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Technological Control Assessment and Concrete Receiving

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Abstract

With the growth in the area of construction, a greater demand is obtained from both the consumer and the current standards, due to this there is the need for a refined assessment on the process of technological control of concrete. Concrete is one of the most important materials in construction, this material is the most tested and properly controlled, thus bringing the need for the development of this article. Upon receiving the concrete on site, according to the NBR technical standard [1], a series of conferences and preliminary test were analyzed, from which there is the first evaluation of the material in the fresh state, with the slump test, to deepen the Diagnosis of concrete evaluation A laboratory was hired to perform tests and ensure quality and reliability. In the laboratory, specimen ruptures were made through the compressive strength test, which is essential for the final verification of structural strength. The objective of this study is to evaluate the technological control of the concrete, focusing on the process of receiving, molding of the specimens and rupture in the hardened state, thus making it difficult to appear any failure, whether due to non-conformity in the process, the verification of the service resistance required or due to some tribulation in the constitution of the elements produced by the concrete, work or laboratory. This research took place particularly in a venture, located in the city of Manaus, addressing hypotheses and theses verifying their veracity about the changes in the results demanded, making clear the ways to improve the dissertated methodology.

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Abstract

With the growth in the area of construction, a greater demand is obtained from both the consumer and the current standards, due to this there is the need for a refined assessment on the process of technological control of concrete. Concrete is one of the most important materials in construction, this material is the most tested and properly controlled, thus bringing the need for the development of this article. Upon receiving the concrete on site, according to the NBR technical standard [1], a series of conferences and preliminary test were analyzed, from which there is the first evaluation of the material in the fresh state, with the slump test, to deepen the Diagnosis of concrete evaluation A laboratory was hired to perform tests and ensure quality and reliability. In the laboratory, specimen ruptures were made through the compressive strength test, which is essential for the final verification of structural strength. The objective of this study is to evaluate the technological control of the concrete, focusing on the process of receiving, molding of the specimens and rupture in the hardened state, thus making it difficult to appear any failure, whether due to non-conformity in the process, the verification of the service resistance required or due to some tribulation in the constitution of the elements produced by the concrete, work or laboratory. This research took place particularly in a venture, located in the city of Manaus, addressing hypotheses and theses verifying their veracity about the changes in the results demanded, making clear the ways to improve the dissertated methodology.

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1. Introduction

The element widely used in civil engineering is concrete. As [2] this material undergoes the action of various types of stresses over its useful life, what is most relevant is the compression because it allows the determination of the performance of concrete in buildings.

In conjunction with the concrete there is the technological control, which aims at the analysis of the tests for preliminary and final acceptance of the work, are constituted by a slump test and the compressive strength test. This last test is the most used because of the properties of the materials and their easy comprehension.

To occur the correct qualification of the concrete first must occur the hiring of third parties in order to control the excellence of the material, at the receiving stage it is extremely important that all relevant points are in accordance with the technological control standard, so that there is no non-compliance. compliance and ensure safety in the structure.

The aim of this paper is to evaluate the technological control of concrete in three environments, construction site, company responsible for the concreting service and laboratory, showing the stage of receipt, molding of the specimens and the tests in the fresh and hardened state, identifying failures. and causes, clarifying through tables and graphs the results obtained from studies made with the help of technical visit and documents obtained by suppliers, as well as bibliographic research that has the purpose of adding more technical information to the final considerations of the proposed theme.

2. Theoretical Reference

In civil construction the most used material is concrete, the main governing standard is ABNT NBR [3] which aims at the basic requirements required for the design of concrete structures, this standard has been updated and its scope has been expanded, as well as the other norms. It is very important that the standards serve to ensure compliance in a company, preventing specific weaknesses and ensuring the quality, comfort and sustainable development of the enterprise.

BAUER [4] emphasizes that concrete needs to be subjected to control like any other product that has a responsible position. Given the large number of variables that influence their characteristics, it is worth stating that in addition to a rigorous selection of materials and a competent study of dosages, it is relevant, as for the other standard industrial products, the control of performance and characteristics. of the concrete end product.

All concrete produced requires proper control, minimizing the risk of defects in the quality of the concrete or structure becomes necessary, hence the need for technological controls, [5].

It is essential that in all works that use concrete, obtain a technological control. The NBR [1] (Concrete - preparation, control and receipt), emphasizes that to have the control of concrete characteristics, first need to be specified in design by qualified professional.

