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Analysis Of Concreting Process's Productivity In The Distrito Federal: Characterization And Proposing Improvements

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Abstract:*this paper presents an analysis of the concreting service held in the distrito federal from data collected in the survey, by the union of construction industry (sinduscon-df), on the concreting indicators between 2010 and 2011. Emphasis on process management and market satisfaction, the main problems are raised, analyzed the root causes and provided potential solutions in order to improve the provision of that service. This work is justified by the absence of detailed knowledge about the relationship of this activity with improved productivity and quality of processes and enterprise.*

Keyword: *productivity; concreting; management; quality.*

I. Introduction

1.1 Context of the Federal District

In 2007 construction began in the Federal District to express their dissatisfaction with the problems in the process of concreting as not meeting the minimum strength required by the designer, however, it was found that they were not restricted only to technical aspects, but were also related to the logistics of deliveries. Being necessary to consider programming as a whole, from manufacturing, transportation, delivery and release of the same construction site.

Regarding service programming concreting, has become constant disagreements between the parties (concreteira, construction and laboratory), given that often the schedule is not respected, or done improperly. Long ago, one concrete reschedule previously scheduled would not cause major inconveniences because concreteira worked with some idle, but currently failure in the delivery of concrete can represent a strong impact not only in the planning of the work, but also in developing the project.

Problems previously restricted to large centers such as urban traffic and restricted hours of concreting, today already impacting process across the Federal District. In addition, power outages in central concrete and dump waste in unauthorized locations for new public administration are limitations that should be considered.

1.2 The service process of concreting

The concreting process became one of the most important activities over the years in the construction industry as it affects work schedules, duration of the project, as well as the quality and durability of the products, therefore it is necessary to use of tools to improve the various stages of production with a focus on quality.

According to Helene (1992), the main flaws in concrete structures, with rare exceptions, have characteristic external manifestation, being derived mainly from the planning and design stages.

According to Helene (1992), the study of the structures, the stages of planning and design should be as thorough as possible, because the lack of foresight results in hasty decisions and adapted during the execution, which implies an increase in the cost five times.

In this scenario, Helene (1992) also highlights that about 40% of failures presented by the structures come from the planning and design phase, 28% during the implementation phase, 18% in materials and 10% in the misuse and the absence of maintenance work.

After highlighting the importance of the early stages of planning and design of concrete structures, it is possible to define the process of concreting service begins with the first research project feasibility and preliminary designs, following increasing levels of detail defined according Obata (2007) as:

Planning: this step is linked to the general decision-making and the adoption of guidelines, usually associated with the economic and technical development, as division of service execution steps, type of purchase, choice of transport system and release of concrete, concrete design team and cycle concreting.

Plan: step arrangement and provision of service in the work, and may be related to the design of the concrete, which will determine the measures and steps to be taken during the service, such as setting the start location of concrete, days of the week and periods in which it occurs, team formation concreting.

Preparation: This is the action of preparing the concrete service, detailing the activities, seeking to conditions appropriate start and continue uninterrupted service, involving, for example, defining the positioning of equipment and check operating site concreting; definition of materials regarding the position and hours of availability (bring water to throw on the floor formwork implementation, at predefined times), among others.

Thus, planning, plan and preparation steps are to ensure the smooth implementation of the concrete and lead to the fulfillment of productivity indicators and expected quality of processes and products.

1.2.1 Planning service concreting

In planning executive concreting, decisions are made that enable the preparation of concrete plan, and its implementation ensured by the actions of preparation (OBATA, 2007).

According Frigieri et al (1997) refer to a complex decision making and simulation options, whose solution is the analysis of the variable major problems.

Illingworth (1972) notes that, for a specific scenario of circumstances decision, it is common to draw up a checklist of items to be examined exhaustively as site characteristics (topography), type of equipment and transport available , frequency of operation (continuous or alternating), variations in the amount of concrete and services during the week, how to purchase, type of concrete, the time of year of service development and cost of leasing in the total budget of the project.

