain required air content. It is also reported$^2$ that an increase in the fine aggregate particles between 600-μm and 150-μm sieves entraps more air than either finer or coarser particles.
3. The amount of fine aggregate passing the 300-μm (No. 50) and 150-μm (No. 100) sieve have a great influence on workability, finishability, stickiness, potential for segregation and bleeding of concrete. The total amount of fines that includes the cementitious materials and that from aggregates should be evaluated when workability is adversely affected. Hand finishing may require higher fines content as opposed to machine finishing.

ACI 304R provides good practices for handling aggregates at the concrete plant to prevent segregation, contamination, variation in moisture content and degradation resulting in more fines. Some of the important recommendations are:

- Build stockpiles, where necessary, in horizontal or gently sloping layers. Avoid conical stockpiles or any unloading procedure involving dumping of aggregates down sloping sides of piles.
- Keep trucks, bulldozers and wheel loaders off stockpiles to prevent degradation and contamination.
- Prevent overlap of the different aggregate sizes by suitable walls or ample spacing between piles.
- Protect dry fine aggregate by the wind using tarps or windbreaks.
- Fine aggregate transported over wet, unimproved haul roads can become contaminated with clay lumps that is usually accumulated between the tires and on mud flaps and gets dislodged during dumping of the transportation unit. To remove this, place a scalping screen over the batch plant bin.
- If possible, separate aggregates into individual sizes and batch separately to minimize segregation.
- If aggregate degradation is likely, rescreen coarse aggregate as it is charged to the bins at the concrete plant to maintain undersized materials (minus No. 4 sieve) to as low as 2%.
- Aggregate stockpiles should be built on a base that minimizes ground contamination when aggregates are removed for intra-plant movement.

**Material Finer than 75-μm (No. 200)**

Aggregate particles that are finer than the 75-μm sieve (No. 200) are measured by ASTM C117 and are generally composed of silt and clay for natural sands or gravels.$^1$ For crushed stone or manufactured sand, the fines are predominantly composed of dust of fracture. ASTM C33 has limits on material finer than 75-μm (No. 200) sieve for both coarse and fine aggregates. A higher amount of material finer than the No. 200 sieve will typically result in increased water demand and reduced air content. This is more significant when the fines are largely composed of clay and/or shale as opposed to being primarily dust of fracture from crushing. A variation on the material finer than the No. 200 sieve can result in variation in water demand and air content. The variation on the material finer than No. 200 sieve can occur due to the following reasons:
Table 1. Aggregates Tests Required in ASTM C33

<table>
<thead>
<tr>
<th>Aggregate Type</th>
<th>Required Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both coarse and fine aggregates</td>
<td>Grading and Fineness Modulus (ASTM C136), Amount of material finer than 0.075-mm (No. 200) sieve (C117), Coal and Lignite (C123), Chert (C123 and if necessary C295), Clay Lumps and Friable Particles (C142), Sulfate Soundness* (C88), Alkali Silica Reactivity* (C1260, and C1293).</td>
</tr>
<tr>
<td>Coarse only</td>
<td>Abrasion* (C131 or C535)</td>
</tr>
<tr>
<td>Fine only</td>
<td>Organic impurities (C40 and if necessary C87)</td>
</tr>
</tbody>
</table>

All aggregates for the tests should be sampled according to ASTM D75 and if necessary the sample size reduced according to ASTM C702. ASTM C33 has limits on all of the tests; for chert there is limit only on coarse aggregate; for fineness modulus there is limit only on fine aggregate.

*ACI 301 requires that results of these tests should not be older than 1 year. Results of all other tests should not be older than 90 days.