When the site buys the dosed concrete from the plant, they are in charge of obtaining the material tests and the experimental dosages, so the responsibility belongs to the concrete itself, according to ABNT NBR [6].

It is of utmost importance that the work be done in parallel tests, to obtain the guarantee that the whole process done in the concrete works with the right results.

The Concrete Technology Control determines the need for testing of samples taken from fresh concrete, as well as the main tests in the process of receiving concrete at the site to verify the quality of material consistency and then the strength test.

First test when concrete arrives at the site is called Cone Slump Test which is used to check the workability of the material. It is one of the most widely used tests in the world because of its simplicity, it defines the consistency of the concrete for workability in its fresh state through the abatement and its degree of use. This test demonstrates the objective consequence of the compressive strength of concrete and its water-cement ratio.

According to NBR [7], with the material already prepared and the wetted plate (Figure 1), the cone is filled in three concrete layers, in each layer with application of 25 strokes in a distributed way, each layer is thickened from the As even as possible with the distribution of the strokes, causing the rod to penetrate approximately 20 mm from the previous layer, the technician has 5 to 10 seconds to lift the cone, according to item 5.3 of the aforementioned standard.

Figure 1: Cylindrical cone and wetted plate

Source: Enterprise X, 2019.

The technician then positions the rod over the inverted cone to verify the distance between the sample height and the bottom of the rod (Figure 2).

Figure 2: Checking the sample height
Source: Enterprise X, 2019.

BAUER [8], says that the workability of this material is essential for a compaction that ensures the maximum density possible, applying a workload compatible with the densification process to be employed. The next test is called the compressive strength test, it is not done at the construction site, only the samples are taken for the laboratory test, which checks the strength of the already hardened material. According to ANDOFALTO [9], simple compressive strength is the most important mechanical property of concrete, not only because concrete works predominantly on compression, but also provides other physical parameters that can be related in practice to compressive strength.

According to the internal specification of the work, two samples are taken by truck. In this step it is necessary to apply the lubricant in the mold, then using a metal rod is made the thickening in each of the layers (total of 02 layers), with 12 blows. According to NBR [10], it is important to emphasize that when removing the stem, if voids appear, it should be lightly tapped on the outside of the mold until it closes. After the thickening in all its extension, the surface is razed.

According to NEVILLE [11], the concrete in the structure may be inferior due to inadequate densification, segregation or insufficient cure, thus if the specimen compressive strength test is treated in a standardized manner that comprises full density and wet cure over an established period results in a representation of the potential quality of the concrete.

It is crucial to hire a qualified laboratory to perform this service, to have a result with quality and responsibility.

Technological control fits learning and technological experience, requiring only specialized technicians to perform the test procedure, with proven technical experience. However, to be effective in the assay, control routines must be standardized.

To meet reliability requirements the laboratory must have calibrated facilities and equipment.

The technological control aims to evaluate the procedures of the material as well as the mixture or application, if it controls the quality encompassing the verification of the results of the tests performed for control, normative reference and analysis as to the fulfillment or not of the enterprise specifications, as well as the adequacy monitoring. the facilities, due calibration of the instruments or equipment used to measure any property, the methods and documentation used, the technical competence and professional experience of those involved, in short, all the criteria to ensure reliability and appropriateness to the results obtained, [12].

3. Methodology

Data collection was performed primarily through a literature search using books, theses and articles that addressed the subject. Such research collaborates with the data collection so that the proposed theme is understood according to the view of different authors.

The study was conducted in three locations, in a company that specializes in concrete dosing (called Concreteira Y), where its headquarters is located in Manaus, the second site visited was at the construction site (called venture X) where the headquarters is in Minas Gerais. Gerais, with branches in several states including Manaus, the third place was the laboratory specialized in technological control of concrete (named laboratory Z) located in Manaus. This nomenclature was adopted at work in order to avoid exposure. During the technical visit, an interview was conducted with specialists in the area, such as laboratory technician Z and concreters rocker Y, asking the following questions: the duration of the concrete transport until arrival at the site, how is the construction performed? slump test at the construction site and the compressive strength test in the laboratory.

The company responsible for the work outsourced the laboratory qualified to perform the specimen tests, following the concreting for sample removal according to NBR [1]. Before the concrete arrived, the work was organized the material near the place of concreting.

To perform the test within the estimated time, it was performed the verification of the site of concrete casting and whether the method used would be pumped or conventional.

