Automation Method of The Concrete Redosage Process in Concrete Business Unit

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ABSTRACT

Mixing concrete is a standardized material whose consistency is measured by the slump, which has a previously defined acceptability range, but not always respected in the tacing water redosage by the mixer operator, causing material losses, when returned by the construction team, or structural problems, by reducing of a final strenght due water excess. Thus, in this article we will evaluate the new technologies for slump characterization, in order to developer an automation mechanism with the use of sensor and internet of things, capable of ensuring the material properties. In this sense, we used the Works of Amziane et al (2005) and Palazzo et al (1989), as well as NBR 7212 (2012) and others developed within this área. Preliminary studies point to the possibility of using sensors inside concrete plant, installed in concrete mixer truck, in order to obtain reliable slump results.

KEY WORDS: Mixing concrete; Slump; Automation; IoT; Concrete mixer truck.

1. INTRODUCTION

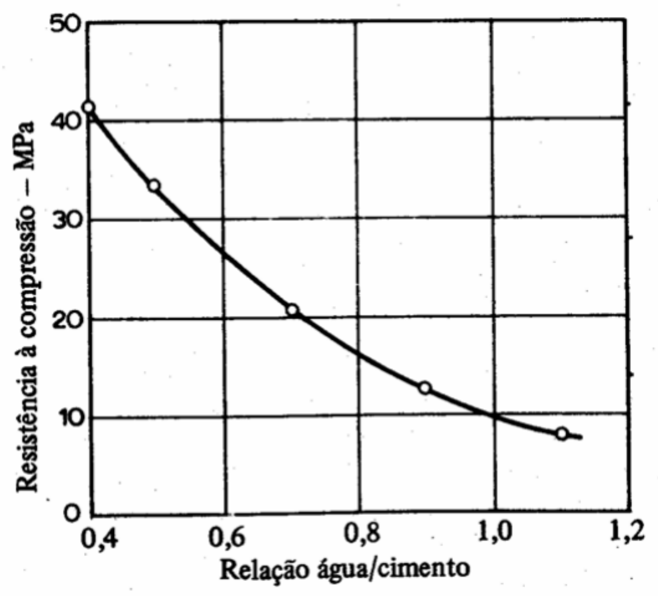
According to United Nations Climate Change (2015), concrete is the second most consumed material in the world, behind only water. The current construction method require the standardization of the material used, in order to avoid the appearance of pathologies and considerable deviations in the quality of concrete supplied. Respecting such procedures establisheds in the standardization, from the receipt of the necessary inputs for its formulation to the specimens rupture, comparing the growth curves, and verifying if the delivered and request resistance are compatible, is essential to ensure the material quality.

All of these procedures take place in a concrete business. In it, there is the presence of a loading automation system responsible for weighing the inputs used. These inputs or materials are represented by aggregates, cement, water, additives.

Altough there are weight guides, called trace charts, previously registered in the system and specifying the correct humidity parameters of the fine aggregates to be used, as well as the slump degree of the concrete to be produced and water/cement ratio, we identified the possibility of weighing failure.

The lack of correct identification of these parameters by the responsible profissional, called concrete laboratory testing technician, causes divergence in the amount of water dosed. The causes of such discrepancies can be diverse, such, for example: laboratory technician´s deficiency or the entry of new shipments of materials, which arrive at different rates than measured in the humidity test and aren´t separeted from older materials, with established humidity.

After concrete dosing, material re-dosing may be required by concrete operator, who visually check that th.e slump conforms to that reference chart specified, and additional watter may be added to achieve the spected standard. We can see the water/cement ratio importance through Abrams´s law. As shown in graph 1, which shows the reduction of resistance from the increse of this ratio.



Graph 1 –Ração w/c ratio x strenght

Source: Associação Brasileira de Cimento Portland[1]

In this sense, this article will deal with the main alternatives methods that have been studied, aiming at reducing the contact of the concrete mixer operator with the concrete, making the dosage more reliable reducing production process failures and dosaging time, by maintaining the concrete fluidity by the automated placement of water in the re-dosage, aiming to improve the concrete properties.

