Make $ $ $ by Saving It

Advancements in the Art and Science of Concrete Mixture Design

By Randell C. Riley, P.E.

Many of you reading this column may not be aware of it, but I started my career in the concrete industry working hands-on in the concrete laboratory of the Iowa Department of Transportation. At the time one of my principal areas of effort and interest was in the area of mixture design. I was routinely involved in developing new mixtures for specific research purposes in efforts typically dedicated to isolating one or more specific inputs such as aggregate type, fly-ash type, cement producer, admixture brand or type, etc. on strength or durability of the in-place mixtures. You would recognize these as part of a typical certification program.

But the most intriguing projects in those days took me into odd areas of concrete mixture design. As an example, one of the most interesting projects in which I was ever involved required breaking down a gradation of the fine and coarse aggregates in order to develop an estimate of the total surface area of the aggregate. The thinking at the time was that we would try to create a mortar film thickness of coating on the aggregate in an effort to control certain properties of the mixture. It was fascinating work that gave me an appreciation, first of the depth of the body of work of people who had come before me, and second of the relative difficulty of quickly doing the math correctly to develop new mixtures. Usually it involved pages of calculations for the theoretical analysis if that was required.

Most of you do not do that today since you depend on mixtures that you have used day in and day out that have been proven to work for most of your day-to-day sidewalks, basement pours and hopefully UTW projects. They do work, but could they be more economical?

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One of the first things a contractor ever taught me was that saving money is making money. It is true regardless of the business you are in. Today new tools are becoming available that allow you as a concrete producer to reexamine your mixtures and point you in new directions that can potentially save you money. The Shilstone family of products are well known and have been around a long time. Indeed, seeMIX® and seeSTAT® have helped many producers over the years, but the underlying principles rested primarily a particular means of calculating a few inputs to achieve a particular objective or two. They are good programs for as far as they go and I have followed them since my days shortly after leaving the Department of Transportation.

But advancements continue. Through efforts supported by Federal Highway Administration (FHWA) in its High Performance Concrete initiative, a new computer program is under development that allows the user a much more comprehensive look at mixture design (see *Figure 1*). It is built for use in a near universal Microsoft Windows based operating environment. The program allows the producer to examine his available aggregate gradations, his cementitious components and his cost of materials to come up with new mixture combinations that may be more economical while meeting the underlying mixture design objectives (*see Figure 2*). The program COMPASS, short for Concrete Mixture Performance Assessment, is under development by the Transtec Group, the producers of such concrete industry specific tools as HiperPAV II and ProVal.

The programs goals from FHWA's website are as follows:

- Identify relevant performance

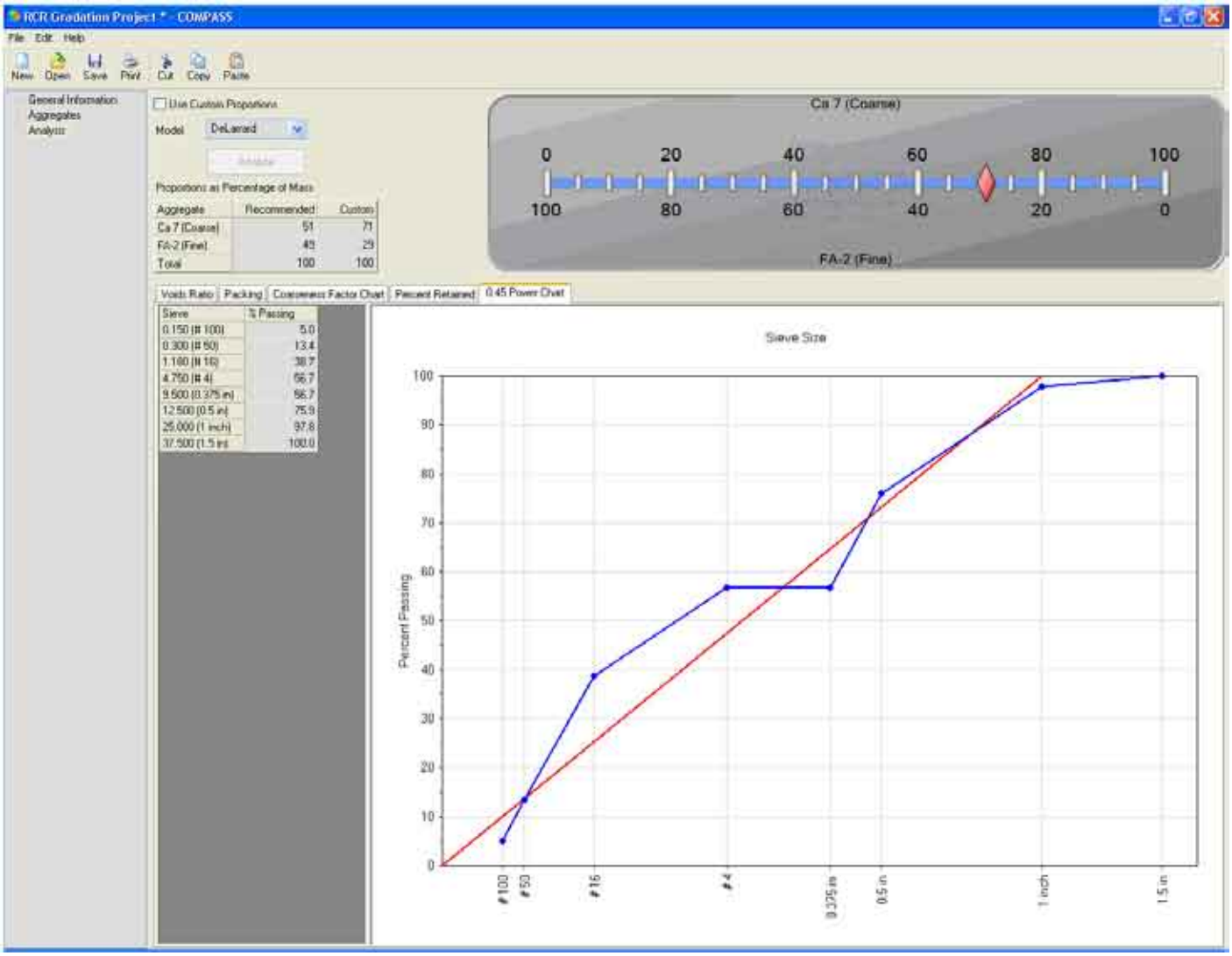

Figure 1

A classic U.S. Bureau of Public roads 0.45 power curve calculation for maximum theoretical aggregate density in the concrete mixture is shown. See the slider. Changes in calculations comparing the percentage of fine to coarse aggregate are just that easy in the BETA. The computer can calculate a best fit or you can develop your own with the slider. Other kinds of analysis are available as well.

criteria that are a function of job-specific inputs.

- Identify applicable mixture performance criteria and recommend test methods.
- Assess the impact that changes in materials or proportions, environmental conditions, and construction procedures have on constructability and performance.
- Provide guidance on aggregate blending.
- Recommend initial mixture proportions.
- Optimize mixture proportions based on multiple, job-specific criteria.

(For more information go here: *http://www.fhwa.dot.gov/pavement/concrete/cptu503.cfm*).

The modules consist of sections for analyzing and optimizing the aggregates, sections for real laboratory analysis and computerized virtual analysis of proposed mixture combinations and a host of other things that hard-core mixture design personnel might like to try if only the calculations were not so cumbersome. Concrete mixture cost calculation is integrated as one of the components of the final mixture design.

Release dates are not yet fixed, but it is circulating in Beta among a few in the concrete industry and is expected to be released in early 2008. The price should be right too. As an FHWA product it will be free as a download. Go here for more information: *www.pccmix.com*.

