Concrete Batching Plants Some Cost and Quality Issues

Preamble

Indian Standard Plain and Reinforced Concrete- Code of Practice (Fourth Revision) IS 456: 2000 incorporated number of changes. A Clause on “Quality Assurance Measures” has been incorporated to give due emphasis to good practices of Concreting. Proper limits have been introduced on the accuracy of measuring equipments to ensure accurate batching of concrete. Design Mix Concrete Has been made obligatory for grades M25 and above. The accuracy of the measuring equipment shall be within +/- 2% of the quantity of cement being measured and within +/- 3% for other materials. These can be realized only by proper batching and mixing Plants. Many Organizations have made it obligatory to use batching plants. Thousands of batch plants are in operation in India. However, their supply, installation and operation in practice raises some cost and quality issues, these are also examined in the paper.

Type of batching plant

A wide variety of configurations are available to suit space restrictions particularly in urban locations. Star type aggregate bins with scraper boom are common in India. They require large space, not always available in Cities.

Bin-Fed batching plants are transportable, fully automated, have their own hydraulic off-loading legs and are capable of producing outputs of up to 40m3 per hour. These batch plants can be custom made to suit construction industry specifications, with accessories added such as: ad-mixture plants, low-level or upright cement silos, aggregate feeders and water chillers.

Tower Batching Plant

The concrete batching plant Tower-type, in addition to having the integrated features of the horizontal type plants, has the added benefit of larger storage capacities and the benefit of gravity batching Considerable reduction of mechanical elements used in the batching process results in considerable power savings and the simplification of the system. Decreases the cycle timings for the production due to the absence of conveyor belts or skip for aggregates movements.

Besides, the vertical disposition of the aggregate storage allows big volumes on a small base surface. All parts of mixing tower are connected by bolts and nuts structure. It is easy and fast to install and dis-install the whole plant, and it saves the time and cost to install and test the plant greatly; The tower, with compact structure, is made of...
external closed steel plates, which are anti-noise, anti-dust, and heat preserved; Has maintenance and repair platforms and stairs with comfortable space; Washing system has high-pressure pumps, with automatic control and manual control; Closed structure design, closed aggregates conveyor, and external 360° lighting allow all-weather operation.

**Aggregates Batcher**

The batcher, with 3-5 aggregate hoppers, can be assembled as per individual requirements. There are independent weighing hoppers and belt conveyor under the aggregate hoppers that could be designed as steel structure type, underground and half-underground types. The aggregates can be fed into the aggregate hoppers by loader or belt conveyor. The hopper discharging gates and discharging speed are controlled by computer via cylinder. After aggregates scaling, the aggregates will be conveyed into the transitional hopper. Each and every aggregate is weighed individually or accumulatively, and the weighing accuracy is guaranteed. The accuracy of aggregates proportional ratio is realized through computer control system, which automatically re-feeds the aggregates if there is shortage of weight, warns if there is overweight.

Location Of Batch Plant: Location should be such that minimum time elapses between mixing and placing concrete. It should preferably be close to pour point. For construction of 23 bridges in Nepal. In the Nineties, the author had mounted a batch plant on a Trailer which was hauled by a tractor to wherever concreting was planned. In contrast, for a project in Orissa, space for batch plant was allotted kilometers away, beyond security gate manned by CISF, involving delays of hours! Concrete Quality suffered. For a cooling Tower Project, Batching Plant was located at the foot of the tower, discharging concrete into the pump directly, minimizing travel time. With longer time interval in moving concrete, quality suffers.

**Batch Plant Components**

Quality Assured concrete requires the following minimum batch plant components in addition to the mixer:

- Weighing system periodically calibrated
- Moisture Probe for fine aggregates
- Program Logic Control for all quality requirements
- Silos for cement, mineral admixtures
- Aggregate handling system
- Bulk/Bagged Cement Feeding System
- Water Weighing System

However, purchase dept of the user delete some items on grounds of economy!

Most common omissions include Moisture Probes, Slump Meter, inadequate PLC, adequate number of Silos, Inadequate Calibration arrangements etc. Majority of Batch Plants in India are not fitted with moisture probes. Fitted at the entry point of fine aggregates into batch hopper, the probe monitors moisture content, quantifies the value and via the PLC automatically adjusts water content in each batch, ensures the designed water content in each mix. Even many RMC Plants in India are not fitted with moisture probes!

