Hope for Change

The spring of 2010 started off at the NRMCA event in Tempe. Pervious concrete mixtures are now recommended to be flowable, slumpable, lighter and wetter. Matt Offenberg stated that specs should not state minimum powder or maximum water and abolished the meatball. Colin Lobo gathered everyone's best ideas into the new training manual and released it by August. I took great courage from this and thought that finally, our industry would recognize the need to revise the pervious mix proportion.

I hoped that everyone would soon be up to speed. But, before the end of 2010, I found people making serious errors that were composed of a series of goofs. Each of these goofs was cut and pasted into the plan for a couple of acres of pervious for a very noteworthy client. They started with #89 stone, check (without evaluating voids). They found popular advise from academia to add sand at 200 lb., check(without evaluating gradation). A promotional group told them to use plenty of cement, ok 630 lb. and 180 lb of ash., check and check(presuming that more is better). They also heard that you can saw cut it, huh?(that will be easy) And above all, hold back on the water, otherwise it will plug! Each of these fragments of advise was obtained from reputable sources. Together, they generate a hazard to the reputation of pervious concrete pavement and hinder our efforts.

When I first saw the pavement, they had just hauled away a number of truckloads of loose aggregate from raveled areas that were everywhere except the areas that are plugged. They starved water from the mixture, neglected proper curing practices and made saw cuts the same day with raveling as deep as two inches. Apparently, these guys did not get the memo about "modern pervious".

The new manual and training program is a wealth of information for Local Sponsoring Groups (LSG). Some engaged the new material but others in the groups seem more interested in keeping it easy to teach. At that point, I was almost in tears. Then, I discovered that some of the LSG people head for the golf course instead of placing some live pervious after class. I was finished, devastated at the end of the season.

I took fresh resolve in 2011, to continue the crusade on three fronts:

survive the installation
resist freeze thaw
sustain permeability

If we can't do the first one, the others don't matter. The real-world limitations of making pervious concrete in a mixer truck must be observed when a pervious mixture is designed. Other limitations in producing pervious this way will come from their available sources of aggregate and available space in their silo without disrupting other production. We find the success of a project being determined by the practices of the producer and his mixture, more than any other part of the pervious team. For this reason, I was inducted into the ready-mixed concrete community, in the interest of my regular clients. It also makes me very keen on making friends at NRMCA. Their connection to most of the producers and connection to the RMC are most valuable in solving the puzzle, at field level. I am pleased to have access to Colin Lobo and Phil Kresge, along with the rest of the crew at NRMCA. Dr. Lobo did heroic work in sorting out the advice from a dozen hard heads and put it into a coherent training manual. I

know that Colin can influence the practices of ready-mix producers and the LSG organization. He is kind to me when I present Neanderthal concepts, and encourages rational processes and level headed thinking.
Matt Offenberg is kind to me as well, in similar ways. But I think I almost lost them both on my last hot topic about aggregate voids. I recently shared the presentation duties with Matt and Colin in State College, PA to a large group of producers. As I went into my talk about "wet voids", I glanced at the front row where my partners were seated. They both appeared as though their eyebrows had been reattached up near the middle of their foreheads and were holding their collective breath.

Wet Voids
One of our main indicators in aggregate examination is the ASTM C-29, using a gravimetric calculation of the aggregate. The dry rodded unit weight is observed as the measure remains on the scale for one more step. Wet voids are found by loading the aggregate-filled bucket with water. Top off the water to the rim of the measure, note the additional weight, then take the temperature.
We calculate the voids, according to the solids. Then, calculate the voids that became filled with water and compare. One might presume that both of these would be "even Steven". No so, Grasshopper! There is a surprising disparity between the two, in some aggregates. It useful to find out the limits of available space in the voids and could explain why the voids choke in some aggregates.
I have revised the springsMix101 spreadsheet to include wet voids. All other functions in the mix calculator remain based on the aggregate calculations, as always. However, a warning field appears and shows the percent of potential variation in the designed void content. I think this will prove to be valuable in proportioning when forced to use troublesome aggregate. This is also a great way to discover errors in specific gravity values, used in the ASTM C-29.
I realize that I make a lot of my friends uneasy when I talk about calculating backwards on the voids. I felt uneasy myself, when Jim Miller and Brian Lutey told me to use it. I always dismissed it because it disregards the aggregate absorption. However, the absorption accounts for a tiny fraction of disparity that we find in some aggregates. We don't want to generate a lot of confusing advice, but certain things we know.
The interconnected voids of finished pervious concrete are designed, based on the known voids of the aggregate supply and the limits of the paste volume. Errors in calculating the available space for paste could explain many of the mixtures that are overloaded with powder. The greatest disparity between agg voids and wet voids that I have found thus far, over 7%.

DVC
Design Void Content has been hotly disputed among the hard heads in the pervious concrete industry. Various tools of reference are used for calculation of voids in a pervious concrete mixture. I prefer a straight-through calculation of the mass and volume of the mix components. The springsMix spreadsheet uses this neat calculation as though the components fit neatly into the same volume as they are combined. In fact, they don't but it usually remains within 3 percent if the mixture has sufficient paste lubricity. The neat calculation is used to design the voids high enough to remain

interconnected. This connectivity is begins to choke off at 17% dvc. It is quite safe to design pervious concrete mixtures that use stone at 18% dvc. However, gravel should be designed at 20% or higher, as round shapes compact more readily.
Voids must be sufficient to properly drain the pavement. But, sufficient voids are also needed for simple cleaning services to restore and maintain permeability in the pavement.

Aggregate
Nathan and Neal suggested that we place perfect pervious and show everyone how nice it can be. We have seen perfect pervious before and that's not the issue, here. I limited the choices for aggregate selection options down to two, bad and worse. I want to show you life in the trenches, on the front lines. This is exactly where half of our industry operates, with troublesome aggregates.
The admixture entrees may have preferred something nicer. But, they too should see and understand how their products manage difficult mixtures. The intent of this lesson is not to show how wonderful pervious concrete can be. The intent is to show how to conform a mixture to a particular aggregate when perfect aggregate is not available.
We are not giving critical attention to infiltration performance in the mixtures using troublesome aggregate because all of these mixes are somewhat overloaded with powder.

Momentive Hexicrete
We gave the toughest batch to the Hexicrete crew. They got one of the highest paste overloads (516) and one of the lowest in design void content (15.4). It was the only load that was truly roasted, with all of their fresh, plastic samples left exposed in the open air. The people on hand from Momentive were confident about roasting their samples, even though normal practice includes curing. Pervious made without Hexicrete and roasted in this way will often not survive the extraction from the mold. We are quite pleased to see the Hexicrete mixture matching and exceeding the performance of the control batch that was properly cured.
The Hexicrete mixture designed at 132.76 pcf and weighed in at 133.6 pcf. Specimens for abrasion observations are 4" X 4" cylinders weighing 3.87 pounds. These hardened samples had reduced to 3.81 pounds and lost 48.7% of their mass after 500 cycles in the LA Rattler. This is almost 2% better than the cured, control batch.
Strength testing includes the ASTM C-496 splitting tensile process, using 4" X 6" cylinders that are formed at 5.83 pounds. This group of samples showed an average of 310 psi, quite suitable for roasted pervious.
The Hexicrete mixture seemed uniform, with good mixing and discharge characteristics. Temperature remained constant. But, the placement crew made two goofs with excessive add-water and excessive cross rolling with a tool of excessive weight.
Our experience with Hexicrete thus far, shows no loss of performance in the Hexicrete mixture from having subjected this product to undue exposure to 92 degrees and 9% humidity.