After these considerations, we may assume for the site specific study of concrete, in the case of a pavement according Frigieri et al (1997) have five major decisions: where the cycle concreting, the mode of vertical movement at the construction site, what type of pan and set cimbramento, which plan of attack to be performed and what the sizing of the workforce.

From these findings, one should design the implementation and control of concrete service, ie the definition of the concrete plan.

1.2.2Plan concreting

According to ABESC (2001), the plan is a set of concrete measures to be taken before the placing of concrete, objective quality of the part to be molded, and should cover the problems during implementation and, therefore, may compromise specified quality and productivity.

According Frigieri et al (1997) refer to phase-changing decisions in the planning of concrete criteria for the use of equipment and drives in definitions and logistical means to achieve maximum productivity and safety and quality.

According Frigieri et al (1997) for creating the plan concrete, it has been detected in many works, the occurrence of five-day cycles for each deck, coinciding on Fridays the castings, so that the healing and obtain deformation resistance develop during the weekend.

As a reference for structuring the plan concreting, cites the following is a listing of shares of the adapted guidelines ABESC (2001), by Frigieri et al (1997), by Obata (2007), by Merbekian and Souza (1996) and Souza (1996).

With respect to labor, the team should already be scaled second functions and availability, including the formation of sub-teams for activities. And provide guidance and training for the implementation is correct.

As for equipment, you should plan and get the materials, equipment and various devices for release, transport, consolidation, finishing, curing and protection. With the choice of systems of horizontal and vertical flow, and opted specified moving beyond the concrete form.

With respect to the concrete, we need to verify your specifications and criteria, in addition to technological control and responsible for receiving. Calculation of the volume projected to be released in each step, and the loss of programming and delivery of concrete in construction, including material loading intervals, in advance. To mix concrete, set the plant with the volume losses, start time delivery, time interval between trucks mixers etc.

In forms and shoring, you need to check the project with calculating and designer cimbramento in regards to the study of the impact of accidental loads concreting. Conference of the assembly and verification of immobility of the set, props, levels of molds, internal dimensions, letting the tops of the pillars and fitting molds these molds to the head of the pillars. And check for leaks, cleaning and application of mold release and treatment of the contact surface (ground or hardened concrete).

As the armature, there is a need to verify gauge, number and size of the bars, positioning, fixing (firmly) encasing the armature (pellets / spacers), cleaning (rust, grease, release agent, etc.) to ensure the spacers spacing and coatings . Observe if there is interference in the meetings of parts that hinder the access of the vibrator as well as any other point of congestion frame, requesting, as appropriate, detailing specific when calculating. Check the positioning of fixtures, inserts, reinforcements of armor and check if the cream has been removed from the cement starts.

At launch, you should check scheduled period for commencement of services and provide correct time interval to examine possible displacement of hardware, fixtures, inserts and other elements; integrity points of leaks and mold, removal of the master levels and thicknesses of slabs . Analyze the sequence of release project: determining the direction of advance of concreting and ending near the stairwell or exit access slab, map establishing this process. Provide the conditions to be observed during the placing of concrete. Predict concrete joints: design and deploy the location of these together (with the calculative) and establish the method of its execution. And making level control of each slab the day after concreting, mapping it and comparing it with the other cast slabs.

For densification should check the densification, avoiding both the absence and excess vibration, determine the heights of the layers according to the equipment used, provide general conditions to be followed, provide reinforcement of formwork and shoring as densification energetic and protect piece of the sun, wind or rain scheduled cleaning of all equipment and tools used.

At the finish you need to consult the study of executive process finishing of concrete, which should already be available for detailing the activity. Check the availability of materials, labor, and equipment to work at least two hours in advance. Determine the period for developing each finishing step, guaranteeing limits its application. Predict and perform all cleaning equipment and tools used and check the release date of the pavement to avoid compromising the finish due to use and the efforts of a new deck to be concreted.