The concrete used in the work was applied to the concrete wall structure of project X. According to the structural design, the particularities required for this concrete are:

• The fck established in the structural design for the characteristic compressive strength of the concrete used on the site must be 25 Mpa.

• The tangent modulus of elasticity of the concrete used in the work must be equal to 28 GPa (will not be evaluated by testing in this study).

• The water / cement factor, ie the relationship between the volume of water and the volume of cement used in the concrete trace used in the work, must be less than or equal to 0.60.

Adding the characteristics required in the structural design specifications, the concrete that was applied in the execution of the concrete wall was composed using the coarse aggregate the “pebble 1”, as a material workability criterion the slump test was performed. required (220 ± 30 mm). Thus, meeting the additional specifications required by undertaking X.

Two-stage concrete and fresh hardened concrete tests were performed. In the fresh state the test performed to determine the concrete consistency was the cone abatement test, according to the NBR [7]. In the hardened state the mechanical performance of the concrete was defined by performing the compressive strength test according to NBR [13].

After removing the concrete for the Slump test during the truck unloading operation, it waited for 1/3 of the concrete to be taken to collect the sample for the compressive strength test, because the higher mixer turnover leads to better homogeneity. .

After molding, specimens (Figure 3 and 4) were identified for the compressive strength test at 24 hours, 7 days and at 28 days.

Figure 4: Identification of specimens

RESPONSIBLE COMPANY	
Client	
Constructions:	
Fck:	

Mpa:	
Date:	
Series:	

Source: Enterprise X, 2019.

Figure 5: Identified Bodies
Source: Enterprise X, 2019.

The specimens were taken to the laboratory after 24 hours of their molding, to perform the compression test, as shown in figure 6 below.

Figure 6: 24-hour specimens
Source: Laboratory Z, 2019.

Upon arrival at the laboratory the cores were dipped into the cure tank (Figure 7) according to NBR [14].

Figure 7: Aged specimens
Source: Laboratory Z, 2019.

The specimens were ruptured using a pavttest manual hydraulic press, as shown in Figure 8. The press can be controlled to progressively increase the load until specimen ruptures.

Figure 8: Manual Hydraulic Press
Source: Laboratory Z, 2019.

4. Results and Discussions

It will be presented the results obtained by the research carried out in all existing sectors in the project X. Through this research it was possible to find out the level of nonconformities.

4.1 Checking Test Slump Results

The standards ABNT NBR [1] and ABNT NBR [6], stipulate that the molding must be done every 50 m³ of concrete, respecting the criteria defined in the work. It is established that each concrete mixer truck has a concrete batch, ie 100% of the material received is tested.

The project design required the 220 ± 30 mm slump for wall concreting due to its better workability in this process. Figure 9 presents the comparative result between the Final Slump, obtained in the field for each concrete sample, and the Project Slump.