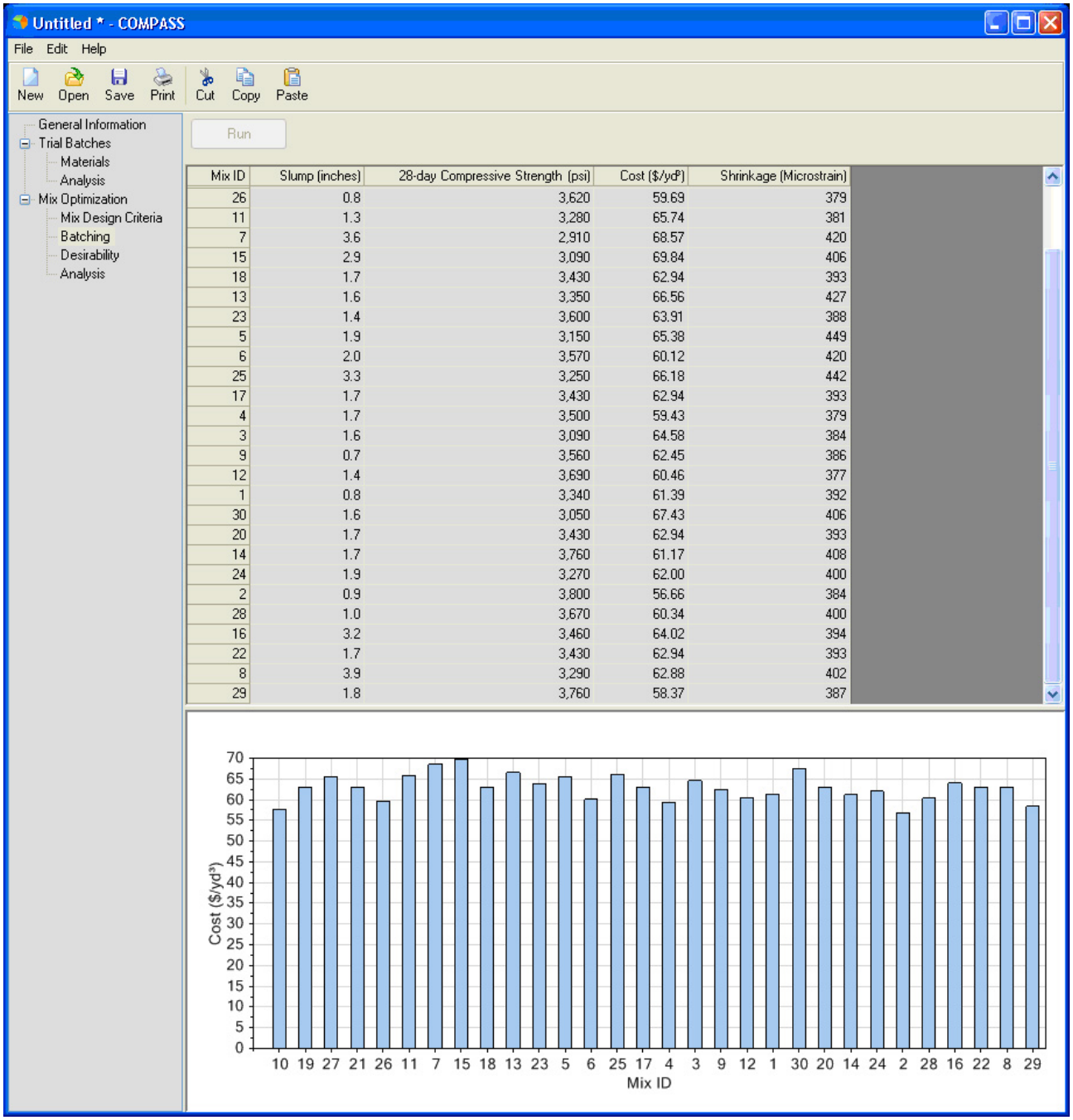

Figure 2

Saving a few pennies to a few bucks can make a big difference in large projects. Cost estimation for a number of theoretical potential mixture combinations meeting the project demands are possible. I'd start with the least expensive three or four to see if they are actually workable and meet your needs.

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