Such theme was selected due to a clamor of the segmento f mixer concrete, which has within its units the incorporation of best methods, according to Mesquita and Alliprandini (2003), for survival and evolution in a highly competitive market, contínuos improvements must occur.

Given this need, it was found the presence of automation process, which reduce production line failures, but are put at stake before the need to use a visual method at the time of slump correction , without any technical input, which causes reduction in the safety of the worked line, and need to be returned due to non-compliance with the specifications contained in NBR 7212 (2012). Such deficiency has generated works that provide a better understanding of such problem, as well as its correction trough the use of emerging Technologies, and which will be confronted in this article.

Finnaly, it is necessary to understand what has been contributing to the market to remedy such deficiency in the production method, as well as a new use of technologies, which will be presented subsequently. This understanding may be of great value to companies in the segment, regarding its use to reduce failures and improve the use of inputs.

2 . METHODOLOGY

This work had its objective based on descriptive research, with qualitative approach, following the understanding of practical issues founded within the concrete plant. Such methodology takes into consideration observation and analysis, as well as dialogue with employees seeking standardization and validation (Thomas; Nelson; Silverman, 2009). The procedure used was a bibliographic review, in order to understanding the concrete occurrences, highlight the possibility of use new technologies to improve the process, and substanciate future studies for the development of a disruptive technology in the área.

3. THEORETICAL FRAMEWORK

According to NBR 7212 (2012), the process of concrete consistency test shall be performed by slump test, carried out in accordance with NBR NM 67 (1998), and in case of divergence of characteristic, the work must make the return, except by agrément of the responsible duly registered. Sometimes, in smaller works, situations of material receipt were verified without proving its properties, collecting samples for breaking or performing the slump test. Failure to perform slump teste, coupled with material non-conformity, may cause problems due to failure of the design resistance by engineer, due to a suplementar water addition authorized or not by the owner, and consented by the concrete worker, in order to make the concrete more fluid and easy to apply. Allied to these factors, we have a lack of communication with the concrete plan, not reporting the material nonconformities.

References such as research from the study of hidraulic componentes of concrete mixer trucks, your preassure indicators and possible resources used in order to give a more adequate slump value, as well as the improvement in brazilian standards on the subject concerned and define quality standard for mixer concrete, which is already a standardized material and has na established standard. Moreover, for the establishment of the new technology, it´s possible do make a correct reading of consistency, one has entered the field of IoT, which, according to Margery Conner, is nothing more than interconnection of objects used on the internet, and its already so widespread in the surrounding objects and facilitates the performance of various functions in any área of knowledge or professional practice.

It was verified the absence of the current bibliographic contribution that substantiate this article, our study linked to articles and patentes found in the research bases. We sought to update the materials presented through analysis of author names in the networks, with visualization of the subsequente studies performed by them, however, most of them were linked to research in the materials technology area, and substitutes that improve their characteristics, leaving aside the deepening of concrete mixer truck.

Due to the great demand to use, as well as the constant process of improvement of established procedures, and material technologies, some researches have already entered the presente theme, proposing solutions to such problem. For the improvement of the process, some works deserve to be presented, as they guided the understanding of what as been developed, as well as emphasized products that seek to facilitate the dosing system.

The first work, by Amziane et al (2005), was presented in Journal of Research of the National Institute of Standards and Technology, and already opens the possibility for the use of eletronic components to perform concrete consistency corretion and eventual water placement. The second work, performed by Palazzo et al (1989), sets a precedente to the use of a power measurement necessary for the rotation of he drum, coupled with a water flow controller within it.