As the healing needs to indicate the procedure to be adopted, plan for this process is not interrupted as well as prevent access in the first twelve hours, with severe impacts on the newly molded parts.

Deformation in you need to check the correct time to cure the concrete parts, using the results of ruptured specimens. Ensure that the deformation and reescoramento are being carried out correctly without aggression forms and parts.

1.2.3 Preparation of concrete service

After the phase of plan development concreting, it is recommended to prepare the service activity, encompassing hand labor, materials and all equipment and accessories needed to concreting operations, to ensure that the service is continuous and the second who settled in this plan (OBATA, 2007).

This phase can be considered, according Frigieri et al (1997), as a small planning activities that particular team should perform, and may be, in the case of concrete, set standards for the activities are cyclical.

According to ABESC (2001), the first step to increase the productivity of concreting service is the preparation of each phase of the structure, which are detailed in the activities, according to the main characteristics of the structural design.

According Frigieri et al. (1997), a way to meet this goal is through "production orders" which are lists of checks to establish details of each transaction, as shown in Table 1, which minimizes problems of delays.

TABLE 1 - Sample order concreting of a pavement.

Serviço	Verificação	Mapa de concretagem/plano
Subir água		
Verificar caminhos e acessos		
Verificar instalações elétricas		
Disponibilizar vibradores de reserva		
Verificar/testar vibradores		
Verificar/subir réguas		
Verificar/subir mangotes		
Verificar/subir mestras		
Verificar condição das jericas		
Limpar laje		
Verificar/subir desempenadeiras		

Source: adapted from Frigieri et al. (1997) and OBATA. (2007).

1.3 Productivity

It is understood by productivity the amount of work done in a unit of time and is basically characterized as the relationship between the results and the resources used. You could say that its increase is a direct consequence of the optimal use of resources. According to Souza (2006), understanding productivity

means knowing your greatness and the reasons for its establishment, seeking greater involvement through a critical analysis identifying potential nonconformities and enable the development of prediction (corrective action) for future services.

Indicators are crucial data to be made a correct reading of activities and in the case where the focus is on improving the productivity of concreting process in DF indicator considered is the RUP (Reason Unitary Production) of SINDUSCON-DF (2011), which guides companies on the future decision-making or ongoing as: adequacy of skilled labor, costing, project analysis, choice of appropriate technology, seasonal data, among others.

For a study, efficient scenario is interesting to analyze the data through the use of quality control tools and recognized by academia that are applicable and easy to understand, as the Pareto (ABC curve), Diagram Cause and effect (Ishikawa diagram), brainstorming among others.

These tools are useful because they allow a thorough examination. As seen in the graphs and quantified the main problems and the Ishikawa diagram, for example, obtained a broader understanding of the origins or causes. The application of these methods allows the creation of an action plan aimed at the resolution of nonconformities.

II. Objectives

Analyze the scenario that develops the process of concreting in DF, raising the probable causes of the problems presented in the search SINDUSCON-DF (2011), and which results in low productivity. Thus, identifying the causes that affect - negatively - the production of concrete and define appropriate measures to improve the performance of related activities in order to increase productivity and benefit stakeholders: concrete producers, contractors and laboratories.

Produce a consultation document on the concrete foundation and the Federal District, taking into account their specificities.

Build table and graph productivity period in search for a more general analysis. Apply and quality control tools like Pareto, Ishikawa and Brainstorming, in order to establish a reference tool for the improvement in the production of concrete.

III. Methodology

The methodology used in the study consisted primarily of research bibliography, survey and analysis to propose solutions upon the data provided by the search SINDUSCON-DF (2011) on the process of concreting in the region of the Federal District.

First, surveys were conducted in the bibliography in order to know the context in which the supply chain was inserted, thereby highlighting the parties involved, their relationships and the influence of other external factors. Still, at this stage, we tried to also define and understand the concept of productivity as well as quality tools more suitable for data interpretation.

