The Need for Speed

by Jerry Kyckelhahn

Tucked away in the pristine wilderness of Pasco County in western Florida is the newest of five ready mixed concrete plants of Keys Concrete Industries. The plant stands just south of the intersection of State Road 52 and Ehren Cutoff Road, some 5 miles west of Interstate 75 leading south into the greater Tampa area. The plant operates as a testimony to the possibilities of managing the convergent needs of nature, agriculture, and emerging residential and commercial growth. To those in the industry, perhaps most noteworthy is the batching speed of the plant.

The Ehren Cutoff Plant is capable of weighing up a 10 cubic yard load and putting it into the truck in under one minute fifteen seconds. This results in a truck to truck-to-truck time of well under two minutes. At worst case the plant is capable of batching 300 yards per hour under normal operational conditions. The question most often asked about the plant is “Why the need for that type of speed”, particularly when the market volume in the area is comparatively small.

Batching speeds in the ready mixed concrete industry are increasingly rapidly. This article looks at four factors having an impact on decisions on plants and puts them into perspective in this day of changing market and profitability needs. These factors include the following:

1. The need to satisfy current market volume demands
2. The need to satisfy current market speed demands
3. The need to improve truck and operator efficiency
4. The need to satisfy future market speed and volume demands

The following terms are used in this article:

1. Batch time: Time from batch start to truck finished loading
2. Cycle time: Time from one truck finishing loading to the following truck finished loading
3. Rated plant capacity: Theoretical capacity of plant assuming no time elapses between end of one load and start of a second load
4. Operational plant capacity: Actual plant capacity given that some time will elapse between the end of one batch and the start of another under normal operations (This article assumes 30 seconds for this change from one truck to the next and 10 cubic yard load sizes)

Satisfying Current Market Volume Demands

One common method used to determine required plant capacity is to balance plant capacity and mixer truck requirements. The calculations generally use the following logic balancing round trip times with plant capacity:
Assumptions:

Expected market volume/day: 800 yards/day

Expected average volume/truck/day: 32 cubic yards

Expected avg. Round Trip Time: 100 minutes

Calculations:

Truck Requirement: 25 trucks (NOTE: 800/32)

Cycle time required (truck-to-truck): 4 minutes (NOTE: 100 min rtt/25 trucks)

Theoretical batch time required: 3.5 minutes

Rated plant capacity: 180 yards per hour

Using this method for planning for plant capacity, the plant is in balance with fleet size. With a cycle time of 4 minutes, truck-to-truck, we can estimate an operational capacity of approximately 150 yards per hour. This in turn requires a batch time of 3 –1/2 minutes and therefore a plant with a rated capacity of approximately 180 yards per hour. There are a number of problems associated with using this method of planning for plant capacity. These include:

- Queuing times can significantly reduce truck and driver efficiency when a number of trucks return to the plant within a short period of time (Leaving a plant at 4 minutes per load does not guarantee returning to the plant at even spacing)
- This method does not address the problem of satisfying customers with faster off-load times while maintaining an existing customer base

Satisfying Current Market Speed Demands

While the volume of a particular market may not have changed significantly over the last few years, it is probable that the speed demands have changed. Much of this increased speed demand is due to technological changes in the concrete placing industry. These changes have resulted in concrete crews being able to place concrete much faster than just a few years ago. Some of these changes include laser screeds, high volume pumps, and better survey control. It is not unusual for even a small crew to now be able to place concrete at rates in excess of 120 cubic yards per hour.

These faster placing rates have had a dramatic impact on ready mixed concrete production that is often not addressed in plant planning and evaluation. Increasingly, we see the batching rate of a plant to be a primary consideration in scheduling instead of
mixer truck fleet size, the historical determinant. But what impacts do high volume placing techniques have on batching speed? It is worth examining some of the considerations of speed planning.

Taking the example from the preceding section, let us assume that we have a plant with an operational capacity of 150 yards per hour. Further let us suppose that Contractor A, one of the company’s better customers, typically uses a boom pump and places concrete at a rate of 120 yards per hour, or one load every five minutes. In order to provide concrete to this fast customer and to maintain the remainder of the company’s base, how fast of a plant is needed?

To provide perfect service to Contractor A alone (being unreal for the moment) and to give him a load every five minutes, obviously we must first have a plant capable of batching 120 yards per hour. Again in the world of perfection, in order to both provide for this customer and to take even one additional order, we would have to have a plant capable of batching 240 yards per hour. Any less than 240 yards per hour and we would not be able to batch a load for this customer ever five minutes. For example, if we had a plant which could batch every 3 minutes, or 200 yards an hour, we would have a six minute gap between loads if any other load was batched between the loads for Contractor A.