Table 2. Suggested Quality Control Program for Aggregates (Adapted from ACI 221R)

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Minimum Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aggregate Plant Samples</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grading and FM</td>
<td>ASTM C136</td>
<td>Once per day</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>ASTM C117</td>
<td>Once per day</td>
</tr>
<tr>
<td>Void Content</td>
<td>ASTM C29</td>
<td>Once per week</td>
</tr>
<tr>
<td>Specific Gravity and Absorption</td>
<td>ASTM C127</td>
<td>Once per 90 days</td>
</tr>
<tr>
<td>Fine aggregate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grading and FM</td>
<td>ASTM C136</td>
<td>Once per day</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>ASTM C117</td>
<td>Once per day</td>
</tr>
<tr>
<td>Void Content (fixed grading)</td>
<td>ASTM C1252 (Meth A)</td>
<td>Twice per week</td>
</tr>
<tr>
<td>Specific Gravity and Absorption</td>
<td>ASTM C128</td>
<td>Once per 90 days</td>
</tr>
<tr>
<td>Sand equivalent</td>
<td>ASTM D2419</td>
<td>Twice per week*</td>
</tr>
<tr>
<td><strong>Concrete Plant Samples</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grading and FM</td>
<td>ASTM C136</td>
<td>Once per 2 weeks</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>ASTM C117</td>
<td>Once per week</td>
</tr>
<tr>
<td>Void Content (fixed grading)</td>
<td>ASTM C29</td>
<td>Once per week</td>
</tr>
<tr>
<td>Specific Gravity and Absorption</td>
<td>ASTM C127</td>
<td>Once per year</td>
</tr>
<tr>
<td>Fine aggregate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grading and FM</td>
<td>ASTM C136</td>
<td>Once per week</td>
</tr>
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<td>ASTM C117</td>
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<td>Void Content (fixed grading)</td>
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<td>Sand equivalent</td>
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<tr>
<td>Specific Gravity and Absorption</td>
<td>ASTM C128</td>
<td>Once per year</td>
</tr>
</tbody>
</table>

*Frequency should reduce to once per 90 days if the aggregate is known to typically pass this test.
Aggregate moisture testing is discussed in Part V of the article series.
1. Poor quality control in washing of aggregates at the pit or quarry which can result in dirty aggregates with coatings.
2. Aggregates stockpiled in a wet condition can collect wind-borne dust and passing traffic.
3. Improper practices by loader operator when stockpiling and removing materials from stockpiles.

Aggregate surface coatings can also prevent the cement paste from adhering to the aggregate particle, causing strength problems and may chemically react and stain the concrete.

In mixtures with higher cement factors, the cement fines tend to provide cohesion and the presence of higher amounts of aggregate material finer than No. 200 sieve can lead to further increase in stickiness and related workability problems. In lower cement factor mixtures workability and cohesion can be improved by the presence of higher amounts of aggregate material passing the No. 200 sieve. Self consolidating concrete has been successfully developed using mineral filler (fines) to improve the stability (resistance to segregation) of fresh concrete. A decrease in the material passing the No. 200 may not always lead to improved workability. What is clear is it will lead to a change in workability.

Sand equivalency

The sand equivalent test (ASTM D2419) indicates the relative proportions of clay-like or plastic fines and dust in fine aggregate that pass the 4.75-mm (No. 4) sieve. Specifications typically require a minimum sand equivalency (SE) of 70 or 75 in this test. A low SE value suggests more clay-like or plastic fines and therefore the water demand and fresh properties of concrete can be affected. After testing about 150 fine aggregate sources Gaynor and Meininger (1983) reported that several aggregates passing the ASTM C33 limits on material finer than No. 200 sieve still failed the typical limits set for the SE test. Therefore, the SE test should be conducted at a greater frequency for such aggregates. A methylene blue test may be an even better indicator of the presence of clay in the aggregate. Different type forms of clay minerals absorb methylene blue indicator to different degrees, so the type of clay in aggregates needs to be known.

Using Aggregate Test Results

Concrete producers should develop relationships with aggregate manufacturers so that the tests required by ASTM C33 (Table 1) and the tests conducted by aggregate manufacturers for quality control (Table 2) are received at the stated frequency. ACI 221R states that the aggregate producer should test the material as it is loaded out of the aggregate producer’s stockpiles to be shipped to the customer; The concrete producer then assumes responsibility for grading variations generated between the point of materials load-out and use in concrete. Concrete producers should take aggregate samples for testing as close to the batching process as possible, understanding that aggregate grading changes every time it is moved.