In the discovery stage, with the theoretical basis already grounded, broke for appropriation and analysis of the productivity indicator ORs by using the Trend Graph, and then organizing the issues presented in the survey to determine the main among them the use of the diagram Pareto.

In the last step of analyzing and proposing solutions, the main problems found were analyzed and thus found the root causes, the use of tools and Cause and Effect Diagram Brainstorming, allowing an exchange and exhibition of diverse ideas, team members, resulting in suggestions for resolution.

IV. Results And Analysis

Through Through collecting research data SINDUSCON-DF (2011) applied the trend graph (Figure 1), it was found that the productivity indicator ORs in the Federal District had values around 10 m^3 / h mostly the months with higher peaks in the months of September and April and lower in the months of January, February and March. A quick analysis it can be inferred that the lower values observed are basically due to climatic and cultural issues, because in this period there is a higher frequency of rainfall in the region and also national holidays. In the months to upper registers the only common factor is that both are in a period of moderate rainfall, but this does not explain the good performance in these months is necessary in a deepening problems.

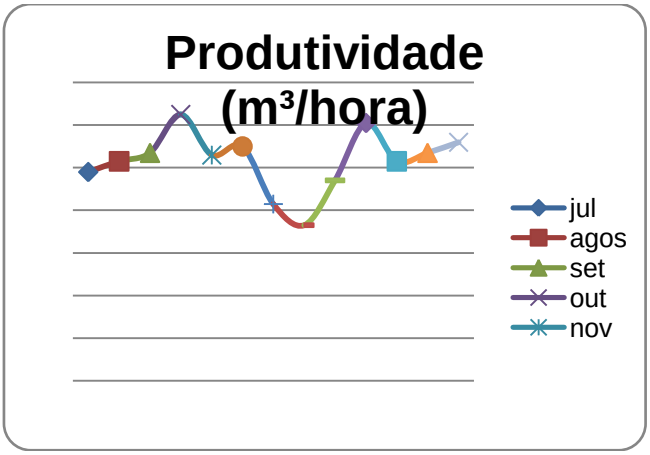

FIGURE 1 - Trend Graph productivity in the Federal District.
Source: Authors.

Therefore in order to determine the causes for these behaviors, we sought in the survey, with accompanying reports of discrimination problems by the construction in concrete. And their answers were divided into 14 classes. They are: discontinuity in the delivery of concrete, faulty equipment, delay in delivery of concrete, faulty supply, equipment failure or delay implementation problems in construction, unidentified problems, bad weather, missing supplies, problems in assembly equipment, lack of energy, problems in controlling technological problems in the factory of concrete and labor missing.

For each of these items was assigned a percentage according to the occurrence, and by Pareto (FIGURE 2) it was possible to establish the account for 80% of non-conformities. Within these, with 43.4% got the item discontinuity in the delivery of concrete, then to 18.6% faulty equipment, then with 6.8% delay in delivery of the concrete and finally with 6.1% defect for supplies of concrete.

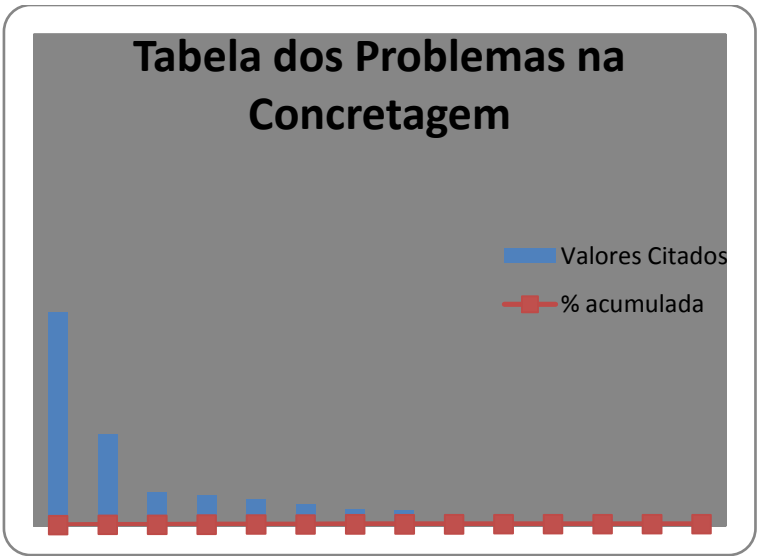

FIGURE 2 - Pareto problems concreting. Source: Authors.