Researchs was carried out on the Scielo and Ieeexplore Digital Library, using keywords presented in comparative table 1 and 2, which follow with the quantity found:

Table 1 – Related Keywords and their quantitative (Ieeexplore)

Keywords	Quantitative
Concrete + mixingtruck	9
Concrete + automatization	7
Mixingtruck	97
Concrete + slump	28
Slump + automatization	0
Concrete + workability	44

Source – Ieeexplore digital library

Table 2 – Related Keywords and their quantitative (scielo)

Keywords	Quantitative
Caminhão-betoneira	1
Slump	65
Slump + concrete	39
Automatization + concrete	0
Automatization + slump	0
Betoneira + automação	0
Concreto usinado	7

Source: www.scielo.org

3.1 MEASUREMENT OF FRESH CONCRETE WORKABILITY USING A CONCRETE MIXER TRUCK

The work developed by Amziane et al (2005) correlates the possibility of correct evaluation of viscosity and yeld stress, aiming at the use of concrete mixer truck as rheometer at loading time. Asthe most common methodology, there is the use of the slump test, whose results are plausible, and presentes little calibration problem, however, it´s only efective to find the yield stress, being the moment of arrival at the best time for its realization. In order to facilitate the monitoring of the measurement of these properties, the study in question propose the use of an ICAR rheometer to draw a comparison with the results found.

The metric worked for measure the ratio between metered slump and performance of the concrete mixer truck starts from the analisys of the torque and speed of the drum, in different turning ranges, taking into account the type of concrete, its volume, density, as well as the shear rate.

The results were compared with the ICAR reomether, and trace slump analisys, being conclusive, within the limit of one day for the tests performed on a concrete mixer, finding similarity in the numbers obtained in the concrete mixer truck and by laboratorial way regarding the yield stress, while no correlaction was found in the result of the plastic viscosity, which may be related to the lack of precision in the collection of torque data and baloon turn. In general, this preliminary study pointed to the feasibility of using the mixer truck as a reomether, and further studies are needed to give greater precision to the parameters analyzed.

2.2 METHOD AND IMPROVEMENT IN MIXED TRUCK TO CONTROL THE IDEAL PLASTICITY OF CONCRETE DURING ITS PREPARATION

This is a study by Palazo et al. (1989), which served as na application for patente PI 8905166-1 A2, presenting a technology coupled to the concrete mixer truck, with the purpose of controlling the addition of water from sensors that read the power needed to keep the drum spinning at a certain speed.

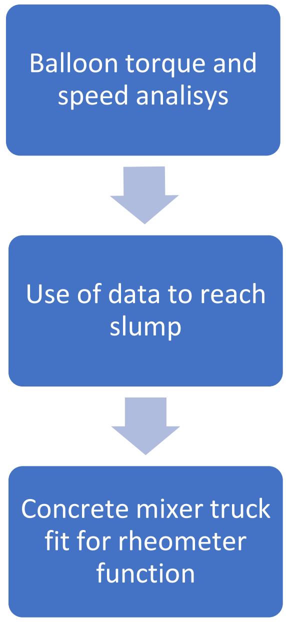
As shown, it would be necessary to install a power meter, with a driver-accessible reader that would be connected to a timer, and a water emission control valve. The correction of the slump would occur during the movement to the work, with remote or authomatic programming, allowing the maintance of the plasticity of the material until its arrival.

This technical criterion is its reading taken from a hydraulic pump outlet, proving data to the drive inside the cab; it is formed by a solenoi, interspersed with a circuit, which is connected to the water tank, and has its your control performed by the timer, already started.

3.3 COMPARISON BETWEEN WORKS

The aforementioned research, regarding the use of the concrete mixer truck as a slump measuring and control equipment, shows the variations that occurs in the equipment when confronted with dosed material variables, such as its volume, density and fluidity. Amziane (2005) was able to trace the correlation between hydraulic pressure and balloon rotation, as presented in flowchart 1, exposes the need for further, deeper research in order to collect more data.

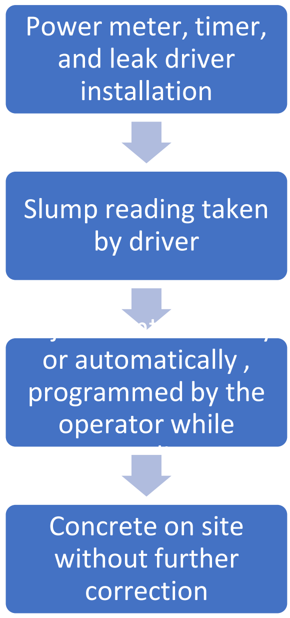
Flowchart 1 – Solution proposed by Amziane et al



Source: Amziane et al (2005)

Already Palazzo (1989) made use of the hydraulic system to characterize the slump range and to be able to correct the fluidity deviations and water losses during the path to the work, which can be better visualized in flowchart 2.