Table 1 test results

The first thing is to ensure that the aggregates that are supplied meet ASTM C33 requirements as required by ACI 301. Most of the test results are required every 90 days except for soundness, abrasion and reactivity which are required on a yearly basis. As soon as the test results are available the concrete producer should ensure that the test results meet the requirements of ASTM C33.

Table 2 test results – Tests conducted by the Aggregate Producer

The aggregate producer should carefully look at the grading and FM results to ensure...
that the percent passing each sieve meets grading limits set in ASTM C33. It may be acceptable to have one in five consecutive grading test results fall outside the limits. Moving average of 5 test results shows trends in the grading results not otherwise apparent. The aggregate producer can use that to adjust the aggregate plant to maintain a certain average value. If the grading is controlled the FM is likely to vary in a narrow range (±0.2 from the base FM) as required by ASTM C33 for fine aggregate. The aggregate producer should look at the void contents of the coarse and fine aggregates which are primarily influenced by aggregate shape and texture. If the results fluctuate by more than ±1.0 percent from the base value then the producer should undertake process changes to ensure that the shape and texture does not vary significantly. On the contrary, the aggregate producer can use control charts of moving average of 5 void content test results to adjust the aggregate plant to maintain a certain average value. The aggregate producer can use similar control charts for cleanliness test results to adjust the aggregate plant so that the material stays within ASTM C33 limits and certain average values are maintained. SE test results are valid for certain fine aggregate sources and when required to be tested by local authorities as discussed earlier. For those sources the aggregate producer can use control charts for SE test results to adjust the aggregate plant so that the material consistently has SE values over 70 percent and certain average values are maintained.

The concrete producer should make appropriate adjustments to concrete mixture proportions based on the specific gravity, absorption and dry rodded unit weight of coarse aggregate and grading and FM of sand results that the aggregate producer supplies every 90 days. In addition, the concrete producer should carefully look at the grading, FM, void content, cleanliness and SE test results, and make sure that the aggregate plant is making efforts to produce a material that is consistent enough to help attain low variability concrete.

Table 2 test results – Tests conducted by the Concrete Producer

The concrete producer establishes credibility of the test reports from each aggregate source by conducting verification tests on specific gravity and absorption (possibly other properties) on an annual basis. The results should be sent to the aggregate producer and significant variations (if any) should be discussed.

The fine aggregate grading and void content tests are conducted at a higher frequency than that for coarse aggregates to reflect the greater influence fine aggregate grading, shape, and texture has on concrete performance. Void content tests for both coarse and fine aggregates should be conducted at a fixed grading to identify the effect of aggregate shape and texture. There are no specification requirements for this. If the test results between consecutive shipments vary by more than 1.0% then concrete performance can be influenced as discussed earlier and therefore suitable changes to concrete mixture proportions may be needed. Moving average of 5 test results shows trends in the results not otherwise apparent. If there is a noticeable trend or if the results fluctuate by more than ±1.0 percent from the base value the producer can share the results with the aggregate producer and have discussions to ensure that the aggregate shape and texture do not vary substantially.

If the grading test results show a greater variation than that obtained from the aggregate producer it is clear that the stockpiling and handling practices at the concrete plant may have to be improved. If the grading test results exceed ASTM C33 requirements then the results should be shared with the aggregate producer and a check test made. As discussed earlier the percent passing the finer sieves for the fine aggregates can significantly influence the concrete performance. So if significant changes are noted in those sieve sizes concrete mixture adjustments (if allowed) can be made. To get an overall effect of grading FM values can be used. If the fine aggregate FM changes more than 0.20 then the coarse aggregate and fine aggregate amounts must be changed as recommended by ACI 211. If the coarse aggregate FM changes more than 0.20 the coarse and fine aggregate amounts must be adjusted such that the combined aggregate FM stays the same.

Cleanliness test results should be plotted on a control chart. If the results exceed ASTM C33 requirements then the results should be shared with the aggregate producer and a check test made. Stockpiling and handling practices should also be scrutinized to see if fines are inadvertently being incorporated. If the test results between consecutive shipments vary by more than 0.5% then concrete performance can be influenced as discussed earlier. Suitable adjustments to concrete mixture proportions may be needed. Moving average of 5 test results shows trends in the results not otherwise apparent.