Having defined the four major problems in Pareto, used the Cause and Effect Diagram (Figure 3) to identify the sources (root causes) of each of them and from a group discussion by application of brainstorming could enlighten them and propose corrective actions. The fundamental causes are: lack of planning and coordination of the parties to the problem of discontinuity delivery, inefficiency or lack of quality control for both teams and for lack of supplies and transport logistics for late deliveries.

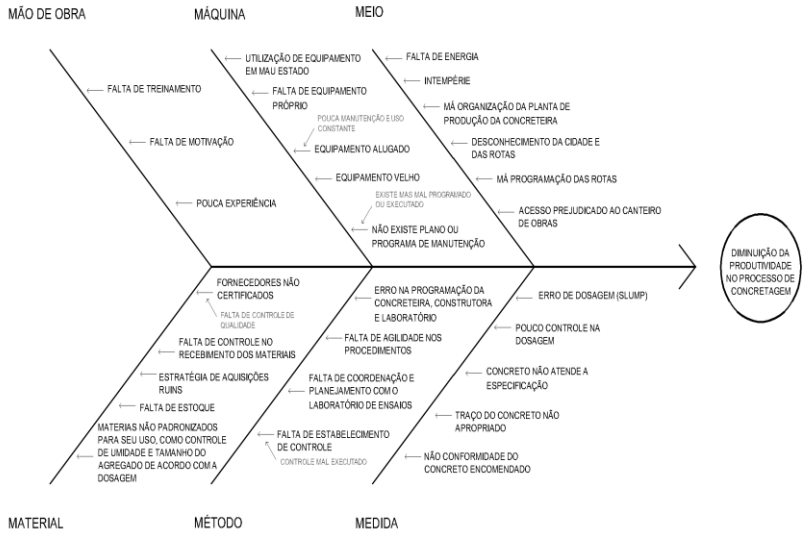

FIGURE 3 - Cause and Effect Diagram, analysis of the main causes. Source: Authors.

4.1 Analysis of the fundamental causes of the main issues raised and planrecommendations

4.1.1 Discontinuity in the delivery of concrete

The root cause for this issue with the greatest impact (43.4%) was identified as the lack of planning and coordination between the three main parties involved, concreteira, construction and laboratory with emphasis on the first two, because what we found is that there is poor communication between them clashing with planning and in many cases lack of any planning and effective quality control.

Another factor was perceived quite alarming that the parties always attributed the occurrences of the other problems without doing any survey or study to prove the share of contribution of each to the composition of the existing scenario. So, knowing that some proposals were made solution.

The main solution found for this item was that both construction companies, such as concrete producers and laboratories should implement some recognized Management System, such as ISO 9001, and if you already own it, it is advisable to reassess the effectiveness of applying your criteria and especially concepts, thus enabling a better understanding of the functioning of the company focusing on quality.

In the case of concreteira, the ideal is that it conduct a study of its correct capacity of concrete and also shipping and delivery to better meet the expectations of its customers, which depending on the type and size of the work is done prior planning with sufficient reserve truck mixers for the service, thus avoiding interruptions.

On the other hand, also noted that the builders have their contribution to the occurrence of this problem, because what often happened because of poor programming of the concrete, which was requested was a smaller volume than that which would be required, thereby causing stoppage of the process by waiting for new shipment. The planning volume must be done in advance and take into account the carrying capacity of the cement truck concreteira.