Even in the real world, it is evident that a company with a customer who often pours 120 yards per hour is strained with the 150 yard per hour plant from the preceding paragraph, even if that plant meets the average volume requirement of 800 yards per day. Intuitively, the plant that can produce only 150 yards per hour is limited to 30 yards per hour in orders for other customers on those days when Customer A is pouring. Even then the excess of 30 yards per hour is only available when providing less that optimum service to Contractor A.

A market may be therefore defined not only by how many yards per day is anticipated, but also by peak hourly demands of its customers. This becomes increasingly important as placement technology continues to improve. Today, even in moderate sized markets, it is common for at least once contractor to place concrete at rates approaching or even exceeding 120 cubic yards per hour, for numerous contractors to be placing at 60-80 cubic yards per hour, and for a large part of the remaining contractors to be placing at 30-50 yards per hour. It is clear that plants with batching capabilities less than 150 yards per hour are becoming increasingly irrelevant and it can be expected that soon plants under 180 yards per hour will be marginal.

**Increasing Truck and Driver Efficiency**

A common statement heard when discussing the virtues of fast plants is “Why should I have a two minute batch plant when my drivers spend 6 minutes on the slump rack?” Simply, with a two minute batch plant, trucks can get on the way to the job every two minutes no matter how long they might spend on the slump rack (within reason of course). If it is known that the drivers will spend 4 minutes on the slump rack, it is much
cheaper to build two slump racks (time on the rack divided by batch time) than to buy more trucks or to build another plant. If they will spend 6 minutes at the rack, one might expect to try to build three racks. Experience also indicates that when trucks are coming to the slump rack quickly, the preceding drivers will move faster to get out of the way, particularly if that is company policy!

It is given that batch time has little impact on round-trip-time and therefore truck or driver efficiency during the round trip time. If an average round trip time is 100 minutes, a four minute batch time will only add 2 minutes to the round trip time with a batch time of two minutes. However, there is a huge difference in the number of trucks that each of these two plants can get out of the gate in one hour. A 2 minute batch plant can get 30 trucks out the gate in an hour, a 4 minute plant only 15 trucks out the gate (regardless of time spent at the slump rack).

Second, it is worth examining the queuing effect of faster plants. With a fleet size of 25 or more, it is a common occurrence for 6 trucks to return to the yard within a short period of time. In a plant with a cycle time of 4 minutes, the last truck will have been in the yard for 20 minutes of non-productive time before being batched. Total lost time for the 5 waiting trucks is 60 minutes. A 2 minute batch time plant will result in a 12 minute loss of time for the last truck and a combined loss for the 5 trucks of only 30 minutes. Though these losses seem small, this is a typical occurrence that happens many times throughout each day. This queuing effect not only results in added cost, but also, and perhaps more significantly, it results in the loss of service quality to the customers.

A final effect is that more orders can be taken for the plant that batches in 2 minutes than for the 4 minute plant. Why? Trucks are able to get out of the yard faster. This volume effect can result in another significant, though somewhat unpredictable, productivity increase even given no increase in the number of trucks.

The combined effect of round trip time decrease, queuing effect decrease, and volume effects are not accurately predictable. On one plant upgrade, from which some of the observations of this article are taken, the change from a 150 yard per hour plant to a 300 yard per hour plant resulted in an 18% productivity increase, with the market and number of trucks remaining the same. Subsequently, it lead to a large market increase due to increased capacity and better service.

**Satisfying Future Market Requirements**

This is such an obvious consideration that it is hardly worthy of mention. The reason that it is mentioned in this article is that, historically, market volume requirements have been recognized in plant planning, however, future technological advances which may impact plant requirements have not been fully considered. From the production side, the industry has seen changes in mixer design including boosters, front discharge mixers, and mixer designs which have not only increased load capacity, but have also increased load height and decreased load times. On the contractor side, the technological changes described above have increased the contractors’ demand per hour thereby increased the
production requirement at the plant. Improved computerized scheduling and dispatching techniques have allowed increased span of control thereby improving the ability to dispatch trucks from a single plant, increasing the number of trucks that can be handled at a plant. Finally, improved computer batching controls allow faster weigh ups and discharges thereby faster batch times.

What all of this leads to is the fact that speed is less expensive than ever before. A 300 yard per hour plant may cost $100,000 more than a 150 yard per hour plant to purchase and construct, but...