SE test results should be plotted on a control chart. If the results decrease below 75 percent the aggregate producer should be asked to increase the results. If the results decrease below 70 percent a different fine aggregate source may have to be considered until this source decrease below 70 percent.

References

2 Oboa, K.H., “Sources of Concrete Strength Variation – Part II of Concrete Quality Series”, Concrete InFocus, July-August 2010, Vol. 9, No. 4, NRMCA, pp. 21-23.
Is the Loader Operator a Member of Your Quality Control Team?

By Fernando Rodriguez

H ow many ready mixed concrete producers consider the load operator as a part of the production team? Probably most of us! I would argue that the loader operator is also a very important member of the quality control/quality assurance team. The loader operator is a QC technician! The production of good quality concrete starts (and unfortunately may end) with the loader operator. The entire day’s production of good, high quality concrete is controlled by the loader operator.

The loader operator’s day should start with performing regular preventative maintenance on the asset. The loader operator must ensure the loader will function throughout the day without any interruptions due to maintenance malfunctions. Any problems with the loader will certainly create a gap in delivery of concrete in a timely manner. We all know that interruptions can cause cold joints, loss of slump or even accelerated set time issues. The worse possible scenario is that the concrete contractor will send you back-charges due to the delays. Therefore, the loader should be “greased” on a regular basis and “fueled up” before production begins for the day. The bucket should be cleaned and free of deleterious material.

Prior to beginning daily production, the quality control technician will need the assistance of the loader operator in order to expose the aggregate in the stockpiles so that they can collect a representative sample. The technician can then perform a moisture content test on the sample collected. The loader operator can certainly move the aggregates easier and more effectively than a technician with a shovel. It is vital to collect a representative sample for the moisture content test, in order that the batchman can properly adjust the required mixing water for each batch of concrete.

A well-trained loader operator understands the importance of the moisture on the aggregates. For example, the well-trained loader operator will avoid the standing water in the aggregate bins. Theoretically, the aggregate bins have been constructed in such a manner that the standing water will continue on page 18.
Designing for Sustainable Pavements

Problem
Increasing the sustainability of our infrastructure is accomplished in ways other than just developing better materials and more efficient processes: it is also about employing the right designs. For pavements, overdesign causes excess materials to be used during construction, leading to higher economic costs and environmental impacts. Optimizing design thicknesses for prescribed service lives, climates, and traffic conditions allows pavement engineers to create structures with minimal waste.

Approach
Advancements in design techniques allow for such optimizations. Pavement design tools, such as the National Cooperative Highway Research Program’s Mechanistic-Empirical Pavement Design Guide (MEPDG), use embedded models to forecast the propagation of various pavement distresses for combinations of materials properties and external parameters. MIT has developed three case studies to demonstrate the effect that design optimization can have on costs and CO₂ emissions. Conventional designs are compared against MEPDG designs for sample low-volume, medium-volume, and high-volume highways in California. The designs are evaluated over a 50-year analysis period using life-cycle assessment (LCA) and life-cycle cost analysis (LCCA) principles.

Findings
Optimized designs can provide significant economic and environmental benefits. For the three case studies, the optimized designs reduce agency net present cost (NPC) by roughly 40–50% and CO₂ emissions by roughly 30%. These are likely to be conservative estimates, as other life-cycle implications, such as shorter construction times and reduced transportation, are not considered in the current demonstrations studies. User costs due to traffic delay may also be reduced using optimized design thicknesses.

Impact
The use of optimized design thicknesses helps reduce costs and CO₂ emissions by minimizing the materials needed to construct a pavement. The economic and environmental benefits are significant and can help transportation agencies reduce their carbon footprint while working within tight budgetary constraints.

More
The research presented here is a part of an ongoing project by the pavements LCA team at the MIT Concrete Sustainability Hub. More information on the MEPDG model can be found at <http://www.trb.org/mepdg/>.
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drain away from the aggregates. After a recent rainstorm in Baltimore, the loader operator at our plant spent a few minutes pushing the aggregates up the stockpile. He was attempting to allow the coarse aggregate to drain the excessive water. In order not to collect the standing water, the bucket should be positioned about six inches from the bottom of the bin. Not only will he avoid collecting the water, but the ultra fines (non representative material) will not be picked up.