Fig 5 Automatic cement bag feeding Machine

In the absence of moisture probes, the moisture content in sand is checked once or twice a day by using stove or oven; neither method monitors moisture continuously, results in variation of water content in the mix, and concrete quality. The mix design assumes aggregates, cement and water are present in the correct proportions, according to the dry material weights. If sand contains 10% moisture, when you weigh out 1000 kg, only 900kg is sand; the rest is water. You can allow for this by estimating or measuring the moisture of the sand and increasing the amount that you weigh in proportion. If your sand moisture decreases by 2% without being noticed, however, the batching system will weigh out 2% more sand than you require and will add appreciably less water than needed, making a dry batch. Moisture Content varies thro the Day. Traditional methods of using frying pan to assess moisture once or twice daily are not good enough. Batch Plants should be fitted with Moisture Probes at the sand feed point. Probe is connected to the computer, which will continuously adjust the mix water accordingly. The aggregate moisture sensor ensures that the batch is proportioned according to the DRY WEIGHT MIX DESIGN.

Moisture probe is unique; it can continuously adjust the load water as the material flows over the probe, a method that ensures consistent slump predictability in high specification concrete and concrete product manufacturing. The probe can be installed and calibrated in a matter of hours. Moisture Probe continuously adjusts the load water as the material flows over the probe; method ensures consistent slump in concrete. Probe is accurate to within ±0.3%; achieves this consistency through self adjusting circuitry that detects and corrects changes caused by time, housed in a one-piece stainless steel casing. Mounted directly above the feed gate, the probe collar makes it unnecessary to drain the bin when installing, the probe can be installed and calibrated to the material in a matter of hours

Mixer Water Dosing System: There are two ways to add water to concrete. The first is to meter the water volumetrically, based on the mix design. This method neglects the error in batched weights, adding the same amount of water regardless of the weight of cement or aggregates in the batch. Variations in slump are the result. The second is to monitor the moisture of the mix and add the quantity of water required to produce the correct slump or water/cement ratio. We need this to eliminate the variations and produce consistent product

What is a slump meter? The water content is controlled by monitoring the effort required to turn the mixer. As water is added to the dry ingredients, the effort increases. Any further increase in water results in a drop in the effort as the mix starts to liquefy. This drop is very rapid and is a sensitive measure of the slump. This is measured with a wattmeter in the motor’s electrical circuit. Slump metering...
Case - Tripoli West Thermal

- Tropicalization of electric parts to resist temp: 50°C
- Lighting for machine platform, traveling path
- Terminal box, Block connections between parts to complete wire of units, limit switches and valves
- All connecting cables
- Radial scraper with distribution box (specify jib length, bucket cap)
- Earth leakage control
- Complete wire of units, limit switches and valves
- Terminal box, Block connections between parts to terminal box
- Lighting for machine platform, traveling path
- Tropicalization of electric parts to resist temp: 50°C, relative humidity: 90%

What is Program Logic Control (PLC)? PLC programs run in an endless loop like a wheel turning, repeating hundreds of times every second. Every time around, they check all the inputs, make decisions based on the program in the loop and set all the outputs. It is possible for a programmer to make a mistake in the program, but no mistake can halt the operation of the PLC; it keeps on running. Because it cannot freeze, it performs reliably throughout its long life, requiring little if any maintenance.

**Batch Plant Erection Time:** Case - Tripoli West Thermal Power Station, Libya: Batch Plant was ordered from ELBA Germany. Contracting Company’s Engineer was exposed for one week in the German plant, before delivery. The supplier had committed to erect & commission the Batch Plant in 24 Hours. Foundation for the batch plant was ready before its receipt at site. Batch Plant was delivered in two modules. Tools and tackle were kept ready. The batch plant was actually commissioned in one day!!! This was in 1976. Today in India it takes two to four weeks to erect and commission a batch plant by the contractor. Supplier is in a position to erect and commission faster. Mobile batching plants are now manufactured in India. In Some cases, the plant has actually been commissioned in four hours.

**Batch Plant Accessories Required For Quality Concrete**

- Program Logic Control
- Vibrator for sand compartment
- Compressor, Screw conveyor support pipe
- Control cabin with locking arrangements
- Additional feed line for cement screw repair
- Cement silo filter controls
- Radial scraper with distribution box (specify jib length, bucket cap)
- Earth leakage control
- All connecting cables
- Complete wire of units, limit switches and valves
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Batch Plant utilization in India Case: 30 cum Plant
Rated output: 30 cum per Hour
Realizable output: 20-22 do
Actual output: 10-12 do Average

**Reasons:** The Mixer is not loaded to capacity. Batch Plant mixed concrete waiting for Truck Mixers, low placement rate, finishing delayed, condition of access road, inadequate no of truck mixers, cement feed delay, aggregate feed delay etc. Low output affects the quality of concrete

**Batching Plant Location & Layout**

Location should be as near to the center of gravity of Job to minimize haulage cost and product quality variations due to variations in haul distances. Aggregate stock pile floor should be in concrete, with drainage slopes. Control cabin should be in a commending position so that the operator can observe the return of empty trucks and positioning. Concrete laboratory should be located on the exit route.