Flowchart 2 – Solution proposed by Palazzo

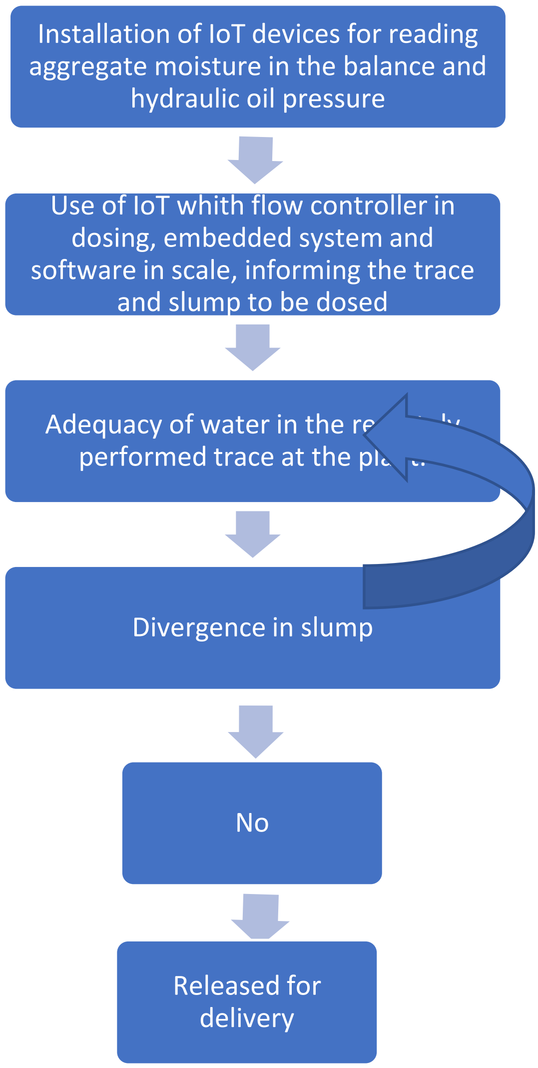


Source: Palazzo et al (1989)

4. SOLUTION

Given the information presented by the aforementioned works, and the lack of more recent studies, opens the possibility of a more thorough research of the subject in question, using Arduino to collect truck data at the moment of weighing, characterization of the variables such as volume, resistance, and dosed slump. With such data, it will be possible to perform a statistical study through regression analisys, with construction of a straight line equation, giving greater predictability to the process, and safety in the study. It will be possible to install IoT devices in the aggregate scale, whose moisture value will be collected and present to the technician in real time, allowing the choice of the best percentage of the trace, increasing the amount of water placed at the moment of dosing, and reduction of redose clearance. Then, it will be possible to adapt the vehicles to use the IoT, as a way to automate the dosing process, removing from the driver the responsibility for correcting the water in the trace, and eventual human failures, according to flowchart 3. Incorporating the concept of embedded systems into this reality may be of paramount importance in eliminating deviations in concrete standards, reducing loading time and, consequently diesel and cement consumption, making breakout analisys data reliable, and accurate water add, which will save the concrete industry and considerably reduce the occurrence of structural problems generated by te concrete.

Flowchart 3 – Solution to be developed in our research



Source: Authors own elaboration

5. CONCLUSION

Given what as been found, it´s possible to glimpse the need for deepening the theme of automation of dosing process due to the small amount of studies that cover the theme of this subject. The problem of incorporating water in the dosing is the major concern for concrete dosing plants, since almost the entire weighing process, which is already automated, put at stake when passing the responsability for placing the water gap to the concrete mixer operator, who needs to perform such a step in timely manner,and at the same time, with due caution. The production of concrete is not yet fully automated, and deserves analysis regarding the use of new Technologies to the production method, which can make the weighing process faster, leading to cost savings, and the exclusion of the mixer operator at the time of dosage.

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