It was also found that there are implementation problems, at the beginning of the process, as unfinished forms, armor misplaced, vibrators defective, among others. And to avoid such inconveniences the builder must surround himself with some care with emphasis on investigation and correction of details, such as the use in advance of a checklist for checking the items that will be part of the concrete.

Last issue as the ideal is that companies deem more attention to communication and integration among them, for problems such as errors in scheduling delivery schedules, with different specifications of concrete required, different volume requested, among others, can have serious consequences and compromising productivity.

4.1.2 Defective Equipment

In this section, all the probable causes raised, it was considered as being the most relevant, the absence or ineffectiveness of quality control equipment, as during the execution at the construction site, constantly had large amount of equipment that were defective and this was attributed to plants (concrete producers), since the supplying them. However, regardlessof the ownership of machinery, leased or owned, it was understood that the crux of the matter was in the facts: whether there is a maintenance program, if there is a proper use and if there is a quality check for your receipt.

Having all these questions and understand the real cause of the alleged problems in mind left to identifying possible solutions.

As a first solution raises the need to create a maintenance plan for all equipment, are owned, leased or subleased in containing data such as dates of revisions, list of observed defects, repairs provided list, list of replaced parts and time of use of the equipment. Putting obviously that data available to clients (contractors and concrete producers), and allowing them to be evaluated in order to ensure quality and minimize the likelihood of defects in construction.

As a second option, the equipment rental companies or own equipment, should be made available to users or customers informative booklets easy to understand to share the correct way to use the form of storage and care required for specific occasions such as need for shelter construction, greater need for the presence of stabilizers generators and power at a certain time of the year.

The third solution is to have construction or rent various types of options or similar equipment that allow to pursue the same activity, but with power supplies power distinct. For example, electric vibrators and by use of fuel or battery.

The fourth option is to create a term of acceptance through a qualitative analysis of the machinery by observation and in situ observation that customers receive the equipment can assess your condition and decide to accept or not, thus classifying suppliers and avoiding mishaps.

As a fifth option means that there is a shortage in this niche market of companies that work exclusively with equipment rental and they can develop a more efficient quality control on their products. So a solution would be the development of companies with this profile what dirimiria the occurrence of problems with machinery and result in increased productivity by a lower frequency of interruptions.

4.1.3 Delay in delivery

It was understood that the main cause was found for this problem is closely linked to the context in which it appears the concreting process, ie, is strongly influenced by the environment, the environment. So the big question concerns the existence or effectiveness of a plan to transport logistics. And in order to solve this situation we propose a delivery schedule based on the following parameters:

The use or development of software that facilitates the work of the programmer routes. This program includes a general plan of the coverage area of distribution of the concrete, ie, a map of the areas served by the company.

This software maps delivery routes of concrete based on traffic flow, information obtained through research in various organs of urban traffic, as well as in situ observations. That said, it is noteworthy that the software needs to be flexible in relation to the supply of information to allow update as changes in daily traffic.

Through the data generated by the software, deliveries are prioritized as the locations, times and type of discharge effected. Establishing a schedule of deliveries last daily planner, aiming to improve the transport time of the concrete.

From the results generated by the software, and the organization of deliveries, it is possible, through planning, which can be weekly, manage the equipment (vehicles, pumps, etc..) And their use, allowing to know when you need to rent other equipment to meet the demand, avoiding waste.

For this task, you need to hire a trained professional, as to the function must have the same abilities to understand, at least two areas of action: knowledge in computer, knowing their responsibility to feed the software and knowledge of routes, one Since the result offered by the software should be evaluated by this professional is defined before the delivery route.

4.1.4 Supplies defective

The major problem occurred for the supply, concrete, was the inadequacy of their characteristics or properties required in the design when delivered to construction sites and fundamental cause raised by the group was the lack of quality control mainly by the manufacturer but also with share of responsibility on the part of the contractor in the question of the programming process.

