SLUMP LOSS

One of the major goals for a concrete producer is to give the right slump at placement. Slump decrease is a fact that the industry has been struggling with forever. The life cycle for fresh concrete is very short, and stretching its transit time may lead to disastrous consequences, especially if the slump is adjusted with either water or admixtures in an uncontrolled way. To maintain the required characteristics of the concrete, extra amount of cement is added to maintain the strength, and admixtures are added to increase the life span. This is a costly solution.

How can a measurement and control equipment change all that?

Cement Setting: The cement starts setting as soon as it comes in contact with water; nothing can change that. Temperature has a major effect on how fast the cement hydrates, which means that starting a mix with high temperature in its constituents such as aggregates sitting in the sun, cement coming from a just blown off cement truck or from a silo that is exposed to the sun for hours, will have a major impact on the final product. These factors, often overlooked, would cause an unnecessary slump loss that needs to be compensated for by adding extra cement, in order to maintain the W/C ratio.

There are ways around it: aggregates that are exposed to the sun can have a temperature rise of 25° Celsius or more; at this point the aggregates are both dry and very hot. Sprinkling is the way of maintaining the moisture above SSD, and the down side is unaccounted for free water. Shading the aggregates would help significantly in lowering the temperature and moisture loss. Cement silos are exposed to the sun as well, and that exposure can increase the cement temperature by 20° Celsius. The disastrous consequences of high temperature in the cement affect both the total mix temperature, and the chances for flash setting (quick set or fast set - more noticeable in type II and type III cements). When fast setting occurs, the hard balls that are created need to be break apart in order to create a homogeneous mix. The process of breaking the hard balls require high energy, which decreases the chances of achieving good uniformity and homogeneity, hence loss in strength.

Speed Regulators: Little awareness has been paid towards the impact of high revolution agitation. This is the case when no drum speed regulators are installed in mixer trucks, or when

speed regulators are installed, yet not properly controlled (too high RPM's).
For example: in an 8-cubic meter truck load, the average weight is 15 metric tons, the material inside the mixer is concrete with high friction indexes, and it generates a great amount of heat. This heat is not dissipated outside but rather absorbed by the already hydrating cement, increasing the setting process, decreasing the slump.
Thus lack of speed regulator causes a significant amount of wasted engine power that is required to accelerate the drum, while decreasing the quality of the concrete. That extra power comes from the fuel, which now-a-days, more than ever, is an expensive factor.

In hot climates the, average slump loss from the plant to the job site is about 37% *, versus 25% in less hot climates (providing the agitating speed is proper). This factor is increased by another 5% to 8% when no speed regulator is present, on a delivery of 50 minutes.