Location of Ready Mix Plants: In India Most of the RMC Plants are located outside the city, resulting in long travel up to 3 hours or more due to city traffic congestion. Large space is required for on-site installation due to type of plant chosen. RMC Plants in Europe are located within the two hour limit of travel. In Case of space constraint, Tower type plants are chosen. The author had visited an RMC plant in Scotland with Tower type unit. There was no space earmarked at ground level for materials. The Tower unit had vertical radial storage above ground for materials. Continuous stream of trucks feed the tower via below ground hopper and vertical bucket conveyor. Land used for the batch plant was hardly about 600 sqm. Elsewhere the RMC supplier strictly follows the two hour maximum time between mixing and delivery of concrete, a quality requirement.

**Access to Truck Mixers**

Layout of road should allow unidirectional truck mixer movement for loading, dispatch. Provide paved access road, drainage and ensure fast movement of loaded truck mixers. Avoid Steep Grade in access road. Cleaning Truck Mixers after every load is discharged, and provide for disposal of dirty water

During construction of JNPT terminal in the eighties, Concreting operation as mechanized, but no attention was paid to proper maintenance of access roads. Concreting was frequently interrupted due to truck mixers bogged down in poor service road; many truck mixer loads were rejected due to delayed delivery. Truck tyre consumption was very high. In retrospect, it was concluded that it would have been cheaper to provide concrete paved service road!!!
Concreting starting time, working hours, night work, impact on quality

During a Korean Visit, it was observed that concreting activities are restricted to daylight working hours, primarily as a quality assurance measure. Workers were unwilling to work at night as it affected their social life.

In India, concreting on major projects generally start late evening due to variety of reasons: attraction of overtime, delayed pour card clearance, unplanned operations etc. The main casualty has been quality. Senior supervision is difficult to ensure at night. Lighting can never match daylight. Most accidents happen at night, interrupting concrete pour, cold joints etc. Work at night is more expensive. Quality Assurance is poor during night. There is less output during night.

Recently in Bangalore, concreting an RC flat slab of large span was started at 0100 hours in the night and continued for 30 hours. It is difficult to control quality in such cases. It would have been preferable to start such major pour in the morning.

The author was involved in management of precast yard for Delhi Metro contract. Initially, activities were carried round the clock for certain monthly output. Work during night required huge expenses towards running diesel generators, besides indifferent quality. Work was reorganized so that concreting was done during the day only. The productivity was same, though the work period was reduced by half, but of improved quality.

Qualified / Trained Operators: Irrespective of the level of sophistication of the batch plant, it is necessary to employ trained operators with elementary knowledge of concrete quality. The author had visited RMC plants in Germany extensively. Every RMC operator is required to undergo one week course dealing with quality requirements prior to employment. There are institutions offering such courses.

We do not have such institutionalized system in India. Some Batch Plant manufacturers do offer training facilities, but not very popular as there is no compulsion to get trained. Majority of batch plants in India are operated by persons promoted from helper category! There are exceptions: some expatriate Companies had employed diploma holders as operators.

Quality is not free. Quality is like buying oats. If you want fresh, clean oats, you must pay a fair price. However, if you can be satisfied with oats that have already been through the horse .... that comes a little cheaper!

“It is unwise to pay too much, but it is worse to pay too little. When you pay too much, you lose a little money .... that is all. When you pay too little you sometimes lose everything, because the thing that you bought was incapable of doing the things it was bought to do. The common law of business balance prohibits paying a little and getting a lot .... it cannot be done. If you deal with the lowest bidder, it is well to add something for the risk that you run. And if you do that you will have enough to pay for the something better” John Ruskin (1819 - 1900)

John Ruskin’s Dictum applies equally to buying batch plants. In India, a typical 30 cum batch plant cost ranges from ₹ 25 to ₹ 50 lakhs depending on quality parameters and range of accesorries. Buyer Beware!!!

A team of researchers (TeNeT group) including IIT-M director Prof. Bhaskar Ramamurthi and Prof. Ashok Jhunjhunwala has developed a cost-effective, alternate solar technology which can make equipment like air-conditioners, water pumps and other devices work efficiently without much investment in batteries to store electricity. According to Prof. Bhaskar Ramamurthi the cost of storing one unit of power in a battery works out to Rs 14 and so they have made some modifications in the air conditioners and other equipment to make it work directly using solar power so that they can eliminate the usage of battery. He further said that IIT-M is working with fan companies to develop brushless DC motor fans for their solar power technology. By using this brushless DC motor fans there is no cost involved in powering these ACs as there is no need to store electricity in batteries instead solar electricity can be used directly. IIT-M putting up solar power in some of the classrooms and offices in a few months and gradually cover the entire campus.