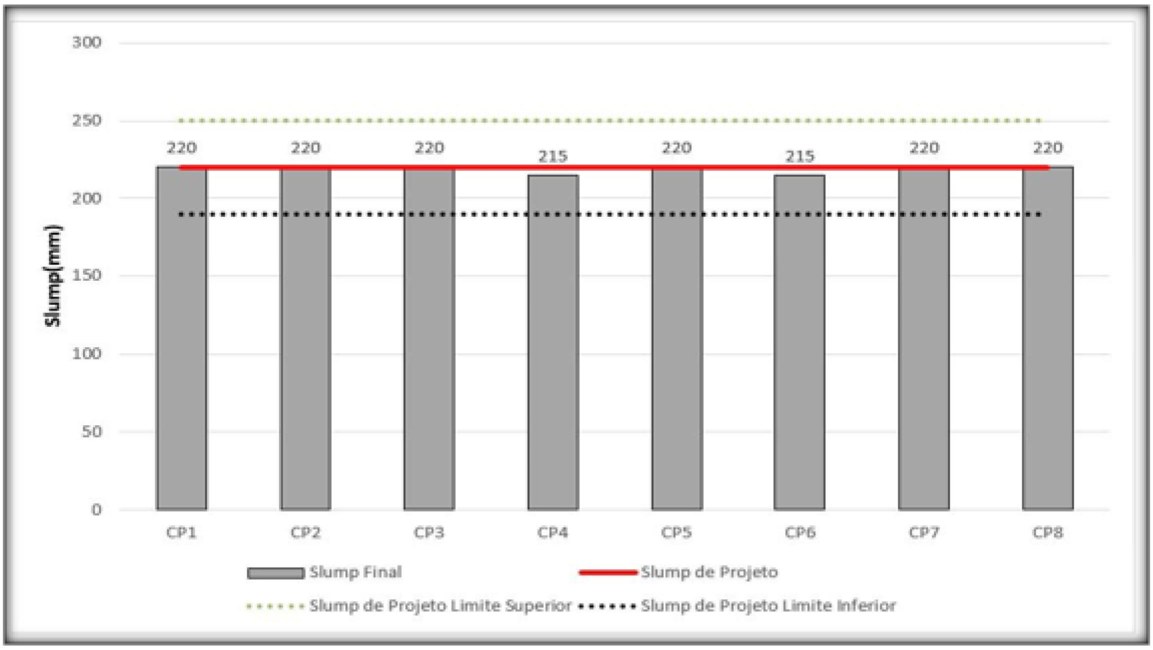

Figure 9: Final Slump vs. Project Slump
Source: Prepared by the Authors, 2019.

From Figure 9, it was found that the Slump data obtained for each sample are within the upper and lower limits, as projected, the arithmetic average was 220 mm which is the exact value of the stipulated for the project. According to the parameters determined in ABNT NBR [6] and ABNT NBR [1], the procedure used by the work with regard to the acceptance of fresh concrete was considered satisfactory in this research.

4.2 Verification of Compression Resistance Test Results

According to the project of project X, 25 Mpa concrete was requested for wall concreting, on the day the specimens were cast, the molds were removed for some concrete curing times, being 24 hours, 7 days, 28 days. and against proof, according to table 1, the results obtained through the compressive strength test were evidenced:

Table 1: Results of specimen disruption

Test	Molding Time	Slump (mm)	N.F	FCK	Part / Structure	Age (Days)	Date of the test	Voltage (MPA)
59519	21:16	220	1290	25	1st Pav. Block 2	1	15/08/19	3,7
59519	21:16	220	1290	25	1st Pav. Block 2	1	15/08/19	3,6
59519	21:16	220	1290	25	1st Pav. Block 2	7	22/08/19	17,4
59519	21:16	215	1290	25	1st Pav. Block 2	7	22/08/19	17,1
59519	21:16	220	1290	25	1st Pav. Block 2	28	12/09/19	23,1
59519	21:16	215	1290	25	Out of Expectation	28	12/09/19	23,6
59519	21:16	220	1290	25	1st Pav. Block 2	63	17/10/19	23,9
59519	21:16	220	1290	25	Out of Expectation	63	17/10/19	21,1

Source: Prepared by the Authors, 2019.

As shown in the figure above, a 24-hour break was performed for the quick release of the forms that are reused in a concrete wall. After this disruption, the 7-day disruption occurred, and the same subjected to the healing tanks technique, the two specimens of this age were ruptured, the highest value found was 17.4 Mpa, so the struts were released.

After curing and disruption of the specimens during the first 7 days, the remaining specimens were cured for a further 21 days, totaling 28 days, considered the final age, and the two specimens of this age were ruptured to Verification of resistance, as shown in Figure 10, the result was 23.6 Mpa, below the established in the project, in this case the evidenced resistance is out of expectation, it must be followed by the breakdown of the control according to ABNT NBR [13].

The batch is accepted when fck is greater than or equal to project fck. When smaller, precautions should be taken to check for strength or structural reinforcement if necessary.

Due to the 28-day disruption is below the specified, therefore the 63-day control disruption was necessary for the possible approval of this assay and to avoid possible structure pathologies, the result obtained at the age of 63 days was 23.9 Mpa, the that matches this piece is out of expectation.

4.3 Discussions on Resistance to Compression (Work)

The search for the cause of the problem occurred with the evaluation and investigation from the hiring of the company responsible for concreting services to the rupture of the specimen in order to highlight possible failures that may have caused low strength of the concrete.

According to Table 2 and Figure 11 below, concrete Y is the closest to the project which provided a great advantage over others that were in the quotation.

Table 2: Concrete distance to site x Duration in minutes

POWER PLANT	DISTANCE	DURATION
Concrete Y	5,8 Km	Aprrox. 10 min.
CONCRETE D	6,6Km	Aprrox. 13 min.
CONCRETE G	16,9 Km	Aprrox. 27 min.

Source: Enterprise Executive Module, 2019

According to (table 1) above, the quotation was made of three concrete companies in which the distance traveled from each one and the forecast arrived at project X were evidenced. It was shown above that Concreteira Y had a dominance over the competitors.