At our plant, we have instructed our loader operator, James Jennings, to stay on one side of the stockpile and let the dump trucks bring material fresh material, place it on the other side of the stockpile. The idea is to keep the new aggregates that are being delivered to the plant on one side of the stockpile and not use it for production. The new material may have different moisture contents than the aggregates in the stockpile. By pulling aggregates from the same side, the moisture will be somewhat constant. A member of the quality control team will need to perform another moisture content test (with the assistance of the loader operator) on the new aggregates and give those numbers to the batchman.

A well trained loader operator should be careful not to contaminate the over-head bins. How much time is lost when you have to stop in the middle of the day to drain your coarse aggregate bin because it was contaminated with sand? The loader operator must be conscious of moving the conveyor belt before sending up another aggregate.

A well trained loader operator will notify the QC or management personnel when he or she notices major differences in the aggregates. Mr. Jennings is constantly informing us of changes in the color of the fine aggregates. He has also informed us of contamination issues with the stone. Remember that the dump truck drivers sometimes back-haul other products and their beds may be contaminated with different types of material. Recently, we had a dump truck that was backhauling coal. James noticed the black dust on the sand and he immediately contacted us. The sand vendor sent us a new load of material to replace the contaminated sand and we returned the contaminated sand. Thanks to Mr. Jennings, we averted a potentially major issue. Had we used that sand, there is no telling what effects the carbon dust may have had on any air-entrained concrete mixtures, not to mention color, setting time and strength issues.

In our operations, the loader operator is a key member of the quality control group. The loader operator can put an extra set of eyes on the aggregates in the bins as well as the aggregates that are being delivered. An experienced, well trained loader operator can be the first line of defense for the QC department. A cubic yard of concrete is made up of approximately 70-75% by volume of aggregates. Therefore, a high quality cubic yard of concrete starts with a good design and good aggregates. Your loader operator controls 70-75% of the material going into your concrete. A good loader operator is worth his or her weight in……. "aggregates". ■

For more information, contact Mr. Rodriguez at concretemechanics@gmail.com.

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The True Costs of Environmental Compliance

By Douglas E. Ruhlin, CCPf, LEED Green Associate, Environmental / Sustainability Consultant, Resource Management Associates

We would all assume that all concrete plants have all the necessary environmental permits that they need from their applicable regulatory agencies, and for the overwhelming majority of concrete producers this is a true statement. However, it still amazes me to find that there are still those out there that lack some pretty basic regulatory requirements. One of the answers I hear when I ask why this is, is that due to the economy the producer is trying to save money and hoping that they can “fly under the radar”. Yes, this still happens (and the concrete industry is not alone in this, it happens in most industries).

The wisdom of hoping to fly under the radar aside, is this truly a sound financial policy? Is this a policy that would be recommended for a successful business? Let’s take a look at two potential scenarios, using some modest (and realistic) numbers.

Non-compliant Plant “A” has avoided a relatively simple regulatory requirement, such as the need to have an appropriate NPDES (National Pollutant Discharge Elimination System) Stormwater Discharge Permit. However, after a plant audit, the facility has been identified by regulatory officials as lacking this permit, and now faces enforcement action. Assume the following: 1) The permit fee is $500, which must be paid. 2) The facility now must engage professionals to assist in addressing this problem, perhaps including legal fees and professional consultants. Assume these fees as in the range of $10,000 to $25,000. 3) Presume that this facility has fine’d by the regulatory agency $25,000, a fairly modest sum in these days (recent penalties levied for similar infractions within the concrete industry have been well in the six figure range). The total cost of non-compliance for this facility? Somewhere in the neighborhood of $35,500 and $50,500.

Now, let’s look at compliant Plant “B”. This plant has the necessary NPDES permit, and has had it for years. Assume the following: 1) The permit fee remains at $500. 2) Professional fees should be much lower, which we will estimate at $5,000 (no legal fees likely needed!). 3) The facility has had no fine. The total cost of compliance at this facility under this scenario is $5,500, considerably less than the non-compliant plant.