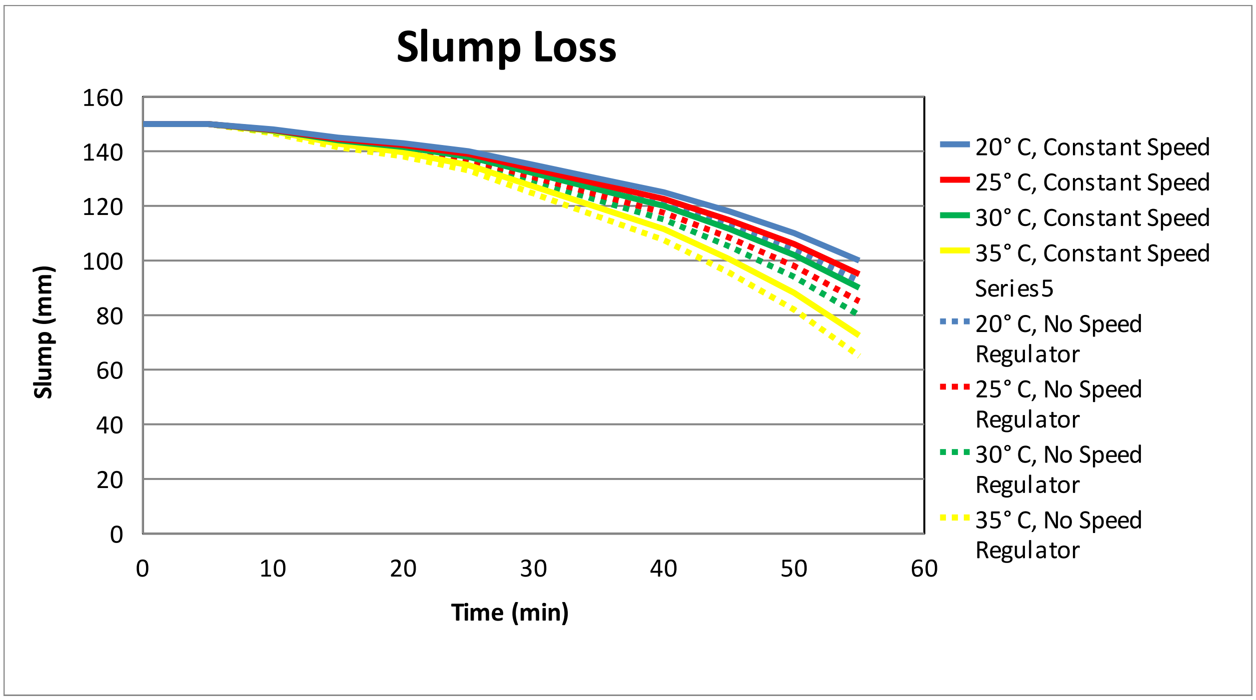
Hard Concrete vs. Dry Concrete: The term "hard concrete" is different to "dry concrete". Hard concrete means that the constituents have never reached the point of concrete, or rather, the cement paste is not covering all these constituents, and there are chunks of partially cement-covered aggregates. Dry concrete is a concrete that after the matrix has formed, it losses water and consequently suffers slump loss.
The bumping sound of hard concrete is clearly recognized by experienced drivers and QA personnel. Hard concrete is common, because the batchers often add less than the predefined water amount value; the reasons being the unknown amount of moisture in the aggregates. Presumably, if too much water was batched, it is "easier" to fix the mix later on with water addition, rather than fixing the problem with cement. Under these circumstances, not only that the concrete will need a lot more intensive mixing action, but the dryer constituents act as a higher than normal heat generator: the drier the concrete, the more power needed to move it (power slump meters work that way). This extra energy in the mix creates another source of heat which accelerates the cement hydration process, adding another approximately 2% of slump loss.

Today, mixes are design around high performance admixtures to reduce water; therefore little margins are left for tail water. Making concrete with low head water, makes it fall into that "hard concrete" region. With the information of the uniformity, the amount of minimum water necessary to create the paste can be fed back into the batching panel, and achieve the right amount of water necessary, saving cement, energy and truck time.

Slump loss with speed regulator vs. slump loss without speed regulator
The graph bellow shows eight trend lines for the same mix design that contains 280 kilograms of cement, at different temperatures. The solid lines represent the slump loss with speed regulators, and the dashed lines represent the slump loss without speed regulators. (The same colour is used for both cases).
The calculations are done for a 8M3 load. A simple calculation can be made to obtain the

amount of extra cement added to compensate for the slump loss, assuming 2 litres/cm/M3 will bring us to 112 litres of water, with a W/C ratio of 0.5, the amount of cement is 66 kilograms. With today's water reducers, this amount of cement can go down by a factor of 2, resulting in 33 kilograms of extra cement per cubic meter.

Optimization can happen in many ways, providing that the reliable data is used. Data acquisition has always been the pillar to support further analysis, as the raw data has to be credible. Sensocrete's technology offers reliable data, and a type of data that could have never been acquired before. One of the extremely important achievements of the Concrete Optimizer, is that the uniformity can be accurately analyzed and used for optimization.



The data provided in this document is based on real time data captured and analyzed by SensoCrete's Concrete Optimizer,.

**** Data extracted from ACIMaterial Journal, September 1, 2008.***