1. The 300 yph plant can support up to 50 trucks while the 150 yph plant can only support 25 (average volume method, 100 minute RTT)
2. The 300 yph plant allows support of a 120 yph contractor while maintaining a sizable customer base (or two 120 yph customers plus others) while the 150 yph plant allows supporting one 120- yph contractor and almost nothing else
3. Assuming a 10% productivity gain with the 300 yph plant (low estimate) this comes to roughly $1.50 per yard improvement. Basically the faster plant is paid for in 80,000 yards (Ignoring time-value of money which is low at current interest rates)
4. Service is significantly improved with the 300 yph plant
5. Future technological and market advances are generally not a problem with the faster plant

Since rarely do two companies share the same methods of generating rate of return calculations, look at one set of very simple numbers. If the 300 yard per hour plant costs $100,000 more than the 150 yard per hour and if these plants will be in use for 20 years, the cost of the faster plant is approximately $400 per month (not getting hung up in the time value of money). Looking at life cycle economics, this seems relatively inexpensive for the obvious returns.

**Fast and Furious – The Ehren Cutoff Plant**

The plant at Ehren Cutoff Road was designed and manufactured by Merts, Inc. according to the requirements placed by the president of Keys Concrete, Jimmy Keys. Analyses had been done on other company plants and the goal at the Ehren Cutoff plant was to balance the weigh up and discharge times in order to achieve plant loading efficiency. As an example, Keys Concrete uses three cementitious materials in most of its loads, i.e., cement, flyash, and slag, and the time involved in weighing up these materials was optimized by using two cement weigh hoppers instead of one. This cement weigh up time was necessary in order to meet the other “material ready” times of aggregate and water. The end result was balanced times, hence faster batches with a minimum of added costs. Some of the elements of the plant are contained in the following paragraphs.

Starting at the rear of the plant, the plant is fed aggregates through a 10’ by 10’ front end loader hopper. To minimize ramping, the loader hopper has “wings” on three sides to
maximize its effective volume and eliminate spillage. The hopper is plastic lined to improve the flow of material on to the 30” belt of the radial stacker feeding the aggregate overhead storage bins. In order to meet batch times, the loader had to meet a cycle time of 34. These cycle times are achieved by using an efficient material storage design that minimized travel distances and by the minimal ramping.

The overhead aggregate storage is rated at 225 tons. These overhead bins feed the aggregate weigh hopper through eight 18”x18” double acting clamshell gates driven by 4” diameter, 10” stroke cylinders. The 472 cubic foot weigh batcher is equipped with two 18” x 45” gates tapered to 10” x 45” with four-15,000 pound load cells. Average aggregate weigh up time for 10 cubic yard loads is approximately 22 seconds.

Cementitious materials are stored in a split silo with a total capacity of 998 barrels and a single silo with a capacity of 622 barrels. Cement is fed from the single silo into one weigh batcher while flyash and slag feed into a second weigh batcher. All cementitious materials are vertically fed eliminating screws and air slides. Constant material flow is optimized by using a Rotron high volume, low pressure air blower for aeration.

Both fresh water and reclaim water have their own holding hoppers. These holding hoppers feed a single water weigh hopper having a 6” butterfly valve discharging through dual 4” pipes.

Critical to fast batch times in a single stage plant is to get the material into the truck quickly, and it is here that the plant differs from conventional low profile plants. The plant uses a 42” charging conveyor that carries the material at a rate of up to 800 pounds per second. Strict inching controls are imposed through features of the Command Alkon Spectrum batch computer and specialized sequences are used to improve loading efficiency. The drop from the aggregate charge conveyor to the truck is approximately 13 feet allowing the material to accelerate and to effectively spread out for a quick charge. At the end of the fall is a ceramic lined hopper through which aggregates, cements, waters, and admixtures enter the truck.

To avoid problems with materials “backing up” waiting to enter the truck, a five cubic yard surge hopper is located between the charge conveyor and the ceramic lined charging hopper. The surge hopper comes into play when a truck does not accept charging at the expected rate. The surge hopper can then fill with aggregates and allow slower feeding into the truck. The unique design of the charging hopper then allows the tail water to assist in flowing the backed up aggregate into the truck. This design feature has eliminated the problem of materials backing up and flowing out onto the loading platform when trucks are not properly under the plant. Trucks have a 24” drop from loading ramp to slab placing them with sufficient angle to facilitate material feeding and reduce spillage.

The site fully supports the loading speed of the plant through both automation and design. Traffic flow was planned to support both front and rear discharge mixers as were the slump racks. The layout minimizes loader cycle time to keep the aggregate overheads
charged. The water system for the plant uses touch screen/PLC controls to allow full control of all waters used in the plant and all sediment pits from the batch office. Staffing is composed of a batch man and a loader operator regardless of the volume requirements placed on the plant.

The plant is a successful application of technology within the industry allowing the speed to support all levels of anticipated operations while minimizing operational costs and concerns.