Figure 11 presents the satellite map of the project, facilitating the visualization and exposes the advantage of Concreteira Y over the others, clarifying the choice of the work and complementing the (table 1) already exposed. After this process was quoted by the cost of each concrete to diagnose which was cheaper to close the contract with the work.

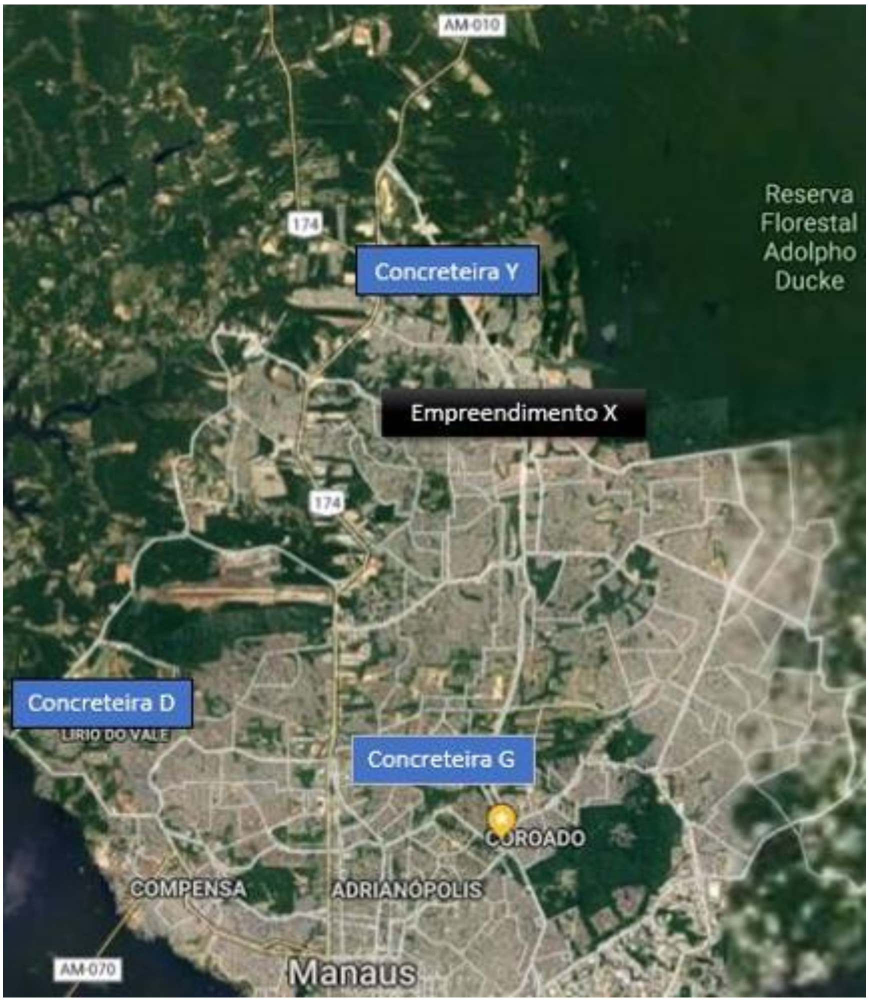

Figure 11: Satellite Map of Project X and the listed concrete companies.
Source: Prepared by the Authors, 2019.

In accordance with figure 12, analyzed three companies to perform the concreting service, it was seen that the unit price had differentiation in reais, and that the final budget varied significantly in the cost of the work. Among the quotations above, concreters Y stood out due to its lower cost, shorter waiting time on arrival of trucks and greater proximity to the jobsite.

Concrete Budget Y					
Item	Description	Items	Qty	R $ Unit	R$ Total
01	FC 14h> 3 Mpa Wall Concrete, Fck 25	M^3	457,00	R$ 377,00	R$ 172.289,00

	Mpa, Gravel 0, Slump 22 ± 3 cm, with polypropylene fibers, w / c 0.60				
Concrete Budget D					
Item	**Description**	**Items**	**Qty**	**R $ Unit**	**R$ Total**
01	FC 14h> 3 Mpa Wall Concrete, Fck 25 Mpa, Gravel 0, Slump 22 ± 3 cm, with polypropylene fibers, w / c 0.60	M³	457,00	R$ 380,00	R$ 173.660,00
Concrete Budget G					
Item	**Description**	**Items**	**Qty**	**R $ Unit**	**R$ Total**
01	FC 14h> 3 Mpa Wall Concrete, Fck 25 Mpa, Gravel 0, Slump 22 ± 3 cm, with polypropylene fibers, w / c 0.60	M³	457,00	R$ 388,00	R$ 177.316,00