The data provided in the order of production, characteristics specified in the request shall be in accordance with the project and be checked on site.

One should also make the conference the seal number of mixer (guaranteed payment and shipping requested volume), which ensures that the material contained in that truck is the way out of the central metering.

With the arrival of the truck mixer on site, before unloading, the professional builder or company designated to do so must follow certain procedures to carry out the delivery of concrete, should add (if necessary) the amount of additive and missing check the invoice data, verifying the delivery document.

Motorists should receive special training for proper handling of concrete, customer service in the work and conduct of the mixer. This is extremely important because the drivers have fundamental responsibilities as well as conduct the trucks, they complete the determination of water in the concrete. It is noteworthy that the invoice is an indication of the amount of water to be added.

Before unloading the truck must evaluate the amount of water added to the core, and the estimated volume of water to be added to existing concrete are compatible with the specifications, there is no excess or shortage of water.

Any extra addition of water not taken by customer ignorance or disagree with the concreteira disclaims any liability with regard to the characteristics of concrete required in the request, and this fact should be recorded in the delivery document.

Regarding control additives must be done through the delivery document, visual inspection, and olfactory performance every shipment. For checks or tests to see: according to the request, variations in appearance, texture, odor, color, sediment, water reduction, air entrainment, takes effect on each consignment.

The specific work done by the central metering should be operated by qualified personnel, to allow control of all materials used in the dosage as well as the properties required for the project and in accordance with current technical standards.

The schedule should include the volume to be delivered by truck, scaled according to the capacity of the concrete application of team work. Programming must be done in advance to avoid delays by specifying start time and concrete supply range.

TABLE 2 - Check List for the proposed works.

CHECK-LIST PARA OBRAS				
	ITENS	SIM	NÃO	OBSERVAÇÕES
1	Existência de software para controle de rotas	□	□	
2	Aplicação do software para controle de rotas	□	□	
3	Hierarquização e planejamento das entregas	□	□	
4	Avaliação do volume de concreto encomendado e recebido	□	□	
5	Alteração no volume encomendado de concreto	□	□	
6	Avaliação da capacidade produtiva e comercial de concreto	□	□	
7	Existência de equipamentos com plano de manutenção	□	□	
8	Verificação e aceitação através do plano de manutenção de equip.	□	□	
9	Existência da cartilha informativa de uso e conservação	□	□	
10	Explicação da cartilha informativa de uso e conservação	□	□	
11	Equipamentos com diversidade de fonte de alimentação energética	□	□	
12	Existência de fontes energéticas alternativas para o canteiro	□	□	
13	Verificação da conformidade das armaduras	□	□	
14	Verificação da conformidade das fôrmas	□	□	
15	Verificação da conformidade dos equipamentos	□	□	
16	Verificação de acessibilidade e locomoção de caminhões no canteiro	□	□	
17	Treinamento e capacitação de profissional para moldar corpos-de-prova	□	□	
18	Análise de documento com especificações do concreto	□	□	
19	Realização de testes de conformidade do concreto	□	□	
20	Treinamento do motorista para complementar dosagem	□	□	

Source: Authors.

V. Conclusion

The service process of concreting, comprising the steps of planning, preparation and plan, besides the use of a continuous improvement process, translates into a tool for achieving a higher rate of productivity and quality of the products generated. Thus, each phase must be developed and detailed, avoiding unnecessary stops and waits for devices that are not functioning correctly or even by errors of calculated volumes, thereby eliminating sources of additional costs.

It is noteworthy that the service process concreting should be focused on job security even as it is closely linked to productivity. This is because personal protective equipment and specific to each activity, as well as protection of workplaces (trays, guardrails etc..) Ensure the proper development of tasks, avoiding accidents and expenses employees standing in unproductive hours. These items are set by the NR-18 and, although not mentioned, are part of the whole process of production of concrete structures. The improvement in the process of concreting will be directly reflected in the construction schedule, decreasing processes, direct and indirect costs and increasing profit.

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