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<tr>
<th>Factor</th>
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<td>Permit Fees</td>
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Yes, but the non-compliant plant saved a lot of money over the years not paying anything, right? Assuming a minimum savings of $30,000 from the table above comparing the minimum cost of non-compliance versus the cost of compliance, you can see that the cost equals out after 60 years of non-compliance, and “flying under the radar” (what is the chance of that for 60 years?). And, this does not include higher fines, additional fines should other regulatory requirements be missed, etc. Also, get in a real jam, and your professional fees and fines would likely be a lot higher.

And don’t believe the numbers above? Substitute your own figures – I doubt you’ll be able to justify any scenario where non-compliance pays off. The figures won’t lie – non-compliance just doesn’t make good business sense, regardless of the economic conditions.

Non-compliance also carries certain less tangible costs. For one thing, this can certainly damage your reputation, with the regulatory agency, neighbors, stockholders. Not good. For example, regulators will certainly make sure to inspect a non-compliant plant more closely in the future (adding a greater risk of more problems down the road), and may in fact require additional requirements for the non-compliant plant that compliant plants don’t face (for example, via a negotiated settlement). These additional costs can add enormous extra cost. Many potential customers are now “buying green”, and the prospect of doing business with a known environmental violator may be less enticing for them, possibly costing the chance to do future business on certain projects. The costs there could also be enormous.

In reality, for most ready mixed concrete producers, non-compliance is a result of simply not knowing or unaware of permit rules and regulations. Unfortunately that’s no excuse in the eyes of regulators. It’s up to all producers to ensure they meet or exceed the minimum requirements to meet our industry’s environmental responsibility.

So what does this tell us? Compliance does indeed pay. If you are merely looking to save money, get into compliance and stay there. It’s a whole lot cheaper in the long run.

For further information on any of the issues in this article, Doug Ruhlin can be contacted at Resource Management Associates, PO Box 512, Forked River NJ 08731; (609) 693-8301; www.resourcemanagementassoc.com; or via email at druhlin@resourcemanagementassoc.com.

By Eileen Dickson, Vice President, Education, NRMCA

For the 14th year, ASTD released its in-depth report for companies and industries to use as a benchmark. Based on 2009 figures, the average annual learning expenditure per employee increased from $1,068 in 2008 to $1,081—an increase of 1.2 percent. Learning functions were serving a smaller workforce; therefore the annual learning expenditure per employee increased slightly. The amount of learning expenditure as a percentage of payroll decreased slightly from 2.24 percent in 2008 to 2.14 percent in 2009. On average, direct learning expenditures increased from 0.59 to 0.71 percent of revenue and from 8.75 to 10.88 percent of profit in 2009. These percentages increased in 2009 because organizations’ financial commitment to learning and development held steady even while their revenue and profit decreased because of the recession.

There were changes in the way the money was spent. For the first time since 2004, organizations increased their spending on outsourcing as they increased reliance on external providers. The consolidated average spent on external services was 26.9 percent of the total learning expenditure, up from 22.0 percent in 2008. Outsourcing includes spending on consultants and outside providers of workshops and training sessions. Despite increased spending on outsourcing, the majority of learning investment was internal. Internal costs for the learning function, including learning staff salaries, administrative costs and development costs, accounted for an average of 62.5 percent of learning expenditures in 2009.

Employees in the surveyed organizations accessed an average of 31.9 hours of formal learning content in 2009, down from 36.3 hours in 2008. Although the number of hours of learning decreased, the amount still demonstrates that organizations expect employees to allocate a meaningful amount of time to formal learning and development activities.

The breakdown of learning content by topic area changed only slightly. The content area with the largest percentage—profession- or industry-specific content—accounted for 17.2 percent of formal learning hours. Managerial and supervisory training was the second-largest content area in 2009 at 10.4 percent. Delivery of content in the information technology (IT) and systems category (9.3 percent) saw a slight decline in 2009. Despite declines in 2009, processes, procedures and business practices (9.2 percent), and mandatory and compliance training (7.8 percent) were content areas that organizations continued to emphasize.