Figure 12: Budget of Concrete
Source: Budget Worksheet Supplies, 2019

It is important to note that at the time of hiring according to the technical visit made in the project, it was reported that there was no inspection of the chosen concrete before the hiring to verify if it met the needs of the work.
As reported, it can be noted that the choice of Concreteira Y had only concern with the final cost of the concrete service and with the savings in this activity, in contrast there may have been a neglect with the quality of services and have significantly influenced the result. lower than expected described in (table 1) of this work.

4.4 Discussions on Compressive Strength (Concrete)

In a technical visit, it was found that the concrete company does not have its own laboratory, which enables the reduction of the efficiency in the process, and it is extremely important that the concrete company has the particular result to ensure the reliability between contractor and construction company. It is also possible that this irregularity may have caused the low result in the disruption, because with technological control in the concrete the reports could ensure the expected resistance of this specimen, not requiring the designer activation, after which it was stated that the reliability of the test. concrete has been reduced.
It is important to argue that there was difficulty in accessing the documents used in the dosing of trucks, because of this it was not possible to investigate the trace produced in the concrete or the methodology used to go deep and show that possibly the trace may have been one of the causes for low resistance obtained.

4.5 Discussions on Compression Resistance (Lab)

The NBR [15] prescribes that the calibration of the test machine under normal conditions must have intervals no longer than 12 months. However, it is recommended that a calibration be performed whenever you suspect an error, or when performing any maintenance, or when the machine is moved.

Evaluating laboratory Z, if it was complying with NBR [13] (Concrete - Cylindrical specimen compression test), it was identified that the calibration certificate was expired. The laboratory provided the report clarifying that the manual hydraulic press was out of date which may have caused the wrong measurement of the specimens, as shown in Figure 13:

EQUIPMENT	Manual Hydraulic Press, with Digital Controller			
	Brand	**Model**	**N.º**	**Capacidade(Kgf)**
	PAVITEST	I-3025-D	138	100000
PRESSURE GAUGE	**Manômetro**			
	Brand	**Scale (Kgf)**	**Sub-Div(Kgf)**	**N.º**
	NOVUS	0 à 100000	10	138

ACCORDING TO NM- THIS 7500-1	**SHELF LIFE**
DATE: 23/08/2018	**DATE:** 23/08/2019
TEMPERATURE: 29,0°C	Under normal circumstances, according to the standard
HUMIDITY: 99,0 %	NM-isso-7500-i ITEM 9,0

Figure 13: Press Calibration Report
Source: Laboratory Z, 2019.

As shown above, it is possible to verify that the laboratory did not perform its annual inspection on the compressive strength equipment, showing a process failure that could have been one of the probable causes for the 28 and 63 days specimen not to have expected. , since the calibration due was 08/23/2019. It should be noted that in laboratory Z there was no new inspection of the equipment to ensure process quality and a new technical visit was not allowed to conclude if this problem was the cause for the highlighted error.

5. Final Considerations

The main purpose of this article was to evaluate the technological control of a work in Manaus. Several topics were studied about the whole procedure regarding the technological control of concrete.

It cannot be concluded from this study that the reason why the compressive strength test gave less than the fck determined by undertaking X. The concrete that is supplied to the work is a material with a low level in relation to its strength. The preliminary acceptance criterion of the concrete, performed by the slump test was considered satisfactory.

The main reason for providing an inferior concrete is the final receipt criterion used by the work, which allows acceptance of batches with strength below the projected value and does not survey their suppliers to ensure reliability in the three environments, which are concrete, work and laboratory, which could thus improve the process.

According to HELENE; TERZIAN [16], points out that the factors that influence the compressive strength of concrete may be the variability of cement, aggregates, water, additives and the relative proportion of these materials; quality and operation of dosing and mixing equipment; efficiency of testing and control operations.

Quality is a hotly debated issue today to ensure compliance in the executive process, because of the error in achieving the expected resistance shown in the article, it is important to emphasize its importance in the process, as faulty farias were diagnosed in three locations that could have If the application of technological control to the prescribed standard were avoided, small practices could have a significant impact on the final stage of the process.

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