In 2009, each learning staff was responsible for an average of 240 employees, down from 253 in 2008. This is consistent with the fact that many organizations continued to downsize their workforces in 2009 which reduced the average number of employees each learning staff served.

The amount of learning content produced and consumed per learning staff also decreased in 2009, as did the average cost per learning hour made available, although the average cost per hour used went up. The average number of learning hours produced per learning staff decreased from 353 to 264 and the average number of hours used per learning staff decreased from 5,507 to 5,350. The average cost per learning hour made available decreased 8.5 percent, from $1,528 to $1,398, while the average cost per hour used rose from $52 to $63. The cost per hour used increased because the average workforce size and the number of learning hours used decreased in 2009, while the investment in learning remained the same.

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The Sinking of the Titanic
An Analogy of Failed Leadership

By Greg Smith

We have struck iceberg...sinking fast...come to our assistance.” Those words pierced the airwaves on a cold evening in 1912. Before they tapped the last bit of Morse Code, they became the epitaph for the lives of the 1200 people lost that night on the Titanic. The ship was doomed and slowly sliding into its watery grave. Why did the largest, most advanced ship of the century sink?
Start looking toward those on the front-line for ideas and solutions. Do it before you hit the icebergs. They are rowing in the same direction for the same purpose. In a disaster everyone is equal.

**The Truth Changes** — The Titanic was unsinkable. . . so they thought. So confident were they, life boats were available for only half the passengers. Dee Hock said, “The problem is never how to get new, innovative thoughts into your mind, but how to get the old ones out.”

**Technology Is Not a Substitute for True Leadership** — Someone said, “The danger is not that computers will replace us. The real danger is when we start acting like computers.” When technology fails, leadership must prevail. Captain E.J. Smith said years before the Titanic’s voyage, “I cannot imagine any condition which would cause a ship to flounder. Modern shipbuilding has gone beyond that.” Many businesses invest and put more reliance in technology than their people. If you don’t have good leadership, the best technology will not save you from a disaster.

**Leadership Focuses on Training** — As the stern of the Titanic lifted out of the water, the crew and passengers struggled with the lifeboats. There were no drills, no rehearsals and the crew stood unfamiliar with their responsibilities. The boats were improperly loaded and only one tried to go back and recover survivors. Everyone must continuously learn new skills and upgrade their knowledge to stay competitive in the global marketplace.

**Leadership Looks Below the Surface** — The greatest dangers as well as the greatest opportunities lie below the surface or just beyond the horizon. The ocean was as smooth as glass, deceptively dangerous. The biggest part of the iceberg lay below. . . unseen. Like steel fangs, it ripped 300 feet of the Titanic’s hull. Those below, the “crew and steerage,” felt and saw the damage first. Like a gasping breath, the steam billowed above as chaos reigned below. Those who know what’s wrong with your “ship” are those who are below, those who work on the front-line. Furthermore, they usually have the best ideas and remedies to your problems. Start looking toward those on the front-line for ideas and solutions. Do it before you hit the icebergs. **Leadership Looks Beyond the Horizon** — The lifespan of a business is getting shorter. Only the most innovative will survive. Success often gets an organization in trouble. A good “Captain” is on the lookout for changing trends, changing needs, storms and icebergs. Sam Walton identified the need and other retailers did not. Apple has overtaken Sony in its ability to create consumer demand and new devices. Mary Kay Ash saw it and others didn’t. Get the picture? Be out there and keep a steadfast lookout for the next change coming your way.

**The Moral of the Story** — None of us were alive when the Titanic sank, but all of us lost something that night. Hopefully, we recognize the lessons learned and will chart your course toward the right direction.

Greg Smith’s cutting-edge keynotes, consulting and training programs have helped businesses accelerate organizational performance, reduce turnover, increase sales, hire better people and deliver better customer service. As President and Lead Navigator of Chart Your Course International he has implemented professional development programs for organizations globally. He has authored nine informative books including his latest book Fired Up! Leading Your Organization to Achieve Exceptional Results. He lives in Conyers, Georgia. For more information please call (770) 860-9464.